SPECIES ACCOUNT: *Allium munzii* (Munz's onion)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/13/1998; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A perennial herb with a flowering stem, 1.5-3.5 dm tall, and a single, cylindrical, hollow leaf, about 1.5 times as long as the stem, arising from an underground bulb. The terminal flower cluster is composed of 10-36 white flowers that become reddish with age (NatureServe, 2015).

Taxonomy

Several former vars. of Allium fimbriatum of, for example, Kartesz 1994 checklist now (1999 Kartesz Floristic Synthesis) treated as distinct species: A. abramsii, A. denticulatum, A. diabolense, A. munzii, A. purdyi, and A. sharsmithiae; the remaining vars. will be A. fimbriatum var. fimbriatum, var. mohavense, and var. purdyi (NatureServe, 2015).

Historical Range

Only known from the Gavilan Plateau and Temescal Valley regions in western Riverside County, California on clay soils (U.S. Fish and Wildlife Service 2004) (NatureServe, 2015). Its historical distribution may have been within clay soils scattered throughout the entire Perris basin in western Riverside County (USFWS, 2013).

Current Range

The range of Allium munzii is entirely within western Riverside County, California (Figure 1). In our listing rule, we identified 13 extant occurrences of Allium munzii (USFWS 1998, p. 54975). Subsequently, in our 2009 5-year review, we identified 18 extant occurrences (USFWS 2009, Appendix 1 therein). In our 2013 5-year review, we identified 18 extant occurrences as well, but we also included data from herbaria collections1 and used a different grouping methodology (see below) (USFWS 2013, pp. 8–9). Since the 2013 5-year review, we have new information that affects our understanding of the species' distribution at two locations; these changes do not affect the species' overall range (USFWS, 2022).

Critical Habitat Designated

Yes; 4/16/2013.

Legal Description

On April 16, 2013, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Allium munzii (Munz's onion) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six critical habitat units (CHUs) in California. In total, approximately 98.4 acres (39.8 hectares) are being designated as critical habitat for A. munzii (78 FR 22626-22658).

Critical Habitat Designation

The critical habitat designation for Allium munzii includes six CHUs in Riverside County, California (78 FR 22626-22658).

Elsinore Peak Unit Elsinore Peak Unit consists of 98.4 ac (39.8 ha). About two-thirds (63.1 ac (25.5 ha)) of the Elsinore Peak unit is contained within the Cleveland National Forest, and one-third is a 35.3- ac (14.3-ha) inholding under State of California (State Lands Commission) ownership within the Western Riverside County MSHCP Conservation Area. The Elsinore Peak Unit represents the most southwestern extent of the range of Allium munzii and is the highest recorded elevation (3,300 to 3,500 ft (1,006 to 1,067 m)) for this species (Boyd and Mistretta 1991, p. 3). Many of the locations of A. munzii found on the Cleveland National Forest portion of this unit have been described as the least disturbed of known locations (Boyd and Mistretta 1991, p. 3), and are also unusual in that they are found on cobble deposits with thinner Bosanko clay soils (PCE 2) (Boyd and Mistretta 1991, p. 3). In 1991, Boyd and Mistretta (1991, p. 2) reported three stands of A. munzii at Elsinore Peak, each with more than 1,000 individual plants, the largest estimated at 5,000 plants. Nine localities were observed in a 2008 survey, with populations ranging from 5 to 100 plants (K. Drennen 2011, pers. comm.). A 2010 survey at Elsinore Peak was conducted by Boyd (2011b, pers. comm.) with approximately 23 general point localities recorded on lands owned and managed by both the U.S. Forest Service and the State Lands Commission. The Elsinore Peak Unit is within the geographical area occupied at the time of listing. The subsurface and surface elements that define this subunit, including clay soils, sloping hillsides, and microhabitats, provide the physical or biological features essential to the conservation of A. munzii. The U.S. Forest Service and the State Lands Commission are not permittees under the Western Riverside County MSHCP. As only discretionary actions under the control of a permittee are covered activities under the Western Riverside County MSHCP, land use activities implemented by these two entities are not considered covered activities under the plan. In addition, the lands owned and managed by the State Lands Commission within this critical habitat unit are not included as part of the conceptual reserve design of the Western Riverside County MSHCP, nor are these considered PQP lands. As outlined in the Special Management Considerations or Protection section above, several threats have been identified for Allium munzii. For A. munzii populations within Elsinore Peak Unit, threats identified at the time of listing included road grading, ORV activity, and nonnative annual grasses (63 FR 54987; October 13, 1998). Recreational activity and invasive species were identified as the two main threats to A. munzii on U.S. Forest Service land in the 2005 Final Environmental Impact Statement prepared for the Cleveland National Forest Land Management Plan (U.S. Forest Service (USFS) 2005, p. 160). A species management guide for A. munzii, completed in 1992, identified a number of management actions to help alleviate these threats, including construction of fencing and barriers to protect populations from ORV activity (Winter 1992, p. 10). Fencing, including a gate, was installed to protect plant populations, and boulders were placed along the roadway leading to Elsinore Peak to restrict ORV activity and other traffic (hikers and mountain bikers) in sensitive areas. This has reduced, but not eliminated, the impacts from ORV and other recreational activities to the population of A. munzii plants located on U.S. Forest Service land within this critical habitat unit (M. Thomas 2011, pers. comm.). In addition to the above activities, wildfire protection, including the use of fire retardant, may also impact the physical or biological features essential to the conservation of A. munzii. Therefore, the essential physical or biological features on the Forest Service lands within this unit may require special management considerations or protection. For the portion of the unit located on lands managed by the State Lands Commission, the essential physical or biological features may require special management considerations or protection to address threats to A. munzii resulting from ORV activity or invasive, nonnative annual grasses (CNDDB 2011a, p. 14). We are unaware of any current conservation actions being implemented for the benefit of A. munzii populations found on lands owned and managed by the State Lands Commission within this critical habitat 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 Allium munzii critical habitat consists of two components in California (78 FR 22626-22658):

(i) Clay soil series of sedimentary origin (for example, Altamont, Auld, Bosanko, Porterville), clay lenses (pockets of clay soils) of those series that may be found as unmapped inclusions in other soil series, or soil series of sedimentary or igneous origin with a clay subsoil (for example, Cajalco, Las Posas, Vallecitos): (A) Found on level or slightly sloping landscapes or terrace escarpments; (B) Generally between the elevations of 1,200 to 3,500 ft (366 to 1,067 m) above mean sea level; (C) Within intact natural surface and subsurface structures that have been minimally altered or unaltered by ground-disturbing activities (for example, disked, graded, excavated, or recontoured); (D) Within microhabitats that receive or retain more moisture than surrounding areas, due in part to factors such as exposure, slope, and subsurface geology; and (E) Part of open native or nonnative grassland plant communities and clay soil flora, including southern needlegrass grassland, mixed grassland, and open coastal sage scrub or occasionally in cismontane juniper woodlands; or

(ii) Outcrops of igneous rocks (pyroxenite) on rocky-sandy loam or clay soils within Riversidean sage scrub, generally between the elevations of 1,200 to 3,500 ft (366 to 1,067 m) above mean sea level.

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 physical or biological features that are essential to the conservation of the species and that may require special management considerations or protection. Allium munzii A detailed discussion of threats to Allium munzii and its habitat can be found in the final listing rule (63 FR 54975; October 13, 1998), the previous proposed and final critical habitat designations (69 FR 31569, June 4, 2004; 70 FR 33015, June 7, 2005), the A. munzii 5-year review signed on June 17, 2009 (Service 2009), and the proposed revised rule for designation of critical habitat (77 FR 23008; April 17, 2012). Actions and development that alter habitat suitable for the species or affect the natural hydrologic processes upon which the species depends could threaten the species. The physical or biological features essential to the conservation of Allium munzii all face ongoing threats that may require special management considerations or protection. Threats that may require special management considerations or protection of the physical or biological features include: (1) Loss or degradation of native plant communities, such as grassland, open coastal sage scrub, and cismontane juniper woodlands, due to urban development, agricultural activities, and clay mining (PCEs 1 and 2); (2) Disturbance of clay or other occupied soils by activities such as offroad vehicles (ORV) and fire management (PCEs 1 and 2); (3) Invasion of nonnative plant species (PCEs 1 and 2); and (4) Long-term threats including climatic variations such as extended periods of drought (PCE 1) (63 FR 54982–54986, October 13, 1998; 69 FR 31571, June 4, 2004; 70 FR 33023, June 7, 2005; Service 2009, pp. 10–22). Special management considerations or protection may be needed to ensure the long-term existence of clay soil integrity within habitats that support the physical or biological features essential to the conservation of Allium munzii. These include: (1) Protection of habitat from urban development or destruction to maintain integrity of clay soils, (2) Reduction of land conversion to agricultural uses and reduction of disking or dryland farming to maintain native habitats, (3) Management and control of invasive nonnative plants to provide open areas for growth and reproduction, and (4) Land acquisition or conservation easements for occurrences not already conserved to protect those populations within occupied habitats.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (NatureServe, 2015); vegetative (USFWS, 2013)

Breeding Season

Adult: March - May (NatureServe, 2015)

Key Resources Needed for Breeding

Adult: Adequate rainfall (NatureServe, 2015); insect pollinators (USFWS, 2013)

Reproduction Narrative

Adult: Three to five years are needed after seeds germinate before the plant reaches sexual maturity and produces flowers. The plant is dormant for most of the year except for the spring and early summer. This species flowers from March to May. Finally, this species responds to the varied amounts of rainfall from year to year which affect its emergence. In years with little rainfall few plants flower, and in years with good rainfall most plants bloom (U.S. Fish and Wildlife Service 2004). Reproduction is sexual (NatureServe, 2015). In addition to sexual reproduction through seed production, Allium munzii plants can reproduce asexually through vegetative division of the bulbs (Ellstrand 1999, p. 1; Ellstrand 1993, p. 5). The Service does not have definitive information regarding pollinators of Allium munzii, but it is likely that a number of insect species serve this function (S. Boyd, Botanist, 2007, pers. comm.). Small beetles of the family Anthicidae (ant-like flower beetles) were found on about one-third of the A. munzii inflorescences of a population in Temescal Canyon (The Environmental Trust 2002, p. 16); however, their role as pollinators was not confirmed. A photograph published in a 2011 A. munzii monitoring report depicts what appear to be March flies (Bibio sp.) (Bibionidae family) on flowering A. munzii (Dudek 2011, front cover). Adult species of Bibio are considered important pollinators (Fitzgerald 2005, p. 17) and are frequently found on flowers (Borror and DeLong 1971, p. 501) (USFWS, 2013).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Coastal-sage scrub (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Occurs at 1,200 - 3,500 ft. elevation (USFWS, 2013)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Habitat Narrative

Adult: Grassy openings in coastal-sage scrub. Soils are moist, heavy clays. This species has a very narrow environmental specificity (NatureServe, 2015). It occurs between the elevations of 1,200 to 3,500 ft. (366 to 1,067 meters (m)) above mean sea level (Boyd 1988, p. 2; Boyd and Mistretta 1991, pp. 1–3; Roberts et al. 2004, pp. 10, 130) (USFWS, 2013). Plants are most frequently found in areas that are minimally disturbed and in areas where there is little competition and overcrowding from nonnative plants. Allium munzii is also found in rocky-sandy loam soil within rocky outcrops (such as North Domenigoni Hills) (CNDDB 2011a, Element Occurrence (EO) 10) (USFWS, 2012).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Wet clay soils facilitate the formation of soil channels for movement of young bulbs (Pu¨tz 1992, p. 1433), which is necessary for establishment and persistence of A. munzii plants (USFWS, 2012).

Population Information and Trends

Population Trends:

Unknown (NatureServe, 2015)

Species Trends:

10 - 70% decline (NatureServe, 2015)

Number of Populations:

15 (USFWS, 2013)

Population Size:

20,000 - 70,000 (NatureServe, 2015)

Adaptability:

Low (inferred from USFWS, 2013)

Population Narrative:

It occurs in populations usually less than 1,000 plants (U.S. Fish and Wildlife Service 2004). The long-term population trend is unknown. About 20,000 to 70,000 individuals are estimated. In response to rainfall and other factors, perennial bulbs may not produce aerial leaves or flowers in a given year or may produce only leaves. As a result, fluctuations in numbers of observed individuals may be misleading. Five populations contain over 2,000 individuals and cover as much as 8 hectares. Most populations contain fewer than 1000 individuals and their areas range from several meters to less than 1 hectare. There are ten element occurrences with good to excellent viability. This species has experienced a short-term decline of 10 - 70 % (NatureServe, 2015). The Service has defined 6 geographic locations representing 15 presumed extant occurrences of A. munzii in western Riverside County. This species exhibits two key attributes that might limit its distribution and population growth. These attributes include: 1) Restriction of the species to specific microhabitats (i.e., specialized niche) that have been significantly reduced in western Riverside County. 2) Dependence on undisturbed clay soils in these microhabitats that are easily and permanently altered by human activities (USFWS, 2013). Over time, the overall number of Allium munzii documented occurrences we considered extant has increased from 13 in 1998 (at listing) to 18 in 2009, 2013, and currently. However, the actual number of on-the-ground occurrences should have been 17 in 2009 and 2013 because we erroneously added an EO in 2009; we no longer consider the “proposed” occurrence in the Bachelor Mountain area to be valid. In 2017, a new Allium munzii population was detected north of Alberhill; we consider the CNDDB-designated EO 24 to be valid. Thus, we currently consider 18 EOs to be extant (USFWS, 2022).

Threats and Stressors

Stressor: Urban development (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Since listing, urban development has continued in western Riverside County, including the Temescal Valley area where portions of available habitat were lost at the Sycamore Creek (EO 3) occurrence and proposed for development (Saddleback Estates) at the De Palma Road (EO 7) occurrence (Dudek 2011, p. 1; Helix Environmental Planning 2011, p. 1). However, salvage and transplant operations for A. munzii plants were successfully conducted at both of these project sites (see Helix Environmental Planning 2011; Dudek 2011). A 7-year maintenance and monitoring period for the De Palma Road occurrence was initiated in 2008, although construction of the proposed road and development has not been initiated (Dudek 2013, p. v). Threats from urban development have been significantly reduced since the time of listing, but are still a concern at two occurrences (Dawson Canyon and Alberhill Creek) (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 within several Allium munzii occurrences. The use of existing trails or the creation of new trails within the Elsinore Peak occurrence located on CNF lands has been and continues to be a threat to A. munzii primarily from disturbance of habitat, although crushing or trampling of individual plants may also result from these activities (USFWS, 2013).

Stressor: Invasive plants (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Disking and grading activities related to agriculture and urban development can promote the spread of invasive weedy grasses (Boyd 1988, p. 3), and therefore reduce the available habitat for A. munzii. Invasive nonnative plants were identified by USFS as a threat to habitat quality for Allium munzii at the Elsinore Peak occurrence (USFS 2005e, Volume 1, p. 160). Roads and road construction from grading of fuel breaks facilitate the introduction and establishment of invasive nonnative plants (discussed above) by creating open, repeatedly disturbed habitat. Invasive nonnative plants can also be transported along these corridors by equipment and other vehicles, as well as recreational activity. They are more readily established

on the exposed cut-and-fill slopes of roads than native plants (USFS 2005e, Volume 1, p. 114). Recent observations of invasive nonnative plants also include the Bachelor Mountain, Estelle Mountain, and Scott Road occurrences (Malisch 2013, pers. comm.) (USFWS, 2013).

Stressor: Fire management (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Allium munzii habitat may be destroyed or modified during the creation and maintenance of fire breaks, a practice which often used for wildland fire management. Under the programmatic direction of the revised Land Management Plans for the four Southern California National Forests, future fuel treatments on CNF, which incorporates the Elsinore Peak occurrence, may have short-term impacts to Allium munzii, but these activities would be conducted to provide long-term benefits to the species (USFWS 2005, p. 122). The risk of wildland fire is expected to increase in western Riverside County by 2020 due to climate change effects (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 Allium munzii due to predicted changes to its habitat. Climate model predications also indicate a moderate increase in fire risk to the geographical range of A. munzii, which, when combined with anthropogenic facilitation, can produce a shortening of the fire return interval and potentially increase wildland fire management practices, such as the creation of fuel breaks, which can disturb native soils (USFWS, 2013).

Recovery

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

Recovery Priority Number: 8C

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

Recovery Actions:
- Not available - this species does not have a recovery plan.
- Continue to work with CNF to ensure that USFS guidelines and directives are being implemented for activities that might directly or indirectly affect Allium munzii habitat. This should also include providing comment on biological assessments for proposed recreational and trail use and maintenance and proposed wildland fire management actions (USFWS, 2013).
- Survey current, presumed extant occurrences of Allium munzii to estimate the level and extent of nonnative invasive plants. Develop site-specific restoration measures such as

thatch removal or prescribed fire (USFWS, 2013).
- Continue to conserve or preserve Allium munzii occurrences on private lands, especially within the Temescal Valley occurrences. 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).
- Identify pollinators of Allium munzii by installing small trigger cameras to record and document pollinators at the occurrence at Elsinore Peak, Cleveland National Forest (USFWS, 2013).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Conduct recovery planning. Currently, there is no recovery plan for Allium munzii. In the interim, the Carlsbad and Palm Springs Fish and Wildlife Offices should develop recovery guidance documents, such as a Species Action Plan. Recovery guidance documents should address the observed low genetic diversity among Allium munzii EOs, as recommended by Mashayekhi and Columbus (2015, pp. 96–97). 2. Continue to work with partners, including the Western Riverside County RCA and the Cleveland National Forest, to (a) acquire land needed to fully conserve two EOs in particular, EO 2 (highest priority) and EO 13; and (b) to monitor and manage these two EOs, which are known to have the highest Allium munzii abundance and, for EO 2, the highest genetic diversity. 3. Work with partners to research whether translocation or population augmentation activities would be appropriate and beneficial for Allium munzii. The low genetic diversity recorded by Mashayekhi and Columbus (2015, entire) suggests that, without intervention, Allium munzii EO-level populations may decline even if they are on conserved lands. 4. Work with partners to better define Allium munzii habitat needs, especially soils, and delineate (at a fine scale) occupied and unoccupied areas that meet those needs throughout the species’ range. This information may (a) help find new, naturally occurring populations of Allium munzii; and (b) provide options for future Allium munzii translocation efforts to increase the number of EO-scale populations. 5. Work with partners to research Allium munzii pollinator species. A better understanding of Allium munzii pollinators could improve habitat management and may lead to more options for managing Allium munzii genetic diversity (USFWS, 2022).

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Designation of Revised Critical Habitat for Allium munzii (Munz's onion) and Atriplex coronata var. notatior (San Jacinto Valley crownscale)

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SPECIES ACCOUNT: *Alopecurus aequalis var. sonomensis* (Sonoma alopecurus)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/21/1997; Pacific Southwest (R8)

Physical Description

A tufted perennial grass, 3-7.5 dm tall (NatureServe, 2015). Alopecurus aequalis var. sonomensis grows from 30 to 75 centimeters (12 to 30 inches) tall. The stems are mostly erect and either straight or weakly bent near the base. The leaf blades are up to 7.5 millimeters (0.3 inch) wide. The panicle is 2.5 to 9.0 centimeters (1.0 to 3.5 inches) long and 4 to 8 millimeters (0.1 to 0.3 inch) wide. The spikelets are usually tinged violet-gray near the tip. The awn is straight, and exceeds the lemma body by 1.0 to 2.5 millimeters (0.04 to 0.1 inch) (USFWS, 2011).

Taxonomy

Recognized as distinct by Kartesz (1999 Synthesis) and by U.S. Fish and Wildlife Service (federal listing as endangered). Kartesz treatment is based on unpublished work by Mary Barkworth for the forthcoming Grass Manual (Kartesz, pers. comm. to Larry Morse, 25Nov99). However, Crins (1993), i.e. Hickman (1993), does not recognize the variety as distinct (NatureServe, 2015). It belongs in the Poaceae (grass family) (USFWS, 2011).

Historical Range

Historically, Alopecurus aequalis var. sonomensis was known from 16 populations in Marin and Sonoma Counties (USFWS, 2011).

Current Range

The plant occurs in freshwater marshes and swamps and riparian scrub within Marin and Sonoma Counties, California (California Natural Diversity Database (CNDDB) 2011) (USFWS, 2011).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual, vegetative (USFWS, 2011)

Breeding Season

Adult: May - August (USFWS, 2011)

Reproduction Narrative

Adult: While the reproductive mechanisms of this species have not been studied, Alopecurus aequalis var. sonomensis appears to reproduce both sexually (assumed via wind pollination) and vegetatively (via rhizomes) (Gennet 2004). Flowering begins in mid - May and lasts through August (Gennet 2004) (USFWS, 2011).

Habitat Type

Adult: Wetland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Permanent freshwater marshes (NatureServe, 2015); swamp, riparian scrub (USFWS, 2011)

Dependencies on Specific Environmental Elements

Adult: Disturbance (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Occurs at 10 - 1,180 ft. elevation (USFWS, 2011)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Moist soils in permanent freshwater marshes. It appears to benefit from disturbance; for example, at Point Reyes National Seashore, this plant has disappeared in areas where grazing has been removed (J. DiGregoria pers. comm. 2009) (NatureServe, 2015). All populations occur in moist soils in permanent freshwater marshes and swamps or riparian scrub between 10 and 1,180 feet in elevation (USFWS, 2011).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Not available

Number of Populations:

6 (USFWS, 2011)

Population Size:

200 (NatureServe, 2015)

Population Narrative:

There are 200 plants total. Historically, the number of individuals in populations of this taxon have varied greatly between years; for instance the largest recorded was 600 plants in 1995 and in 1996 there were only 100 (USFWS 1997) (NatureServe, 2015). Five of six known populations are clustered within a 12-square kilometer (4.6-square mile) area on the Point Reyes Peninsula in Marin County (USFWS, 2011).

Threats and Stressors

Stressor: Change in land use (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: The primary threats to Alopecurus aequalis var. sonomensis were habitat destruction and modification due to urbanization, land use changes, or alterations in hydrology. We noted that a portion of the historical range of A. aequalis var. sonomensis was within the project boundaries of a wastewater treatment facility (Service 1997). The majority of the historical populations of Alopecurus aequalis var. sonomensis experienced dramatic human-influenced land use changes prior to their decline or extirpation. Some wetland areas had been drained or altered in preparation for the construction of structures or buildings; others were fenced and intensively grazed (CNDDB 2002; Gennet 2004) (USFWS, 2011).

Stressor: Invasive species (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Threats to Alopecurus aequalis var. sonomensis under Factor E included competition from invasive emergent wetland species, including Juncus spp. (rushes) and Cyperus spp. (nutsedges) at one location. Competition from native invasive emergent wetland species currently impacts Alopecurus aequalis var. sonomensis at two populations. In addition, Holcus lanatus potentially threatens A. aequalis var. sonomensis at one location (PRNS 2006). (USFWS, 2011)

Stressor: Stochastic events (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Alopecurus aequalis var. sonomensis has six currently known extant populations. The combination of few populations, small range, and restricted habitat makes this species highly susceptible to extinction or extirpation from a significant portion of its range due to random events, such as flood, drought, disease, or other occurrences (Shaffer 1981; Primack 2006). Alopecurus aequalis var. sonomensis is considered by NPS resource management staff and CNPS botanists as one of the taxa at greatest risk of extinction on PRNS due the low number of populations and the high degree of interannual census fluctuations (Gennet 2004) (USFWS, 2011).

Stressor: Genetic diversity (USFWS, 2011)
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 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). The extant occurrences of Alopecurus aequalis var. sonomensis includes populations, which have been observed to dip below 200 individuals (USFWS, 2011).

Stressor: Climate change (USFWS, 2011)
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 Alopecurus aequalis var. sonomensis are unknown, the effects of increased winter flooding and drought conditions in the spring have the potential to adversely affect this species (USFWS, 2011).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: At the time of listing, regulatory mechanisms thought to provide inadequate protection for Alopecurus aequalis var. sonomensis included: (1) the California Environmental Quality Act (CEQA); and (2) the Clean Water Act. The listing rule (Service 1997) provides an analysis of the level of protection that was anticipated from those regulatory mechanisms. This analysis appears to remain currently valid for the CEQA, but not for the Clean Water Act. There are several State and Federal laws and regulations that are pertinent to federally listed species, each of which may contribute in varying degrees to the conservation of federally listed and non-listed species. These laws, most of which have been enacted in the past 30 to 40 years, have greatly reduced the threat of wholesale habitat destruction. 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, 2011)

Stressor: Disease or predation (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: At the time of listing, we reported that 7 of the 8 known sites of Alopecurus aequalis var. sonomensis were currently grazed or had been grazed in recent years by cattle (CNDDB

1996; V. Norris, in litt. 1995; R. Soost, in litt. 1996). We stated that some grazing may be necessary to maintain populations of A. aequalis var. sonomensis in the face of competition from other plants, but that excessive grazing by cattle can adversely impact the species (Service 1997). Too much or too little grazing may be detrimental to a population. For example, PRNS Population 1 was extirpated within three years after grazing cessation at the site (Shook pers. comm. 2001 in Gennet 2004). Conversely, the number of reproducing tillers at PRNS Population 5 was reduced by 90 percent in June 2001 after cattle were released onto the site (Gennet 2004). Tillers are shoots that are capable of producing a new plant. Both heavy grazing and exclusion from grazing can adversely affect the species. Overgrazing of foliage could limit the plant's ability to photosynthesize, which could result in death or diminished reproductive output. Consumption of inflorescence or seed could reduce the genetic variability of plants within a given population and could decrease the overall reproductive output of the individual plant. However, grazing may reduce competition from more abundant or invasive species. All natural populations of Alopecurus aequalis var. sonomensis within the PRNS are currently managed by grazing (Service 2002). The population at Annadel State Park is the only known natural population not maintained by grazing. Grazing activities may additionally result in trampling of individual plants, soil compaction, and impacts which may influence presence of invasive species (see Factor E). (USFWS, 2011)

Recovery

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

Recovery Priority Number: 9

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

Recovery Actions:

- Not available - this species does not have a recovery plan.
- Conduct grazing studies to investigate the effects of trampling, soil churning and compaction, direct removal of shoot and reproductive tissue of Alopecurus aequalis var. sonomensis plants by cattle, and timing and duration of grazing. An improved understanding of the mechanisms and magnitudes of impacts to Alopecurus aequalis var. sonomensis plants and populations by cattle grazing would help ranchers and resource managers determine optimal timing, duration, and intensity of grazing (USFWS, 2011).
- Conduct surveys to try to locate additional natural occurrences of Alopecurus aequalis var. sonomensis (USFWS, 2011).
- Continue attempt to isolate factors controlling the size and viability of Alopecurus aequalis var. sonomensis populations including: (a) timing and duration of grazing, (b) timing and quantity of precipitation, (c) temperature patterns, and (d) groundwater regimes (USFWS, 2011).
- Conduct a site assessment study to improve potential success of future Alopecurus aequalis var. sonomensis populations (USFWS, 2011).

References

USFWS. 2011. Alopecurus aequalis var. sonomensis (Sonoma alopecurus) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service. Sacramento, California. 21 pp. September 8, 2011. https://ecos.fws.gov/docs/five_year_review/doc3898.pdf

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

USFWS 2011. Alopecurus aequalis var. sonomensis (Sonoma alopecurus) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Sacramento Fish and Wildlife Office Sacramento, California.

SPECIES ACCOUNT: *Brodiaea filifolia* (Thread-leaved brodiaea)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/13/1998; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A perennial herb with a flowering stem, 2-4 dm tall, and several shorter, narrow leaves arising from an underground bulb, a corm. Flowers (March-June) are violet to red-purple in color (NatureServe, 2015).

Taxonomy

A member of the Themidaceae family. When the Service listed Brodiaea filifolia (Service 1998, p. 54975), the species was considered to be in a large and broadly defined family, Liliaceae (Lily family). Salisbury (1866) recognized a group of several genera that includes taxa now named Brodiaea, as a family and distinct from Allium and other Liliaceae. He named the family Themidaceae (Salisbury 1866, pp. 84-87) (USFWS, 2009).

Historical Range

Endemic to southern California (NatureServe, 2015). The historical range of Brodiaea filifolia extends from the foothills of the San Gabriel Mountains at Glendora (Los Angeles County), east to Arrowhead Hot Springs in the western foothills of the San Bernardino Mountains (San Bernardino County), and south through eastern Orange and western Riverside Counties to Rancho Santa Fe in central coastal San Diego County, California (Figure 1 below; CNDDB 2007) (USFWS, 2009).

Current Range

Presently known from Riverside, Los Angeles, San Bernardino, San Diego and Orange Counties (USFWS 2009).

Critical Habitat Designated

Yes; 2/8/2011.

Legal Description

On February 8, 2011, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Brodiaea filifolia (Thread-leaved brodiaea) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes ten critical habitat units (CHUs), in California (76 FR 6848-6925).

Critical Habitat Designation

The critical habitat designation for Brodiaea filifolia includes ten CHUs (multiple sub-units) in Los Angeles, San Bernardino, Riverside, Orange, and San Diego Counties, California. This species critical habitat encompasses approximately 2,947 acres (ac) (1,193 hectares (ha)) (76 FR 6848-6925).

Unit 1: Los Angeles County: Unit 1 is located in Los Angeles County, and consists of two subunits totaling 206 ac (83 ha). This unit contains 13 ac (5 ha) of federally owned land and 192 ac (78 ha) of private land. Subunit 1a: Glendora: Subunit 1a consists of 67 ac (27 ha) of private land in the

City of Glendora, in the foothills of the San Gabriel Mountains in Los Angeles County. Lands within this subunit contain Cieneba-Exchequer-Sobrante soils, a type of silty loam, and consist primarily of northern mixed chaparral and coastal sage scrub habitat. Subunit 1a contains the physical and biological features essential to the conservation of Brodiaea filifolia because it: (1) Contains the PCEs for B. filifolia, including sandy loam soils (PCE 1E) and areas with a natural, generally intact surface and subsurface soil structure that support B. filifolia and pollinator habitat (PCE 2); (2) supports a rare or unique occurrence, representing one of two occurrences located in the foothills of the San Gabriel Mountains which are part of the Transverse Ranges where the species was historically found, and is also significant because it is the northernmost occurrence known; and (3) supports a stable, persistent occurrence of approximately 2,000 plants. 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 invasive plants. The site is protected from development and is owned by the Glendora Community Conservancy (GCC). The GCC has expressed interest in creating a management plan for their land; however, a comprehensive management plan that would specifically address the control of nonnative plants has not been completed at this time. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to B. filifolia habitat and potential management considerations. Subunit 1b: San Dimas: Subunit 1b consists of 13 ac (5 ha) of Federal land (Angeles National Forest) and 125 ac (51 ha) of private land near the City of San Dimas in the foothills of the San Gabriel Mountains in Los Angeles County. Lands within this subunit contain Cieneba-ExchequerSobrante soils, a type of silty loam, and consist primarily of northern mixed chaparral and coastal sage scrub habitat. Subunit 1b contains the physical and biological features essential to the conservation of Brodiaea filifolia because it: (1) Contains the PCEs for B. filifolia, including sandy loam soils (PCE 1E) and areas with a natural, generally intact surface and subsurface soil structure that support B. filifolia and pollinator habitat (PCE 2); (2) supports a rare or unique occurrence, representing one of two occurrences located in the foothills of the San Gabriel Mountains which are part of the Transverse Ranges where the species was historically found, and represents the only likely genetic connection to plants in the Glendora subunit; and (3) supports two significant populations totaling about 6,000 individuals of B. filifolia, as documented in 1990 (CNDDB 2009, p. 37). Several proposals for development of this area have been reviewed by the City of Glendora (D. Walter, Senior Planner City of Glendora pers. comm. to G. Wallace, Service 2005). Additionally, illegal grading has occurred on the northern portion of this subunit (grading was halted by the City of Glendora). 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 urban development on private lands, including minimizing disturbance to the surface and subsurface structure, and to maintain pollinator habitat. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to B. filifolia habitat and potential management considerations.

Unit 2: San Bernardino County— Arrowhead Hot Springs: Unit 2 is located in San Bernardino County, California, and consists of 61 ac (25 ha) of private land at the southwestern base of the San Bernardino Mountains. This unit was not included in the 2005 final critical habitat designation, but is included in this rule based on new information related to the distribution of Brodiaea filifolia. Lands within this unit contain Cieneba-rock outcrop complex and Ramona family-Typic Xerothents soils altered by hydrothermal activity, some of which are considered alluvial, and consist primarily of coastal sage scrub habitat. Unit 2 contains the physical and biological features essential to the conservation of B. filifolia because it: (1) Contains the PCEs for

B. filifolia, including soils altered by hydrothermal activity (PCE 1B) and areas with a natural, generally intact surface and subsurface soil structure that support B. filifolia and pollinator habitat (PCE 2); (2) supports a rare or unique occurrence, representing the only occurrence of this plant in the foothills of the San Bernardino Mountains part of the Transverse Ranges where the species was historically found, and representing the type locality for B. filifolia (Niehaus 1971, p. 57; CNDDB 2009, p. 7); and (3) supports a stable, persistent occurrence. 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 invasive plants. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to B. filifolia habitat and potential management considerations.

Unit 3: Central Orange County—Aliso Canyon: Unit 3 is located in central Orange County, California, and consists of 11 ac (4 ha) of private land in the City of Laguna Niguel, southwestern Orange County. These totals do not include 102 ac (42 ha) of land in Unit 3 that we are exercising our delegated discretion to exclude from this revised 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 not included in the 2005 final critical habitat designation, but is included in this rule based on new information related to the distribution of Brodiaea filifolia. Lands within this unit contain clay loam or other types of loam and consist of annual and needlegrass grassland. Unit 3 contains the physical and biological features essential to the conservation of B. filifolia because it: (1) Contains the PCEs for B. filifolia, including loamy soils underlain by a clay subsoil (PCE 1A) and areas with a natural, generally intact surface and subsurface soil structure that support B. filifolia and pollinator habitat (PCE 2); and (2) supports an occurrence of at least 5,000 individuals of B. filifolia, as documented in 2001 (CNDDB 2009, p. 51). 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 fuel management activities (annual mowing) and pipeline work. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to B. filifolia habitat and potential management considerations.

Unit 4: Southern Orange County: Unit 4 is located in southern Orange County, California, and consists of 3 subunits totaling 732 ac (297 ha) of private land. These totals do not include portions of Subunit 4b (192 ac (78 ha)) that we are exercising our delegated discretion to exclude from this revised designation under section 4(b)(2) of the Act (see the Exclusions under Section 4(b)(2) of the Act section of this rule). Subunits 4a, 4d, 4e, 4f, 4h, and 4i as proposed in the December 8, 2004, rule (69 FR 71283) did not meet the definition of critical habitat and were not proposed for revised designation. Subunit 4b: Wilderness Park: Subunit 4b consists of 12 ac (5 ha) of private land in the City of San Juan Capistrano and the Audubon California Starr Ranch Sanctuary, in the southwestern region of the Santa Ana Mountains, southern Orange County. Lands within this subunit contain clay loam, sandy loam, or rocky outcrop, and consist primarily of grassland and sagebrush-buckwheat scrub habitat. Subunit 4b contains the physical and biological features essential to the conservation of Brodiaea filifolia because it: (1) Contains the PCEs for B. filifolia, including clay soils and loamy soils underlain by a clay subsoil (PCE 1A), and areas with a natural, generally intact surface and subsurface soil structure that support B. filifolia and pollinator habitat (PCE 2); and (2) supports a stable, persistent occurrence. This subunit is located in the foothills of the Santa Ana Mountains and represents the highest elevation and northernmost occurrence in Orange County. 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 invasive plants. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to B. filifolia habitat and potential management considerations. Subunit 4c: Can ada Gobernadora/ Chiquita Ridgeline: Subunit 4c consists of 133 ac (54 ha) of private land in and around Can˜ ada Gobernadora on Rancho Mission Viejo in southern Orange County. Lands within this subunit contain clay, clay loam, or sandy loam and consist primarily of dry-land agriculture and sagebrush-buckwheat scrub habitat. Subunit 4c contains the physical and biological features essential to the conservation of Brodiaea filifolia because it: (1) Contains the PCEs for B. filifolia, including clay soils and loamy soils underlain by a clay subsoil (PCE 1A), and areas with a natural, generally intact surface and subsurface soil structure that support B. filifolia and pollinator habitat (PCE 2); and (2) supports a stable, persistent occurrence. 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 the indirect effects associated with urban development. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to B. filifolia habitat and potential management considerations. Subunit 4g: Cristianitos Canyon: Subunit 4g consists of 587 ac (238 ha) of privately owned land in Cristianitos Canyon on Rancho Mission Viejo in southern Orange County. Lands within this subunit are underlain by clay and sandy loam soils and consist primarily of annual grassland and needlegrass grassland. Subunit 4g contains the physical and biological features essential to the conservation of Brodiaea filifolia because it: (1) Contains the PCEs for B. filifolia, including clay soils and loamy soils underlain by a clay subsoil (PCE 1A), and areas with a natural, generally intact surface and subsurface soil structure that support B. filifolia and pollinator habitat (PCE 2); (2) supports an occurrence in rare and unique habitat, representing one of the few places where this species occurs in needlegrass grassland in Orange County; and (3) supports an occurrence of at least 6,505 individuals of B. filifolia, as documented in 2003 (Dudek & Associates, Inc. 2006, Chapter 3 pp. 73– 74, 83; Service 2007, pp. 149–150). 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 the indirect effects associated with urban development. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to B. filifolia habitat and potential management considerations.

Unit 5: Northern San Diego County: Unit 5 is located in northern San Diego County, and consists of one subunit totaling 274 ac (111 ha). This unit contains 266 ac (108 ha) of Federal Government land and 8 ac (3 ha) of private land. This unit is located entirely within the boundary of the CNF. Subunit 5a as proposed in the December 8, 2004, rule (69 FR 71283) did not meet the definition of critical habitat and was not proposed for revised designation. Subunit 5b: Devil Canyon: Subunit 5b consists of 266 ac (108 ha) of Federal land (CNF) and 8 ac (3 ha) of private land in northern San Diego County. Hybrids between Brodiaea filifolia and B. orcuttii have been reported from the Devil Canyon site, however, we believe B. filifolia occurs in sufficient numbers in this area to meet the criteria for critical habitat designation (see the Special Management Considerations or Protection section of this rule for a discussion of Brodiaea hybridization). Lands within this subunit contain Cieneba Very Rocky Coarse Sandy Loam, Fallbrook Sandy Loam, and Cieneba Coarse Sandy Loam soils and consist primarily of chaparral and oak woodland vegetation. Subunit 5b contains the physical and biological features essential to the conservation of Brodiaea filifolia because it: (1) Contains the PCEs for B. filifolia, including sandy loam soils (PCE 1E) and areas with a natural, generally intact surface and subsurface soil structure that support B. filifolia and pollinator habitat (PCE 2); (2) supports an occurrence in rare and unique habitat, representing one of the few places where this species occurs in a drainage in oak woodland habitat and occurring in unusual seeps and drainages on low granitic outcrops; and (3) supports a stable, persistent occurrence. The CNF does not currently have a management plan specific to B. filifolia. The 2005 critical habitat rule for B. filifolia and the 2009 proposed revised critical habitat rule erroneously stated that grazing occurs in this area; this area is in fact not subjected to cattle grazing (Winter 2004, pers. comm.). 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 invasive plants. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to B. filifolia habitat and potential management considerations.

Unit 6: Oceanside, San Diego County: Unit 6 is located in Oceanside, San Diego County, California, and consists of five subunits totaling 230 ac (93 ha) of private land. Subunit 6a: Alta Creek: Subunit 6a consists of 72 ac (29 ha) of private land in the City of Oceanside, in northern coastal San Diego County. This subunit was not included in the 2005 final critical habitat designation, but is included in this rule based on new information related to the distribution of Brodiaea filifolia. Lands within this subunit contain fine sandy loam, loam, or loamy fine sand and consist primarily of coastal sage scrub habitat. Subunit 6a contains the physical and biological features essential to the conservation of B. filifolia because it: (1) Contains the PCEs for B. filifolia, including loamy soils underlain by a clay subsoil (PCE 1A) and areas with a natural, generally intact surface and subsurface soil structure that support B. filifolia and pollinator habitat (PCE 2); and (2) supports a stable, persistent occurrence of at least 1,500 individuals of B. filifolia (Affinis 2005, pp. 1–3; AMEC 2005 pp. 3–18). 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 the indirect effects associated with urban development. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to B. filifolia habitat and potential management considerations. Subunit 6b: Mesa Drive: Subunit 6b consists of 17 ac (7 ha) of private land in the City of Oceanside, in northern coastal San Diego County. Lands within this subunit contain loamy fine sands and consist primarily of grassland habitat. Subunit 6b contains the physical and biological features essential to the conservation of Brodiaea filifolia because it: (1) Contains the PCEs for B. filifolia, including loamy soils underlain by a clay subsoil (PCE 1A) and areas with a natural, generally intact surface and subsurface soil structure that support B. filifolia and pollinator habitat (PCE 2); and (2) supports a stable, persistent occurrence of at least 1,500 individuals of B. filifolia (Roberts 2005a, pp.1–2). 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 the indirect effects associated with urban development and habitat disturbance on local government lands (Roberts 2005, pp. 1–3). Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to B. filifolia habitat and potential management considerations. Subunit 6c: Mission View/Sierra Ridge: Subunit 6c consists of 12 ac (5 ha) of private land in the City of Oceanside, in northern coastal San Diego County. This subunit was not included in the 2005 final critical habitat designation, but is included in this rule based on new information related to the distribution of Brodiaea filifolia. Lands within this subunit contain fine loamy sands and consist primarily of coastal sage scrub habitat. Subunit 6c contains the physical and biological features essential to the conservation of B. filifolia because it: (1) Contains the PCEs for B. filifolia, including loamy soils underlain by a clay subsoil (PCE 1A) and areas with a natural, generally intact surface and subsurface soil structure that support B. filifolia and pollinator habitat (PCE 2); and (2) supports a stable, persistent occurrence of at least 1,300 individuals of B. filifolia (Roberts 2005b, p. 1). 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 the indirect effects associated with urban development. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to B. filifolia habitat and potential management considerations. Subunit 6d: Taylor/Darwin: Subunit 6d consists of 35 ac (14 ha) of private land in the City of Oceanside, in northern coastal San Diego County. Lands within this subunit contain clay soil and fine loamy sands and consist primarily of annual and needlegrass grassland. Subunit 6d contains the physical and biological features essential to the conservation of Brodiaea filifolia because it: (1) Contains the PCEs for B. filifolia, including loamy soils underlain by a clay subsoil (PCE 1A) and areas with a natural, generally intact surface and subsurface soil structure that support B. filifolia and pollinator habitat (PCE 2); and (2) supports an occurrence of at least 6,200 individuals of B. filifolia, as documented in 2005 (CNDDB 2009, p. 38). 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 invasive plants. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to B. filifolia habitat and potential management considerations. Subunit 6e: Arbor Creek/Colucci: Subunit 6e consists of 94 ac (38 ha) of private land in the City of Oceanside, in northern coastal San Diego County. This subunit was not included in the 2005 final critical habitat designation but is included in this rule based on new information related to the distribution of Brodiaea filifolia. Lands within this subunit contain clay soil and fine loamy sands and consist primarily of annual and needlegrass grassland. Subunit 6e contains the physical and biological features essential to the conservation of B. filifolia because it: (1) Contains the PCEs for B. filifolia, including loamy soils underlain by a clay subsoil (PCE 1A) and areas with a natural, generally intact surface and subsurface soil structure that support B. filifolia and pollinator habitat (PCE 2); and (2) supports a stable, persistent occurrence; and (3) consists primarily of annual and needlegrass grassland and occurs in the largest continuous block of grassland habitat remaining in the City of Oceanside. 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 invasive plants and urban development. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to B. filifolia habitat and potential management considerations.

Unit 7: Carlsbad, San Diego County: Unit 7 is located in Carlsbad, San Diego County, California, and consists of three subunits totaling 105 ac (43 ha). This unit contains 1 ac (<1 ha) of State land and 104 ac (43 ha) of private land. These totals do not include Subunit 7d (98 ac (40 ha)) and portions of Subunit 7a (13 ac (5 ha)) and Subunit 7c (45 ac (18 ha)) that we are exercising our delegated discretion to exclude from this revised designation under section 4(b)(2) of the Act (see the Exclusions under Section 4(b)(2) of the Act section of this rule), or 2 ac (<1 ha) that were proposed as revised critical habitat but are not included in this final revised critical habitat designation because they do not support suitable habitat for the species. Subunit 7a: Letterbox Canyon: Subunit 7a consists of 1 ac (<1 ha) of State land and 41 ac (17 ha) of private land in the City of Carlsbad, in northern coastal San Diego County, California. Lands within this subunit contain heavy clay soils and consist primarily of annual grassland. Subunit 7a contains the physical and biological features essential to the conservation of B. filifolia because it: (1) Contains the PCEs for B. filifolia, including loamy soils underlain by a clay subsoil (PCE 1A) and areas with a natural, generally intact surface and subsurface soil structure that support B. filifolia and pollinator habitat (PCE 2); and (2) supports an occurrence of at least 39,500 individuals of B.

filifolia, as documented in 2005 (CNDDB 2009, p. 15). 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 the indirect effects associated with urban development. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to B. filifolia habitat and potential management considerations. Subunit 7b: Rancho Carrillo: Subunit 7b consists of 37 ac (15 ha) of private land in the City of Carlsbad, in northern coastal San Diego County, California. This subunit was not included in the 2005 final critical habitat designation, but is included in this rule based on new information related to the distribution of Brodiaea filifolia. Lands within this subunit contain clay or sandy loam soils and consist primarily of annual grasslands and coastal sage scrub habitat. Subunit 7b contains the physical and biological features essential to the conservation of B. filifolia because it: (1) Contains the PCEs for B. filifolia, including loamy soils underlain by a clay subsoil (PCE 1A) and areas with a natural, generally intact surface and subsurface soil structure that support B. filifolia and pollinator habitat (PCE 2); and (2) supports an occurrence of at least 797,000 individuals of B. filifolia, as documented in 2005 (this estimate was of vegetative plants and not flowering plants) (Scheidt and Allen 2005, p. 1). 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 the indirect effects associated with urban development and nonnative invasive plants. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to B. filifolia habitat and potential management considerations. Subunit 7c: Calavera Hills Village H: Subunit 7c consists of 26 ac (11 ha) of private land in the City of Carlsbad, in northern coastal San Diego County. Lands within this subunit contain clay soil and consist primarily of annual and needlegrass grassland. Subunit 7c contains the physical and biological features essential to the conservation of Brodiaea filifolia because it: (1) Contains the PCEs for B. filifolia, including loamy soils underlain by a clay subsoil (PCE 1A) and areas with a natural, generally intact surface and subsurface soil structure that support B. filifolia and pollinator habitat (PCE 2); and (2) supports a stable, persistent occurrence of at least 2,243 plants, as documented in 2008 (McConnell 2008, p. 9). 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 invasive plants. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to B. filifolia habitat and potential management considerations.

Unit 8: San Marcos, San Diego County: Unit 8 is located in San Marcos, northern San Diego County, California, and consists of three subunits totaling 108 ac (44 ha) of private land. Subunits 8a, 8c, and 8e as proposed in the December 8, 2004, rule (69 FR 71283) did not meet the definition of critical habitat and were not proposed for revised designation. Subunit 8b: Rancho Santalina/Loma Alta: Subunit 8b consists of 47 ac (19 ha) of private land in the City of San Marcos, northern San Diego County, California. This subunit was not included in the 2005 final critical habitat designation, but is included in this rule based on new information related to the distribution of Brodiaea filifolia. Lands within this subunit contain clay, loam, or loamy fine sand soils and consist primarily of annual and needlegrass grassland. Subunit 8b contains the physical and biological features essential to the conservation of B. filifolia because it: (1) Contains the PCEs for B. filifolia, including loamy soils underlain by a clay subsoil (PCE 1A) and areas with a natural, generally intact surface and subsurface soil structure that support B. filifolia and pollinator habitat (PCE 2); and (2) supports an occurrence of at least 5,552 individuals of B. filifolia, as documented in 2000, and approximately 12,000 B. filifolia corms were transplanted to the area in 2004 (CNDDB 2009, p. 10). 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 the indirect effects associated with urban development, unauthorized recreational activities, and nonnative invasive plants. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to B. filifolia habitat and potential management considerations. Subunit 8d: Upham: Subunit 8d consists of 54 ac (22 ha) of private land in the City of San Marcos, northern San Diego County. Hybrids between Brodiaea filifolia and B. orcuttii have been reported from the Upham site (Chester et al. 2007, p. 188), however, based on the best scientific information available to us at this time, we believe B. filifolia occurs in sufficient numbers in this area to meet the criteria for critical habitat designation (see the Special Management Considerations or Protection section of this rule for a discussion of Brodiaea hybridization). Lands within this subunit contain clay soils and consist primarily of annual and needlegrass grassland and vernal pool habitat. Subunit 8d contains the physical and biological features essential to the conservation of Brodiaea filifolia because it: (1) Contains the PCEs for B. filifolia, including loamy soils underlain by a clay subsoil (PCE 1A) and areas with a natural, generally intact surface and subsurface soil structure that support B. filifolia and pollinator habitat (PCE 2); (2) supports a rare or unique occurrence, representing one of three occurrences that are associated with vernal pool habitat; and (3) supports an occurrence of at least 342,000 individuals of B. filifolia, as documented in 1993 (CNDDB 2009, p. 9). 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 the indirect effects associated with urban development, unauthorized recreational activities, and nonnative invasive plants. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to B. filifolia habitat and potential management considerations. Subunit 8f: Oleander/San Marcos Elementary: Subunit 8f consists of 7 ac (3 ha) of land owned by the San Marcos Unified School District near the City of San Marcos, in northern San Diego County. This subunit was not included in the 2005 final critical habitat designation, but is included in this rule based on new information related to the distribution of Brodiaea filifolia. Lands within this subunit contain clay, loam, or loamy fine sand soils and consist primarily of annual grassland. Unit 8f contains the physical and biological features essential to the conservation of B. filifolia because it: (1) Contains the PCEs for B. filifolia, including loamy soils underlain by a clay subsoil (PCE 1A) and areas with a natural, generally intact surface and subsurface soil structure that support B. filifolia and pollinator habitat (PCE 2); and (2) supports an occurrence of at least 3,211 individuals of B. filifolia, as documented in 2005 (Dudek and Associates, Inc. 2007, p.9). 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 invasive plants. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to B. filifolia habitat and potential management considerations.

Unit 11: Western Riverside County: Unit 11 is located in western Riverside County, California, and consists of 6 subunits totaling 1,113 ac (450 ha). This unit contains 53 ac (21 ha) of Federal land, 366 ac (148 ha) of State land, 33 ac (13 ha) of local government land, and 661 ac (267 ha) of private land. These totals do not include Subunits 11g (117 ac (47 ha)), 11h (44 ac (18 ha)) and portions of Subunit 11f (221 ac (89 ha)) that we are exercising our delegated discretion to exclude from this revised 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 11a: San Jacinto Wildlife Area: Subunit 11a consists of 366 ac (148 ha) of State land (California Department of Fish and Game (CDFG)), 17 ac (7 ha) of local government land, and 18 ac (7 ha) of private land at the San Jacinto Wildlife Area, in western Riverside County. Lands within this subunit contain Willows silty clay, Waukena loam and Waukena fine sandy loam, Traver fine sandy loam and Traver loamy fine sand, and Hanford coarse sandy loam soils and consist primarily of annual grassland, alkali scrub habitat, and alkali playa habitat. Subunit 11a contains the physical and biological features essential to the conservation of Brodiaea filifolia because it: (1) Contains the PCEs for B. filifolia, including silty loam soils underlain by a clay subsoil or caliche that are generally poorly drained and moderately to strongly alkaline (PCE 1C) and areas with a natural, generally intact surface and subsurface soil structure that support B. filifolia and pollinator habitat (PCE 2); (2) supports a rare or unique occurrence, representing one of four occurrences associated with alkali playa habitat; and (3) supports a stable, persistent occurrence. 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 invasive plants and construction of new roads or improvements to existing roadways (Service 2004b, pp. 137–189). Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to B. filifolia habitat and potential management considerations. Subunit 11b: San Jacinto Avenue/ Dawson Road: Subunit 11b consists of 117 ac (47 ha) of private land near San Jacinto Avenue and Dawson Road, in western Riverside County. Lands within this subunit contain Willows silty clay and Domino silt loam soils and consist primarily of annual grassland, alkali scrub habitat, and alkali playa habitat. Subunit 11b contains the physical and biological features essential to the conservation of Brodiaea filifolia because it: (1) Contains the PCEs for B. filifolia, including silty loam soils underlain by a clay subsoil or caliche that are generally poorly drained and moderately to strongly alkaline (PCE 1C) and areas with a natural, generally intact surface and subsurface soil structure that support B. filifolia and pollinator habitat (PCE 2); and (2) supports a rare or unique occurrence, representing one of four occurrences that are associated with alkali playa habitat. 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 discing, grazing, manure dumping, and nonnative invasive plants (CNDDB 2009, p. 60). Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to B. filifolia habitat and potential management considerations. Subunit 11c: Case Road: Subunit 11c consists of 11 ac (4 ha) of local government land and 169 ac (68 ha) of private land near the City of Perris, in western Riverside County. Lands within this subunit contain Willows silty clay and Domino silt loam soils and consist primarily of agricultural land, floodplain habitat, alkali scrub habitat, and alkali playa habitat. Subunit 11c contains the physical and biological features essential to the conservation of Brodiaea filifolia because it: (1) Contains the PCEs for B. filifolia, including silty loam soils underlain by a clay subsoil or caliche that are generally poorly drained and moderately to strongly alkaline (PCE 1C) and areas with a natural, generally intact surface and subsurface soil structure that support B. filifolia and pollinator habitat (PCE 2); (2) supports a rare or unique occurrence, representing one of four occurrences that are associated with alkali playa habitat; and (3) supports an occurrence of at least 4,555 individuals of B. filifolia, as documented in 2000 (Glenn Lukos Associates, Inc. 2000a, Map of San Jacinto River Stage 3 Project Impacts Version 2 Alignment; Glenn Lukos Associates, Inc. 2000b, pp. 17–18; CNDDB 2009, p. 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 OHV activity, encroaching urban development, manure dumping, and nonnative invasive plants. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to B. filifolia habitat and potential management considerations. Subunit 11d: Railroad Canyon: Subunit 11d consists of 53 ac (21 ha) of Federal land owned by the Bureau of Land Management, 1 ac (<1 ha) of local government land, and 204 ac (83 ha) of private land north of Kabian County Park and southwest of the City of Perris, in western Riverside County. Lands within this subunit contain Lodo rocky loam, Garretson gravelly very fine sandy loam and Garretson very fine sandy loam, Escondido fine sandy loam, and Grangeville fine sandy loam soils and consist primarily of annual grassland. Subunit 11d contains the physical and biological features essential to the conservation of Brodiaea filifolia because it: (1) Contains the PCEs for B. filifolia, including silty loam soils underlain by a clay subsoil or caliche that are generally poorly drained and moderately to strongly alkaline (PCE 1C) and areas with a natural, generally intact surface and subsurface soil structure that support B. filifolia and pollinator habitat (PCE 2); and (2) supports an occurrence of at least 3,205 individuals of B. filifolia, as documented in 2000 (Glenn Lukos Associates 2000a, pp. 13, 24; CNDDB 2009, p. 23). The occurrence in Railroad Canyon is at risk from the San Jacinto River Flood Control Project. That project includes channelization of the river, which may result in changes in floodplain process essential to the species persistence in this subunit (Service 2004b, p. 382). 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 the indirect effects associated with urban development, river channelization for flood control, and nonnative invasive plants. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to B. filifolia habitat and potential management considerations. Subunit 11e: Upper Salt Creek (Stowe Pool): Subunit 11e consists of 145 ac (59 ha) of private land in the Upper Salt Creek drainage west of Hemet, in western Riverside County. Lands within this subunit contain Willows silty clay, Chino silt loam, Honcut loam, and Wyman loam and consist primarily of annual grassland, alkali scrub habitat, and alkali playa habitat. Subunit 11e contains the physical and biological features essential to the conservation of Brodiaea filifolia because it: (1) Contains the PCEs for B. filifolia, including silty loam soils underlain by a clay subsoil or caliche that are generally poorly drained and moderately to strongly alkaline (PCE 1C), and areas with a natural, generally intact surface and subsurface soil structure that support B. filifolia and pollinator habitat (PCE 2); and (2) supports a rare or unique occurrence, representing one of three occurrences that are associated with vernal pool habitat. This subunit is crossed by roadways that, if altered (widened or realigned), could change the topography and thereby negatively affect the hydrologic integrity of the pool complexes and favor the growth of nonnative invasive plant species (CNDDB 2009, p. 24; Service 2004b, p. 382). 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 invasive plants (such as Hordeum marinum subsp. gussoneanum) and transportation projects. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to B. filifolia habitat and potential management considerations. Subunit 11f: Santa Rosa Plateau—Mesa de Colorado: Subunit 11f consists of 5 ac (2 ha) of local government land and 8 ac (3 ha) of private land in southwestern Riverside County. Lands within this subunit contain Murrieta stony clay loam, and Las Posas rocky loam and Las Posas loam soils and consist primarily of annual and needlegrass grassland and vernal pool habitat. Subunit 11f contains the physical and biological features essential to the conservation of Brodiaea filifolia because it: (1) Contains the PCEs for B. filifolia, including clay loam soil series underlain by heavy clay loams or clays derived from olivine basalt lava flows that generally occur on mesas and gentle to moderate slopes (PCE 1D) and areas with a natural, generally intact surface and subsurface soil structure that support B. filifolia and pollinator habitat (PCE 2); (2) supports a rare or unique occurrence, representing one of three occurrences that are associated with vernal pool habitat; and (3) supports an occurrence of at least 31,725 individuals of B. filifolia, as documented in 1990 (CNDDB 2009, p. 5). 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 the indirect effects associated with urban development and nonnative invasive plants. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to B. filifolia habitat and potential management considerations.

Unit 12: Central San Diego County— Artesian Trails Unit 12 is located in central San Diego County, California, and consists of 105 ac (43 ha). This unit contains 7 ac (3 ha) of local government land and 98 ac (40 ha) of private land. These totals do not include 4 ac (2 ha) of land in Unit 12 that we are exercising our delegated discretion to exclude from this revised 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 not included in the 2005 final critical habitat designation, but is included in this rule based on new information related to the distribution of Brodiaea filifolia. Lands within this subunit contain fine loamy sands and consist primarily of coastal sage scrub habitat and annual grassland. Unit 12 contains physical and biological features that are essential to the conservation of B. filifolia because it: (1) Contains the PCEs for B. filifolia, including loamy soils underlain by a clay subsoil (PCE 1A) and areas with a natural, generally intact surface and subsurface soil structure that support B. filifolia and pollinator habitat (PCE 2); and (2) supports a stable, persistent occurrence. 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 the indirect effects associated with urban development and nonnative invasive plants. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to B. filifolia 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 Brodiaea filifolia critical habitat consists of two components (76 FR 6848-6925):

(i) PCE 1—Appropriate soil series at a range of elevations and in a variety of plant communities, specifically: (A) Clay soil series of various origins (such as Alo, Altamont, Auld, or Diablo), clay lenses found as unmapped inclusions in other soils series, or loamy soils series underlain by a clay subsoil (such as Fallbrook, Huerhuero, or Las Flores) occurring between the elevations of 100 and 2,500 ft (30 and 762 m). (B) Soils (such as Cieneba-rock outcrop complex and Ramona familyTypic Xerothents soils) altered by hydrothermal activity occurring between the elevations of 1,000 and 2,500 ft (305 and 762 m). (C) Silty loam soil series underlain by a clay subsoil or caliche that are generally poorly drained, moderately to strongly alkaline, granitic in origin (such as Domino, Grangeville, Traver, Waukena, or Willows) occurring between the elevations of 600 and 1,800 ft (183 and 549 m). (D) Clay loam soil series (such as Murrieta) underlain by heavy clay loams or clays derived from olivine basalt lava flows occurring between the elevations of 1,700 and 2,500 ft (518 and 762 m). (E) Sandy loam soils derived from basalt and granodiorite parent materials; deposits of gravel, cobble, and boulders; or hydrologically fractured, weathered granite in intermittent streams and seeps occurring between 1,800 and 2,500 ft (549 and 762 m).

(ii) PCE 2—Areas with a natural, generally intact surface and subsurface soil structure, not permanently altered by anthropogenic land use activities (such as deep, repetitive discing, or grading), extending out up to 820 ft (250 m) from mapped occurrences of Brodiaea filifolia to provide for space for individual population growth, and space for pollinators.

Special Management Considerations or Protections

When designating critical habitat within the geographical area occupied by the species at the time of listing, we assess whether the physical or biological features essential to the conservation of the species may require special management considerations or protection. In all units/subunits, special management considerations or protection of the essential features may be required to provide for the growth, reproduction, and sustained function of the habitat on which Brodiaea filifolia depends. The lands designated as revised critical habitat represent our best assessment of the habitat that meets the definition of critical habitat for Brodiaea filifolia at this time. The essential physical or biological features within the areas designated as revised critical habitat may require some level of management to address current and future threats to B. filifolia, including the direct and indirect effects of habitat loss and degradation from urban development; the introduction of nonnative invasive plant species; recreational activities; discing and mowing for agricultural practices or fuel modification for fire management; dumping of manure and sewage sludge; and hybridization with other species of Brodiaea. Loss and degradation of habitat from development was cited in the final listing rule as a primary cause for the decline of Brodiaea filifolia. Most of the populations of this species are located in San Diego, Orange, and Riverside counties. These counties have had (and continue to have) increasing human populations and attendant housing pressure. Natural areas in these counties are frequently near or bounded by urbanized areas. Urban development removes the plant community components and associated clay soils identified in the PCEs, which eliminates or fragments the populations of B. filifolia. Grading, discing, and scraping areas in the preparation of areas for urbanization also directly alters the soil surface as well as subsurface soil layers to the degree that they will no longer support plant community types and pollinators associated with B. filifolia (PCE 2). Conservation and management of B. filifolia habitat and adjacent pollinator habitat is needed to address the threat of development. Nonnative invasive plant species may alter the vegetation composition or physical structure identified in the PCEs to an extent that the area does not support Brodiaea filifolia or the plant community that it inhabits. Additionally, invasive species may compete with B. filifolia for space and resources by depleting water that would otherwise be available to B. filifolia. Management activities including (but not limited to) nonnative plant removal and control are needed to reduce this threat. Unauthorized recreational activities may impact the vegetation composition and soil structure that supports Brodiaea filifolia to an extent that the area will no longer have intact soil surfaces or the plant communities identified in the PCEs. Off-highway vehicle (OHV) activity is an example of this type of activity. Management activities such as (but not limited to) fencing or other barriers to unauthorized access, signage, and monitoring are needed to address this threat. Some methods of mowing or discing for agricultural purposes or fuel modification for fire management may preclude the full and natural development of Brodiaea filifolia by adversely affecting the PCEs. Mowing may preclude the successful reproduction of the plant, or alter the associated vegetation needed for pollinator activity (PCE 2). Dumping of sewage sludge can cover plants as well as the soils they need. Additionally, this practice can alter the chemistry of the substrate and lead to alterations in the vegetation supported at the site (PCE 1). Management activities such as (but not limited to) fencing, signage, and education of landowners and land managers about the detrimental effects that mowing, discing, and dumping sewage have on B. filifolia and its habitat are needed to address this threat. Manure dumping on private property along the San Jacinto River area is impacting habitat within the Western Riverside County MSHCP plan area. These impacts are occurring despite identification of these areas as important for the survival and recovery of Brodiaea filifolia in the Western Riverside County MSHCP. Manure dumping is not a covered activity under the Western Riverside County MSHCP and was not discussed as an impact to B. filifolia in the Biological Opinion on the Western Riverside County MSHCP (Service 2004b, pp. 378–386). As outlined in the Western Riverside County MSHCP, we have been working with permittees to implement additional ordinances that will help to control activities (such as manure dumping) that may impact the implementation of the Western Riverside County MSHCP conservation objectives. To date, the City of Hemet is the only Western Riverside County MSHCP permittee that has addressed the negative impacts that manure dumping has on species such as B. filifolia and Navarretia fossalis and their habitats through the enactment of Ordinance 1666 (i.e., the ordinance that prevents manure dumping activities and educates its citizens). We will continue to work with Riverside County and permittees of the Western Riverside County MSHCP to address activities that may impact the species within the Western Riverside County MSHCP plan area. The Service is aware of occurrences of some hybrids within the range of Brodiaea filifolia in Subunit 5b (Devil Canyon) in northwestern San Diego County (Chester et al. 2007, p. 193). The presumed parent taxa of these hybrids are considered to be B. filifolia and B. orcuttii because of the apparent morphological intermediacy of the individuals and proximity of their ranges. This is supported by the close relationship of the two species noted above. Although there are some hybrids of B. filifolia and B. orcuttii in this subunit, it is likely that a minimum of 850 plants are pure B. filifolia (Service 2009b, p. 15) (we consider occurrences that have between 850 and 3,000 flowering stems observed in multiple years to be stable and persistent because we expect these occurrences to have a sufficient amount of corms to sustain the occurrence for a number of years if the habitat remains unaltered (see Criteria Used section below)). Plants of hybrid origin have also been reported in Subunit 8d (Upham) in the City of San Marcos (Chester et al. 2007, p. 191). Chester et al. (2007) only found a few hybrid specimens at this location, therefore it is likely that a minimum of 850 plants are pure B. filifolia. Hybridization could result in the loss of portions of B. filifolia occurrences if other Brodiaea species are transplanted adjacent to existing B. filifolia occurrences, or if existing B. filifolia occurrences are transplanted adjacent to other Brodiaea species and the two species are able to hybridize. Informing biological resource managers of the existence of this threat will help to keep human-mediated hybridization from occurring. In summary, we find that the areas we are designating as revised critical habitat contain the physical or biological features essential to the conservation of Brodiaea filifolia, and that these features may require special management considerations or protection. Special management considerations or protection may be required to eliminate, or reduce to negligible level, the threats affecting each unit/subunit and to preserve and maintain the essential features that the revised critical habitat units/subunits provide to B. filifolia. Additional discussions of threats facing individual sites are provided in the individual unit/subunit descriptions. The designation of critical habitat does not imply that lands outside of critical habitat may not play an important role in the conservation of Brodiaea filifolia. In the future, and with changed circumstances, these lands may become essential to the conservation of B. filifolia. Activities with a Federal nexus that may affect areas outside of revised critical habitat, such as development, agricultural activities, and road construction, are still subject to review under section 7 of the Act if they may affect B. filifolia because Federal agencies must consider both effects to the plant and effects to critical habitat independently. The prohibitions of section 9 of the Act applicable to B. filifolia under 50 CFR 17.71 (e.g., the prohibition against reducing to possession or maliciously damaging or destroying listed plants on Federal lands) also continue to apply both inside and outside of designated critical habitat.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual: vegetative; sexual: cross-pollination (NatureServe, 2015)

Breeding Season

Adult: March - June (USFWS, 2009)

Key Resources Needed for Breeding

Adult: Bee pollinators (USFWS, 2009). Multiple potential pollinators including multiple Coleoptera, Hymentoptera species (USFWS, 2023)

Other Reproductive Information

Adult: Pollination studies were initiated at MCBCP and by CNLM since the last 5-year review. Between 2018 and 2020, the CNLM implemented a pollination study at several of the preserves they manage in San Diego County (Prentice-Dekker 2019, pp. 5–6, 12–14; Prentice-Dekker 2020, pp. 5, 7–10). The study assessed pollinator abundance diversity, visitation rates, and measured seed pod and seed production (Prentice-Dekker 2019, pp. 12–14; Prentice-Dekker 2020, pp. 7–10). Successful pollination, defined as at least one seed pod and seed produced, was observed at 16 (18 percent) of the 90 plants measured in 2020 (Prentice-Dekker 2020, p. 9). At MCBCP, several native and nonnative potential pollinators were observed (Kenney 2021, in litt;) (Appendix A); observations from both studies contribute to our understanding of potential Brodiaea filifolia pollinators. Additional research is needed to characterize the range of seed set and whether certain populations may have reduced sexual reproduction due to pollinator limitation or reduced genetic diversity (USFWS, 2023).

Reproduction Narrative

Adult: Brodiaea filifolia's main means of reproduction is vegetative; it produces small cormlets. When reproducing sexually, this species is an obligate out-crosser, in other words it cannot produce seed when pollinated by flowers on the same plant or flowers from other plants that have the same alleles (USFWS 2005) (NatureServe, 2015). The California Native Plant Society (CNPS) reported that the flowering period extends from March to June (CNPS 2001, p. 99). Bell and Rey (1991) report that native bees observed pollinating Brodiaea filifolia on the Santa Rosa Plateau in Riverside County included Bombus californicus (Apidae, Hymenoptera), Hoplitus sp. (Megachilidae, Hymenoptera), Osmia sp. (Megachilidae, Hymenoptera), and an unidentified Anthophorid (digger-bee) (Bell and Rey 1991, p. 3) (USFWS, 2009).

Habitat Type

Adult: Terrestrial, wetland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Grassland, alkali playa, vernal pool (USFWS, 2009)

Dependencies on Specific Environmental Elements

Adult: Mesic conditions (USFWS, 2009)

Geographic or Habitat Restraints or Barriers

Adult: 100 - 2,500 ft. elevation (USFWS, 2009)

Environmental Specificity

Adult: Very narrow to narrow (NatureServe, 2015)

Habitat Narrative

Adult: Grasslands, often in association with vernal pools and in floodplains. Grows in heavy clay soil (Munz, 1959). The environmental specificity is very narrow to narrow; it requires clay soils in herbaceous communities (USFWS 2005) (NatureServe, 2015). This species is usually found in herbaceous plant communities that occur in open areas on clay soils, soils with a clay subsurface, or clay lenses within loamy, silty loam, loamy sand, silty deposits with cobbles, or alkaline soils. They may range in elevation from 100 feet (30 meters) to 2,500 feet (765 meters), depending on soil series. This species is usually found in herbaceous plant communities such as valley needlegrass grassland, valley sacaton grassland, nonnative grassland, alkali playa, southern interior basalt vernal pools, San Diego mesa hardpan vernal pools, and San Diego mesa claypan vernal pools (Holland 1986, pp. 34-37, 41, 44) (USFWS, 2009).

Dispersal/Migration

Dispersal

Adult: Low (USFWS, 2009)

Dispersal/Migration Narrative

Adult: The seeds are dispersed as wind rattles the capsules and releases the seeds (Smith 1997, p. 29). Dispersal of seeds from an individual is likely localized, leading to patches of plants with the same self-incompatible alleles (USFWS, 2009).

Population Information and Trends

Population Trends:

Not available

Species Trends:

3 occurrences extirpated since listing (USFWS, 2009)

Number of Populations:

148 extant/presumed extant (USFWS, 2023)

Population Size:

Unknown (USFWS, 2009)

Population Narrative:

Sixty-eight discontinuous occurrences are distributed across southern California. No accurate estimate of the overall abundance of Brodiaea filifolia is available at this time. Only three occurrences are considered to be extirpated since listing (USFWS, 2009). This 2023 review of new information finds that there is a substantial increase in the number of occurrences: a total of 148 occurrences are extant or presumed extant, and 18 are possibly extirpated or extirpated (Figure 1; Table 1). Although new occurrences of the plant have been found since listing, none of the new documented occurrences are outside of the original range identified in the final listing rule (Service 1998, p. 54977). The current distribution is discussed by county below and maps by county can be found in Appendix B (USFWS, 2023).

Threats and Stressors

Stressor: Urbanization (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Development may directly impact B. filifolia plants through removal, reduction of suitable habitat, and increased isolation between occurrences. At least 151 individuals in three locations within the San Dimas/Gordon Highlands occurrence were destroyed (LDC 2006, pp. 1, 47-48) and the remaining individuals are likely to be impacted by future development (M. Meyer, California Department of Fish and Game, in litt. 2005, p. 1). A proposed channelization associated with the San Jacinto River Flood Control Project may result in the translocation of the Railroad Canyon occurrence (Dudek 2003, p. 438; Service 2004b, pp. 384-385). Of the 20 occurrences in San Diego County, 12 of them have been impacted by development. At the Loma Alta occurrence in the City of San Marcos, unforeseen impacts to Brodiaea filifolia occurred when approximately 4,000 plants, that were to be conserved, were buried by a manufactured slope, leaving only 13 plants (Roberts, in litt. 2001, pp. 1-5; CDFG and Service 2002, p. 2; Roberts, in litt. 2004a, p. 1). Occurrences of Brodiaea filifolia in the cities of Oceanside and San Marcos are not yet addressed under the MHCP because these cities have not completed their respective subarea plans; B. filifolia occurrences in these cities are not yet assured of conservation or management and remain threatened by development (USFWS, 2009).

Stressor: Alteration of hydrological conditions (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Alteration of site hydrology as a result of urbanization potentially threatens Brodiaea filifolia. Brodiaea filifolia requires moist clay soils to facilitate seedling and cormlet disposition to an appropriate soil depth, and corm persistence through seedling and adult phases of flowering and fruit set. Development projects upslope and adjacent to B. filifolia occurrences may dewater the site, interfering with these processes. Conversely, water runoff from nearby developments may inundate B. filifolia occurrences with excessive amounts of water, depositing silt, and drowning plants. Alteration of hydrological conditions and channelization currently pose a threat to five B. filifolia occurrences in Riverside County (USFWS, 2009).

Stressor: Discing and mowing (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: There are at least 12 occurrences of Brodiaea filifolia threatened by discing or mowing, but additional occurrences may also be subject to this because site-specific threats are not fully known for all of the extant occurrences. Discing may cut up and/or bury the entire plant, including the underground corms. Either of these actions suppresses growth and reduces reproductive output. Systematic discing up to four times a year has been reported on some sites along the San Jacinto River (Roberts, in litt. 2003, p. 1). In 2008, Service staff noted habitat

degradation and recent discing within the Case Road occurrence (A. Braswell, U.S. Fish and Wildlife Service, pers. obs. 2008, p. 3). Illegal discing was also reported at the Oleander/San Marcos Elementary occurrence in the City of San Marcos, San Diego County, impacting an estimated 3,802 individual plants (Dudek 2005, p. 19). Mowing may reduce the production and dispersal of seeds, alter the associated vegetation needed for pollinator activity, or reduce the number and vigor of plants present by cutting off the leaves (Service 2005a, p. 73839). Mowing has occurred at two sites in the City of Oceanside (USFWS, 2009).

Stressor: Nonnative plants (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Invasive, nonnative plants may compete for space and resources, and alter habitat in an area to the extent that it no longer supports B. filifolia. Since listing, Dudek (2006) identified the invasion of nonnative plants as likely “the main stressor” to seven occurrences within southern Orange County (Dudek 2006, p. E-440). Some Brodiaea filifolia preserves within the City of Carlsbad in San Diego County have required significant effort to control nonnative plants (J. Vinje, Center for Natural Lands Management, pers. comm. 2007, pp. 1-3). Approximately 25 percent (17 of 68) of Brodiaea filifolia occurrences are currently reported to be threatened by nonnative plants (USFWS, 2009).

Stressor: Grazing (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Dudek (2006, p. E-440) identified cattle-related impacts, including trampling and crushing of soils, and browsing of vegetation and flower stalks during the growing season as an “environmental stressor” to seven occurrences of B. filifolia in southern Orange County (Dudek 2006, p. E-440). Grazing may be a threat to about 18 percent (12 of 68) of Brodiaea filifolia occurrences, primarily by trampling of plants, but rangewide it is not likely to pose a threat to the continued existence of B. filifolia (USFWS, 2009).

Stressor: Off-highway vehicles (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: At least 18 percent (12 of 68) of Brodiaea filifolia occurrences are noted as threatened by OHV activity. In addition, occurrences impacted or threatened by development may be threatened by this activity due to lack of protection from OHV access and close proximity to roads (USFWS, 2009).

Stressor: Manure dumping (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Since listing, manure dumping was recognized by the Service as a threat to 2 of the 4 occurrences of Brodiaea filifolia along the San Jacinto River in Riverside County (Service 2005a, p. 73821; Table 1). Dumping of livestock manure results in physical disturbance of the soil surface,

burial of the plants and seed bank, and dilution or alteration of the alkali character of soil or soil chemistry (Roberts, in litt. 2005a, p. 1). These changes create conditions more favorable to invasive nonnative plants that would otherwise be hampered by the higher alkaline nature of the soil (Roberts, in litt. 2005a, p. 1). Although manure dumping threatens Brodiaea filifolia where such activity occurs, this threat is localized to certain areas within Riverside County and is not a rangewide threat to the species (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)
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. 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 5–6° F (Morse et al. 1995, p. 393). Whether or not this would include Brodiaea filifolia is unknown (USFWS, 2009).

Recovery

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

Recovery Priority Number: 8C

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

Recovery Actions:
- Not available - this species does not have a recovery plan.
- Work with partners to help conserve Brodiaea filifolia. Identify opportunities through the Service's Partners for Fish and Wildlife Program to seek habitat restoration and enhancement opportunities. Acquire and protect sites with large or geographically distinct B. filifolia occurrences, such as those found at: San Dimas, Arrowhead Hot Springs, the San Jacinto River, Cristianitos Canyon, the undeveloped Darwin parcel, the Upham site, and Artesian Trails (USFWS, 2009).
- Determine the status of management and monitoring, and control on nonnative plants at sites that have been set aside for conservation including, but not limited to: Darwin Knolls and Darwin Glen, Arbor Creek/Colucci, Calavera Heights Mitigation site, FoxMiller, Taylor Made, Rancho Carrillo, and New Millennium (USFWS, 2009).
- Reestablish effective management at sites formerly managed by TET, including the Newton Business Center site and the Mission View/Sierra Ridge site (USFWS, 2009).
- Work with partners to conduct research for the conservation of Brodiaea filifolia: a. Determine the home ranges and species fidelity of pollinators of B. filifolia and their impact on recruitment. b. Work with Camp Pendleton in the design and implementation of a study investigating soil characteristics that facilitate B. filifolia establishment and propagation. c. Work with Rancho Santa Ana Botanic Garden's to design and implement a germination study. d. Determine the relationship of B. santarosae to B. filifolia, its habitat specificity, and its distribution (USFWS, 2009).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS To recover Brodiaea filifolia, we need to conserve additional 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 B. filifolia. We recognize that conservation of this species will require cooperation and coordination with partners. 1. Conduct a Species Status Assessment to analyze the species resiliency, redundancy, and representation in light on new occurrences and conservation efforts. 2. Monitor known and historical occurrences to determine presence and condition of Brodiaea filifolia. Evaluate threats and develop site-specific recommendations to prioritize management actions. 3. Model suitable habitat across the range of Brodiaea filifolia and prioritize areas for further survey. 4. Conduct further research to understand pollinator composition and availability, and the potential effects of low seed set on Brodiaea filifolia viability and recovery. 5. Characterize the genetic variation and population structure to understand the level of gene flow between occurrences. Evaluate the extent of hybridization. Conduct phylogenetic studies to determine the relationship to Brodiaea santarosae. 6. Develop a reintroduction, augmentation, and translocation program to improve connectivity between populations and enhance the resiliency of small populations. Outline techniques for successful restoration and translocation. 7. Collect Brodiaea filifolia seed and corms from occurrences throughout the range and conserve seed in an off-site conservation seed bank or botanic garden as appropriate. 8. Adaptively manage Brodiaea filifolia habitat to maintain, enhance, or restore habitat and maintain population viability over time. Use the site-specific recommendations developed under actions 1–3 above, including measures to enhance habitat for native pollinators and ameliorate threats. 9. At Brodiaea filifolia occurrences that are not conserved, identify opportunities to work with landowners to acquire lands or encourage conservation actions for Brodiaea filifolia. Work with local, State, and Federal partners to identify and leverage funding (i.e., section 6) to acquire occupied and potential habitat. 10. Identify adaptive management and monitoring approaches that could be applied rangewide, especially regarding invasive species management and promoting pollinator habitat. (USFWS, 2023).

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SPECIES ACCOUNT: *Brodiaea pallida* (Chinese Camp brodiaea)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/14/1998; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A perennial herb from an underground bulb. Leaves are narrow, fleshy, reaching 1-3 dm in height. Several to many lilac-colored flowers, each 2 cm across, bloom at the tip of the flowering stem in late May to early June (NatureServe, 2015).

Taxonomy

Grows in association with 2 sympatric congeners and can hybridize with 1 of them (Keator 1993 as cited in USFWS 1994). Despite this, the species is considered stable (Blaine Rogers, Collumbia College, as cited in USFWS 1994) (NatureServe, 2015). A member of the Themidaceae (false onion family) (USFWS, 2012).

Historical Range

This plant species was first discovered in the Town of Chinese Camp in Tuolumne County (USFWS, 2012).

Current Range

Currently occurs in Calveras county and Tuolumne county, CA (USFWS, 2012).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual: vegetative; sexual: cross-pollination (USFWS 2012)

Lifespan

Adult: > 2 years (inferred from USFWS, 2012)

Breeding Season

Adult: May - June (USFWS, 2013)

Key Resources Needed for Breeding

Adult: Germination: unknown; pollination: insects, especially solitary bees (USFWS, 2012)

Reproduction Narrative

Adult: Daughter corms are the primary reproductive units of B. pallida (Hoover 1938; R. Ornduff, University of California, Berkeley, California, in litt. 1989; F. Hrusa, California Department of Food and Agriculture, pers. comm. 2000) and are identical genetically to the main (parent) corm. By March, the buds have developed and the flower stalk elongates. However, the flowers do not open until late May or early June, and flowering lasts only 2 to 3 weeks. The seeds are mature by late summer (Hoover 1939, Niehaus 1971) but probably are not dispersed until the capsule ruptures in the autumn, which is typical of other Californian Brodiaea species (Schmidt 1980). Conditions conducive to triggering natural germination are also unknown. Members of the genus Brodiaea are self-incompatible and cannot sexually reproduce without the aid of insect pollinators (Niehaus 1971; Preston 2011). Therefore, cross-pollination is essential for the survival and recovery of B. pallida. A variety of insects are known to cross-pollinate Brodiaea, including native bees (Krombein and Hurd; 1979; Michener 2000) and tumbling flower beetles (Preston 2011). Due to the focused foraging habits of solitary bees, they may be the most important for the successful reproduction of B. pallida. As perennial plants, Brodiaea pallida individuals persist from year to year (USFWS, 2012).

Habitat Type

Adult: Terrestrial, wetland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Valley and foothill grassland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Mesic conditions (inferred from USFWS, 2012)

Geographic or Habitat Restraints or Barriers

Adult: Occurs ~380 m elevation (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Linear (inferred from NatureServe, 2015)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Inhabits an old, intermittent (vernal) stream channel with a serpentine substrate; about 380 m elevation. Occurs in valley and foothill grassland (vernal streambeds, serpentinite) (California Native Plant Society 2001). This species requires specific edaphic factors (NatureServe, 2015). Brodiaea pallida grows in overflow channels, seeps, and springs in clays that may be derived from serpentine soils (Safford et al. 2005; Service 2008; California Natural Diversity Database (CNDDB) 2011) (USFWS, 2012).

Dispersal/Migration

Dispersal

Adult: Low (USFWS, 2012)

Dispersal/Migration Narrative

Adult: Brodiaea seeds are large and do not disperse far from the parent plants. Therefore the rate of dispersal is very low (USFWS, 2012).

Population Information and Trends

Population Trends:

Declining (USFWS, 2022)

Number of Populations:

3 (USFWS, 2022)

Population Size:

Chinese Camp population ~30 in 2022. Sawmill/Black Creek population ~6,800 in 2017. Littlejohns Creek population ~112 in 2019 (USFWS, 2023)

Population Narrative:

The number of genetic individuals is unknown because this species spreads by producing suckers and shoots (USFWS 1998). The number of ramets is estimated at around 10,000 individuals (CNDDB 2003). Only two occurrences exist near Chinese Camp, California in Calaveras and Tuolumne counties (CNPS 2001, CNDDB 2003). The occurrences of this species are reported to be increasing in numbers (CNDDB 2003) (NatureServe, 2015). Currently, B. pallida is known from three populations. Two of the populations occur in in southern Calaveras County, near Copperopolis California; the other population occurs near Chinese Camp in northern Tuolumne County. The number of genetically unique individuals in the three populations is unknown (USFWS, 2012). 3 populations. Chinese Camp population ~30 in 2022. Sawmill/Black Creek population ~6,800 in 2017. Littlejohns Creek population ~112 in 2019 (USFWS, 2023)

Threats and Stressors

Stressor: Development (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Currently, B. pallida is still threatened by development. Additionally, B. pallida is potentially threatened by alteration of site hydrology as a result of development. Development projects upslope and adjacent to B. pallida populations may dewater the site. Conversely, water runoff from nearby developments may inundate B. pallida occurrences with excessive amounts of water, depositing silt, and drowning plants. Residential development outside of the populations themselves could indirectly affect the habitat for B. pallida in both counties by modifying stream contours during the construction of roads (Hrusa, pers. comm. 2000; Stone, pers. comm. 2001) or firebreaks (CNDDB 2006), and by altering hydrology in adjacent streams. Only a small part of the Tuolumne County site receives some level of protection through a temporary lease by an environmental organization, and residential development for another part of the site has been planned in the past and is not precluded for the future. The Calaveras County populations are being designated and considered for residential development (USFWS, 2009).

Stressor: Small population size (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Small population size increases the susceptibility of a population to extirpation from random demographic, environmental, and/or genetic events (Service 1998). The combination of

only two populations, small range, and restricted habitat still renders B. pallida highly susceptible to extinction from a significant portion of its range due to random events such as flood, drought, disease, or other factors. Another concern is the possible lack of genetic diversity in the two Brodiaea pallida populations due to the species' tendency toward vegetative reproduction (Ornduff, in litt. 1989). The preponderance of vegetative reproduction in B. pallida may limit the opportunities for production of new genotypes, and the great physical distance (about 24 kilometers [15 miles]) between the two known populations likely precludes the opportunity for natural transfer of pollen, seeds, or corms between them (USFWS, 2012).

Stressor: Nonnative vegetation (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Increased nitrogen deposition initially causes ecological perturbations by altering microbial and plant communities. One of the primary adverse effects is the enhancement of environmental conditions for the invasion of non-native weeds, which outcompete native plants (Padgett et al. 1999; Allen et al. 2005), particularly star thistle and non-native grasses such as rip-gut brome. These invasive exotic plants "choke out" native plants through extensive proliferation, and significantly reduce the available area for colonization of native plant species and ground-nesting pollinators. Weeds also grow so densely that Brodiaea pallida may not easily be found by its pollinators. Nitrogen deposition also affects the natural fire cycle because of greater fuel loads caused by the excess growth of non-native grasses and weeds (D'Antonio and Vitousek 1992). Nonnative vegetation occurs in at least two of the populations (ICF Jones & Stokes 2009; CNDDB 2011) (USFWS, 2012).

Stressor: Loss of pollinators (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: A number of the native bee species that pollinate Brodiaea pallida could be adversely affected by insecticides and other pesticides associated with the Oak Canyon Ranch or other developments. A number of the solitary, semi-solitary, or colonial bees that pollinate this plant make their nests in the ground, and they could be vulnerable to toxic chemical agents that are the result of runoff from the proposed project. Their ground nests also could be adversely affected by increased seasonal flows, especially summer flows that could flood out the animals, thus eliminating or preventing these insects from inhabiting the area (USFWS, 2012).

Stressor: Climate change (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Ongoing climate change (Inkley et al. 2004; Kerr 2007; Adger et al. 2007; Kanter 2007) likely imperils Brodiaea pallida 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 at a rate equal to the change in environmental conditions (USFWS, 2012).

Stressor: Grazing (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: In the final listing rule as well as in the subsequent status reviews, we noted that it is unclear whether grazing is beneficial or detrimental to Chinese Camp brodiaea (Service 1998, p. 49029; Service 2008, pp. 6–7; Service 2012, p. 9). Observation of herbivory are for the most part assumed to be from grazing, although it is also possible that herbivory by deer or other herbivores could impact the species. At this time, it appears that at least some level of grazing is likely beneficial to the species, but that herbivory between flowering and seed set could greatly impact sexual reproduction. The effects on plants from livestock grazing are highly variable and dependent on many factors, including but not limited to the timing, intensity, and duration of livestock use. Negative impacts from grazing include direct consumption and habitat trampling. Grazing during flower development or blooming season could result in direct consumption of the above-ground parts of the plant (Niehaus 1977, p. 1), which can reduce or eliminate seed output. The potential for this to affect the species would be related to the grazing intensity, or the number of cattle or other livestock in an area. Although the primary method of propagation is asexual reproduction via corms, seed production is important for genetic diversity. Reduction in seeds could lead to short-term decreases in new growth, as well as limiting the ability of the species to produce a seedbank. Grazing can also result in trampling or soil compaction. While trampling from livestock could result in soil compaction, accelerated erosion of soils, and breaking of corms, the severity and magnitude of this stressor at any of the three known occurrences is unknown at this time. Trampling can also affect habitat by reducing rainfall infiltration rates (Warren et. al. 1986, pp. 493-494). Although moderate-intensity cattle grazing at the Sawmill/ Black Creek location in 2008 was not thought to be having an adverse effect on Chinese Camp brodiaea plants (ICF Jones & Stokes 2009, p. 4), in 2017 severe damage to Chinese Camp brodiaea was noted (Brenneman in litt. 2017). Of the 6,800 plants counted in June of 2017, only 50 to 60 plants were counted in July of that year. At that time, the only surviving plants were found among the tall boulders inaccessible to grazing cattle. While grazing at an inappropriate time or intensity can result in damaging effects to Chinese Camp brodiaea and its habitat, as stated above, it is possible for grazing to occur in a manner that supports and even encourages growth of Chinese Camp brodiaea. In areas that contain both Chinese Camp brodiaea and non-native plants, grazing that occurs after seed has matured and before substantial leaf emergence/flower development may be beneficial in reducing competing vegetation. The consumption and removal of non-native plants would increase bare soil areas, sunlight exposure, and access to water and minerals. In April 1991, The Nature Conservancy and the Plant Society purchased and installed fencing and gates surrounding the Chinese Camp brodiaea population at Chinese Camp to protect the population from the effects of grazing (Lozier in litt. 1991; Stone in litt. 2001). At that time, the Plant Society also entered into a lease agreement with the landowner, paying him to exclude his cattle from the area for one year. Though to our knowledge this agreement has ended, the area is still ungrazed and the fencing and gates remain. The area has experienced an increase in weedy species such as barbed goatgrass (Aegilops triuncialis), wild oat (Avena fatua), tarweed (Hemizonia spp.), and spikeweed (Centromadia pungens) in recent years (Congdon in litt. 2018). Though annual trend data are not available, it is likely that the removal of cattle at the Chinese Camp population precipitated the increase in these non-native invasive plants and a decrease in Chinese Camp brodiaea. Therefore, it is likely that appropriate grazing, managed to reduce competing non-native plants, may have a beneficial effect on the

species at the Chinese Camp site (USFWS, 2022).

Stressor: Development (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: Because all three Chinese Camp brodiaea populations are located on privately owned lands that are vulnerable to development impacts, with no provision for protection or management, development continues to be a threat. The General Plans for both Calaveras County and Tuolumne County were updated in November 2019 and December 2018, respectively (Calaveras County 2019, entire; Tuolumne County Community Resources Agency 2018, entire). Potential development in Calaveras County threatens both populations in that area. Black Creek Ranch, which contains the Sawmill/Black Creek population, was slated for development as of the last status review (Service 2012, p. 8). The property was recently sold to a different developer that plans to proceed with residential development on the hilltops surrounding the plants (Lewis in litt. 2020). Portions of the property that contain Chinese Camp brodiaea will not be developed according to the most recent plans, but the plant could still be affected by any increased run-off or irrigation. Also in Calaveras County, Sawmill Lake is a planned future community that consists of a 245-acre extension to the Copperopolis Town Square upstream of the Chinese Camp brodiaea occurrences and Copper Valley Ranch is a future community that is being developed on the North Shore of Lake Tulloch. An online website (Copper Valley Realty 2020) that has since been removed included detailed information about the type of residential units planned for the development; however, that information is no longer available and we are not aware of the current status of this project. A motion to amend the land use of Copper Valley from Resource Production to Working Lands, which would allow increased residential development of those lands, was voted down at a June 2019 planning commission meeting (Calaveras County Planning Commission 2019). Overlaying the Calaveras County General Plan with Diversity Database occurrences of Chinese Camp brodiaea shows that the Sawmill/Black Creek population occurs on lands labeled as Resource Production, Working Lands, and Rural Residential, and that the Littlejohns Creek population is on parcels labeled as Working Lands and Resource Production (Calaveras County Open Data 2021). Descriptions of the land use designations are provided in the general plan (Calaveras County 2019, pp. LU5–LU7). Briefly, Resource Production identifies lands capable of and primarily used for agricultural operations, timber production and/or mineral resource production, and also includes lands with conservation easements. Working Lands have a slightly higher population density than Resource Production (0.06–0.12 person/acre compared to 0.015– 0.06 person/acre) and are generally on smaller parcels than lands designated as Resource Production, but are still suitable for agricultural and forestry practices. The Rural Residential designation identifies rural residential uses in areas appropriate for or that were previously subdivided into lots of one acre or larger where public sewer is not available. The development agreement for the Oak Canyon Ranch development project (upstream of the Black Creek/Sawmill Creek and Littlejohns Creek populations) that was described in the previous status review (Service 2012, pp. 7-8) was rescinded in 2018. Oak Canyon Ranch is now under conservation easement (California Rangeland Trust 2020) (see Land protection below). In Tuolumne County, proposed development projects described in the previous status review (Service 2012, p. 8) include development of 93 hectares (230 acres) at a private ranch, as well as an unnamed project at the junction of Highway 108 and Highway 120. The private ranch includes Chinese Camp brodiaea on the property, while the latter project could have potential impacts to hydrology. In 2016, the Tuolumne County Planning Department reported that both of these projects were on

hold because of a lack of water accommodations (Paszkowski pers. comm. 2016). As of 2021, there is no active project for development at the private ranch. The Highway 108/120 junction project requires an Environmental Impact Report and there is no date or timeline for the project moving forward (Rizzi in litt. 2021) (USFWS, 2022).

Stressor: Altered hydrology (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: Changes to the amount and/or inundation period of water in, upstream, or adjacent to Chinese Camp brodiaea habitat could impact the species. These changes could occur through a variety of mechanisms including, but not limited to, development, land use changes, increases in the frequency and severity of precipitation events associated with climate change (both deluges and droughts), and vegetative community changes. Development can lead to increased flows if irrigation or other sources discharge into streams, or can reduce flows if water is diverted away from the natural flow. For example, summer irrigation or upstream drainage (Tuolumne County Planning Department 1982, p. 3), or damming of a stream (Hrusa pers. comm. 2000 in Service 2008, p. 6) could lead to perennially wet conditions and prevent required drying of the soils supporting Chinese Camp brodiaea. Vegetation impeding drainage through a culvert near the Chinese Camp population has been observed in association with ponding above that area, which could make that habitat unsuitable for Chinese Camp brodiaea if excessive inundation causes corms to rot (Congdon in litt. 2020). Land has been increasingly converted to cannabis farms in Calaveras and Tuolumne Counties, which can also alter hydrology. Land converted to this use, especially when irrigation water is illegally diverted from natural waterways, has the potential to impact Chinese Camp brodiaea habitat. The Calaveras County Board of Supervisors legalized commercial cannabis cultivation for approximately 190 formerly registered growers in 2018, despite objections from some that the county's environmental impact report does not address foreseeable impacts to water resources (Calaveras Enterprise 2019). Information has not been gathered to date on the total amount of water used, the extent of fertilizer and pesticide use, and the extent of habitat destroyed by cannabis cultivation. In Tuolumne County, commercial grows of cannabis are not legal (Tuolumne County 2021). A personal grow cannabis ordinance that passed in 2018 requires those planning outdoor grows to register for a permit and limits the number of plants allowed (Tuolumne County 2018, pp. 17-166–17-168). Increases in greenhouse gas emissions during the 20th century have already 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). Climate change in the Sierra Nevada region specifically is predicted to lead to increases in temperature and extreme precipitation events (i.e., both deluges and droughts); a change in the elevation of transition from rainfall to snow, and more rainfall instead of snow at higher elevations; and substantial decreases in snowpack. Because the watersheds containing Chinese Camp brodiaea habitat are influenced by local rainfall rather than snowmelt (Preston in litt. 2020), changes to snowfall and snowpack are unlikely to impact the species. The increase in precipitation extremes (i.e., both deluges and droughts) may have a bigger impact on Chinese Camp brodiaea populations than the changes in average rainfall and snowfall (USFWS, 2022).

Stressor: Hybridization (USFWS, 2022)
Exposure:
Response:

Consequence:
Narrative: A potential future threat to the species is hybridization with harvest brodiaea (Brodiaea elegans), a related native species common on drier ground (Niehaus 1971, p. 54). Because we have no information that hybridization is currently spreading or causing a trend towards endangerment or extinction, we do not consider hybridization a current threat to the species; however, additional information about current trends or increases in the extent or areal coverage of hybrids could change this assessment. Hybridization could be a potential threat in the future because harvest brodiaea is associated with drier habitat and altered hydrology that reduces stream flow could theoretically increase populations of hybrids. Hybrids can be distinguished from either of the two parent species by their appearance. Specifically, Chinese Camp brodiaea have staminodes near stamens and are not appressed to tepals, giving a “waist-like” appearance, whereas harvest brodiaea have staminodes held away from stamens and appressed to tepals (no waist); hybrids are intermediate between the two in these respects (Congdon in litt. 2020). At the time of listing, the Service specified that it was not listing hybrids between Chinese Camp brodiaea and harvest brodiaea (Service 1998, p. 49022). To our knowledge all hybrids occur in the immediate vicinity of the Chinese Camp population of Chinese Camp brodiaea. Surveys in 2017 for Chinese Camp brodiaea at Chinese Camp found that predominantly hybrids appeared to be present within the Plant Society fenced area (Congdon in litt. 2017c), but in 2018 there were more Chinese Camp brodiaea than hybrids (Congdon in litt. 2018). Harvest brodiaea is common at that site, but uncommon at the sites in Calaveras County (USFWS, 2022).

Recovery

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

Recovery Priority Number: 2C

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

Recovery Actions:
- Not available - this species does not have a recovery plan.
- Work with private landowners to determine the entire extent of the extant populations and monitor the status and trends of Brodiaea pallida in order to estimate current population sizes (i.e., number of above-ground stems), the number and distribution of populations, and whether the species is stable, increasing, or declining (USFWS, 2012).
- Seed collection and accession. Collect mature seed during a minimum of two years from the Sawmill Creek and Black Creek population (and if possible from the Littlejohns Creek population). Collect seed from no more than 5 percent of plants at each population in each year and store in at least two locations approved by the Service in the event that the population(s) fails. Eventually reach a goal of 1,000 stored seeds. Seed storage locations should be affiliates of the Center for Plant Conservation. Collection of seed shall be conducted in a manner that will not significantly harm the reproductive potential of the population for that year and shall be made in a manner that captures the majority of the genetic variation found in the sampled population. Different genotypes or seed from different occurrences shall not be intermingled during collection or storage activities

(USFWS, 2012).
- Continue surveying for Brodiaea pallida in suitable habitats on substrates other than serpentine to determine if additional populations exist (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 Chinese Camp brodiaea. Some of these recommendations have already been discussed in previous recovery documents (Service 2008, pp. 9–10; Service 2012, p. 15) and remain valid. 1. Complete and publish a draft recovery plan, and approve a final recovery plan. The recovery plan will likely contain additional information about many of the elements described in the recommendations below. 2. Habitat protection. Work with private landowners to provide permanent protection for lands upstream and occupied by Chinese Camp brodiaea. 3. Habitat management. Work with private landowners and partners to implement habitat management practices that benefit Chinese Camp brodiaea. Volunteers from the Plant Society have expressed interest in helping to maintain the Plant Society fenced area (e.g., pulling weeds) given appropriate guidance from species experts and support from the land owner (Krajnovich in litt. 2021b). 4. Monitor known populations. Work with private landowners to determine the entire extent of the extant populations and monitor the status and trends of Chinese Camp brodiaea in order to estimate current population sizes (i.e., number of above-ground stems), the number and distribution of populations, and whether those populations are stable, increasing, or declining. 5. Seed collection and accession. Work with private landowners to obtain permission for seed collection if possible. Collect mature seed over a minimum of two years from the Sawmill Creek/Black Creek and Littlejohns Creek populations. Collect seed from no more than 5 percent of plants at each population in each year and store in at least two locations approved by the Service in the event that the population(s) fails. Seed storage locations should be affiliates of the Center for Plant Conservation and seed collection should follow best plant conservation practices (Center for Plant Conservation 2019). 6. Survey for additional populations. Continue surveying for Chinese Camp brodiaea in suitable habitats on substrates other than serpentine to determine if additional populations exist (USFWS, 2022).

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SPECIES ACCOUNT: *Carex albida* (White sedge)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/22/1997; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A perennial herb in the sedge family (Cyperaceae) with short fiber-covered rhizomes. The culms (stems) are triangular, 4 to 6 decimeters (1.3 to 2.0 feet) tall, erect, and longer than the leaves. Several traits distinguish C. albida from other closely related sedges. Carex albida has inflorescences with staminate (male) flowers above the pistillate (female) flowers, especially on the terminal inflorescence, lateral spikelets, and leaves that are shorter than the stems and 3 to 5 millimeters (0.1 to 0.2 inch) wide. Some individuals of C. lemmonii (Lemmon's sedge), which has not been documented in Sonoma County, resemble C. albida, but differ in perigynia and fruit size, and in other respects. (USFWS, 2009)

Taxonomy

Since the previous status review (USFWS 2009), white sedge (Carex albida) has been found to be morphologically indistinguishable from Lemmon's sedge (Carex lemmonii), a species which is wide-ranging and abundant throughout the North-Coast and Sierra Cascade mountain ranges of California (Calflora 2018; Zika et al. 2015). In light of this new information, here we summarize the available taxonomic information available on white sedge. The first specimen for white sedge was collected in 1854 by botanists during an exploratory expedition to find a railway route from the Mississippi River to the Pacific Ocean (Torrey and Gray 1857). These specimens were probably collected from Santa Rosa Creek, in the Laguna de Santa Rosa wetland complex in Sonoma County (Howell 1957; Best et al. 1996). No specimens were collected again until the early 1900's (Howell 1957). The initial type specimen from 1854 was immature, which lead to confusion among botanists, and for many decades, there were few additional collections of the species to compare (Zika and Wilson 2012). Several early taxonomic studies questioned the validity of white sedge as a distinct species. Mackenzie (1922) combined white sedge with the woodrush sedge (C. luzulina), and later grouped white sedge with the Lemmon's sedge (Mackenzie 1940). Sedge specimens from Pitkin Marsh were initially defined as a distinct species, C. sonomensis (Stacey 1937). However, in 1957 C. sonomensis was combined with white sedge, while remaining distinct from Lemmon's sedge (Howell 1957). Howell based his taxonomic description on the immature specimen collected in 1854, and used assumptions about the suspected morphology of mature plants to conclude that adult white sedge plants would have unique morphology from Lemmon's sedge (Howell 1957). This nomenclature has been accepted since 1957, although it has been difficult for botanists to reconcile similarities in morphology between the species (Mastrogiuseppe 1993; Zika et al. 2012). According to the 2009 status review (USFWS 2009), there were several traits which distinguish white sedge from closely related sedge species. White sedge inflorescences have staminate (male) flowers above the pistillate (female) flowers (USFWS 2009) and the leaves are generally shorter than the stems (USFWS 2009). However, Lemmon's sedge have similar leaf, stem, and inflorescence traits (Zika et al. 2015). The only trait specifically mentioned to differentiate the white sedge and Lemmon's sedge was the size of the perigynium (scale-like leaf enclosing a pistil (male flower)) and achene (small, dry seed or fruit) (USFWS 2009). Taxonomists often use the shape of perigynia to separate closely related Carex species (Zika and Wilson 2012), as the character is unique to the sedge family (Harris and Harris 2001). Zika and Wilson (2012) evaluated the morphological characters various botanists have used to discriminate between white sedge and Lemmon's sedge. The authors first reviewed the literature to determine morphological characters used to separate the taxa in previous taxonomic descriptions (Ball and Mastrogiuseppe 2002). Based on their research, morphological characters of the perigynum, achene, inflorescence, and foliage (leaf width) were measured on museum specimens (Zika and Wilson 2012; Harris and Harris 2013). Specimens of Lemmon's sedge came from 12 counties in California, and represented several isotypes (Zika and Wilson 2012). Leaf width was measured on fresh specimens of Lemmon's sedge from three counties and on cultivated white sedge (Zika and Wilson 2012). Zika and Wilson (2012) were not able to separate white sedge and Lemmon's sedge using perigynium differences, which was a previously accepted method for differentiating the two taxa (USFWS 2009). The only character, which was measurably different in white sedge plants, was leaf blade width (Zika and Wilson 2012). However, field visits to Butte, Mariposa, and San Bernardino counties show broad variation in many characteristics within Lemmon's sedge, including a number of individuals that resembled white sedge (Zika and Wilson 2012). Statistical results for all characteristics showed that white sedge did not differ from Lemmon's sedge (F=0.27, P-value = 0.99) (Zika and Wilson 2012). Except for leaf width, all characteristics were well within the range of variation found among Lemmon's sedge plants (Zika and Wilson 2012). If considered alone, the variation of leaf width might be enough to distinguish between the two taxa. However, there is still significant overlap in leaf width variation between the white sedge and Lemmon's sedge (Zika and Wilson 2012). Therefore, statistical results fail to separate white sedge and Lemmon's sedge as distinct entities. Because Lemmon's sedge was named before white sedge, it is appropriate to synonymize both entities under the same scientific name for Lemmon's sedge, Carex lemmonii. Currently, botanists are testing Zika and Wilson's (2012) hypothesis to determine if genetics can confirm the conclusion of their 2012 study (usfws, 2019)

Historical Range

See current range/distribution.

Current Range

Known only from a 10 square km area in Sonoma County, California. (NatureServe, 2015).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available

Habitat Type

Adult: Marshes and sphagnum bogs. (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Bog/fen, herbaceous wetland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Acidic wetlands (USFWS, 2009)

Geographic or Habitat Restraints or Barriers

Adult: Restricted to freshwater wetlands with acidic, sandy/peaty fens, perennial wetlands, hillside seeps, and elevations between 45 and 60 m (USFWS, 2009)

Spatial Arrangements of the Population

Adult: Colonies (USFWS, 2009)

Environmental Specificity

Adult: Narrow/specialist

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 2009)

Site Fidelity

Adult: High (inferred from USFWS, 2009)

Habitat Narrative

Adult: The only extant occurrence of Carex albida is found in perennial freshwater wetlands and hillside seeps, between 45 and 60 meters in elevations. These marshes have acidic sandy/peaty fens and supports mixed native willow riparian, oak woodland, grasslands, perennial freshwater marsh containing seeps and other diverse wetland features such as two quaking fens. Plant surveys in 2008 documented six colonies or patches. The species continues to be known from only one extant occurrence in the world in patches totaling no more than 5 acres (USFWS, 2009). White sedge (Carex albida) is an herbaceous perennial in the sedge family (Cyperaceae). There has only ever been one, confirmed population in Sonoma County, California since 1997 at a site known as Pitkin Marsh (USFWS 1997). The marsh is a riparian wetland with a unique microclimate, fed most of the year by underground seeps (USFWS 1997).(USFWS, 2019)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Decreasing (USFWS, 2009)

Species Trends:

Decreasing (NatureServe, 2015)

Number of Populations:

1 extant occurrence (USFWS, 2009)

Population Size:

~300 (USFWS, 2009)

Population Narrative:

3 historically known occurrences were extirpated by wetland drainage, channelization of a stream, and by the disposal of cannery waste (CNPS 2001). At the time of listing Carex albida was known from a single extant occurrence with approximately 1,000 individuals. Current, Carex albida continues to be known from only occurrence in Sonoma County with approximately 300 reproductive stems.

Threats and Stressors

Stressor: Drought
Exposure:
Response:
Consequence:
Narrative: Factors cited to contributing to the low count were the driest spring on record, low temperatures during spring 2008, which could have reduced culm formation and flowering, and also the density and height of nonnative grasses that made it difficult to detect C. albida (Warner, 2008). (USFWS, 2009)

Stressor: Low temperatures
Exposure:
Response:
Consequence:
Narrative: Factors cited to contributing to the low count were the driest spring on record, low temperatures during spring 2008, which could have reduced culm formation and flowering, and also the density and height of nonnative grasses that made it difficult to detect C. albida (Warner, 2008). (USFWS, 2009)

Stressor: Well installations
Exposure:
Response:
Consequence:
Narrative: The marsh had become drier by the time of listing because the addition of wells and other construction had altered the marsh ecology (Guggolz, in litt. 1993). Drying of wetlands would not only directly impact the species but would encourage the spread of blackberries, which have become dominant in other parts of the marsh that have been drained (DFG 1993; Guggolz, in litt. 1993; CNDDB 1996).

Stressor: Loss of habitat
Exposure:
Response:
Consequence:
Narrative: The threat of direct loss of historical habitat, particularly in the upper northern marsh continues with the incremental addition of new rural residences, driveways, and new agricultural operations (e.g., vineyards). Indirect effects of the impervious or bare surfaces from residential and agricultural land uses, respectively, accelerate runoff, increases nutrient loading, erosion, and sedimentation in the marsh and result in changes in soil pH and nutrients, in an otherwise acidic nutrient poor soil type. (USFWS, 2009)

Stressor: Water treatment facility
Exposure:
Response:
Consequence:
Narrative: Impacts cited in the 1997 listing from the water treatment facility located approximately 300 meters downstream of the northern marsh included the potential application of recycled treated water on potentially suitable, but unoccupied habitat downstream, but within the historical range of Carex albida through modification of surface hydrology (Environmental Science Associates 1993). (USFWS, 2009)

Stressor: Highway maintenance and construction
Exposure:
Response:
Consequence:
Narrative: The State highway is located downstream and within 46 meters of the nearest colony of Carex albida. County road maintenance crews periodically trim back the willows and other riparian species from the road edges, which leave openings that facilitate invasion of weedy species. If highways were ever widened, it would involve encroachment into the wetland area which would impact the hydrology, possibly resulting in the direct loss of occupied habitat, and facilitate the invasion of nonnative vegetation. (USFWS, 2009)

Stressor: Surrounding land practices
Exposure:
Response:
Consequence:
Narrative: C. albida continues to be vulnerable to threats from surrounding land use practices which have potential to adversely alter surface and subsurface hydrology, and from competition from invasive species, and potential disturbance from repair or alteration of a nearby State highway. (USFWS, 2009)

Stressor: Invasive plants
Exposure:
Response:
Consequence:
Narrative: Invasive, nonnative blackberries and grasses as well as native willow have encroached into the habitat of these species and appear to be increasing in density in recent years (Cooley, pers. Comm. 2008). (USFWS, 2009)

Stressor: Foot traffic
Exposure:
Response:
Consequence:
Narrative: Trampling from increased human foot traffic for scientific, educational, and possible recreational purposes poses a threat. Carex albidia blends with surrounding vegetation and can be difficult to identify. (USFWS, 2009)

Stressor: Climate change

Exposure:
Response:
Consequence:
Narrative: A trend of warming of western North America is expected to decrease snowpack, hasten spring runoff, and reduce summer stream flows (IPCC 2007). Increased summer heat may increase the frequency and intensity of wildfires (IPCC 2007). Rapid climate change may place native species with long generation times at a disadvantage because they cannot quickly move into newly suitable habitat. (USFWS, 2009)

Stressor: Random events
Exposure:
Response:
Consequence:
Narrative: The habitat is extremely limited and isolated through their ranges due to the natural rarity of their habitat. (USFWS, 2009)

Recovery

Reclassification Criteria:
Reclassification criteria is not available.

Recovery Priority Number: 5C

Delisting Criteria:
Delisting criteria is not available.

Recovery Actions:

- No recovery plans are available for this species.
- Increase the size of existing protected habitat through conservation easements or, preferably, fee-title acquisition Manage these properties to protect and enhance the habitat and occurrences of Carex albida.
- Prepare and publish a draft recovery plan and ultimately finalize the recovery plan.
- Work with willing landowners in or near historical occurrences to develop access agreements to conduct surveys, monitoring, and habitat enhancements, and provide them assistance to minimize their indirect land use impacts on occupied habitat.
- Monitor and continue adaptive management of existing protected areas to control invasive vegetation, address excess sediment and nutrients in the marshes, and encourage growth of listed species and co-occurring rare plant taxa within their historical occurrences.
- Continue to maintain a viable, protected seed collection for Carex albida. Ensure sufficient seeds exist, preferably in more than one repository, to maintain genetic heterogeneity. For long term preservation of genetic diversity consideration should be given to having a clone bank as a supplement or alternative to seed storage. A clone bank would be a low-maintenance partial shade garden from either seed or bulb scales of the original occurrence.

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SPECIES ACCOUNT: *Carex lutea* (Golden sedge)

Species Taxonomic and Listing Information

Listing Status: Endangered; 2/22/2002; Southeast Region (R4)

Physical Description

A perennial member of the sedge family (Cyperaceae). Fertile culms (stems) may reach 39 inches (in) (1 meter; m) or more in height. The yellowish green leaves are grasslike, with those of the culm mostly basal and up to 11 in (28 centimeters; cm) in length, while those of the vegetative shoots reach a length of 25.6 in (65 cm). Fertile culms produce two to four flowering spikes (compact flower clusters), with the terminal spike being male and the one to three (usually two) lateral spikes being female. Lateral spikes are subtended by leaflike bracts (a much-reduced leaf). The male spike is about 0.8 – 1.6 in (2 - 4 cm) long, 0.06 – 0.1 in (1.5 - 2.5 millimeters; mm) wide, with a peduncle (stalk) about 0.4 – 2.4 in (1 - 6 cm) long. Female spikes are round to elliptic, about 0.4 – 0.6 in (1 - 1.5 cm) long and 0.4 in (1 cm) wide. The upper female spike is sessile (not stalked; sitting), while lower female spikes, if present, have peduncles typically 0.2 – 1.8 in (0.5 - 4.5 cm) long. When two to three female spikes are present, each is separated from the next along the culm by 1.8 – 7.1 in (4.5 to 18 cm). The inflated perigynia (sac which encloses the seed) are bright yellow when seeds mature and about 0.16 – 0.20 in (4 to 5 mm) long. The perigynia are out-curved and spreading, with the lowermost in a spike strongly reflexed (turned downward) (LeBlond et al. 1994). (USFWS, 2014)

Taxonomy

Carex lutea was first collected by Richard LeBlond on April 11, 1990, in Pender County, North Carolina. It was collected in an immature state. From analysis of a mature specimen collected on May 22, 1991, it was determined that the taxon belonged to the genus Carex, section Ceratocystis (=Extensae), a circumboreal section not previously known from North Carolina. Sedges of the section Ceratocystis occur in temperate regions in North America, Europe, Asia, and Australia. In North America, they are primarily in the northern temperate region. Carex lutea is the southern-most species in the section in North America (Ball and Reznicek 2003). (USFWS, 2014)

Historical Range

Endemic to the outer coastal plain of North Carolina (USFWS, 2014).

Current Range

Known occurrences are in Pender and Onslow Counties, NC. (USFWS, 2015)

Critical Habitat Designated

Yes; 3/31/2011.

Legal Description

On March 1, 2011, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective March 31, 2011) for Carex lutea (Golden sedge) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes eight critical habitat units (CHUs), in North Carolina (76 FR 11086-11111). (USFWS, 2011)

Critical Habitat Designation

The critical habitat designation for Carex lutea includes eight CHUs (including 19 sub-units) in Onslow and Pender Counties, North Carolina. This species critical habitat encompasses approximately 202 acres (ac) (82 hectares (ha)). Brief descriptions and promulgated descriptions are provided below; maps are available in the Final Rule (76 FR 11086-11111). (USFWS, 2011)

Unit 1: Watkins Savanna, Pender County, North Carolina: Unit 1 consists of 3.8 ac (1.5 ha) and includes three subunits in Pender County, NC. Promulgated Unit 1 description: (i) Unit 1, subunits A, B, and C, for Carex lutea comprises 3.8 acres (ac) (1.5 hectares (ha)) of somewhat overgrown Pine Savanna habitat. Unit 1 is located approximately 5.1 miles (mi) (8.2 kilometers (km)) southeast of the intersection of NC 50 and NC 53, and all three subunits are on the north side of NC 50. (ii) Subunit 1A. Land bounded by the following UTM Zone 18, NAD 83 coordinates (E,N): 732264, 99984; 732203, 99954; 732184, 100016; 732234, 100065; 732264, 99984. (iii) Subunit 1B. Land bounded by the following UTM Zone 18, NAD 83 coordinates (E,N): 733143, 99288; 733053, 99268; 733055, 99291; 733065, 99309; 733055, 99320; 733048, 99344; 733053, 99364; 733090, 99377; 733140, 99370; 733143, 99288. (iv) Subunit 1C. Land bounded by the following UTM Zone 18, NAD 83 coordinates (E,N): 732155, 99677; 732128, 99667; 732093, 99716; 732109, 99732; 732166, 99692; 732155, 99677. (USFWS, 2011)

Unit 2: Haws Run Mitigation Site, Onslow County, North Carolina: Unit 2 (EO 7) consists of 27.1 ac (11.0 ha) in Onslow County, NC. Promulgated Unit 2 description: (i) Unit 2 for Carex lutea comprises 27.1 ac (11.0 ha) of Pine Savanna. Unit 2 is located approximately 7.6 mi (12.2 km) southeast of the intersection of NC 50 and NC 53, on the south side of NC 50. (ii) Unit 2. Land bounded by the following UTM Zone 18, NAD 83 coordinates (E,N): 735078, 96823; 735188, 96794; 735282, 96812; 735423, 96489; 735296, 96437; 735329, 96364; 735233, 96324; 735132, 96601; 735053, 96564; 734996, 96686; 735049, 96740; 735078, 96823. (USFWS, 2011)

Unit 3: Maple Hill School Road Savanna, Pender County, North Carolina: Unit 3 (EO 10) consists of 27.7 ac (11.2 ha) in Pender County, NC. Promulgated Unit 3 description: (i) Unit 3 for Carex lutea comprises 27.7 ac (11.2 ha) of Pine Savanna. Unit 3 is located approximately 3.7 mi (6.0 km) southeast of the intersection of NC 50 and NC 53, east of SR 1580 and north of NC 50. (ii) Unit 3. Land bounded by the following UTM Zone 18, NAD 83 coordinates (E,N): 731509, 101826; 731333, 101675; 731094, 101706; 731187, 101962; 731239, 101964; 731253, 101975; 731264, 102030; 731435, 102129; 731509, 101826. (USFWS, 2011)

Unit 4: Southwest Ridge Savanna, Pender County, North Carolina: Unit 4 (EO 11) consists of 3.3 ac (1.3 ha) in two subunits in Pender County, NC. Promulgated Unit 4 description: (i) Unit 4, subunits A and B, for Carex lutea comprises 3.3 ac (1.3 ha) of maintained power line on the edge of Pine Savanna. Unit 4 is located approximately 9.1 mi (14.7 km) southwest of the intersection of NC 50 and NC 53. (ii) Subunit 4A. Land bounded by the following UTM Zone 18, NAD 83 coordinates (E,N): 723852, 89908; 723720, 89734; 723688, 89761; 723756, 89851; 723820, 89935; 723852, 89908. (iii) Subunit 4B. Land bounded by the following UTM Zone 18, NAD 83 coordinates (E,N): 724036, 90152; 723975, 90075; 723946, 90104; 724004, 90177; 724036, 90152. (USFWS, 2011)

Unit 5: Sandy Run Savannas, Onslow County, North Carolina: Unit 5 consists of 25.2 ac (10.2 ha) in Onslow County, NC, and is divided into five subunits. Promulgated Unit 5 description: (i) Unit 5, subunits A, B, C, D and E, for Carex lutea comprises 25.2 ac (10.2 ha) of power line right-of-way, ecotone and Pine Savanna habitat. Unit 5 is located approximately 7.1 mi (11.4 km) southeast of the intersection of NC 50 and NC 53. Subunit A is located in a power line corridor east of NC 50, and subunits B, C, D, and E are west of NC 50. (ii) Subunit 5A. Land bounded by the following UTM Zone 18, NAD 83 coordinates (E,N): 736771, 99308; 736625, 99178; 736587, 99216; 736737, 99350; 736771, 99308. (iii) Subunit 5B. Land bounded by the following UTM Zone 18, NAD 83 coordinates (E,N): 735365, 98631; 735349, 98617; 735348, 98651; 735379, 98706; 735452, 98755; 735543, 98767; 735619, 98723; 735502, 98683; 735365, 98631. (iv) Subunit 5C. Land bounded by the following UTM Zone 18, NAD 83 coordinates (E,N): 735711, 98665; 735692, 98664; 735692, 98680; 735687, 98688; 735664, 98688; 735650, 98706; 735666, 98715; 735673, 98706; 735697, 98704; 735711, 98689; 735711, 98670; 735711, 98665. Subunit 5D. Land bounded by the following UTM Zone 18, NAD 83 coordinates (E,N): 735817, 98757; 735769, 98743; 735761, 98762; 735812, 98776; 735817, 98757; and, 735756, 98767; 735745, 98774; 735722, 98827; 735720, 98863; 735761, 98907; 735787, 98905; 735795, 98859; 735810, 98821; 735864, 98838; 735899, 98854; 735928, 98871; 735958, 98894; 735983, 98894; 735990, 98820; 735850, 98795; 735756, 98767. (vi) Subunit 5E. Land bounded by the following UTM Zone 18, NAD 83 coordinates (E,N): 736501, 99084; 736411, 99048; 736382, 99079; 736375, 99137; 736318, 99202; 736292, 99251; 736374, 99312; 736476, 99354; 736532, 99252; 736610, 99159; 736559, 99115; 736501, 99084. (USFWS, 2011)

Unit 6: The Neck Savanna, Pender County, North Carolina: Unit 6 consists of 4.4 ac (1.8 ha) in Pender County, NC, and is divided into three subunits. Promulgated Unit 6 description: (i) Unit 6, subunits A, B, and C, for Carex lutea comprises 4.4 ac (1.8 ha) of power line right-of-way, Pine Savanna habitat. Unit 6 is located approximately 5.3 mi (8.5 km) southeast of the intersection of NC 50 and NC 53. All three subunits are located south of NC 50. Subunits 6A and 6B are located in remnant Pine Savanna ecotones southeast of SR 1532, and Subunit 6C is located along a power line right-of-way adjacent to Williams Road. (ii) Subunit 6A. Land bounded by the following UTM Zone 18, NAD 83 coordinates (E,N): 731077, 98383; 731055, 98378; 731023, 98410; 731008, 98465; 731036, 98516; 731078, 98542; 731132, 98546; 731132, 98531; 731117, 98465; 731114, 98417; 731112, 98391; 731077, 98383. (iii) Subunit 6B. Land bounded by the following UTM Zone 18, NAD 83 coordinates (E,N): 731177, 97874; 731139, 97824; 731093, 97810; 731042, 97830; 731047, 97843; 731094, 97828; 731130, 97839; 731168, 97888; 731198, 97895; 731200, 97879; 731177, 97874. (iv) Subunit 6C. Land bounded by the following UTM Zone 18, NAD 83 coordinates (E,N): 731691, 98462; 731678, 98456; 731668, 98491; 731680, 98496; 731691, 98462. (USFWS, 2011)

Unit 7: Shaken Creek Savanna, Pender County, North Carolina: Unit 7 consists of 57.7 ac (23.4 ha) in Pender County, NC, and is divided into three subunits. Promulgated Unit 7 description: (i) Unit 7, subunits A, B, and C, for Carex lutea comprises 57.7 ac (23.4 ha) of Pine Savanna habitat. Unit 7 is located approximately 8.6 mi (13.8 km) southeast of the intersection of NC 50 and NC 53. All three subunits are located west of NC 50. Subunit 7A is immediately south side of Flo Road and east of Alligator Lake Road. Subunit 7B is immediately south of Flo Road and west of Alligator Lake Road. Subunit 7C is immediately south of Flo Road and approximately 1,800 feet (549 meters) west of Alligator Lake Road. (ii) Subunit 7A. Land bounded by the following UTM Zone 18, NAD 83 coordinates (E,N): 734066, 92945; 734015, 92941; 733993, 92959; 733995, 92973; 733987, 92987; 733976, 93018; 733972, 93074; 733967, 93130; 733970, 93156; 733983, 93185; 734006, 93222; 734060, 93204; 734057, 93140; 734080, 93088; 734114, 93044; 734096, 92963; 734066, 92945. (iii) Subunit 7B. Land bounded by the following UTM Zone 18, NAD 83 coordinates (E,N): 733868, 92812; 733817, 92804; 733727, 92937; 733704, 93040; 733648, 93073; 733640, 93213; 733823, 93232; 733964, 93244; 733997, 93225; 733955, 93155; 733966, 93022; 733985, 92968; 733959, 92949; 733926, 92936; 733886, 92909; 733862, 92857; 733868, 92812. (iv) Subunit 7C. Land bounded by the following UTM Zone 18, NAD 83 coordinates (E,N): 733556, 93081; 733560, 92976; 733522, 92933; 733449, 92943; 733393, 92985; 733351, 93010; 733327, 93048; 733280, 93055; 733217, 93035; 733165, 92990; 733106, 92968; 733059, 92992; 733030, 93034; 732976, 93056; 732902, 93101; 732883, 93132; 733202, 93163; 733318, 93178; 733549, 93206; 733556, 93081. (USFWS, 2011)

Unit 8: McLean Savanna, Pender County, North Carolina: Unit 8 consists of 52.6 ac (21.3 ha) and includes three subunits in Pender County, NC. Promulgated Unit 8 description: (i) Unit 8, subunits A, B, and C, for Carex lutea comprises 52.6 ac (21.3 ha) of Pine Savanna and ecotone habitat. Unit 8 is located approximately 16.4 mi (26.4 km) south of the intersection of NC 50 and NC 53 and approximately 2.1 mi (3.4 km) east of NC 210. (ii) Subunit 8A. Land bounded by the following UTM Zone 18, NAD 83 coordinates (E,N): 722520, 77995; 722417, 77935; 722283, 78037; 722146, 78244; 722013, 78436; 722019, 78444; 722433, 78542; 722540, 78390; 722492, 78276; 722398, 78205; 722520, 77995. (iii) Subunit 8B. Land bounded by the following UTM Zone 18, NAD 83 coordinates (E,N): 722780, 77840; 722846, 77820; 722907, 77802; 722903, 77787; 722842, 77806; 722774, 77825; 722780, 77840; 722780, 77840; 722779, 77841; 722780, 77840; 722780, 77840. (iv) Subunit 8C. Land bounded by the following UTM Zone 18, NAD 83 coordinates (E,N): 723268, 78269; 723209, 78309; 723166, 78305; 723179, 78361; 723313, 78465; 723446, 78537; 723408, 78370; 723395, 78307; 723335, 78264; 723268, 78269. (USFWS, 2011)

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 Carex lutea critical habitat consists of three components (76 FR 11086-11111) :

(i) Moist to completely saturated loamy fine sands, fine sands, fine sandy loams, and loamy sands soils with a pH between 5.5 and 7.2;

(ii) Open to relatively open canopy that allows full to partial sunlight to penetrate to the herbaceous layer between savannas and hardwood forests; and

(iii) Areas of bare soil immediately adjacent (within 12 inches (30 centimeters)) to mature Carex lutea plants where seeds may fall and germinate or existing plants may expand in size.

Special Management Considerations or Protections

The major threats to the features in the areas identified as critical habitat for Carex lutea include: Habitat alteration; conversion of its limited habitat for residential, commercial, or industrial development; mining; drainage activities associated with silviculture and agriculture; suppression of fire; highway expansion; and herbicide use along utility and highway rights-of-way. Through our review of the existing data on Carex lutea, we conclude that these threats, which were also listed in the final listing rule (67 FR 3120, January 23, 2002), continue to impact this species and its essential physical and biological features. The destruction of habitat or conversion of habitat for residential, commercial, or industrial development can change the topography, soils, and general character of the site, making it uninhabitable for Carex lutea. These activities can remove the primary constituent element by removing soil (by grading) and changing Carex lutea habitat to developed land, which is unsuitable for the species. Drainage activities associated with silviculture and agriculture may alter the hydrology, which can change the groundwater levels and the amount of moisture in the soil, creating conditions under which Carex lutea may not be able to survive. Further, removal of existing vegetation or the planting of trees for silviculture may change the existing conditions such that Carex lutea plants no longer receive optimal amounts of sunlight. The close proximity of roadways and power line corridors to populations of Carex lutea may affect the species. Herbicide treatment to maintain vegetation in rights-of-ways has the potential to kill non-target plant species such as Carex lutea. Highway expansion may change the local topography and affect water runoff making the site drier or wetter than is optimal for Carex lutea. Mining has been documented in close proximity to one Carex lutea population. Mining activities may alter many aspects of Carex lutea habitat. Heavy equipment can compact or remove the appropriate soils. The grading of areas adjacent to Carex lutea habitat can change the hydrology of those areas and make them more susceptible to invasion by nonnative plant species. Regular fire in areas where Carex lutea occurs helps to maintain the open savanna habitat that is conducive to Carex lutea growth. Fire reduces competition and allows seeds to germinate in open, bare soil areas. Fire suppression in areas where Carex lutea occurs may result in the growth of shrubs and trees that will eventually shade out herbaceous species such as Carex lutea. Fire suppression also allows the invasion of nonindigenous plants and animals that are not fireadapted. All of these activities may in turn lead to the disruption of the growth and reproduction of Carex lutea. In summary, we find that the areas we are designating as critical habitat contain the features essential to the conservation of Carex lutea, and that these features may require special management considerations or protection. Special management considerations or protection may be required to eliminate, or reduce to negligible level, the threats affecting each unit or subunit and to preserve and maintain the essential features that the critical habitat units and subunits provide to Carex lutea. Additional discussions of threats facing individual sites are provided in the individual unit and subunit descriptions. (USFWS, 2011)

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual, asexual (USFWS, 2014)

Lifespan

Adult: > 2 years (USFWS, 2014)

Breeding Season

Adult: April - May (USFWS, 2014)

Key Resources Needed for Breeding

Adult: Wind (USFWS, 2014)

Reproduction Narrative

Adult: Pollination probably occurs vis abiotic factors (EPA, 2016). Carex lutea is a perennial (plant with a life span greater than two years). Flowering occurs from mid April to early May. Because ample mature seed production has been observed, the Service can confidently surmise that Carex lutea reproduces both sexually, involving gravity and wind dispersed pollen, as well as vegetatively (L. Bruederle, University of Colorado Denver, pers. comm. 2007). Survival rates and the nature of mortality of individual plants are unknown (USFWS, 2014).

Habitat Type

Adult: Palustrine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forested wetland, herbaceous wetland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Soil pH 5.5 - 7.2; periodic fires (USFWS, 2015)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 2015)

Environmental Specificity

Adult: Very narrow to narrow (NatureServe, 2015)

Habitat Narrative

Adult: Carex lutea is found in very wet to saturated to periodically shallowly inundated soils. The largest populations are found in the wet to saturated ecotones of savannas and hardwood forests. At a few sites, the plants are most abundant in wet to saturated soils adjacent to drainage ditches, and in the saturated to shallowly inundated ditches themselves. While ditches are not natural habitat for the species, they serve as surrogate, but not high quality, habitat. The occurrence of C. lutea plants in ditches is likely due to the wetter soils of the ditches, and/or the washing of seeds into the ditches from adjacent microhabitat. C. lutea occasionally occurs in very wet soil in areas of savanna habitat charactenzed by an open to absent canopy, suggesting that its abundance in the savanna/wet hardwood ecotone is strongly influenced by hydrologic conditions as well as by edaphic and/or light conditions. Taggart and Long (2012) found that mean pH values for the topsoils within three C. lutea populations were strongly (4.7) to moderately (5.7) acidic. (USFWS, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seeds have been observed in ditches adjacent to colonies, indicating dispersal by precipitation sheet flow. Animals may also be seed dispersers; the perigynia beaks are minutely serrulate, perhaps an adaptation for attachment to fur (USFWS, 2014).

Population Information and Trends

Population Trends:

Unknown (NatureServe, 2015)

Species Trends:

Stable (USFWS, 2015)

Number of Populations:
11 (USFWS, 2022)

Population Size:
1000 - 2500 individuals (NatureServe, 2015)

Population Narrative:
The long-term population trend is unknown. The Lanier quarry site has over 1000 clumps and the rest of the sites have a combined total of 100 clumps (NatureServe, 2015). Based on four years of monitoring data and great strides in the protection of C. lutea sites, the Service believes that the status of this species is currently stable. According to genetic analysis by Derieg et al. (2008 ,2013), Carex lutea maintains the highest levels of genetic diversity observed in North American populations of section Ceratocystis taxa. It is extremely rare due to high habitat specificity and narrow range of distribution (USFWS, 2015). The North Carolina Natural Heritage Program (NCNHP) currently recognizes eight populations of Carex lutea (USFWS, 2014). Including the FL populations mentioned above, there are currently 11 extant populations and one population that may be extirpated (surveyors failed to find individuals when the population was last visited. Since the completion of the September 24, 2015, Five-Year Review, three new populations of Carex lutea have been discovered in Florida (FL) and one in South Carolina (SC). Since the last Five-Year Review, the ranks of one NC population improved and two NC populations declined. NC 15 changed from a poor (D) to fair (C) ranking, indicating the population is better than previously reported. Even though this population has improved, approximately 5% of this population was destroyed by a road improvement project in 2021 (Ed Corey, NC State Parks, pers. comm., January 19, 2022). Population NC 18 changed from a rank of excellent (A) to poor (C) indicating the population has declined, due to fire suppression and herbicide damage. Population 10 changed from a rank of poor? (C?) to “failed to find” (F) indicating that no plants were found during recent surveys of that site (NCNHP 2022). In 2021, three new populations were discovered in FL and one was discovered in SC. All four new populations occur on conservation lands (FNAI 2022, SCHTP 2022). Additional information about population rankings and these new populations is provided in Appendices A and B, respectively (USFWS, 2022).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Habitat destruction, resulting from development, also threatens C. lutea, but to a lesser degree than the other factors listed above as many of the populations are in conservation ownership. Sites located within road and utility rights-of-way arc threatened by herbicide use or mowing during critical growth periods. While the recovery plan listed timber operations such as harvesting, bedding and ditching as threats to the species, the Service knows that timber operations to varying degrees have occurred at all C. lutea sites at some point in the past. Observations in 2012 indicate that a large portion of land in the vicinity of this population has been converted into a blueberry farm. (USFWS, 2015)

Stressor: Invasive species (USFWS, 2015)

Exposure:
Response:
Consequence:
Narrative: Cogon grass (lmperata cylindrica) was introduced to the United States in 1912 and is found in longleaf pine plant communities throughout the southeast. A population of cogon grass was found in Pender County in 2012 (Glen2012). Cogon grass is listed as a federal noxious weed by the U.S. Department of Agriculture and a state noxious weed by the NC Department of Agriculture and Consumer Services (NCDACS 2015). Given its growth habit and habitat preferences, L. cylindrica could displace native species such as C. lutea, however, it has not yet been observed at any of the known C. lutea sites (USFWS, 2015).

Stressor: Stochastic events (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Small population sizes likely diminish the resiliency of Carex lutea occurrences to stochastic disturbances, and the lack of redundancy across the landscape leaves the species at greater risk of extinction due to potential extirpation of these vulnerable occurrences. Other threats to the species include extended drought that may be exacerbated by the installation of drainage ditches (USFWS, 2015).

Stressor: Fire suppression (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Carex lutea is threatened by fire suppression and the ecological succession (competition and/or shading by woody species) associated with areas that are not burned as often as they were historically (USFWS 20I4).

Recovery

Reclassification Criteria:
1. There are 10 protected C. lutea sites in the wild that are distributed across the range of the species. [Note: Recovery sites will be considered permanently protected when they are placed under a conservation easement or other binding land agreement and a management agreement and are ranked as an A or B population by the NCNHP. See Appendix C of the Recovery Plan for additional information about the rank specifications for C. lutea.] (USFWS, 2014).

2. On each of the 10 C. lutea sites, for at least 5 years, any non-native plant species that have the potential to displace C. lutea are maintained at or below 10 percent of total number of species and at or below 10 percent cover (volume) (USFWS, 2014).

3. All 10 C. lutea sites demonstrate stable or increasing population trends for five consecutive years (USFWS, 2014).

4. Habitat management plans are actively being implemented for at least seven of the protected sites (USFWS, 2014).

5. A prescribed fire regime has been developed and is being conducted at all sites to mimic historical frequency and timing (the frequency will be determined through recovery actions in this plan) (USFWS, 2014).

Recovery Priority Number: 8

Delisting Criteria:
1. There are 15 protected sites in the wild that are distributed across the range of the species. [Note: Recovery sites will be considered permanently protected when they are placed under a conservation easement or other binding land agreement and a management agreement and are ranked as an A or B population by the NCNHP. See Appendix C of the Recovery Plan for additional information about the rank specifications for C. lutea.] (USFWS, 2014).

2. On each of the 15 C. lutea sites, for at least 5 years, any non-native plant species that have the potential to displace C. lutea are maintained at or below 10 percent of total number of species and at or below 10 percent cover (volume) (USFWS, 2014).

3. All 15 C. lutea sites demonstrate stable or increasing population trends for ten consecutive years (USFWS, 2014).

4. Habitat management plans are actively being implemented for all protected sites and are showing evidence that actions are proving effective for this plant (USFWS, 2014).

5. A prescribed fire regime is being conducted at all sites to mimic historical frequency and timing (which will be determined through recovery actions) (USFWS, 2014).

Recovery Actions:
- Protect Carex lutea sites/occurrences and adjacent buffer habitat around these sites: Carex lutea is a unique plant in the wet pine savannas of North Carolina. Due to threats, it is now known from a limited number of occurrences in Pender and Onslow Counties that need to be protected to ensure their survival. (USFWS, 2014)
- Increase and strengthen Carex lutea sites/occurrences: For this relatively recently described plant, there is much to learn about its biology (see actions under 6.0 for Research) and how it fits as a key piece in the wet pine savanna. As we complete population augmentations and other recovery actions, we will strengthen our largest Carex lutea occurrences. (USFWS, 2014)
- Management: Since this plant clearly occurs on limited islands of habitat within pine savanna that have unique habitat characteristics (higher pH, wet soils, limestone), we need to work to manage aspects like invasive plants to ensure Carex lutea can thrive. (USFWS, 2014)
- Surveys: Extensive surveys that have been conducted for Carex lutea have led to the discovery of a few new occurrences. Based on existing knowledge, we do not anticipate finding a lot of additional populations, but it should be a priority to survey any remaining patches of unique wet pine savanna habitat to ensure that we protect this endangered plant. Survey efforts should focus on identifying areas of suitable habitat where Carex lutea may occur with the goal of finding additional populations of this species. (USFWS, 2014)
- Monitoring: Range-wide, long-term monitoring is critical to understanding population trends and the overall health of individual sites and populations. (USFWS, 2014)

- Research: Carex lutea is relatively recently described and has a very restricted range. Consequently, little research has been conducted on this species. (USFWS, 2014)
- Education and Outreach: Education and outreach is important in order to inform the residents and land managers in the vicinity of Carex lutea sites about the significance of the species and why long term management of these sites, through prescribed burning and other measures, is necessary for their survival. (USFWS, 2014)
- Conduct surveys for additional populations, especially in shady areas where it was previously thought the species did not occur (USFWS, 2015)
- Protect as many populations as possible (USFWS, 2015).
- Develop site specific management and prescribed burn land managers to implement management plans (USFWS, 2015).
- Continue long term monitoring that was initiated by plans for each site and encourage the NCBG to assess population trends, reproductive success and threats (USFWS, 2015).
- Conduct additional research on general life history and biology of the species (USFWS, 2015).
- Conduct research to determine the effects of various timber operations on this species (USFWS, 2015).
- Develop and implement an education and outreach program to help partners and local landowners (USFWS, 2015).
- Identify potential sites for introducing new populations of the species (USFWS, 2015).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIVITIES The recommended actions listed in the 2015 Five-Year Review remain important to the conservation and recovery of Carex lutea and efforts to accomplish those actions should continue. The Service recommends initiating or continuing the following efforts that will contribute to the recovery of the species: • Conduct genetic analysis on the newly discovered populations to confirm they are Carex lutea. • Since the species has been found in two new states, consider updating/amending the Recovery Plan to make references to specific state agencies more general after genetic studies confirm these populations are definitely Carex lutea. • Conduct surveys for additional populations, especially in shady areas where it was previously thought the species did not occur, • Protect and manage as many populations as possible, • Determine status of known populations that have not been visited in recent years, • Develop site specific management and prescribed burn plans for NC 10, 11 and 18, • Check in with land managers annually to ensure that management plans are being implemented, • Continue long term monitoring that was initiated by the NC Botanical Garden and The Nature Conservancy to assess population trends, reproductive success and threats, • Conduct additional research on general life history and biology of the species, • Conduct research to determine the effects of various management and timber operations on this species, • Develop and implement an education and outreach program to help partners and local landowners, • Identify potential sites for introducing new populations of the species, • Make sure all populations are represented in the seed bank at the NC Botanical Garden (USFWS, 2022).

References

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SPECIES ACCOUNT: *Chlorogalum purpurem var. reductum* (Camatta Canyon amole)

Species Taxonomic and Listing Information

Listing Status: Threatened; 03/20/2000; California/Nevada Region (R8) (USFWS, 2015)

Physical Description

A perennial lily with a basal cluster of bright green leaves, which are elongate, with a wavy margin, and with a thickened midrib (Service 2002, Holland 2004, Guretzky et al. 2005). The basal leaves typically range from 1 to 8 in number (Woodbury 2005b), but as many as 14 have been recorded (Guretzky et al. 2005), with a width of 2 to 5 mm. The bulb is ovoid, 2.5 to 3.0 cm long, white to brown in color, and occurs in the upper few inches of soil (Service 2002, Holland 2004). The flower cluster is borne on a single stem with multiple branches. The flowers are deep blue or purple with bright yellow anthers. The fruits are capsules, each with three chambers containing one or two black, ovoid seeds (Jernstedt 1993). (USFWS 2008)

Taxonomy

Chlorogalum purpureum is the only member of the genus with flowers that are blue or purple in color; the other members of the genus have flowers that are white or pink (Hoover 1940, Jernstedt 2007). Two varieties of Chlorogalum purpureum are recognized (Hoover 1940, Jernstedt 2007): Chlorogalum purpureum var. purpureum and Chlorogalum purpureum var. reductum. However, the International Plant Names Index (2005) places the genus Chlorogalum in the hyacinth family (Hyacinthaceae), while recent comparative molecular studies support the inclusion of the genus in the agave family (Agavaceae; Bolger et al. 2006). (USFWS, 2008)

Historical Range

See current range/distribution.

Current Range

The Camatta Canyon amole Chlorogalum purpureum var. reductum is endemic to the La Panza Range in central San Luis Obispo County. The type locality for the Camatta Canyon amole is 18 miles east of Creston on La Panza road, San Luis Obispo County, California. The taxon is known only from a small geographic area. The main population is approximately 0.8 km (0.5 mi) east of the southern end of Camatta Canyon. (USFWS 2008)

Critical Habitat Designated

Yes; 10/24/2002.

Legal Description

On October 24, 2002, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), Chlorogalum purpureum var. reductum (Camatta Canyon amole).

Critical Habitat Designation

The critical habitat designation for Chlorogalum purpurem var. reductum includes two units totaling approximately 1,772 ha (4,378 ac) of land. Approximately 25 percent of this total area consists of Federal lands, private lands comprise approximately 75 percent, and State lands comprise less than 0.1 percent.

Jolon Unit: This unit consists of 620 ha (1,532 ac) of private property near Jolon Road. This population is probably a remnant of a much larger population that historically extended beyond the immediate Fort Hunter Liggett area. The land within this unit provides those characteristics essential for the species.

Camatta Canyon Unit: This unit consists of one area that encompasses the similar topographic features and vegetative communities that surround the only two known occurrences of this species. The Camatta Canyon Unit (1,772 ha (4,378 ac)) encompasses the plateau on both the north and south sides of Highway 58 near Camatta Canyon, extending south approximately 5 km (3 mi) to include two private inholding areas within the LPNF boundaries. The land within this unit provides those characteristics essential for the species discussed above. More specifically, the area surrounding the known distribution of Chlorogalum purpureum var. reductum and the plateau adjacent to the known distribution (i.e., finger-like extensions in northern portion of the unit) are essential because: (1) Chlorogalum purpureum var. reductum is found at only two sites in the La Panza Range in central San Luis Obispo County. The two sites likely make up one ‘‘population’’ of plants due to the close proximity of the sites and the characteristic ‘‘patchiness’’ of plants that has been observed with both varieties of C. purpureum. The limited geographic distribution of C. p. var. reductum increases the likelihood of its extinction. The risk of extinction elevates the need for protecting all existing plants, habitat, and soil conditions for the taxon’s expansion. Additionally, ecological attributes upon which the species relies (e.g., pollinators, seed dispersal agents) should be protected. Activities that may adversely affect or destroy the plant and the habitat that is critical for its survival and expansion should be limited. These activities include, but are not limited to, off-road vehicle use, livestock grazing, herbivory, and ground disturbance by gophers. (2) Thorough surveys of the distribution of Chlorogalum purpureum var. reductum have not been conducted in the area. Surveys are needed across multiple years to determine the presence or absence of the species. Monitoring of C. p. var. purpureum at Fort Hunter Liggett has found known individual mature plants to be dormant for at least three years. During dormancy, both varieties of Chlorogalum are not detectable on the surface. Because discoveries of new C. p. var. purpureum sites are being found within the range of the taxon at Fort Hunter Liggett, one may expect ‘‘new patches’’ of C. p. var. reductum to occur in the Camatta Canyon Unit if surveys were conducted within the critical habitat boundary in those areas where the primary constituent elements occur. (3) An extension of the plateau/flattop area where Chlorogalum purpureum var. reductum is currently known to occur exists between the northern site and the southern site. This area harbors the soils and vegetation appropriate for C. p. var. reductum growth and expansion. The Service believes it is important to provide connectivity between the two sites. Additionally, the area encompasses what appear to be flat-top/ mesa-like extensions (which likely contain suitable habitat) that occur between the two known distributions (D. Chipping, California Polytechnic State University, in litt., 1997). A. Koch (CDFG, pers. comm., 2001) also notes that C. p. var. reductum occurs on private property which falls between the two known sites and within the critical habitat boundary line. (4) The vegetation community that Chlorogalum purpureum var. reductum depends on extends beyond the boundary of the known distribution. By encompassing plateau areas, the known distribution, and a portion of the adjacent vegetation community that the species depends on, ecological functions (e.g., cryptogamic crust formation, predator-prey relationships, pollinator activity) within the habitat are maintained such that ‘‘edge effects’’ from encroaching activities not conducive to C. p. var. reductum persistence (e.g., off-road vehicle use, livestock grazing, etc.) do not inhibit the taxon's expansion or survival. Additionally, adjacent grassland and oak woodland habitat that is adversely affected could result in greater rates of herbivory or regeneration/expansion of nonnative plants that can outcompete smaller, herbaceous species such as C. p. var. reductum. Lands proposed are under private, State, and Federal jurisdiction. State lands are managed by CalTrans, and Federal lands are managed by the the Forest Service (i.e., LPNF).

Primary Constituent Elements/Physical or Biological Features

The primary constituent elements of critical habitat for Chlorogalum purpureum var. reductum consist of, but are not limited to:

(i) Well-drained, red clay soils with a large component of gravel and pebbles on the upper soil surface; and,

(ii) Plant communities in functioning ecosystems that support associated plant and animal species (e.g., pollinators, predator-prey species, etc.), including grassland, blue oak woodland (Quercus douglasii) or oak savannahs, and open areas within shrubland communities. Within these vegetation communities C. p. var. reductum appears where there is little cover of other species which compete for resources available for growth and reproduction.

Special Management Considerations or Protections

Critical habitat does not include existing features and structures, such as buildings, hard-packed roads (e.g., asphalt, pavement), aqueducts, railroads, airport runways and buildings, other paved areas, lawns, and other urban landscaped areas not containing any of the primary constituent elements.

Special management and protection that C. purpureum critical habitat may require are: (1) The soils on which Chlorogalum purpureum is found should be maintained. Physical properties of the soil, such as its chemical composition, structure, and drainage capabilities, would best be maintained by limiting or restricting the use of herbicides, fertilizers, or other soil amendments; and by minimizing or avoiding activities that result in soil compaction (e.g., offroad wheeled and tracked vehicle use, trampling by people and livestock) and those that would alter the hydrology of areas immediately adjacent to or upslope of the species and its critical habitat. (2) The soil surface should be maintained to enhance cryptogamic crust formation by minimizing the intensity, frequency, duration, and acreage of soil surface disturbance. The soil surface should be protected at relict sites (i.e., sites with well-developed crusts) to provide reference areas and baseline comparisons for research. Because cryptogamic crusts are highly susceptible to hot fires (Belnap et al. 2001) and the presence of nonnative annual grasses in Chlorogalum purpureum habitat may promote fires. Annual, intense fires should be avoided. The effects of activities that can damage biotic soil crusts (e.g., excavations, offroad vehicle use, trampling) should be reduced by moving them to areas where crusts are less vulnerable, limiting the area affected, and conducting such activities in dryer seasons. (3) The associated plant and animal communities should be maintained to ensure the habitat needs of pollinators and seed dispersal agents are maintained, and predator-prey relationships are functioning. The use of pesticides should be restricted so that viable populations of pollinators are present to facilitate reproduction of Chlorogalum purpureum. Fragmentation of habitat through road construction, development, and certain types of fencing should be limited. Additionally, predator-prey relationships should be managed and protected. For example, installation of fencing could exclude predator species (e.g., coyotes, bobcats, San Joaquin kit fox), thus causing an increase in prey species (e.g., ground squirrels, gophers, rabbits) abundance. A change such as this could result in increased herbivory, bulb predation, or burrowing that could affect C. purpureum growth and survival. (4) In all plant communities where Chlorogalum purpureum occurs, invasive, nonnative species such as Centuarea solstitialis (yellow starthistle), Avena spp. (wild oats), Bromus spp. (B. hordeaceus, B. diandrus, B. madritensis, B. rubens (brome)), Erodium spp. (storksbill or fillaree), and other species need to be actively managed and controlled to maintain the open habitat that Chlorogalum purpureum needs. Nonnative annual grasses may promote fires by providing recurring annual fuel sources. Thus, proactive management should be implemented to prevent annual fires, unless future research demonstrates that a series of annual fires can benefit Chlorogalum purpureum by reducing competition from nonnative species. (5) Certain critical habitat areas (i.e., suitable, unoccupied habitat between or adjacent to known patches of Chlorogalum purpureum) may need to be temporarily fenced or demarcated to identify exclusion areas for protection from accidental or intentional trampling by humans, livestock, or off-road vehicle use. Heavy disturbance to these critical areas may be detrimental to this species' persistence. Seasonal exclusions may work in certain areas to protect the critical habitat and C. purpureum plants during the critical season of growth and reproduction. (6) In areas where Chlorogalum purpureum and its habitat occur in conjunction with off-road vehicle traffic (e.g., military wheeled and tracked vehicles, OHVs), the Service recommend managing to minimize the severity of those effects. Management should include: limiting or avoiding new structures and permanent roads and trails; managing excavations, scrapings, or other ground surface disturbance; managing tracked and wheeled vehicle use during C. purpureum growing and dormant seasons; and managing foot traffic, bivouacking, and congregations of high numbers of people during C. purpureum growing and dormant seasons. These types of activities should be managed to limit loss of adults, bulbs, and seeds, loss of habitat, increased soil compaction, and increased nonnative species encroachment. (7) Monitoring programs should be developed or enhanced so that areas occupied by purple amole are studied, allowing for a full range of life-history data and a thorough analysis of the compatibility and impacts of those activities that may adversely affect the species. Representative areas should be chosen throughout the distribution of the species, including large, highdensity populations that have a higher potential for persistence. Monitoring studies should be designed to aid in the determination of population stability as well as provide basic life-history information and data on the ecological needs of the species (e.g., identification and status of pollinator species, disturbance factors, etc.).

Life History

Food/Nutrient Resources

Dependency on Other Individuals or Species

Adult: Small bees are common pollinators of the Camatta Canyon amole, including sweat bees (Halictidae; Center for Plant Conservation 2007b). (USFWS, 2008)

Breeding Season

Adult: April to June (USFWS, 2008)

Reproduction Narrative

Adult: Small bees are common pollinators of the Camatta Canyon amole, including sweat bees (Halictidae; Center for Plant Conservation 2007b). Flowering and fruit development occurs during May and June for the purple amole and from April to June for the Camatta Canyon amole. As the fruits mature, the leaves wither and the inflorescence dries and turns brown. The plant is then dormant as a bulb during the summer and fall. (USFWS, 2008)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Barrens, Forest/Woodland, Grassland/herbaceous, Shrubland/chaparral, Woodland - Hardwood, Woodland - Mixed (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Mediterranean climate with summers that are hot and dry, and winters that are cool and wet (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 305 to 630 m (1,000 to 2,050 ft) (NatureServe, 2015)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: All locations for C. purpureum var. purpureum and C. purpureum var. reductum are in semiarid environments and have a Mediterranean climate with summers that are hot and dry, and winters that are cool and wet (USFWS 2008). C. purpureum var. reductum in the Los Padres National Forest grows in open areas on a ridgetop in blue oak savanna and annual grassland, and in open areas in grassland and woodland. The Service (2001, 2002) reported the Camatta Canyon amole to occur at 305 to 625 m (1,000 to 2,050 ft) elevation. However, others (e.g., Jernstedt 1993, 2007; California Department of Fish and Game 2007; California Native Plant Society 2007) reported elevations from 579 to 630 m. (USFWS, 2008; NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Stable (USFWS, 2008)

Population Growth Rate:

Slow (USFWS, 2008)

Number of Populations:

four (USFWS, 2020)

Population Size:

100,000 to 500,000 (USFWS, 2008)

Population Narrative:

One record in the California Natural Diversity Data Base (California Department of Fish and Game 2007) reports approximately 500,000 Camatta Canyon amole at the site in 1991. The Center for Plant Conservation (2007) states that as many as 100,000 Camatta Canyon amole may exist, with most of these plants on approximately 2 ha to 3 ha (5 ac to 7 ac) of land. Based upon general observations, the California Department of Fish Game has not observed the Camatta Canyon amole to be decreasing over the past ten years (Koch pers. com. 2007). The Camatta Canyon amole grows extremely slowly and requires years to mature and produce seeds (California Department of Fish and Game 2005). (USFWS, 2008). Camatta Canyon amole is known form four occurrences in La Panza Range and adjacent hills in central San Luis Obispo County. Camatta Canyon amole currently occupies an area of approximately 36 hectares (90 acres).

Threats and Stressors

Stressor: Road maintenance (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: The intended use of the highway right-of-way along State Highway 58 is for transportation purposes. A two-lane highway right-of-way is typically comprised of a 40-ft wide strip of land: a paved road, 24 ft wide; then a shoulder on each side, each 4 ft wide; and then another 4 ft of ground on each side. In the location with the Camatta Canyon amole, the plants are usually growing "sporadically" along the fenceline boundary with the adjacent private properties (Edell pers. com. 2007). The California Department of Transportation has designated the right-of-way with the Camatta Canyon amole as a botanical management area. Because of this designation, the California Department of Transportation conducts occasional monitoring and gives greater scrutiny when construction or maintenance occurs in the area (Edell in litt. 2007a, 2007b). (USFWS, 2008)

Stressor: Displacement by non-native annual grasses (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Non-native annual grasses and other invasive plant species continue to be a threat to the purple amole at Fort Hunter Liggett and Camp Roberts and to the Camatta Canyon amole on the Los Padres National Forest. The invasive plant species may have the ability to displace the Chlorogalum purpureum by outcompeting and monopolizing limited resources (growing space, sunlight, soil nutrients, water; Stephenson and Calcarone 1999), with the potential effects of preventing growth and recruitment (U.S. Army 2004b). The invasive plant species may also have the ability to alter characteristics of the fire regime, such as frequency, intensity, and seasonality of fires (Brooks et al. 2004). (USFWS, 2008)

Stressor: Illegal vehicle trespass in the National Forest (USFWS, 2008)

Exposure:
Response:
Consequence:
Narrative: The taxon is at risk of destruction, modification, and curtailment of its habitat and known range due to illegal vehicle trespass and cattle grazing in the Camatta Canyon amole area on the Los Padres National Forest. Off-highway vehicles and cattle grazing can cause physical damage to the Camatta Canyon amole, compact the soil, stimulate soil erosion, damage cryptogamic crusts, reduce the presence of native plants, and increase the presence of invasive plants (e.g. Fleischner 1994, Service 2000, Belnap and Eldridge 2001). (USFWS, 2008)

Stressor: Livestock grazing (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: The area occupied by the Camatta Canyon amole on the Los Padres National Forest is in the Navajo Allotment where the permittee is authorized to graze cattle between February and May. Because the Camatta Canyon amole flowers and develops fruit from April to June, we believe that cattle grazing is likely adversely affecting the taxon by trampling, soil compaction, and possibly herbivory. (USFWS, 2008)

Stressor: Recreation (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: The Camatta Canyon amole area is in the Pozo-La Panza unit of the Los Padres National Forest. The unit "is best known for its variety of OHV [off-highway vehicle] opportunities that require advanced skill levels." The OHV routes, which include an unofficial staging area near the Camatta Canyon amole area, are heavily used (U.S. Forest Service 2005). (USFWS, 2008)

Stressor: Fires (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: The frequency of fires in California is increasing (Syphard et al. 2007), and fires at certain times of the year have the ability to prevent annual reproductive success of the purple amole (Niceswanger 2002) and also of the Camatta Canyon amole. The Chlorogalum purpureum are susceptible to damage by fire when the living structures, including the seeds, are above ground or near the soil surface. However, fires at certain times of the year may potentially benefit the Chlorogalum purpureum by removing other competitive plants, both native and invasive species. The Chlorogalum purpureum may also respond favorably to fire in other ways. (USFWS, 2008)

Recovery

Reclassification Criteria:
Reclassification criteria are not available.

Recovery Priority Number: 8

Delisting Criteria:
1. At least four resilient occurrences or occupied area of 250 hectares (617 acres), across the single population, display evidence of recruitment of new individuals and stable or increasing population trend averaged over 10 consecutive years (USFWS, 2022)

2. Each of the four resilient occurrences, or occupied area of 250 hectares (617 acres), is protected from habitat loss, including development activities (USFWS, 2022)

3. Each of the four resilient occurrences, or occupied area of 250 hectares (617 acres), is being managed in a way, currently and into the future, that will support continued existence of Camatta Canyon amole and its habitat, including management of non-native, invasive species, and protection from off-highway vehicles (USFWS, 2022)

4. Management is effective as shown by monitoring over 10 consecutive years (USFWS, 2022)

5. An ex situ permanent conservation seedbank is established in a Center for Plant Conservation-affiliated botanic garden that reflects the breadth of the taxon's genetic diversity (USFWS, 2022)

Recovery Actions:
- 1. Protect all currently unprotected habitat where the taxon occurs (Priority 1) (USFWS, 2022)
- 2. Manage habitat that supports the taxon to reduce or eliminate threats (Priority 1) (USFWS, 2022)
- 3. Conduct annual census monitoring (Priority 2) (USFWS, 2022)
- 4. Collect seed and deposit accessions into the permanent conservation seedbank (Priority 3) (USFWS, 2022)
- 5. Conduct experimental research projects (Priority 3) (USFWS, 2022)

References

USFWS. 2015. Environmental Conservation Online System (ECOS) – Species Profile. http://ecos.fws.gov/speciesProfile/. Accessed May 2016.

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Final Designation of Critical Habitat for Chlorogalum purpureum, a Plant From the South Coast Ranges of California. Final rule. 67 FR 65414 - 65445 (October 24, 2002).

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USFWS. 2022. Recovery Plan for Purple Amole (Hooveria purpurea [Chlorogalum purpureum]). U.S. Fish and Wildlife Service, Pacific Southwest Region. Ventura, California. Ventura, California. 14 pp.

SPECIES ACCOUNT: *Chlorogalum purpurem var. reductum* (Camatta Canyon amole)

Species Taxonomic and Listing Information

Listing Status: Threatened; 03/20/2000; California/Nevada Region (R8) (USFWS, 2015)

Physical Description

A perennial lily with a basal cluster of bright green leaves, which are elongate, with a wavy margin, and with a thickened midrib (Service 2002, Holland 2004, Guretzky et al. 2005). The basal leaves typically range from 1 to 8 in number (Woodbury 2005b), but as many as 14 have been recorded (Guretzky et al. 2005), with a width of 2 to 5 mm. The bulb is ovoid, 2.5 to 3.0 cm long, white to brown in color, and occurs in the upper few inches of soil (Service 2002, Holland 2004). The flower cluster is borne on a single stem with multiple branches. The flowers are deep blue or purple with bright yellow anthers. The fruits are capsules, each with three chambers containing one or two black, ovoid seeds (Jernstedt 1993). (USFWS 2008)

Taxonomy

Chlorogalum purpureum is the only member of the genus with flowers that are blue or purple in color; the other members of the genus have flowers that are white or pink (Hoover 1940, Jernstedt 2007). Two varieties of Chlorogalum purpureum are recognized (Hoover 1940, Jernstedt 2007): Chlorogalum purpureum var. purpureum and Chlorogalum purpureum var. reductum. However, the International Plant Names Index (2005) places the genus Chlorogalum in the hyacinth family (Hyacinthaceae), while recent comparative molecular studies support the inclusion of the genus in the agave family (Agavaceae; Bolger et al. 2006). (USFWS, 2008)

Historical Range

See current range/distribution.

Current Range

The Camatta Canyon amole Chlorogalum purpureum var. reductum is endemic to the La Panza Range in central San Luis Obispo County. The type locality for the Camatta Canyon amole is 18 miles east of Creston on La Panza road, San Luis Obispo County, California. The taxon is known only from a small geographic area. The main population is approximately 0.8 km (0.5 mi) east of the southern end of Camatta Canyon. (USFWS 2008)

Critical Habitat Designated

Yes; 10/24/2002.

Legal Description

On October 24, 2002, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), Chlorogalum purpureum var. reductum (Camatta Canyon amole).

Critical Habitat Designation

The critical habitat designation for Chlorogalum purpurem var. reductum includes two units totaling approximately 1,772 ha (4,378 ac) of land. Approximately 25 percent of this total area consists of Federal lands, private lands comprise approximately 75 percent, and State lands comprise less than 0.1 percent.

Jolon Unit: This unit consists of 620 ha (1,532 ac) of private property near Jolon Road. This population is probably a remnant of a much larger population that historically extended beyond the immediate Fort Hunter Liggett area. The land within this unit provides those characteristics essential for the species.

Camatta Canyon Unit: This unit consists of one area that encompasses the similar topographic features and vegetative communities that surround the only two known occurrences of this species. The Camatta Canyon Unit (1,772 ha (4,378 ac)) encompasses the plateau on both the north and south sides of Highway 58 near Camatta Canyon, extending south approximately 5 km (3 mi) to include two private inholding areas within the LPNF boundaries. The land within this unit provides those characteristics essential for the species discussed above. More specifically, the area surrounding the known distribution of Chlorogalum purpureum var. reductum and the plateau adjacent to the known distribution (i.e., finger-like extensions in northern portion of the unit) are essential because: (1) Chlorogalum purpureum var. reductum is found at only two sites in the La Panza Range in central San Luis Obispo County. The two sites likely make up one ‘‘population’’ of plants due to the close proximity of the sites and the characteristic ‘‘patchiness’’ of plants that has been observed with both varieties of C. purpureum. The limited geographic distribution of C. p. var. reductum increases the likelihood of its extinction. The risk of extinction elevates the need for protecting all existing plants, habitat, and soil conditions for the taxon’s expansion. Additionally, ecological attributes upon which the species relies (e.g., pollinators, seed dispersal agents) should be protected. Activities that may adversely affect or destroy the plant and the habitat that is critical for its survival and expansion should be limited. These activities include, but are not limited to, off-road vehicle use, livestock grazing, herbivory, and ground disturbance by gophers. (2) Thorough surveys of the distribution of Chlorogalum purpureum var. reductum have not been conducted in the area. Surveys are needed across multiple years to determine the presence or absence of the species. Monitoring of C. p. var. purpureum at Fort Hunter Liggett has found known individual mature plants to be dormant for at least three years. During dormancy, both varieties of Chlorogalum are not detectable on the surface. Because discoveries of new C. p. var. purpureum sites are being found within the range of the taxon at Fort Hunter Liggett, one may expect ‘‘new patches’’ of C. p. var. reductum to occur in the Camatta Canyon Unit if surveys were conducted within the critical habitat boundary in those areas where the primary constituent elements occur. (3) An extension of the plateau/flattop area where Chlorogalum purpureum var. reductum is currently known to occur exists between the northern site and the southern site. This area harbors the soils and vegetation appropriate for C. p. var. reductum growth and expansion. The Service believes it is important to provide connectivity between the two sites. Additionally, the area encompasses what appear to be flat-top/ mesa-like extensions (which likely contain suitable habitat) that occur between the two known distributions (D. Chipping, California Polytechnic State University, in litt., 1997). A. Koch (CDFG, pers. comm., 2001) also notes that C. p. var. reductum occurs on private property which falls between the two known sites and within the critical habitat boundary line. (4) The vegetation community that Chlorogalum purpureum var. reductum depends on extends beyond the boundary of the known distribution. By encompassing plateau areas, the known distribution, and a portion of the adjacent vegetation community that the species depends on, ecological functions (e.g., cryptogamic crust formation, predator-prey relationships, pollinator activity) within the habitat are maintained such that ‘‘edge effects’’ from encroaching activities not conducive to C. p. var. reductum persistence (e.g., off-road vehicle use, livestock grazing, etc.) do not inhibit the taxon's expansion or survival. Additionally, adjacent grassland and oak woodland habitat that is adversely affected could result in greater rates of herbivory or regeneration/expansion of nonnative plants that can outcompete smaller, herbaceous species such as C. p. var. reductum. Lands proposed are under private, State, and Federal jurisdiction. State lands are managed by CalTrans, and Federal lands are managed by the the Forest Service (i.e., LPNF).

Primary Constituent Elements/Physical or Biological Features

The primary constituent elements of critical habitat for Chlorogalum purpureum var. reductum consist of, but are not limited to:

(i) Well-drained, red clay soils with a large component of gravel and pebbles on the upper soil surface; and,

(ii) Plant communities in functioning ecosystems that support associated plant and animal species (e.g., pollinators, predator-prey species, etc.), including grassland, blue oak woodland (Quercus douglasii) or oak savannahs, and open areas within shrubland communities. Within these vegetation communities C. p. var. reductum appears where there is little cover of other species which compete for resources available for growth and reproduction.

Special Management Considerations or Protections

Critical habitat does not include existing features and structures, such as buildings, hard-packed roads (e.g., asphalt, pavement), aqueducts, railroads, airport runways and buildings, other paved areas, lawns, and other urban landscaped areas not containing any of the primary constituent elements.

Special management and protection that C. purpureum critical habitat may require are: (1) The soils on which Chlorogalum purpureum is found should be maintained. Physical properties of the soil, such as its chemical composition, structure, and drainage capabilities, would best be maintained by limiting or restricting the use of herbicides, fertilizers, or other soil amendments; and by minimizing or avoiding activities that result in soil compaction (e.g., offroad wheeled and tracked vehicle use, trampling by people and livestock) and those that would alter the hydrology of areas immediately adjacent to or upslope of the species and its critical habitat. (2) The soil surface should be maintained to enhance cryptogamic crust formation by minimizing the intensity, frequency, duration, and acreage of soil surface disturbance. The soil surface should be protected at relict sites (i.e., sites with well-developed crusts) to provide reference areas and baseline comparisons for research. 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Thus, proactive management should be implemented to prevent annual fires, unless future research demonstrates that a series of annual fires can benefit Chlorogalum purpureum by reducing competition from nonnative species. (5) Certain critical habitat areas (i.e., suitable, unoccupied habitat between or adjacent to known patches of Chlorogalum purpureum) may need to be temporarily fenced or demarcated to identify exclusion areas for protection from accidental or intentional trampling by humans, livestock, or off-road vehicle use. Heavy disturbance to these critical areas may be detrimental to this species' persistence. Seasonal exclusions may work in certain areas to protect the critical habitat and C. purpureum plants during the critical season of growth and reproduction. 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Life History

Food/Nutrient Resources

Dependency on Other Individuals or Species

Adult: Small bees are common pollinators of the Camatta Canyon amole, including sweat bees (Halictidae; Center for Plant Conservation 2007b). (USFWS, 2008)

Breeding Season

Adult: April to June (USFWS, 2008)

Reproduction Narrative

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Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Barrens, Forest/Woodland, Grassland/herbaceous, Shrubland/chaparral, Woodland - Hardwood, Woodland - Mixed (NatureServe, 2015)

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Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: All locations for C. purpureum var. purpureum and C. purpureum var. reductum are in semiarid environments and have a Mediterranean climate with summers that are hot and dry, and winters that are cool and wet (USFWS 2008). C. purpureum var. reductum in the Los Padres National Forest grows in open areas on a ridgetop in blue oak savanna and annual grassland, and in open areas in grassland and woodland. The Service (2001, 2002) reported the Camatta Canyon amole to occur at 305 to 625 m (1,000 to 2,050 ft) elevation. However, others (e.g., Jernstedt 1993, 2007; California Department of Fish and Game 2007; California Native Plant Society 2007) reported elevations from 579 to 630 m. (USFWS, 2008; NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Stable (USFWS, 2008)

Population Growth Rate:

Slow (USFWS, 2008)

Number of Populations:

four (USFWS, 2020)

Population Size:

100,000 to 500,000 (USFWS, 2008)

Population Narrative:

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Threats and Stressors

Stressor: Road maintenance (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: The intended use of the highway right-of-way along State Highway 58 is for transportation purposes. A two-lane highway right-of-way is typically comprised of a 40-ft wide strip of land: a paved road, 24 ft wide; then a shoulder on each side, each 4 ft wide; and then another 4 ft of ground on each side. In the location with the Camatta Canyon amole, the plants are usually growing "sporadically" along the fenceline boundary with the adjacent private properties (Edell pers. com. 2007). The California Department of Transportation has designated the right-of-way with the Camatta Canyon amole as a botanical management area. Because of this designation, the California Department of Transportation conducts occasional monitoring and gives greater scrutiny when construction or maintenance occurs in the area (Edell in litt. 2007a, 2007b). (USFWS, 2008)

Stressor: Displacement by non-native annual grasses (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Non-native annual grasses and other invasive plant species continue to be a threat to the purple amole at Fort Hunter Liggett and Camp Roberts and to the Camatta Canyon amole on the Los Padres National Forest. The invasive plant species may have the ability to displace the Chlorogalum purpureum by outcompeting and monopolizing limited resources (growing space, sunlight, soil nutrients, water; Stephenson and Calcarone 1999), with the potential effects of preventing growth and recruitment (U.S. Army 2004b). The invasive plant species may also have the ability to alter characteristics of the fire regime, such as frequency, intensity, and seasonality of fires (Brooks et al. 2004). (USFWS, 2008)

Stressor: Illegal vehicle trespass in the National Forest (USFWS, 2008)

Exposure:
Response:
Consequence:
Narrative: The taxon is at risk of destruction, modification, and curtailment of its habitat and known range due to illegal vehicle trespass and cattle grazing in the Camatta Canyon amole area on the Los Padres National Forest. Off-highway vehicles and cattle grazing can cause physical damage to the Camatta Canyon amole, compact the soil, stimulate soil erosion, damage cryptogamic crusts, reduce the presence of native plants, and increase the presence of invasive plants (e.g. Fleischner 1994, Service 2000, Belnap and Eldridge 2001). (USFWS, 2008)

Stressor: Livestock grazing (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: The area occupied by the Camatta Canyon amole on the Los Padres National Forest is in the Navajo Allotment where the permittee is authorized to graze cattle between February and May. Because the Camatta Canyon amole flowers and develops fruit from April to June, we believe that cattle grazing is likely adversely affecting the taxon by trampling, soil compaction, and possibly herbivory. (USFWS, 2008)

Stressor: Recreation (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: The Camatta Canyon amole area is in the Pozo-La Panza unit of the Los Padres National Forest. The unit "is best known for its variety of OHV [off-highway vehicle] opportunities that require advanced skill levels." The OHV routes, which include an unofficial staging area near the Camatta Canyon amole area, are heavily used (U.S. Forest Service 2005). (USFWS, 2008)

Stressor: Fires (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: The frequency of fires in California is increasing (Syphard et al. 2007), and fires at certain times of the year have the ability to prevent annual reproductive success of the purple amole (Niceswanger 2002) and also of the Camatta Canyon amole. The Chlorogalum purpureum are susceptible to damage by fire when the living structures, including the seeds, are above ground or near the soil surface. However, fires at certain times of the year may potentially benefit the Chlorogalum purpureum by removing other competitive plants, both native and invasive species. The Chlorogalum purpureum may also respond favorably to fire in other ways. (USFWS, 2008)

Recovery

Reclassification Criteria:
Reclassification criteria are not available.

Recovery Priority Number: 8

Delisting Criteria:
1. At least four resilient occurrences or occupied area of 250 hectares (617 acres), across the single population, display evidence of recruitment of new individuals and stable or increasing population trend averaged over 10 consecutive years (USFWS, 2022)

2. Each of the four resilient occurrences, or occupied area of 250 hectares (617 acres), is protected from habitat loss, including development activities (USFWS, 2022)

3. Each of the four resilient occurrences, or occupied area of 250 hectares (617 acres), is being managed in a way, currently and into the future, that will support continued existence of Camatta Canyon amole and its habitat, including management of non-native, invasive species, and protection from off-highway vehicles (USFWS, 2022)

4. Management is effective as shown by monitoring over 10 consecutive years (USFWS, 2022)

5. An ex situ permanent conservation seedbank is established in a Center for Plant Conservation-affiliated botanic garden that reflects the breadth of the taxon’s genetic diversity (USFWS, 2022)

Recovery Actions:
- 1. Protect all currently unprotected habitat where the taxon occurs (Priority 1) (USFWS, 2022)
- 2. Manage habitat that supports the taxon to reduce or eliminate threats (Priority 1) (USFWS, 2022)
- 3. Conduct annual census monitoring (Priority 2) (USFWS, 2022)
- 4. Collect seed and deposit accessions into the permanent conservation seedbank (Priority 3) (USFWS, 2022)
- 5. Conduct experimental research projects (Priority 3) (USFWS, 2022)

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SPECIES ACCOUNT: *Chlorogalum purpureum* (Purple amole)

Species Taxonomic and Listing Information

Listing Status: Threatened; 03/20/2000; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A perennial herb with a basal rosette of long, linear leaves and a widely branching stem, 1-2 dm tall, arising from an underground bulb. The flower cluster is borne on a single stem with multiple branches. The flowers are deep blue or purple with bright yellow anthers. The fruits are capsules, each with three chambers containing one or two black, ovoid seeds (Jernstedt 1993). (NatureServe, 2015)

Taxonomy

The genus Chlorogalum comprises five plant species in the lily family (Liliaceae; Jernstedt 2007) which inhabit western North America from southern Oregon to Baja California, Mexico. Chlorogalum purpureum is the only member of the genus with flowers that are blue or purple in color; the other members of the genus have flowers that are white or pink (Hoover 1940, Jernstedt 2007). Two varieties of Chlorogalum purpureum are recognized (Hoover 1940, Jernstedt 2007): Chlorogalum purpureum var. purpureum and Chlorogalum purpureum var. reductum. There have been no changes or proposed changes in nomenclature since the species was listed in 2000 (Jernstedt 2007). However, the International Plant Names Index (2005) places the genus Chlorogalum in the hyacinth family (Hyacinthaceae), while recent comparative molecular studies support the inclusion of the genus in the agave family (Agavaceae; Bolger et al. 2006). (USFWS, 2008)

Historical Range

When Chlorogalum purpureum was listed as threatened in 2000, the Chlorogalum purpureum var. purpureum taxon was known only from three localities on Fort Hunter Liggett. (USFWS, 2008)

Current Range

The purple amole Chlorogalum purpureum var. purpureum is endemic to the Santa Lucia Range of Monterey and San Luis Obispo counties, California. The taxon is known from two properties: several localities on Fort Hunter Liggett, southern Monterey County; and one locality on Camp Roberts in northern San Luis Obispo County (USFWS, 2008)

Critical Habitat Designated

Yes; 10/24/2002.

Legal Description

On October 24, 2002, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Chlorogalum purpureum (Purple amole) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two critical habitat units (CHUs), in California (67 FR 65414-65445).

Critical Habitat Designation

The critical habitat designation for Chlorogalum purpureum includes two CHUs in San Luis Obispo and Monterey counties, California. This species critical habitat encompasses approximately 5,910 acres (ac) (2,443 hectares (ha)) (67 FR 65414-65445).

Jolon Unit: This unit consists of 620 ha (1,532 ac) of private property near Jolon Road. This population is probably a remnant of a much larger population that historically extended beyond the immediate Fort Hunter Liggett area. The land within this unit provides those characteristics essential for the species discussed above.

Camatta Canyon Unit This unit consists of one area that encompasses the similar topographic features and vegetative communities that surround the only two known occurrences of this species. The Camatta Canyon Unit (1,772 ha (4,378 ac)) encompasses the plateau on both the north and south sides of Highway 58 near Camatta Canyon, extending south approximately 5 km (3 mi) to include two private inholding areas within the LPNF boundaries. The land within this unit provides those characteristics essential for the species discussed above. More specifically, the area surrounding the known distribution of Chlorogalum purpureum var. reductum and the plateau adjacent to the known distribution (i.e., finger-like extensions in northern portion of the unit) are essential because: (1) Chlorogalum purpureum var. reductum is found at only two sites in the La Panza Range in central San Luis Obispo County. The two sites likely make up one ‘‘population’’ of plants due to the close proximity of the sites and the characteristic ‘‘patchiness’’ of plants that has been observed with both varieties of C. purpureum. The limited geographic distribution of C. p. var. reductum increases the likelihood of its extinction. The risk of extinction elevates the need for protecting all existing plants, habitat, and soil conditions for the taxon’s expansion. Additionally, ecological attributes upon which the species relies (e.g., pollinators, seed dispersal agents) should be protected. Activities that may adversely affect or destroy the plant and the habitat that is critical for its survival and expansion should be limited. These activities include, but are not limited to, off-road vehicle use, livestock grazing, herbivory, and ground disturbance by gophers. (2) Thorough surveys of the distribution of Chlorogalum purpureum var. reductum have not been conducted in the area. Surveys are needed across multiple years to determine the presence or absence of the species. Monitoring of C. p. var. purpureum at Fort Hunter Liggett has found known individual mature plants to be dormant for at least three years. During dormancy, both varieties of Chlorogalum are not detectable on the surface. Because discoveries of new C. p. var. purpureum sites are being found within the range of the taxon at Fort Hunter Liggett, one may expect ‘‘new patches’’ of C. p. var. reductum to occur in the Camatta Canyon Unit if surveys were conducted within the critical habitat boundary in those areas where the primary constituent elements occur. (3) An extension of the plateau/flattop area where Chlorogalum purpureum var. reductum is currently known to occur exists between the northern site and the southern site. This area harbors the soils and vegetation appropriate for C. p. var. reductum growth and expansion. We believe it is important to provide connectivity between the two sites. Additionally, the area encompasses what appear to be flat-top/ mesa-like extensions (which likely contain suitable habitat) that occur between the two known distributions (D. Chipping, California Polytechnic State University, in litt., 1997). A. Koch (CDFG, pers. comm., 2001) also notes that C. p. var. reductum occurs on private property which falls between the two known sites and within the critical habitat boundary line. (4) The vegetation community that Chlorogalum purpureum var. reductum depends on extends beyond the boundary of the known distribution. By encompassing plateau areas, the known distribution, and a portion of the adjacent vegetation community that the species depends on, ecological functions (e.g., cryptogamic crust formation, predator-prey relationships, pollinator activity) within the habitat are maintained such that ‘‘edge effects’’ from encroaching activities not conducive to C. p. var. reductum persistence (e.g., off-road vehicle use, livestock grazing, etc.) do not inhibit the taxon’s expansion or survival. Additionally, adjacent grassland and oak woodland habitat that is adversely affected could result in greater rates of herbivory or regeneration/expansion of nonnative plants that can outcompete smaller, herbaceous species such as C. p. var. reductum. Lands proposed are under private, State, and Federal jurisdiction. State lands are managed by CalTrans, and Federal lands are managed by the the Forest Service (i.e., LPNF). The approximate areas of proposed 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 Chlorogalum purpureum critical habitat consists of two components (67 FR 65414-65445):

The primary constituent elements of critical habitat for Chlorogalum purpureum var. reductum consist of, but are not limited to: (i) Well-drained, red clay soils with a large component of gravel and pebbles on the upper soil surface; and,

(ii) Plant communities in functioning ecosystems that support associated plant and animal species (e.g., pollinators, predator-prey species, etc.), including grassland, blue oak woodland (Quercus douglasii) or oak savannahs, and open areas within shrubland communities. Within these vegetation communities C. p. var. reductum appears where there is little cover of other species which compete for resources available for growth and reproduction.

Special Management Considerations or Protections

Special management considerations or protections may be needed to maintain the primary constituent elements for Chlorogalum purpureum within the units being proposed as critical habitat. In some cases, protection of existing habitat and current ecological processes may be sufficient to ensure that populations of C. purpureum are maintained at those sites, and have the ability to reproduce and disperse into surrounding habitat. In other cases, however, active management may be needed to maintain the primary constituent elements for C. purpureum. We have outlined below the most likely kinds of special management and protection that C. purpureum critical habitat may require. (1) The soils on which Chlorogalum purpureum is found should be maintained. Physical properties of the soil, such as its chemical composition, structure, and drainage capabilities, would best be maintained by limiting or restricting the use of herbicides, fertilizers, or other soil amendments; and by minimizing or avoiding activities that result in soil compaction (e.g., offroad wheeled and tracked vehicle use, trampling by people and livestock) and those that would alter the hydrology of areas immediately adjacent to or upslope of the species and its critical habitat. (2) The soil surface should be maintained to enhance cryptogamic crust formation by minimizing the intensity, frequency, duration, and acreage of soil surface disturbance. The soil surface should be protected at relict sites (i.e., sites with well-developed crusts) to provide reference areas and baseline comparisons for research. Because cryptogamic crusts are highly susceptible to hot fires (Belnap et al. 2001) and the presence of nonnative annual grasses in Chlorogalum purpureum habitat may promote fires. Annual, intense fires should be avoided. The effects of activities that can damage biotic soil crusts (e.g., excavations, offroad vehicle use, trampling) should be reduced by moving them to areas where crusts are less vulnerable, limiting the area affected, and conducting such activities in dryer seasons. (3) The associated plant and animal communities should be maintained to ensure the habitat needs of pollinators and seed dispersal agents are maintained, and predator-prey relationships are functioning. The use of pesticides should be restricted so that viable populations of pollinators are present to facilitate reproduction of Chlorogalum purpureum. Fragmentation of habitat through road construction, development, and certain types of fencing should be limited. Additionally, predator-prey relationships should be managed and protected. For example, installation of fencing could exclude predator species (e.g., coyotes, bobcats, San Joaquin kit fox), thus causing an increase in prey species (e.g., ground squirrels, gophers, rabbits) abundance. A change such as this could result in increased herbivory, bulb predation, or burrowing that could affect C. purpureum growth and survival. (4) In all plant communities where Chlorogalum purpureum occurs, invasive, nonnative species such as Centuarea solstitialis (yellow starthistle), Avena spp. (wild oats), Bromus spp. (B. hordeaceus, B. diandrus, B. madritensis, B. rubens (brome)), Erodium spp. (storksbill or fillaree), and other species need to be actively managed and controlled to maintain the open habitat that Chlorogalum purpureum needs. Nonnative annual grasses may promote fires by providing recurring annual fuel sources. Thus, proactive management should be implemented to prevent annual fires, unless future research demonstrates that a series of annual fires can benefit Chlorogalum purpureum by reducing competition from nonnative species. (5) Certain critical habitat areas (i.e., suitable, unoccupied habitat between or adjacent to known patches of Chlorogalum purpureum) may need to be temporarily fenced or demarcated to identify exclusion areas for protection from accidental or intentional trampling by humans, livestock, or off-road vehicle use. Heavy disturbance to these critical areas may be detrimental to this species' persistence. Seasonal exclusions may work in certain areas to protect the critical habitat and C. purpureum plants during the critical season of growth and reproduction. (6) In areas where Chlorogalum purpureum and its habitat occur in conjunction with off-road vehicle traffic (e.g., military wheeled and tracked vehicles, OHVs), we recommend managing to minimize the severity of those effects. Management should include: limiting or avoiding new structures and permanent roads and trails; managing excavations, scrapings, or other ground surface disturbance; managing tracked and wheeled vehicle use during C. purpureum growing and dormant seasons; and managing foot traffic, bivouacking, and congregations of high numbers of people during C. purpureum growing and dormant seasons. These types of activities should be managed to limit loss of adults, bulbs, and seeds, loss of habitat, increased soil compaction, and increased nonnative species encroachment. (7) Monitoring programs should be developed or enhanced so that areas occupied by purple amole are studied, allowing for a full range of life-history data and a thorough analysis of the compatibility and impacts of those activities that may adversely affect the species. Representative areas should be chosen throughout the distribution of the species, including large, highdensity populations that have a higher potential for persistence. Monitoring studies should be designed to aid in the determination of population stability as well as provide basic life-history information and data on the ecological needs of the species (e.g., identification and status of pollinator species, disturbance factors, etc.).

Life History

Food/Nutrient Resources

Lifespan

Adult: 5 to 7 years (USFWS, 2008)

Breeding Season

<u>Adult: </u>April to May (NatureServe, 2015)

Reproduction Narrative

<u>Adult: </u>In one study, Chlorogalum purpureum flowered at three years following germination, and all plants had flowered at four years following germination. C. purpureum typically flower between April and May (NatureServe, 2015). Most plants died between the fifth and seventh year following germination. For seed-producing plants at Fort Hunter Liggett, the number of seeds produced per plant was highly variable, with a recorded range of 1 to 386 seeds per plant and a recorded mean of 28 seeds per plant (Niceswanger 2002). (USFWS, 2008; NatureServe, 2015))

Habitat Type

<u>Adult: </u>Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

<u>Adult: </u>Barrens, Forest/Woodland, Grassland/herbaceous, Shrubland/chaparral, Woodland - Hardwood, Woodland - Mixed (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

<u>Adult: </u>Found at elevations between 213 to 407 m (700 to 1,336 feet)

Spatial Arrangements of the Population

<u>Adult: </u>Discontinuous patches (USFWS, 2008)

Environmental Specificity

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

Dependency on Other Individuals or Species for Habitat

<u>Adult: </u>The purple amole (e.g., Guretzky et al. 2005; Woodbury 2006) and the Camatta Canyon amole (E.L. Painter in litt. 1998) have been reported to grow in association with cryptogamic crusts. (USFWS, 2008)

Habitat Narrative

<u>Adult: </u>The taxon is known from the lower elevations on the eastern side of the range, at approximately 213 to 407 meters (m) (700 to 1,336 feet (ft)) elevation. On Fort Hunter Liggett, there are hundreds of discontinuous patches of purple amole in grassland, oak savanna, and oak woodland communities where they occur in association with gravelly, clay soils. The purple amole (e.g., Guretzky et al. 2005; Woodbury 2006) and the Camatta Canyon amole (E.L. Painter in litt. 1998) have been reported to grow in association with cryptogamic crusts. The purple amole occurs in patches that range from a few plants to more than 10,000 individuals per ha (4,047 individuals per ac) at the densest locations. (USFWS, 2008)

Dispersal/Migration

Dispersal/Migration Narrative

<u>Adult: </u>Not available

Population Information and Trends

Population Trends:

Stable to increasing (USFWS, 2008)

Resiliency:

In summary, for Santa Lucia purple amole, the resiliency analysis shows that three of the four populations have moderate resiliency and one is low. For Camatta Canyon amole, the resiliency analysis shows that one occurrence has moderate resiliency and two occurrences have low resiliency; there is insufficient information to calculate a resiliency score for occurrence 4 because the area of the occurrence is not known. The populations/occurrences with moderate resiliency have a moderate ability to sustain themselves in the face of environmental variation and therefore a moderate risk of extirpation in the near future. The populations/occurrences with an overall low resiliency have a low ability to sustain themselves in the face of environmental variation and therefore a high risk of extirpation in the near future. (USFWS, 2020)

Representation:

Representation describes the ability of a species to adapt to changing environmental conditions over time. It is characterized by the breadth of genetic and environmental diversity within and among populations. Measures may include the number of varied niches occupied, genetic diversity, heterozygosity, or alleles per locus. Given morphological and ecological differences between Santa Lucia purple amole and Camatta Canyon amole, representation across both varieties contributes to the species ability to adapt to changing environmental conditions over time. Both varieties have relatively small geographic ranges with mostly similar landscape features throughout. The Santa Lucia purple amole currently occupied area consists of approximately 500 hectares (1,230 acres). The known occupied area of Camatta Canyon amole in 2020 consists of greater than 36 hectares (89 acres). The niches and habitats each variety occupies have little heterogeneity. Therefore, each variety is a narrow, endemic taxon and the types of habitats or niches that it occupies are nearly uniform. Although information is lacking regarding genetics of either Santa Lucia purple amole or Camatta Canyon amole, we consider each to comprise one genetic unit due to geography. While we are not aware of any extirpated locations or occurrences, or of any contraction in the geographic range, the productivity data for Santa Lucia purple amole suggest three of the four populations may be declining. The combined data from several studies suggest that the number of Camatta Canyon amole, where monitored, has declined. Thus, declining numbers of individuals may affect genetic diversity, and the spatial extent and associated ecological representation of both Santa Lucia purple amole and Camatta Canyon amole are inherently low. (USFWS, 2020)

Redundancy:

Redundancy describes the ability of a species to withstand catastrophic events. Redundancy is characterized by having multiple, resilient populations distributed within the species' ecological settings and across the species' geographic range. It can be measured by population number, spatial extent, and degree of connectivity. Given sufficient redundancy, single or multiple catastrophic events are unlikely to cause the extinction of a species. Purple amole is composed of two varieties, both narrow, endemic taxa with relatively small geographic ranges. Santa Lucia purple amole only has four populations located within approximately 280 kilometers2 (108 square miles). Camatta Canyon amole only has four occurrences located within approximately 3 kilometers2 (1 square mile). Because all four populations of Santa Lucia purple amole and all four occurrences of Camatta Canyon amole are situated close together, they could possibly be simultaneously affected by a catastrophic event. Given that the two varieties are approximately 61 km (38 miles) apart, a prolonged, catastrophic drought could affect both varieties simultaneously. However, the two varieties are far enough apart such that a large, intense wildfire is unlikely to deleteriously affect both varieties at once. Therefore, purple amole has inherently low redundancy due to being composed of two narrow endemic varieties, but having two spatially separated varieties does provide some protection for the species as a whole from extinction due to less expansive catastrophic events. (USFWS, 2020)

Number of Populations:

4 (USFWS, 2020)

Population Narrative:

Purple amole is endemic to Monterey and San Luis Obispo Counties in central California. Santa Lucia purple amole is known from 17 occurrences in four populations in the Santa Lucia Range in southwestern Monterey County (Fort Hunter Liggett) and north central San Luis Obispo County (Camp Roberts) (CNDDB 2020, website). Camatta Canyon amole is known from four occurrences in the La Panza Range and adjacent hills in central San Luis Obispo County (Kofron et al. 2013a, entire). The Santa Lucia purple amole currently occupied area consists of less than 500 hectares (1,230 acres). The Camatta Canyon amole currently occupied area consists of greater than 36 hectares (90 acres). The species needs appropriate soil types, including welldrained with gravel components in the top and subsoil strata; suitable habitats, including openings within blue oak woodland and California buckwheat and/or chamise shrubland, blue oak savanna and valley and California prairie; sparsely vegetated areas with some open, bare ground; adequate annual precipitation; suitable temperatures; insect pollinators; and biological soil crusts. (USFWS, 2020)

Threats and Stressors

Stressor: Habitat alteration (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: The property comprising Fort Hunter Liggett has a long history of settlement and use by "Europeans," dating back to 1771, which has affected the current distribution of the purple amole. On Fort Hunter Liggett, the purple amole is nearly absent from areas that were previously cultivated by disking. The taxon is most abundant in areas that were not previously disked, including areas where intensive military training has been common since 1941 (U.S. Army 2004a, 2004b). (USFWS, 2008)

Stressor: Military activities (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: The California Army National Guard ceased conducting military activities in the purple amole area in 2000, with exception of road use for four weeks in 2001 and 2003 and occasional use of the tank trail where the taxon does not occur. (USFWS, 2008)

Stressor: Gophers (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Niceswanger (2002) reported that "gophers (or possibly other rodents) tunneled through the sites and ate the leaves and flowering stems." Woodbury's (2005a, 2005b, 2006) data suggested that gophers may forage on the leaves of purple amole, with little or no interest in the bulbs. Woodbury (2006) stated that gophers displace the soil and the bulbs. From 2003 to 2006, the amounts of quadrats with gopher activity within 1 m were 41 percent, 32 percent, 26 percent, and 23 percent, respectively. (USFWS, 2008)

Stressor: Fungus (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Niceswanger (2002) observed a fungus affecting the purple amole at two transects during 2000, causing the plants to whither and rot. This is the only report of any disease affecting the purple amole. (USFWS, 2008)

Stressor: Feral pigs (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Holland (2007) observed pervasive soil disturbance by feral pigs in the purple amole habitat. Although Holland (2007) reported the effects to the purple amole to be unknown, Olson (pers. com. 2007) informed us that feral pigs eat the bulbs. (USFWS, 2008)

Stressor: Non-native annual grasses and invasive species (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Non-native annual grasses and other invasive plant species continue to be a threat to the purple amole at Fort Hunter Liggett and Camp Roberts and to the Camatta Canyon amole on the Los Padres National Forest. The invasive plant species may have the ability to displace the Chlorogalum purpureum by outcompeting and monopolizing limited resources (growing space, sunlight, soil nutrients, water; Stephenson and Calcarone 1999), with the potential effects of preventing growth and recruitment (U.S. Army 2004b). The invasive plant species may also have the ability to alter characteristics of the fire regime, such as frequency, intensity, and seasonality of fires (Brooks et al. 2004). We have no information on the site-specific presence of non-native plants in purple amole occurrences on Fort Hunter Liggett and Camp Roberts, or the effects that non-native competitors have on the frequency and seasonality of fire. (USFWS, 2008)

Stressor: Fire (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: The frequency of fires in California is increasing (Syphard et al. 2007), and fires at certain times of the year have the ability to prevent annual reproductive success of the purple

amole (Niceswanger 2002) and also of the Camatta Canyon amole. The Chlorogalum purpureum are susceptible to damage by fire when the living structures, including the seeds, are above ground or near the soil surface. However, fires at certain times of the year may potentially benefit the Chlorogalum purpureum by removing other competitive plants, both native and invasive species. The Chlorogalum purpureum may also respond favorably to fire in other ways. (USFWS, 2008)

Stressor: Stochastic events (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Niceswanger (2002) believed that the population of purple amole on Fort Hunter Liggett is highly vulnerable to stochastic events, especially catastrophes affecting mature plants such as fire. She therefore recommended protection and management of the habitat by administrative regulations, including prohibitions against physical disturbances during the reproductive stage. (USFWS, 2008)

Recovery

Reclassification Criteria:
Reclassification criteria are not available.

Recovery Priority Number: 8

Delisting Criteria:
1. At least four resilient populations display evidence of recruitment of new individuals and stable or increasing population trends averaged over 10 consecutive years (USFWS, 2022);

2. Each of the four resilient populations is being managed in a way, currently and into the future, that will support continued existence of Santa Lucia purple amole and its habitat, including management of non-native, invasive species, and anthropogenic disturbance and feral wildlife (USFWS, 2022)

3. Management is effective as shown by monitoring over 10 consecutive years (USFWS, 2022)

4. An ex situ permanent conservation seedbank is established in a Center for Plant Conservation-affiliated botanic garden that reflects the breadth of the taxon’s genetic diversity (USFWS, 2022)

Recovery Actions:
- Recovery actions are not available.
- We recommend that the U.S. Army search for the purple amole in potentially-suitable habitat on nearby private properties and at additional localities on Fort Hunter Liggett. (USFWS, 2008)
- We recommend that the U.S. Army complete its endangered species management plan for the purple amole on Fort Hunter Liggett as soon as possible. (USFWS, 2008)
- In light of the known error by first-year surveyors in 2002 (Clark in litt. 2007a), we recommend that the U.S. Army re-analyze its data regarding fire and the purple amole on

Fort Hunter Liggett. Further, we recommend that the U.S. Army conduct research regarding the effects of fire (frequency, seasonality) and invasive plants to the purple amole. (USFWS, 2008)

- We recommend that the U.S. Army actively manage the known occupied localities for the benefit of the purple amole. In particular, we recommend that the U.S. Army evaluate and consider conducting activities that may potentially benefit the purple amole on Fort Hunter Liggett, including controlled burns to remove invasive plants, the removal of feral pigs, and the use of the ball-and-chain method to remove competing plants in potential habitat. (USFWS, 2008)
- We recommend that the U.S. Army conduct research to determine the effects of gophers and feral pigs on the purple amole, and the relationship between the purple amole and cryptogamic crusts. (USFWS, 2008)
- We recommend that the California Army National Guard search for the purple amole in potentially-suitable habitat on nearby private properties and at additional localities on Camp Roberts. (USFWS, 2008)
- We recommend that the California Army National Guard complete the process of updating its draft Integrated Natural Resources Management Plan for Camp Roberts and consulting with the Service regarding it and the ongoing activities that may affect the purple amole. (USFWS, 2008)
- We recommend that the California Army National Guard statistically analyze its data regarding the effects of fire on the purple amole at Camp Roberts. Further, we recommend that the California Army National Guard conduct research regarding the effects of fire (frequency, seasonality) and invasive plants to the purple amole. (USFWS, 2008)
- We recommend that the California Army National Guard actively manage the known occupied localities for the benefit of the purple amole. In particular, we recommend that the California Army National Guard evaluate and consider conducting activities that may potentially benefit the purple amole on Camp Roberts, including controlled burns to remove invasive plants, controlled grazing by goats or sheep to remove invasive plants, and the removal of feral pigs. (USFWS, 2008)
- We recommend that the California Army National Guard conduct research to determine the effects of gophers and feral pigs on the purple amole, and the relationship between the purple amole and cryptogamic crusts. (USFWS, 2008)

Conservation Measures and Best Management Practices:

- Recovery actions for Santa Lucia purple amole 1. Manage habitat that supports the taxon to reduce or eliminate threats (Priority 1) 2. Conduct annual census monitoring (Priority 2) 3. Collect seed and deposit accessions into the permanent conservation seedbank (Priority 3) 4. Conduct experimental research projects (Priority 3) (USFWS, 2022)

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SPECIES ACCOUNT: *Chlorogalum purpureum* (Purple amole)

Species Taxonomic and Listing Information

Listing Status: Threatened; 03/20/2000; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A perennial herb with a basal rosette of long, linear leaves and a widely branching stem, 1-2 dm tall, arising from an underground bulb. The flower cluster is borne on a single stem with multiple branches. The flowers are deep blue or purple with bright yellow anthers. The fruits are capsules, each with three chambers containing one or two black, ovoid seeds (Jernstedt 1993). (NatureServe, 2015)

Taxonomy

The genus Chlorogalum comprises five plant species in the lily family (Liliaceae; Jernstedt 2007) which inhabit western North America from southern Oregon to Baja California, Mexico. Chlorogalum purpureum is the only member of the genus with flowers that are blue or purple in color; the other members of the genus have flowers that are white or pink (Hoover 1940, Jernstedt 2007). Two varieties of Chlorogalum purpureum are recognized (Hoover 1940, Jernstedt 2007): Chlorogalum purpureum var. purpureum and Chlorogalum purpureum var. reductum. There have been no changes or proposed changes in nomenclature since the species was listed in 2000 (Jernstedt 2007). However, the International Plant Names Index (2005) places the genus Chlorogalum in the hyacinth family (Hyacinthaceae), while recent comparative molecular studies support the inclusion of the genus in the agave family (Agavaceae; Bolger et al. 2006). (USFWS, 2008)

Historical Range

When Chlorogalum purpureum was listed as threatened in 2000, the Chlorogalum purpureum var. purpureum taxon was known only from three localities on Fort Hunter Liggett. (USFWS, 2008)

Current Range

The purple amole Chlorogalum purpureum var. purpureum is endemic to the Santa Lucia Range of Monterey and San Luis Obispo counties, California. The taxon is known from two properties: several localities on Fort Hunter Liggett, southern Monterey County; and one locality on Camp Roberts in northern San Luis Obispo County (USFWS, 2008)

Critical Habitat Designated

Yes; 10/24/2002.

Legal Description

On October 24, 2002, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Chlorogalum purpureum (Purple amole) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two critical habitat units (CHUs), in California (67 FR 65414-65445).

Critical Habitat Designation

The critical habitat designation for Chlorogalum purpureum includes two CHUs in San Luis Obispo and Monterey counties, California. This species critical habitat encompasses approximately 5,910 acres (ac) (2,443 hectares (ha)) (67 FR 65414-65445).

Jolon Unit: This unit consists of 620 ha (1,532 ac) of private property near Jolon Road. This population is probably a remnant of a much larger population that historically extended beyond the immediate Fort Hunter Liggett area. The land within this unit provides those characteristics essential for the species discussed above.

Camatta Canyon Unit This unit consists of one area that encompasses the similar topographic features and vegetative communities that surround the only two known occurrences of this species. The Camatta Canyon Unit (1,772 ha (4,378 ac)) encompasses the plateau on both the north and south sides of Highway 58 near Camatta Canyon, extending south approximately 5 km (3 mi) to include two private inholding areas within the LPNF boundaries. The land within this unit provides those characteristics essential for the species discussed above. More specifically, the area surrounding the known distribution of Chlorogalum purpureum var. reductum and the plateau adjacent to the known distribution (i.e., finger-like extensions in northern portion of the unit) are essential because: (1) Chlorogalum purpureum var. reductum is found at only two sites in the La Panza Range in central San Luis Obispo County. The two sites likely make up one ‘‘population’’ of plants due to the close proximity of the sites and the characteristic ‘‘patchiness’’ of plants that has been observed with both varieties of C. purpureum. The limited geographic distribution of C. p. var. reductum increases the likelihood of its extinction. The risk of extinction elevates the need for protecting all existing plants, habitat, and soil conditions for the taxon’s expansion. Additionally, ecological attributes upon which the species relies (e.g., pollinators, seed dispersal agents) should be protected. Activities that may adversely affect or destroy the plant and the habitat that is critical for its survival and expansion should be limited. These activities include, but are not limited to, off-road vehicle use, livestock grazing, herbivory, and ground disturbance by gophers. (2) Thorough surveys of the distribution of Chlorogalum purpureum var. reductum have not been conducted in the area. Surveys are needed across multiple years to determine the presence or absence of the species. Monitoring of C. p. var. purpureum at Fort Hunter Liggett has found known individual mature plants to be dormant for at least three years. During dormancy, both varieties of Chlorogalum are not detectable on the surface. Because discoveries of new C. p. var. purpureum sites are being found within the range of the taxon at Fort Hunter Liggett, one may expect ‘‘new patches’’ of C. p. var. reductum to occur in the Camatta Canyon Unit if surveys were conducted within the critical habitat boundary in those areas where the primary constituent elements occur. (3) An extension of the plateau/flattop area where Chlorogalum purpureum var. reductum is currently known to occur exists between the northern site and the southern site. This area harbors the soils and vegetation appropriate for C. p. var. reductum growth and expansion. We believe it is important to provide connectivity between the two sites. Additionally, the area encompasses what appear to be flat-top/ mesa-like extensions (which likely contain suitable habitat) that occur between the two known distributions (D. Chipping, California Polytechnic State University, in litt., 1997). A. Koch (CDFG, pers. comm., 2001) also notes that C. p. var. reductum occurs on private property which falls between the two known sites and within the critical habitat boundary line. (4) The vegetation community that Chlorogalum purpureum var. reductum depends on extends beyond the boundary of the known distribution. By encompassing plateau areas, the known distribution, and a portion of the adjacent vegetation community that the species depends on, ecological functions (e.g., cryptogamic crust formation, predator-prey relationships, pollinator activity) within the habitat are maintained such that ‘‘edge effects’’ from encroaching activities not conducive to C. p. var. reductum persistence (e.g., off-road vehicle use, livestock grazing, etc.) do not inhibit the taxon’s expansion or survival. Additionally, adjacent grassland and oak woodland habitat that is adversely affected could result in greater rates of herbivory or regeneration/expansion of nonnative plants that can outcompete smaller, herbaceous species such as C. p. var. reductum. Lands proposed are under private, State, and Federal jurisdiction. State lands are managed by CalTrans, and Federal lands are managed by the the Forest Service (i.e., LPNF). The approximate areas of proposed 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 Chlorogalum purpureum critical habitat consists of two components (67 FR 65414-65445):

The primary constituent elements of critical habitat for Chlorogalum purpureum var. reductum consist of, but are not limited to: (i) Well-drained, red clay soils with a large component of gravel and pebbles on the upper soil surface; and,

(ii) Plant communities in functioning ecosystems that support associated plant and animal species (e.g., pollinators, predator-prey species, etc.), including grassland, blue oak woodland (Quercus douglasii) or oak savannahs, and open areas within shrubland communities. Within these vegetation communities C. p. var. reductum appears where there is little cover of other species which compete for resources available for growth and reproduction.

Special Management Considerations or Protections

Special management considerations or protections may be needed to maintain the primary constituent elements for Chlorogalum purpureum within the units being proposed as critical habitat. In some cases, protection of existing habitat and current ecological processes may be sufficient to ensure that populations of C. purpureum are maintained at those sites, and have the ability to reproduce and disperse into surrounding habitat. In other cases, however, active management may be needed to maintain the primary constituent elements for C. purpureum. We have outlined below the most likely kinds of special management and protection that C. purpureum critical habitat may require. (1) The soils on which Chlorogalum purpureum is found should be maintained. Physical properties of the soil, such as its chemical composition, structure, and drainage capabilities, would best be maintained by limiting or restricting the use of herbicides, fertilizers, or other soil amendments; and by minimizing or avoiding activities that result in soil compaction (e.g., offroad wheeled and tracked vehicle use, trampling by people and livestock) and those that would alter the hydrology of areas immediately adjacent to or upslope of the species and its critical habitat. (2) The soil surface should be maintained to enhance cryptogamic crust formation by minimizing the intensity, frequency, duration, and acreage of soil surface disturbance. The soil surface should be protected at relict sites (i.e., sites with well-developed crusts) to provide reference areas and baseline comparisons for research. Because cryptogamic crusts are highly susceptible to hot fires (Belnap et al. 2001) and the presence of nonnative annual grasses in Chlorogalum purpureum habitat may promote fires. Annual, intense fires should be avoided. The effects of activities that can damage biotic soil crusts (e.g., excavations, offroad vehicle use, trampling) should be reduced by moving them to areas where crusts are less vulnerable, limiting the area affected, and conducting such activities in dryer seasons. (3) The associated plant and animal communities should be maintained to ensure the habitat needs of pollinators and seed dispersal agents are maintained, and predator-prey relationships are functioning. The use of pesticides should be restricted so that viable populations of pollinators are present to facilitate reproduction of Chlorogalum purpureum. Fragmentation of habitat through road construction, development, and certain types of fencing should be limited. Additionally, predator-prey relationships should be managed and protected. For example, installation of fencing could exclude predator species (e.g., coyotes, bobcats, San Joaquin kit fox), thus causing an increase in prey species (e.g., ground squirrels, gophers, rabbits) abundance. A change such as this could result in increased herbivory, bulb predation, or burrowing that could affect C. purpureum growth and survival. (4) In all plant communities where Chlorogalum purpureum occurs, invasive, nonnative species such as Centuarea solstitialis (yellow starthistle), Avena spp. (wild oats), Bromus spp. (B. hordeaceus, B. diandrus, B. madritensis, B. rubens (brome)), Erodium spp. (storksbill or fillaree), and other species need to be actively managed and controlled to maintain the open habitat that Chlorogalum purpureum needs. Nonnative annual grasses may promote fires by providing recurring annual fuel sources. Thus, proactive management should be implemented to prevent annual fires, unless future research demonstrates that a series of annual fires can benefit Chlorogalum purpureum by reducing competition from nonnative species. (5) Certain critical habitat areas (i.e., suitable, unoccupied habitat between or adjacent to known patches of Chlorogalum purpureum) may need to be temporarily fenced or demarcated to identify exclusion areas for protection from accidental or intentional trampling by humans, livestock, or off-road vehicle use. Heavy disturbance to these critical areas may be detrimental to this species' persistence. Seasonal exclusions may work in certain areas to protect the critical habitat and C. purpureum plants during the critical season of growth and reproduction. (6) In areas where Chlorogalum purpureum and its habitat occur in conjunction with off-road vehicle traffic (e.g., military wheeled and tracked vehicles, OHVs), we recommend managing to minimize the severity of those effects. Management should include: limiting or avoiding new structures and permanent roads and trails; managing excavations, scrapings, or other ground surface disturbance; managing tracked and wheeled vehicle use during C. purpureum growing and dormant seasons; and managing foot traffic, bivouacking, and congregations of high numbers of people during C. purpureum growing and dormant seasons. These types of activities should be managed to limit loss of adults, bulbs, and seeds, loss of habitat, increased soil compaction, and increased nonnative species encroachment. (7) Monitoring programs should be developed or enhanced so that areas occupied by purple amole are studied, allowing for a full range of life-history data and a thorough analysis of the compatibility and impacts of those activities that may adversely affect the species. Representative areas should be chosen throughout the distribution of the species, including large, highdensity populations that have a higher potential for persistence. Monitoring studies should be designed to aid in the determination of population stability as well as provide basic life-history information and data on the ecological needs of the species (e.g., identification and status of pollinator species, disturbance factors, etc.).

Life History

Food/Nutrient Resources

Lifespan

Adult: 5 to 7 years (USFWS, 2008)

Breeding Season

Adult: April to May (NatureServe, 2015)

Reproduction Narrative

Adult: In one study, Chlorogalum purpureum flowered at three years following germination, and all plants had flowered at four years following germination. C. purpureum typically flower between April and May (NatureServe, 2015). Most plants died between the fifth and seventh year following germination. For seed-producing plants at Fort Hunter Liggett, the number of seeds produced per plant was highly variable, with a recorded range of 1 to 386 seeds per plant and a recorded mean of 28 seeds per plant (Niceswanger 2002). (USFWS, 2008; NatureServe, 2015))

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Barrens, Forest/Woodland, Grassland/herbaceous, Shrubland/chaparral, Woodland - Hardwood, Woodland - Mixed (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 213 to 407 m (700 to 1,336 feet)

Spatial Arrangements of the Population

Adult: Discontinuous patches (USFWS, 2008)

Environmental Specificity

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

Dependency on Other Individuals or Species for Habitat

Adult: The purple amole (e.g., Guretzky et al. 2005; Woodbury 2006) and the Camatta Canyon amole (E.L. Painter in litt. 1998) have been reported to grow in association with cryptogamic crusts. (USFWS, 2008)

Habitat Narrative

Adult: The taxon is known from the lower elevations on the eastern side of the range, at approximately 213 to 407 meters (m) (700 to 1,336 feet (ft)) elevation. On Fort Hunter Liggett, there are hundreds of discontinuous patches of purple amole in grassland, oak savanna, and oak woodland communities where they occur in association with gravelly, clay soils. The purple amole (e.g., Guretzky et al. 2005; Woodbury 2006) and the Camatta Canyon amole (E.L. Painter in litt. 1998) have been reported to grow in association with cryptogamic crusts. The purple amole occurs in patches that range from a few plants to more than 10,000 individuals per ha (4,047 individuals per ac) at the densest locations. (USFWS, 2008)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Stable to increasing (USFWS, 2008)

Resiliency:

In summary, for Santa Lucia purple amole, the resiliency analysis shows that three of the four populations have moderate resiliency and one is low. For Camatta Canyon amole, the resiliency analysis shows that one occurrence has moderate resiliency and two occurrences have low resiliency; there is insufficient information to calculate a resiliency score for occurrence 4 because the area of the occurrence is not known. The populations/occurrences with moderate resiliency have a moderate ability to sustain themselves in the face of environmental variation and therefore a moderate risk of extirpation in the near future. The populations/occurrences with an overall low resiliency have a low ability to sustain themselves in the face of environmental variation and therefore a high risk of extirpation in the near future. (USFWS, 2020)

Representation:

Representation describes the ability of a species to adapt to changing environmental conditions over time. It is characterized by the breadth of genetic and environmental diversity within and among populations. Measures may include the number of varied niches occupied, genetic diversity, heterozygosity, or alleles per locus. Given morphological and ecological differences between Santa Lucia purple amole and Camatta Canyon amole, representation across both varieties contributes to the species ability to adapt to changing environmental conditions over time. Both varieties have relatively small geographic ranges with mostly similar landscape features throughout. The Santa Lucia purple amole currently occupied area consists of approximately 500 hectares (1,230 acres). The known occupied area of Camatta Canyon amole in 2020 consists of greater than 36 hectares (89 acres). The niches and habitats each variety occupies have little heterogeneity. Therefore, each variety is a narrow, endemic taxon and the types of habitats or niches that it occupies are nearly uniform. Although information is lacking regarding genetics of either Santa Lucia purple amole or Camatta Canyon amole, we consider each to comprise one genetic unit due to geography. While we are not aware of any extirpated locations or occurrences, or of any contraction in the geographic range, the productivity data for Santa Lucia purple amole suggest three of the four populations may be declining. The combined data from several studies suggest that the number of Camatta Canyon amole, where monitored, has declined. Thus, declining numbers of individuals may affect genetic diversity, and the spatial extent and associated ecological representation of both Santa Lucia purple amole and Camatta Canyon amole are inherently low. (USFWS, 2020)

Redundancy:

Redundancy describes the ability of a species to withstand catastrophic events. Redundancy is characterized by having multiple, resilient populations distributed within the species' ecological settings and across the species' geographic range. It can be measured by population number, spatial extent, and degree of connectivity. Given sufficient redundancy, single or multiple catastrophic events are unlikely to cause the extinction of a species. Purple amole is composed of two varieties, both narrow, endemic taxa with relatively small geographic ranges. Santa Lucia purple amole only has four populations located within approximately 280 kilometers2 (108 square miles). Camatta Canyon amole only has four occurrences located within approximately 3 kilometers2 (1 square mile). Because all four populations of Santa Lucia purple amole and all four occurrences of Camatta Canyon amole are situated close together, they could possibly be simultaneously affected by a catastrophic event. Given that the two varieties are approximately 61 km (38 miles) apart, a prolonged, catastrophic drought could affect both varieties simultaneously. However, the two varieties are far enough apart such that a large, intense wildfire is unlikely to deleteriously affect both varieties at once. Therefore, purple amole has inherently low redundancy due to being composed of two narrow endemic varieties, but having two spatially separated varieties does provide some protection for the species as a whole from extinction due to less expansive catastrophic events. (USFWS, 2020)

Number of Populations:

4 (USFWS, 2020)

Population Narrative:

Purple amole is endemic to Monterey and San Luis Obispo Counties in central California. Santa Lucia purple amole is known from 17 occurrences in four populations in the Santa Lucia Range in southwestern Monterey County (Fort Hunter Liggett) and north central San Luis Obispo County (Camp Roberts) (CNDDB 2020, website). Camatta Canyon amole is known from four occurrences in the La Panza Range and adjacent hills in central San Luis Obispo County (Kofron et al. 2013a, entire). The Santa Lucia purple amole currently occupied area consists of less than 500 hectares (1,230 acres). The Camatta Canyon amole currently occupied area consists of greater than 36 hectares (90 acres). The species needs appropriate soil types, including welldrained with gravel components in the top and subsoil strata; suitable habitats, including openings within blue oak woodland and California buckwheat and/or chamise shrubland, blue oak savanna and valley and California prairie; sparsely vegetated areas with some open, bare ground; adequate annual precipitation; suitable temperatures; insect pollinators; and biological soil crusts. (USFWS, 2020)

Threats and Stressors

Stressor: Habitat alteration (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: The property comprising Fort Hunter Liggett has a long history of settlement and use by "Europeans," dating back to 1771, which has affected the current distribution of the purple amole. On Fort Hunter Liggett, the purple amole is nearly absent from areas that were previously cultivated by disking. The taxon is most abundant in areas that were not previously disked, including areas where intensive military training has been common since 1941 (U.S. Army 2004a, 2004b). (USFWS, 2008)

Stressor: Military activities (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: The California Army National Guard ceased conducting military activities in the purple amole area in 2000, with exception of road use for four weeks in 2001 and 2003 and occasional use of the tank trail where the taxon does not occur. (USFWS, 2008)

Stressor: Gophers (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Niceswanger (2002) reported that "gophers (or possibly other rodents) tunneled through the sites and ate the leaves and flowering stems." Woodbury's (2005a, 2005b, 2006) data suggested that gophers may forage on the leaves of purple amole, with little or no interest in the bulbs. Woodbury (2006) stated that gophers displace the soil and the bulbs. From 2003 to 2006, the amounts of quadrats with gopher activity within 1 m were 41 percent, 32 percent, 26 percent, and 23 percent, respectively. (USFWS, 2008)

Stressor: Fungus (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Niceswanger (2002) observed a fungus affecting the purple amole at two transects during 2000, causing the plants to whither and rot. This is the only report of any disease affecting the purple amole. (USFWS, 2008)

Stressor: Feral pigs (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Holland (2007) observed pervasive soil disturbance by feral pigs in the purple amole habitat. Although Holland (2007) reported the effects to the purple amole to be unknown, Olson (pers. com. 2007) informed us that feral pigs eat the bulbs. (USFWS, 2008)

Stressor: Non-native annual grasses and invasive species (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Non-native annual grasses and other invasive plant species continue to be a threat to the purple amole at Fort Hunter Liggett and Camp Roberts and to the Camatta Canyon amole on the Los Padres National Forest. The invasive plant species may have the ability to displace the Chlorogalum purpureum by outcompeting and monopolizing limited resources (growing space, sunlight, soil nutrients, water; Stephenson and Calcarone 1999), with the potential effects of preventing growth and recruitment (U.S. Army 2004b). The invasive plant species may also have the ability to alter characteristics of the fire regime, such as frequency, intensity, and seasonality of fires (Brooks et al. 2004). We have no information on the site-specific presence of non-native plants in purple amole occurrences on Fort Hunter Liggett and Camp Roberts, or the effects that non-native competitors have on the frequency and seasonality of fire. (USFWS, 2008)

Stressor: Fire (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: The frequency of fires in California is increasing (Syphard et al. 2007), and fires at certain times of the year have the ability to prevent annual reproductive success of the purple

amole (Niceswanger 2002) and also of the Camatta Canyon amole. The Chlorogalum purpureum are susceptible to damage by fire when the living structures, including the seeds, are above ground or near the soil surface. However, fires at certain times of the year may potentially benefit the Chlorogalum purpureum by removing other competitive plants, both native and invasive species. The Chlorogalum purpureum may also respond favorably to fire in other ways. (USFWS, 2008)

Stressor: Stochastic events (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Niceswanger (2002) believed that the population of purple amole on Fort Hunter Liggett is highly vulnerable to stochastic events, especially catastrophes affecting mature plants such as fire. She therefore recommended protection and management of the habitat by administrative regulations, including prohibitions against physical disturbances during the reproductive stage. (USFWS, 2008)

Recovery

Reclassification Criteria:
Reclassification criteria are not available.

Recovery Priority Number: 8

Delisting Criteria:
1. At least four resilient populations display evidence of recruitment of new individuals and stable or increasing population trends averaged over 10 consecutive years (USFWS, 2022);

2. Each of the four resilient populations is being managed in a way, currently and into the future, that will support continued existence of Santa Lucia purple amole and its habitat, including management of non-native, invasive species, and anthropogenic disturbance and feral wildlife (USFWS, 2022)

3. Management is effective as shown by monitoring over 10 consecutive years (USFWS, 2022)

4. An ex situ permanent conservation seedbank is established in a Center for Plant Conservation-affiliated botanic garden that reflects the breadth of the taxon’s genetic diversity (USFWS, 2022)

Recovery Actions:
- Recovery actions are not available.
- We recommend that the U.S. Army search for the purple amole in potentially-suitable habitat on nearby private properties and at additional localities on Fort Hunter Liggett. (USFWS, 2008)
- We recommend that the U.S. Army complete its endangered species management plan for the purple amole on Fort Hunter Liggett as soon as possible. (USFWS, 2008)
- In light of the known error by first-year surveyors in 2002 (Clark in litt. 2007a), we recommend that the U.S. Army re-analyze its data regarding fire and the purple amole on

Fort Hunter Liggett. Further, we recommend that the U.S. Army conduct research regarding the effects of fire (frequency, seasonality) and invasive plants to the purple amole. (USFWS, 2008)

- We recommend that the U.S. Army actively manage the known occupied localities for the benefit of the purple amole. In particular, we recommend that the U.S. Army evaluate and consider conducting activities that may potentially benefit the purple amole on Fort Hunter Liggett, including controlled burns to remove invasive plants, the removal of feral pigs, and the use of the ball-and-chain method to remove competing plants in potential habitat. (USFWS, 2008)
- We recommend that the U.S. Army conduct research to determine the effects of gophers and feral pigs on the purple amole, and the relationship between the purple amole and cryptogamic crusts. (USFWS, 2008)
- We recommend that the California Army National Guard search for the purple amole in potentially-suitable habitat on nearby private properties and at additional localities on Camp Roberts. (USFWS, 2008)
- We recommend that the California Army National Guard complete the process of updating its draft Integrated Natural Resources Management Plan for Camp Roberts and consulting with the Service regarding it and the ongoing activities that may affect the purple amole. (USFWS, 2008)
- We recommend that the California Army National Guard statistically analyze its data regarding the effects of fire on the purple amole at Camp Roberts. Further, we recommend that the California Army National Guard conduct research regarding the effects of fire (frequency, seasonality) and invasive plants to the purple amole. (USFWS, 2008)
- We recommend that the California Army National Guard actively manage the known occupied localities for the benefit of the purple amole. In particular, we recommend that the California Army National Guard evaluate and consider conducting activities that may potentially benefit the purple amole on Camp Roberts, including controlled burns to remove invasive plants, controlled grazing by goats or sheep to remove invasive plants, and the removal of feral pigs. (USFWS, 2008)
- We recommend that the California Army National Guard conduct research to determine the effects of gophers and feral pigs on the purple amole, and the relationship between the purple amole and cryptogamic crusts. (USFWS, 2008)

Conservation Measures and Best Management Practices:

- Recovery actions for Santa Lucia purple amole 1. Manage habitat that supports the taxon to reduce or eliminate threats (Priority 1) 2. Conduct annual census monitoring (Priority 2) 3. Collect seed and deposit accessions into the permanent conservation seedbank (Priority 3) 4. Conduct experimental research projects (Priority 3) (USFWS, 2022)

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SPECIES ACCOUNT: *Digitaria pauciflora* (Florida Pineland crabgrass)

Species Taxonomic and Listing Information

Listing Status: Threatened; 11/6/2017; Southeast Region (R4) (USFWS, 2017)

Physical Description

Digitaria pauciflora is a small perennial clump-grass, appearing blue-green to gray with reddish-brown stems, typically 0.5 to 1 m (1.5 to 3 ft) tall. The leaves form a subtle zig-zag pattern as the leaf blades come off the stem at an angle. The flowers are dull green and very small, and are borne on wispy spikes on the ends of the leafy stems, with usually only a few flower clusters forming per clump of grass. Stolons (aboveground horizontal stems) are not present. Inflorescence branches have been known to produce roots infrequently at their nodes, and these have been observed producing new ramets (belowground horizontal stems) that allow for vegetative spread. (USFWS, 2017)

Taxonomy

Digitaria pauciflora was first described in 1928, based on specimens collected in 1903, and was later placed in the genus Syntherisma (Small 1933). Subsequent authors (Hitchcock 1935; Webster & Hatch 1990; Wunderlin 1998) have retained it in the genus Digitaria. D. pauciflora was absent from collections from 1939 until 1973, when it was rediscovered in Everglades National Park. The online Atlas of Florida Vascular Plants uses the name Digitaria pauciflora. The Integrated Taxonomic System (ITIS 2016), NatureServe (2016), and the Florida Department of Agriculture and Consumer Services (FDACS) indicates that its taxonomic status is accepted. It has been determined after careful review of all taxonomic data that Digitaria pauciflora is a valid taxon. The only synonym is Syntherisma pauciflora (Hitchcock) Hitchcock ex Small (ITIS 2016). (USFWS, 2017)

Historical Range

The historical range of D. pauciflora consists of central and southern Miami-Dade County, Florida, along the Miami Rock Ridge, from southern Miami to Long Pine Key region of ENP, a range of approximately 42 mi. (USFWS, 2017)

Current Range

In Miami-Dade and Monroe counties in Florida, in the Long Pine Key area of Everglades National Park and Big Cypress National Park. (USFWS, 2017)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual. Plants can also spread clonally via rhizomes. (USFWS, 2017)

Breeding Season

Adult: The species produces flowers from summer to late fall on both new and older growth, some plants have been observed to finish seeding as late as December. (USFWS, 2017)

Reproduction Narrative

Adult: Reproduction is sexual, with new plants generated from seeds.vThe species produces flowers from summer to late fall on both new and older growth, some plants have been observed to finish seeding as late as December. Plants can also spread clonally via rhizomes. (USFWS, 2017)

Habitat Type

Adult: Seasonally flooded ecotone between pine rockland and marl prairie, and with some overlap into both 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: Very narrow; specialist or community with key requirements scarce; species occurs in ecotonal regions between marl praries and pine rocklands, usually a strip approx. 200 m across at widest point.(NatureServe 2015)

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: Digitaria pauciflora occurs predominantly within the seasonally flooded ecotone between pine rockland and marl prairie, although the species may overlap somewhat into both habitats. Plants can withstand inundation with fresh water for one to several months each year. These habitats are maintained by regular fire, and are prone, particularly marl prairie, to annual flooding for several months during the wet season. (USFWS, 2017)

Dispersal/Migration

Population Information and Trends

Population Trends:

Unknown (USFWS, 2017)

Number of Populations:

2 extant populations (USFWS, 2023)

Population Size:

Estimates: 100,000 to 200,000 individuals within Everglades National Park; 100 - 1,000 at Camp Everglades; >10,000 within the Big Cypress National Park (USFWS, 2023)

Population Narrative:

In 2002, Digitaria pauciflora was discovered within the Lostmans Pines region of Big Cypress National Park in Monroe County, Florida. Subsequent surveys for the species within BCNP have documented up to nine occurrences, some of which contain an estimated 500-600 plants . The rangewide population estimate for D. pauciflora is 100,000 to 200,000 individuals at Long Pine Key, and greater than 10,000 individuals within Big Cypress National Park. (USFWS, 2017). Currently, Florida crabgrass is extant only in two locations, ENP and BCNP. The Long Pine Key region of ENP, has a population estimate greater than 200,000 individuals (Maschinski and Lange 2015). In 2007, the BCNP population estimate was greater than 10,000 individual plants (Bradley, pers. comm. 2007). While Florida crabgrass populations remain abundant within ENP and BCNP, these areas represent only half of the species' historical range (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)

Stressor: Climate Change (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Climate change poses a significant threat to the two remaining populations of Florida crabgrass. Sea level rise is expected to greatly reduce the land area within the range of Florida crabgrass in the coming decades (Sweet et al. 2022). Increased frequency and duration of severe hurricanes, increased precipitation rates, and magnitude of storm surges (Intergovernmental Panel on Climate Change 2019) have the potential to modify or destroy the remaining habitat for Florida crabgrass throughout its historical range. While the hydrologic requirements for Florida crabgrass is not well understood, increased inundation for longer periods than normal or increased soil salinity from storm surges has the potential to harm individual organisms as well as negatively impact the integrity of the habitat (USFWS, 2023).

Recovery

Reclassification Criteria:
Not defined.

Recovery Priority Number: 8

Delisting Criteria:
Not defined.

Recovery Actions:
- Not defined.
- Determine the effects (positive or negative) from Everglades restoration and other hydrologic manipulations and changes.

- Continue ex situ conservation work.
- Control exotic plant species where the species is found.
- Determine the frequency with which prairies within Big Cypress National Park burn, and work with partners to adjust accordingly.
- Assist in management recommendations and accurate evaluation of site suitability for possible reintroduction by conducting research on the habitat requirements, plant associates, and response to hydroperiod shifts and fire.
- Assess the potential impacts of off-road vehicles on occurrences within Big Cypress National Park.
- Evaluate the feasibility of reintroduction if suitable habitat exists or can be restored at the Luis C. Martinez U.S. Army Reserve Station in the Richmond Pine Rocklands and at sites with indefinite occurrences and potentially suitable habitat.

Conservation Measures and Best Management Practices:

- RECOMMENDED 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 • Maintain current populations of the pine rockland habitat with an approved management plan including a prescribed fire regimen. • Conduct extensive eradication of invasive plants within known populations. • Develop a translocation/reintroduction plan to identify potential recipient sites for reintroducing or establishment of populations within the historical range. Emphasis should be put on the known extirpated populations in table 1 as well as Nixon Smiley Preserve, Lucille Preserve, Tamiami Complex Addition, and Snapper Creek Pineland. • Identify and restore patches of historically wetter environmentally endangered lands within Florida crabgrass's historic range. • Establishing partnerships with private landowners to promote conservation easements and landowner agreements within remaining Florida crabgrass habitats. Monitoring / Research Activities • Conduct regular monitoring of populations to better understand species trends. • Survey extensively in and around the Gum Slough/Stair Steps area of BCNP to better understand the extent of this population. • Research species demographics such as life history and ecology with an emphasis on understanding the hydrological periods required by the species. • Evaluate the 16,000 seeds collected for viability in long-term cold storage. Determine storage lifespan and the rate at which banks should be replenished. • Map the extant populations of Florida crabgrass and identify remaining suitable habitat within the species range. 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).

References

USFWS. 2017. Endangered Species Status for Dalea carthagenensis var. floridana (Florida Prairie-clover), and Threatened Species Status for Sideroxylon reclinatum ssp. austrofloridense (Everglades Bully), Digitaria pauciflora (Florida Pineland Crabgrass), and Chamaesyce deltoidea ssp. pinetorum (Pineland Sandmat). Final Rule. 82 FR 46691-46715 (October 6, 2017).

USFWS. 2017. Endangered Species Status for Dalea carthagenensis var. floridana (Florida Prairie-clover), and Threatened Species Status for Sideroxylon reclinatum ssp. austrofloridense (Everglades Bully), Digitaria pauciflora (Florida Pineland Crabgrass), and Chamaesyce deltoidea ssp. pinetorum (Pineland Sandmat). Final Rule. 82 FR 46691-46715 (October 6, 2017). USFWS. 2023. Florida

Pineland Crabgrass (Digitaria pauciflora) 5-Year Review: Summary and Evaluation. Southeast Region. Florida Ecological Services Field Office. Vero Beach, Florida. 12 pp.

USFWS. 2017. Endangered Species Status for Dalea carthagenensis var. floridana (Florida Prairie-clover), and Threatened Species Status for Sideroxylon reclinatum ssp. austrofloridense (Everglades Bully), Digitaria pauciflora (Florida Pineland Crabgrass), and Chamaesyce deltoidea ssp. pinetorum (Pineland Sandmat). Final Rule. 82 FR 46691-46715 (October 6, 2017).

USFWS. 2023. Florida Pineland Crabgrass (Digitaria pauciflora) 5-Year Review: Summary and Evaluation. Southeast Region. Florida Ecological Services Field Office. Vero Beach, Florida. 12 pp.

USFWS 2013. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form for Digitaria pauciflora (Florida Pineland Crabgrass). U.S. Fish and Wildlife Service, Southeast Region (Region 4)

March 4, 2013. 18 p.

SPECIES ACCOUNT: *Helonias bullata* (Swamp pink)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/11/1988; Northeast Region (R5)

Physical Description

A smooth perennial herb with thick, stocky rhizomes. Its leaves, which form a basal rosette, are evergreen, oblong—spatulate or oblanceolate, parallel—veined, 0.9-2.5 diii long, 2-4 cm wide, acute, and attenuated at the base. A stout hollow stem arises from the rosette and may grow from a height of 2-9 dm at the time of flowering to 1.5 m at the time of seed maturation. The sparsely bracteate flower stalk is 1-3 dm high when flowering and up to 6 dm when in fruit. The stalk is terminated by a simple and short, dense, bractless, 3—8 cm long raceme. The rootstock is stout with many fibrous roots. The inflorescence consists of 30—50 fragrant flowers (Sutter 1982, 1984); individual flowers are about 1 cm wide. Pedicels are very short at first, elongating to 4-8 mm. The perianth is composed of six spatulate-oblong, pink to lavender segments that are 5-9 mm long and 1-2 mm wide. As the inflorescence elongates, the perianth persists and retains a pink color interfused with green. The fruit capsule is 3-lobed, papery, 3-5 mm long and 8- 10 mm wide, with an inverted heart shape and consisting of many ovules. The ovule opens into six lobes releasing linear-shaped seeds that are 5 mm long with appendages at both ends (Johnson undated). Mature seeds were not described by Johnson or Sutter. During the winter months, the leaves of Helonias lie flat or slightly raised from the ground, and are often hidden by fallen leaf litter. The flowerhead of the next season is visible, appearing like a large button in the center of the rosette. Leaves often turn a reddish-brown color over the winter; new, bright green leaves appear in spring. Plants bloom as early as March and often last until May, while seed production occurs in June. Typically small at the time of plant flowering, leaves may increase in length to 4 dm or more as the season progresses. (USFWS, 1991)

Taxonomy

Taxonomic authorities have reassigned swamp pink to a different family in the Order Liliales. Starting with the first version in 1998 (APG 1998), and continuing through the current (third) version (APG 2009; Stevens 2012), the Angiosperm Phylogeny Group (APG) has recognized the Family Melanthiaceae (Order Liliales). Within the Melanthiaceae, Stevens (2012) recognizes five tribes including Helionadeae (i.e., Heloniadeae, with Helonieae treated as a synonym by Zomlefer et al. [2001])(USFWS, 2014). - Swamp pink (Helonias bullata L.) was first collected by Swedish naturalist Peter Kalm near Philadelphia -- most likely around Pennsneck, New Jersey -- in the mid-1700s (Brown 1910). Kalm's specimens were submitted to Linnaeus, who described the species in the first edition of Species Plantarum as a monotypic genus in the Liliaceae (Lily) family (U.S. Fish and Wildlife Service 1988). (USFWS, 1991)

Historical Range

Historically occurred in eight states (New York, New Jersey, Delaware, Maryland, Virginia, North Carolina, South Carolina, and Georgia). (USFWS, 2014)

Current Range

In 2001, extant populations were documented in seven states: New Jersey, Delaware, Maryland, Virginia, North Carolina, South Carolina, and Georgia. (USFWS, 2014)

Critical Habitat Designated
No;

Life History

Food/Nutrient Resources

Reproductive Strategy
Adult: Asexual: vegetative; sexual: self-pollination, cross-pollination (NatureServe, 2015)

Lifespan
Adult: 2+ years (NatureServe, 2015)

Breeding Season
Adult: April - June (NatureServe, 2015)

Key Resources Needed for Breeding
Adult: Possibly insect pollinators (USFWS, 1991)

Reproduction Narrative
Adult: Blooms from early April or early May through mid-June. It is a perennial species. Reproduces sexually and asexually; reproduces vegetatively via rhizomes forming clusters of closely spaced rosettes, and also produces prolific seed following flowering (although very few of the plants in a population typically produce flowers in a given year) (Sutter 1984 cited in CPC 2008, USFWS Swamp Pink Recovery Plan Technical Draft 1990). Highly self-compatible (Sutter 1984 cited in CPC 2008), although the rate of selfing vs. outcrossing in nature appears to vary widely; of fifteen natural populations sampled in a genetic study, estimates suggested that seven of the populations were highly outcrossing, while several other populations had much lower outcrossing estimates (Godt et al. 1995). Seeds are viable for only a few weeks, so the species does not have a seed bank (Godt et al. 1995). A low incidence of flowering, limited seed dispersal, and poor seedling establishment combine to make colonization of new sites via reproduction from seed rare for this species (Godt et al. 1995, USFWS 2007) (NatureServe, 2015). Beetles, black flies, and a variety of other insects have been observed at Helonias flowers (USFWS, 1991).

Habitat Type
Adult: Wetlands (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification
Adult: Atlantic white cedar swamps, headwater seepage wetlands, red maple swamps, mixed hardwood/evergreen swamps, (rarely) black spruce-tamarack (Picea mariana-Larix laricina) bogs, Blue Ridge seepage swamps (mountain bogs) (NatureServe, 2015)

Dependencies on Specific Environmental Elements
Adult: Water depth 5.0 - 9.9 cm (USFWS, 2014)

Spatial Arrangements of the Population
Adult: Clumped (USFWS, 1991)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Restricted to forested wetlands that are groundwater influenced and are perennially water-saturated with a low frequency of inundation. Sutter (1982) described these as sites where the water table is at or very near the surface and is stable, fluctuating only slightly during spring and summer. These habitats include emergent portions of hummocks in and along stream channels in Atlantic white cedar (Chamaecyparis thyoides) swamps, headwater seepage wetlands, red maple (Acer rubrum) swamps, mixed hardwood/evergreen swamps, and (rarely) black spruce-tamarack (Picea mariana-Larix laricina) bogs. In Georgia, the species is found in coldwater Blue Ridge seepage swamps (mountain bogs) with purple pitcher plant (Sarracenia purpurea), red maple, mountain laurel (Kalmia latifolia), Carolina sheep laurel (K. caroliniana), rosebay rhododendron (Rhododendron maximum), and thickets of tag alder (Alnus serrulata) and peat moss (Sphagnum). The species appears to be somewhat shade tolerant and to need enough canopy to minimize competition with other more aggressive species and herbivory by deer. It is often found at stream sources. The specific wetland habitat required by this species is easily degraded through both direct and secondary disturbances; among the wetland types it inhabits, some such as sphagnum bogs and Atlantic white cedar swamps are particularly fragile. The environmental specificity is narrow; it is adapted to stable habitats with a number of specialized conditions (e.g., low light, limited nutrients, and saturated soils), this species appears to compete poorly when change in one or more habitat parameters creates an opportunity for the establishment of other species (USFWS 2007) (NatureServe, 2015). Laidig et al. (2009) found that swamp pink clusters, composed of groups of individual plants, were typically associated with the emergent portions of hummocks in and along the stream channels. The greatest total cluster area was associated with water levels between 5.0 and 9.9 cm, which may be the optimal water-level range for swamp pink (USFWS, 2014). There appears to be a strong correlation between the presence of conifer tree species (e.g., pitch pine, Atlantic white cedar, American larch, black spruce, and red spruce) and the occurrence of Helonias. Clumping may be due to clonal reproduction and limited seed dispersal (USFWS, 1991).

Dispersal/Migration

Dispersal

Adult: Typically low, possibly high with water dispersal (NatureServe, 2015)

Dispersal/Migration Narrative

Adult: Primary seed dispersal takes place by gravity and wind, which probably carries seeds less than 40 cm (Godt et al. 1995). Secondary seed dispersal by ants and water has been experimentally verified (Peterson 1992 cited in USFWS 2007). Seeds possess eliasomes (lipid-rich ridges of soft tissue) that foster dispersal by ants. Seeds can also float for days, which could facilitate long-distance downstream dispersal by water (NatureServe, 2015).

Population Information and Trends

Population Trends:
Decline of 30-50% (NatureServe, 2015)

Species Trends:
10 - 50% decline (NatureServe, 2015)

Number of Populations:
235 EOs (USFWS, 2021)

Adaptability:
Low (inferred from NatureServe, 2015)

Population Narrative:
The total number of known extant occurrences of swamp pink (235 in 2020) has decreased for the first time since listing (from 249 in 2011), though the extent of the species' distribution has not changed appreciably. The number of known extant occurrences of swamp pink in 2020 is almost double the number of known extant occurrences in 1991 (123 occurrences) and has increased the species' representation and redundancy since ESA listing. There are 114 extant swamp pink occurrences (49% of total extant occurrences) located at least partially on protected lands, which is more than a three-fold increase compared to the number of known occurrences at least partially protected in 1991 (approximately 35). Of the 114 occurrences that are at least partially protected, 38 are robust A- or B- ranked occurrences that are well distributed across the species' range. However, a significant number of swamp pink occurrences throughout the range, including some occurrences located at least partially on protected land, are clearly declining. In most cases, the declines are gradual and may only become evident over long periods of time, which affords some time for intervention. Cryopreservation of swamp pink seeds has been demonstrated to be possible for the first time and long-term storage of seeds from one swamp pink population was initiated at the Atlanta Botanical Garden (Perullo et al. 2015). Additional collections of marginal and highly imperiled genotypes will be needed to preserve the adaptive capacity of the species long-term. (USFWS, 2021)

Threats and Stressors

Stressor: Habitat degradation from development (USFWS, 1991)
Exposure:
Response:
Consequence:
Narrative: Over the years, cumulative habitat destruction resulting from development projects, draining and filling of wetlands, and timbering and clearing activities has significantly reduced the amount of available area for Helonias. As one example, many Southern Appalachian bogs have been destroyed by drainage and development, particularly for industrial sites and recreational resorts (e.g., golf courses) -- once destroyed, these bogs are impossible to re-create. With particular regard to the Pink Beds population in North Carolina, this area is currently threatened by plans to expand recreational development in the National Forest; further, one colony in this vicinity has already been seriously degraded by construction of trails and runoff from nearby roads. - With the enactment of the Federal Clean Water Act, along with state wetland laws and endangered species protection measures, direct habitat loss has been supplanted by secondary

impacts resulting from off-site disturbances as the major threat 16 to Helonias. While some degree of direct habitat damage is still occurring, the destruction of wetlands that support Helonias populations and contain suitable habitat has slowed; however, upstream development continues to accelerate. Although definitive data do not currently exist, it is suspected that many extant and seemingly vigorous New Jersey populations are in the process of a slow decline due to, in several instances, the secondary impacts of development of areas surrounding these populations combined with the lack of adequate buffers. (USFWS, 1991)

Stressor: Climate change (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: In a 1997 assessment of climate change impacts in North America (Watson et al., 1997), the Intergovernmental Panel on Climate Change (IPCC) found that important vulnerabilities of water resources to potential scenarios of climate change involve changes in runoff and stream flow regimes, reductions in water quality associated with changes in runoff, and human demands for water supplies. Specific findings of this assessment relevant to swamp pink include: • Seasonal and annual runoff may change over large regions as a result of changes in precipitation or evapotranspiration. n Seasonal patterns in the hydrology of mid- and high-latitude regions could be altered substantially, with runoff and stream flows generally increasing in winter and declining in summer. n Altered precipitation and temperature regimes will affect the seasonal pattern and variability of water levels of wetlands, thereby affecting their functioning including flood protection, carbon storage, water cleansing, and waterfowl/wildlife habitat. ▪ Increases in the frequency or magnitude of extreme hydrological events could result in water quality deterioration and water management problems. • Increases in competition for limited water under a warmer climate could lead to supply shortfalls and water-quality problems, particularly in regions experiencing declines in runoff. (USFWS, 2008)

Stressor: Collection (USFWS, 1991)
Exposure:
Response:
Consequence:
Narrative: Plant collection remains a continuing problem. Traditionally, collection of this wildflower has been a common practice of both amateur and professional gardeners, scientific and other collectors (due to its unusual appearance), and curiosity seekers (U.S. Fish and Wildlife Service 1988). The plant is very conspicuous, particularly during the flowering season because it frequently blooms before other wildflowers and before growth of other herbaceous vegetation. In The Pine Barrens, John McPhee (1967) noted that “Pineys” collected swamp pink for sale in the cities. Wildflower and gardening field guides often point to Helonias as a beautiful plant, suitable for home gardens. In addition to collection, foot traffic presents a problem at some sites. By altering hydrologic conditions, soil compaction probably represents a greater threat to the species than trampling of plants. This problem can be somewhat offset by constructing boardwalks; at a site in the George Washington National Forest, a boardwalk was constructed by the Forest Service to alleviate the trampling pressure on a site located there (Robert Glasgow, George Washington National Forest, pers. comm.). However, there is also a concentration of use along boardwalks that may lead to increased collection. (USFWS, 1991)

Stressor: White-tailed deer (USFWS, 2014)

Exposure:
Response:
Consequence:
Narrative: Many field biologists report that herbivory pressure on swamp pink from white-tailed deer (Odocoileus virginianus) is increasing. Observations from recent surveys in Delaware suggest that three populations may have been extirpated due to deer eating the plants (McAvoy 2011). Deer are a major threat in Camden County, and to a lesser extent also in Salem County, New Jersey (Hogan pers. comm. 2011). Based on work at three south Jersey populations, Dodds (pers. comm. 2011) concludes that the contribution of deer predation to the decline of the species may be much for substantial than previously believed. Kunz (pers. comm. 2011) considers deer browse one of the primary threats to swamp pink in New Jersey (USFWS, 2014).

Stressor: Beaver activity (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Many field biologists report that hydrologic impacts on swamp pink from beaver (Castor canadensis) activity are increasing. During 2011 surveys, Brown et al. (2012) found two of nine swamp colonies impacted by beaver on Fort A.P. Hill, Virginia. McAvoy (pers. comm. 2011) finds that the primary threat to swamp pink populations and habitat in Delaware appears to be from beaver activity, i.e., dam creation and subsequent flooding. Laidig (pers. comm. 2011) considers beavers one of the primary short-term threats to swamp pink populations in the New Jersey Pinelands (USFWS, 2014).

Stressor: Encroachment of woody vegetation (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Several sites in the southern Appalachians are considered threatened by the encroachment of woody vegetation. Radcliff (pers. comm. 2011) considers this a primary threat in Georgia. Specifically, it is believed that a lack of disturbance mechanisms is leading to encroachment of woody vegetation in southern Appalachian bogs, which in turn is leading to decreased flowering and recruitment in rare plant species like swamp pink (Wells pers. comm. 2011) (USFWS, 2014).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Regulatory mechanisms in New Jersey have improved but are still inadequate to protect swamp pink from its primary threat of gradual habitat degradation from development of surrounding uplands. Further protections for swamp pink that may be afforded by proposed regulatory changes in New Jersey will be considered during the next 5-year review. In other states, the primary protection for swamp pink, especially on private lands, is through consultation on Section 404 wetland permits under Section 7 of the ESA. This Federal regulatory mechanism offers limited protection to swamp pink (e.g., does not guarantee buffers or protection of off-site plants), and its effectiveness may be decreasing due to new limits on Federal jurisdiction over wetlands from recent court decisions. - No State laws prohibit the

collection or destruction of Federal- or State-listed plants on private lands with permission of the landowner, although some restrict possession, commercial trade, or collection of State-listed plants from public land. Although it offers no special protections for State-listed plants, New Jersey's FWPA regulates "destruction of plant life which would alter the existing pattern of vegetation" within freshwater wetlands. - Outside of New Jersey, State laws do not prohibit destruction of swamp pink or its habitat incidental to an otherwise lawful activity. In New Jersey, prohibition against such "incidental take" is afforded to State-listed plants in certain geographic areas (e.g., Highlands, Pinelands, Coastal Zone). However, over 60 percent of New Jersey's swamp pink occurrences are outside these areas and are afforded incidental take protection under the FWPA solely due to the species' status as a Federally listed species. (USFWS, 2008)

Stressor: Agriculture (USFWS, 1991)
Exposure:
Response:
Consequence:
Narrative: Agriculture has contributed to the loss and degradation of suitable habitat through (1) off-site water withdrawal for irrigation or crop production, (2) drainage of wetlands for crop production, (3) conversion of wetlands for agricultural uses, e.g., cranberry production), and (4) degradation of water quality by the influx of nutrients, sediment, and chemicals to the water. In the last instance, nutrient loading is thought to contribute to increased rates of succession and colonization by opportunistic species such as common reed (Phracrmites communis), red maple (Acer rubrum), red alder (Alnus serrulata), and mountain laurel (Kalmia latifolia). (USFWS, 1991)

Stressor: Stream improvement (USFWS, 1991)
Exposure:
Response:
Consequence:
Narrative: Stream improvement for trout has destroyed at least one colony in North Carolina. Other off-site sources of habitat degradation include discharge from sewage treatment plants and other similar operation, as well as watershed perturbations such as siltation resulting from inadequate soil erosion control and modification of the hydrologic regime and/or frequency and duration of “normal” flood events in developed watersheds resulting from random stormwater discharge. Evidence suggests that in developed watersheds, particularly where stormwater is discharged through outfall structures, the frequency and duration of “normal” storm event flooding is altered, leading to adverse impacts to wetlands from increased floodwater elevations, increased flow rates, and increased deposition of floatables and sediments. Helonias appears to be very slow, and perhaps unable, to recolonize openings in suitable habitat, making it susceptible to such perturbations (Virginia Natural Heritage Program 1987). This limited ability to colonize new sites underscores the need to protect existing sites. (USFWS, 1991)

Recovery

Reclassification Criteria:
Not applicable.

Recovery Priority Number: 7C

Delisting Criteria:

1. Permanent habitat protection is secured for those occurrences that: (a) are ranked as “A” or “B” according to the quality specifications in Appendix B of the Recovery Plan; or (b) are representative of the species’ range-wide distribution; or (c) are representative of habitat or genetic diversity. Habitat will be considered permanently protected when: (1) adequate acreage is secured through acquisition or easement by government agencies or conservation organizations with primary responsibilities for resource protection; (2) sites on public lands are formally designated as protected areas; and (3) preserve designs and/or management stipulations, based on definitive research results, are in place for each site. (USFWS, 1991)

2. Regulatory protection is sufficiently strong at the Federal, state, and/or local levels to ensure continued range-wide conservation of viable populations and their habitat (including an adequate buffer zone) after the protection afforded by the Endangered Species Act is withdrawn. (USFWS, 1991)

3. As necessary, representative genotypes are established and maintained in cultivation at plant breeding facilities. (USFWS, 1991)

Recovery Actions:

- 1. Protect all known Helonias sites. The overriding recovery necessity for Helonias is habitat protection. Measures such as land acquisition and conservation easements will be considered as ways to fully secure the habitat of viable populations. All existing sites will be actively protected by obtaining landowner agreements whenever possible, conducting population monitoring, and enforcing protective regulations. Habitat on public lands should be designated as protected areas or otherwise be exempted from management and development activities that could disturb the species. (USFWS, 1991)
- 2. Characterize extant colonies. Studies to determine genetic variability, population dynamics, and habitat characteristics at several Helonias populations will provide information regarding the species’ biology, which will, in turn, aid in conservation efforts. (USFWS, 1991).
- 3. Eliminate, to the fullest extent possible, on- and off-site threats to viable populations. The success of eliminating threats to currently or potentially viable populations will be contingent on the ability of resource experts and land managers to assess the potential for impact of diverse disturbances on populations and to adequately buffer essential habitats from significant threats. (USFWS, 1991)
- 4. Identify and, as needed, implement manacrement techniques for improving habitat gualitv or increasing population size/vigor. Known techniques (such as cultivation, clearing of competing vegetation) will be considered and incorporated as appropriate into the conservation plans developed in Task 1.4. These techniques will then be refined and/or added to as warranted by the results of Tasks 2 and 3. Consideration will be given to the benefits and risks of re-establishing colonies on historical sites, establishing new colonies in areas identified as potential habitat, and expansion of existing colonies. The effects of implementing active management will be carefully monitored. (USFWS, 1991)
- 5. As needed. Preserve representative genotypes through plant cultivation. If a need is indicated, plants from marginal or highly threatened genotypes will be cultivated in qualified plant breeding facilities. Further, if shown to be technically feasible, the possibility of storing Helonias seed and/or plant tissue by cryopreservation will be considered. This would be followed by, as needed, breaking seed dormancy in the laboratory and/or using tissue culture as a method of replicating plants. (USFWS, 1991)

- 6. Provide public information and education. As Helonias is an attractive plant with considerable value to collectors, the means by which public information and education is achieved is a critical component of recovery. Outreach opportunities for educating concerned parties and the general public about the species will be identified, and appropriate informational materials will be developed. For instance, a color brochure that describes Helonias and the threats to its survival will be developed to increase public awareness and to aid in soliciting the cooperation of landowners and developers regarding site protection. While focusing on Helonias, this type of brochure can also be used to increase general awareness of endangered and threatened plants. Other opportunities that will be capitalized upon include displays for visitor centers at public recreational areas such as National Forests, National Perks, and various state lands; popular articles exposing the general public to the species and issues of managing endangered and threatened plant species; and visual media that could be presented in conjunction with school and civic programs. (USFWS, 1991)
- 7. Review recovery Progress and revise plan as necessary. Progress towards recovery will be reviewed on an annual basis, and this plan will be updated and revised as needed. (USFWS, 1991)
- Revaluate Recovery Criteria in Light of New Information: - Conduct a population viability analysis (PVA) with cautious assumptions about collection, herbivory, beaver activity, woody vegetation encroachment, and climate change. - Use the results of the PVA to determine the importance and viability of C and D-ranked sites, and to determine if the recovery criteria need revision (particularly the number, type, and conditions for “protected” sites). (USFWS, 2014).
- Monitor and Track Recovery: - Develop criteria to determine which populations are representative of the species’ range, habitat, or genetic diversity, and identify those specific occurrences. - Develop a rapid assessment protocol to map and rank occurrences with minimal effort, expense, and disturbance in a consistent way across the range. Use the protocol to rank and map 20 percent of sites each year (e.g., a five-year cycle), using volunteers where possible. Make sure the information is entered in Natural Heritage Program databases. Track element occurrence ranks and plant numbers over time (USFWS, 2014).
- Watershed-Level Protection: Conduct a study to look for correlations between buffer width and changes in population size and vigor (USFWS, 2014).
- Watershed-Level Protection: Develop Best Management Practices to protect swamp pink habitat, and encourage their adoption by Federal and State regulatory agencies, local governments, and public and private landowners (USFWS, 2014).
- Watershed-Level Protection: Incorporate swamp pink in watershed planning, especially where multiple occurrences are clustered in small watersheds. Examples of watershed planning activities may include identifying priority areas for acquisition or conservation easements; mapping groundwater recharge areas; mapping up-gradient areas of steep slopes or highly erodible soils; and seeking protections through surface water quality standards, development design standards, or regulation of flood plains or stormwater management (USFWS, 2014).
- Site-Specific Protection: Work with public and private land trusts to acquire and manage important sites and buffers, prioritizing A and B-ranked sites and sites identified as representative of the species’ range, habitat, or genetic diversity (USFWS, 2014).

- Site-Specific Protection: Continue to seek landowner agreements to protect swamp pink on private lands where outright acquisition is a low priority or is not feasible (USFWS, 2014).
- Site-Specific Protection: Work with restoration groups to halt or reverse declines at impacted sites. Seek out new funding sources, such as those for non-point source pollution control or preservation of lands important to water supplies (USFWS, 2014).
- Site-Specific Protection: Continue to protect swamp pink sites through various regulatory processes as necessary and appropriate (USFWS, 2014).
- Propagation: Pursue long-term seed storage at CPC member institutions (USFWS, 2014).
- Propagation: Investigate the need, feasibility, methods, and opportunities for reintroduction of plants. Support research on propagation and genetics. Investigate how swamp pink colonizes new habitat under natural conditions to determine if natural dispersal is precluded in developed areas and could be augmented by reintroductions consistent with the Service's propagation policy (USFWS, 2014).
- Propagation: Develop partnerships with horticultural groups to learn more about the amount and origin of swamp pink in cultivation and trade for ornamental gardens. Work cooperatively with these partners to develop a statement of principles for responsible cultivation and trade of swamp pink (USFWS, 2014).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS Identify Priority Sites • Investigate the genetic diversity of swamp pink occurrences range-wide (especially in states that are under-represented in existing genetic studies, including North Carolina, Virginia, Delaware, Maryland, and New Jersey). Smaller, less vigorous swamp pink occurrences can harbor significant genetic diversity (Godt et al. 1995) and must not be overlooked during sampling. Develop guidance or criteria to identify occurrences that are representative of the species' genetic diversity and designate those occurrences as priority sites for protection. (Section 2.2.3, Priority 2 action) • Develop guidance or criteria to identify the swamp pink occurrences that are representative of the species' range and habitat. Designate the occurrences that meet the criteria as priority sites for protection. (Section 2.2.3, Priority 2 action) • Develop a swamp pink-specific protocol for delimiting element occurrences and pursue uniform implementation across the species' range. Consider implementing 'parent and child' structure for element occurrences to delineate populations and their corresponding sub-populations/occurrences. (Section 2.3.1.2, Priority 3 action) Research to Inform Management • Conduct a study to look for correlations between buffer widths, level of watershed development, and changes in swamp pink population size and vigor over time. Use this information to develop guidance on adequate buffer size/acreage for swamp pink sites to be considered permanently protected. Investigate whether buffer enhancement activities can be implemented to achieve adequate buffer protection at swamp pink occurrences that already have development in the buffer zone. (Section 2.2.3, Priority 2 action) • Investigate the impacts of herbivory (at different frequencies and intensities) on the growth and survival of swamp pink in the short- and long-term, as well as potential synergistic interactions with other co-occurring threats (e.g., groundwater drawdown). Investigate alternate management strategies (e.g., habitat management to increase light availability) to mitigate the effect of herbivory in situations where deer cannot effectively be excluded. (Section 2.3.2.3, Priority 2 action) • Based on the results of research, create guidance that describes the minimum protections and management stipulations (to be tailored to the site-specific conditions) required for a swamp pink occurrence to be considered permanently protected. (Section 2.2.3, Priority 3 action) Safeguarding Actions • Develop a captive propagation plan for swamp pink that clarifies objectives of ongoing in-situ and ex-situ safeguarding efforts and their significance for swamp pink recovery. (Section 2.2.3, Priority 2 action) • Pursue long-term storage (ex-situ safeguarding) of swamp pink seed and/or tissue at Center for Plant Conservation member institutions. Prioritize collection and preservation of occurrences that are known or suspected to be representative of the species' genetic diversity and are currently imperiled, or may become imperiled in the future. (Section 2.2.3, Priority 2 action) • Investigate the need, methods, and opportunities for the establishment of in-situ swamp pink safeguarding sites and/or reintroductions to sites that have become extirpated. (Section 2.2.3, Priority 3 action) Land Preservation and Management • Work with public and private land trusts to acquire and manage swamp pink priority sites and buffer areas. Continue to seek landowner agreements to protect swamp pink on private lands where outright acquisition is a low priority or is not feasible. (Section 2.2.3, Priority 3 action) • Work with restoration groups to halt or reverse declines at impacted sites. Seek out new funding sources, such as those for non-point source pollution control or preservation of lands important to water supplies. (Section 2.3.2.1, Priority 2 action) • Incorporate swamp pink in watershed planning, especially where multiple occurrences are clustered in small watersheds. Examples of watershed planning activities may include identifying priority areas for acquisition or conservation easements; mapping groundwater recharge areas; mapping up-gradient areas of steep slopes or highly erodible soils; and seeking protections through surface water quality standards, development design standards, or regulation of flood plains or stormwater management. (Section 2.3.2.1, Priority 3 action) Continue Survey Efforts • Continue surveying swamp pink occurrences, especially sites which haven't been surveyed in 20+ years and are nearing historic status. New Jersey and Delaware in particular have a significant number of sites that have not been visited for several decades but are still believed to be extant. Build relationships with private landowners and secure property access for swamp pink surveys. (Section 2.3.1.2, Priority 3 action) • Conduct de novo surveys for swamp pink in suitable habitat on public and private lands, especially in remote or otherwise undisturbed areas. Public lands have continued to yield new A- or B- ranked swamp pink occurrences in New Jersey, and discovery of new populations (or subpopulations) is also possible in the southern portion of the range (e.g., North Carolina). (Section 2.3.1.2, Priority 3 action) (USFWS, 2021)

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SPECIES ACCOUNT: *Iris lacustris* (Dwarf lake iris)

Species Taxonomic and Listing Information

Listing Status: Threatened; 09/28/1988; Great Lakes-Big Rivers Region (R3) (USFWS, 2016)

Physical Description

A low-growing perennial herb with fan-shaped clusters of flattened, sword-like leaves, about 1.6 dm high or less, arising from enlarged nodes on slender, creeping rhizomes. The showy blue (occasionally lilac or white) flowers with yellow splotches are borne singly on flowering stems no more than 4 cm long. Flowers emerge mostly from mid- to late-May (NatureServe, 2015).

Taxonomy

Dwarf lake iris is classified within the subgenus Limniris, one of the six subgenera of Iris and which includes all of the native iris species of North America, a group frequently referred to as the beardless irises (Henderson 2002). Although I. lacustris has sometimes been treated as a subspecies of I. cristata (Dykes 1913; Mason and Iltis 1965), most authors recognize dwarf lake iris as a distinct species, based on consistent and marked differences in morphology, geographical range, and habitat (Small 1924; Foster 1937) (USFWS, 2013).

Historical Range

Dwarf lake iris is endemic to the modern and ancient shorelines of northern Lakes Huron and Michigan. Historical records indicate that it once occurred as far south as Milwaukee, Wisconsin (Anderson, in litt. 2005) and possibly along the Detroit River (near Sandwich) in Ontario (COSEWIC 2004) (USFWS, 2011).

Current Range

Almost exclusively found on the northern shores of Lakes Michigan, Huron and Superior. Approximate range extent is 4100 sq. miles (NatureServe, 2015). The global population of dwarf lake iris is collectively restricted to Michigan, Wisconsin, and Ontario (USFWS, 2011).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination, self-pollination, asexual: vegetative (USFWS, 2011 and USFWS, 2013). Pollinated by halictid bees and other bee species(USFWS, 2022)

Lifespan

Adult: 2+ years (inferred from USFWS, 2013)

Dependency on Other Individuals or Species

Adult: The only identified pollination vector was halictid bees (Augochlorella striata, Larson 1998, p. 523). Additional pollination vectors have since been identified, including bee species from 4 families (Adrena carlini, Bombus vagans, Bombus impatiens, Bombus affinis, Augochlorella persimilis, Augochlorella striata, and Hoplitis spp.), the bee hawk-moth (Hemaris affinis), and a species of rove beetle (COSEWIC 2010, p. 17; Brotske 2018, p. 14). Visitation of dwarf lake iris by bees was positively related to the number of open flowers in the area (Brotske 2018, p. 18).

Breeding Season

Adult: April - June (USFWS, 2013). Seedlings appeared at the beginning of the growing season and continued to appear throughout the summer (USFWS, 2022).

Key Resources Needed for Breeding

Adult: Partial shade (NatureServe, 2015); possibly halictid bees (USFWS, 2011); possibly bee flies, several months of cold temperatures, soil seed bank (USFWS, 2013). Number of seedlings was positively related to light availability and number of ramets (the individual members of a clone) (Brotske 2018, p. 20) (USFWS, 2022).

Other Reproductive Information

Adult: As discussed in the 2011 5-year review, previous research has found limited heterozygosity and gene flow in dwarf lake iris populations (Orick 1992, entire; Simonich and Morgan 1994, entire). More recent and advanced genetic analysis has found increased genetic diversity within the species (Cohen et al. 2021, entire). The greatest amount of genetic diversity was found in inland Michigan populations (Cohen et al. 2021, entire). This aligns with previous research that suggested inland populations represent relics containing more diverse genomes (Orick 1992, entire)

Reproduction Narrative

Adult: While it has been found in full sun and nearly complete shade, optimal sexual reproduction appears to occur in partially shaded or sheltered forest edges (NatureServe, 2015). Larson (1998) reported halictid bees (Augochlorella striata) visiting dwarf lake iris flowers at Dorcas Bay, Bruce Peninsula, Ontario in late May 1996. Observations of floral visitation and grooming behaviors suggest halictid bees are potential pollinators. Dwarf lake iris seed capsules, on average, contain 20 - 22 small seeds (Planisek 1983). Dwarf lake iris allocates a far lower percentage of resources to sexual than to vegetative reproduction (USFWS, 2011). Dwarf lake iris is a spring flowering perennial. Flowering usually occurs from late April to early June, typically peaking from about mid-May to early June. Although dwarf lake iris is self-compatible, fruit set requires a pollen vector (Planisek 1983; Van Kley 1989). Van Kley (1989) reported bee flies (Bombyliidae) visiting flowers and probing in such a way that contact with stigma/stamens was likely. Field observations and laboratory studies indicate that seeds are dormant at the time of dispersal and require several months of cold temperatures for germination but can remain viable for at least 15 years within a soil bank (Morgan and Wolf 2008) (USFWS, 2013). Recent research on pollination, seed dispersal, and germination suggest sexual reproduction may be contributing more to dwarf lake iris populations than previously believed (Brotske 2018, entire). Research at the time of the last 5-year review suggested dwarf lake iris had low flower production, fruit set, and seed production. This indicated limited pollination, though seed viability may also be a limiting factor (Doyle 2015, p. 3). The only identified pollination vector was halictid bees (Augochlorella striata, Larson 1998, p. 523). Additional pollination vectors have since been identified, including bee species from 4 families (Adrena carlini, Bombus vagans, Bombus impatiens, Bombus affinis, Augochlorella persimilis, Augochlorella striata, and Hoplitis spp.), the bee hawk-moth (Hemaris affinis), and a species of rove beetle (COSEWIC 2010, p. 17; Brotske 2018, p. 14). Visitation of dwarf lake iris by bees was positively related to the number of open flowers in the area (Brotske 2018, p. 18). We note declines in bee abundance and richness have been documented in the Great Lakes basin (e.g., Graham et al. 2021, entire) and plan to evaluate how changes in pollinator abundance and richness may be potentially affecting dwarf lake iris population resilience in an upcoming Species Status Assessment (SSA). Dwarf lake iris seed capsules contain 20-22 seeds, each with an attached elaiosome (fleshy structures attached to a seed) (Planisek 1983, pp. 93-99). Studies in Michigan and Wisconsin have shown ants (Formica spp.) will remove these seeds and likely play a role in seed dispersal (Planisek 1983, p. 99; Brotske 2018, p. 18). Further studies on dispersal by ants are needed to understand how far and where ants distribute seeds (Brotske 2018, p. 23). Seed germination has been reported rarely for dwarf lake iris populations. Recent research suggests seed germination may be more common than initially believed (Brotske 2018, p. 14). Up to 36 individual seedlings were found in 400 cm2 plots at 2 sites in Wisconsin (Brotske 2018, p. 20). Seedlings appeared at the beginning of the growing season and continued to appear throughout the summer. Seedlings can be identified by the presence of a bright green loop at the top of the plant. This loop begins to shrivel within 2 weeks of emergence, which may explain why previous studies have reported low germination (Brotske 2018, pp. 25-27). Soil disturbance did not affect the number of seedlings that germinated. Number of seedlings was positively related to light availability and number of ramets (the individual members of a clone) (Brotske 2018, p. 20). Research over two years in Wisconsin showed an inconsistent relationship between seed viability and canopy cover. Seed viability is likely tied to seasonal conditions, such as rainfall, and shaded conditions may prove more favorable during drought conditions (Doyle 2015, p. 3). (USFWS, 2022).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Coniferous forest (USFWS, 2011)

Dependencies on Specific Environmental Elements

Adult: Natural disturbance processes (USFWS, 2011)

Geographic or Habitat Restraints or Barriers

Adult: Succession (NatureServe, 2015; see population narrative); thick leaf litter (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Colonial (USFWS, 2011)

Environmental Specificity

Adult: Narrow (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from USFWS, 2011)

Habitat Narrative

Adult: Thrives best in close proximity to the northern Great Lakes shores, where it is most often found in young, well-drained soils ranging from sands to gravels to sandy clay loam and organic-enriched sands. Distributional and field data demonstrate that it achieves its best growth in calcareous environments. It is most often associated with coniferous forest dominated by northern white-cedar (Thuja occidentalis) and balsam fir (Abies balsamea). Old beach ridges associated with post-glacial shorelines, many occurring significant distances inland from current lake shores, provide similar habitat that often supports the species, but in many of these inland sites the species persists mostly as sterile colonies, slowly senescing under the shade of more mature overstory vegetation. The environmental specificity is narrow; edaphic and canopy factors are important (NatureServe, 2015). Geographically distinct occurrences, consisting of more or less contiguous colonies, are used to estimate the overall abundance (Michael Penskar, Michigan Natural Features Inventory, pers. comm. 1998). It is most often associated with coniferous forest dominated by northern white-cedar (Thuja occidentalis) and balsam fir (Abies balsamea) (Van Kley 1989). Thick leaf litter restricts seedling establishment either by preventing the developing roots from reaching mineral soil or by preventing the developing shoot from reaching light (Makholm 1986). Cyclical fluctuations of Great Lakes levels and other factors, such as wind, waves and winter ice formations, are significant natural disturbance features (Van Kley 1989). These disturbance processes create a ragged forest edge as well as forest openings and gaps in the canopy that provide microsites for subsequent colonization by dwarf lake iris (Van Kley 1989). This species is a persistent and rather ecologically resilient plant that can withstand some level of disturbance and can often recolonize small disturbed areas if it flourishes nearby (Penskar et al. 2001) (USFWS, 2011). Van Kley (1989) found that soil pH varied from 5.4 to 7.5, although most measurements were above 6.5. (USFWS, 2013).

Dispersal/Migration

Dispersal

Adult: Low (USFWS, 2013). Possibly dispersed by ants (USFWS, 2022)

Dispersal/Migration Narrative

Adult: Although Planisek (1983) demonstrated that ants are attracted to and will move dwarf lake iris seeds, the extent of their role, if any, in the dispersal of this species is not known. It has an apparent limited dispersal ability (even nearby microsites that appear favorable often support no plants) (USFWS, 2013).

Population Information and Trends

Population Trends:

Increasing (USFWS, 2022)

Species Trends:

Stable (USFWS, 2011); Increasing (USFWS, 2021)

Number of Populations:

144 (USFWS, 2024)

Population Size:

~60 million (USFWS, 2024)

Adaptability:

Low (inferred from NatureServe, 2015)

Additional Population-level Information:

The SSA analysis showed that populations are widely distributed across the four representation units, increasing the species' ability to adapt to novel changes in its environment and making a catastrophic event that negatively impacts all populations highly unlikely (Fig. 1). All representation groups have multiple populations with high condition: nine in the East (15%), four in the Upper Straits (13%), six in the Lower Straits (29%), and nine in the West (27%). Overall, the species has maintained redundancy across its range compared to its historical range. Though 20 populations have been extirpated or presumed extirpated and 12 populations are historical, new populations have also been discovered. At the time of listing in 1988, 75 occurrences were known in the U.S.: 60 in Michigan and 15 in Wisconsin. We now know of 74 extant or unknown populations in Michigan and 28 extant or unknown in Wisconsin. Survey efforts in Canada have also discovered new populations. Both the PVA and SSA analyses suggest large and/or dense populations of DLI are stable at current conditions and likely to persist for several decades. DLI is now believed to occur in at least 144 populations distributed across Michigan, Wisconsin, and Ontario. Using a count of minimum estimates over the last 20 years, the species has a current estimate of 60 million plants, which includes counts of individuals and their ramets, of which 50 million are located at Thompson's Harbor State Park in Michigan (USFWS, 2024).

Population Narrative:

Can colonize suitable habitats (roadside ditches, etc.), not tolerant to long-term flooding. The species has low genetic diversity and low rate of sexual reproduction. This species has experienced a long term decline of 50 - 80%. The number of genets is unknown, but likely over 10,000. This number is likely in the hundreds of millions (NatureServe, 2015). Overall, the total population of dwarf lake iris appears relatively stable (USFWS, 2011). There are 167 extant occurrences (USFWS, 2013). Though dwarf lake iris remains a rare endemic species with a limited distribution, the species has increased since its listing, and analyses suggest the species is likely to persist for several decades at a minimum. Since listing, the number of known dwarf lake iris occurrences has increased from approximately 118 to 165 extant occurrences (USFWS, 2022). At the time of the previous 5-year review in 2011, there was a total of 143 known extant occurrences of dwarf lake iris: 84 in Michigan, 41 in Wisconsin, and 18 in Ontario, Canada. There is now a total of 165 known extant occurrences (Figure 1). In Michigan, there are 89 extant occurrences of dwarf lake iris (Hackett et al. 2021, p. 15). These occurrences mainly exist along the Great Lakes shorelines of the northern Lower Peninsula and the southern Upper Peninsula, though there are some anomalous inland occurrences. In Wisconsin, there are 36 extant occurrences of dwarf lake iris (Owen Boyle, Wisconsin Department of Natural Resources, pers. comm. 2021). (USFWS 2022)

Threats and Stressors

Stressor: Development (USFWS, 2011)
Exposure:
Response:
Consequence:

Narrative: Loss of shoreline habitat is increasing along Lakes Michigan and Huron in part due to residential, especially second home, development. Habitat is physically destroyed by home construction, driveways, access roads, associated landscaping, and long-term maintenance, such as mowing (Penskar, pers. comm. 1998). Home development can also fragment habitat. The main threat to dwarf lake iris on private property is cottage development; however, cottage owners sometimes maintain natural landscaping around cottages, allowing dwarf lake iris to survive (COSEWIC 2004). Major recreational activities along the northern Great Lakes shores include sightseeing, fishing, camping, hiking, boating, skiing, and hunting. With the influx of vacationers from the south, the market for constructed attractions, such as golf courses, amusements and shopping, has also increased (Penskar, pers. comm. 1998). In Michigan, marina development along the Great Lakes is being fueled by high demand and the State of Michigan's Harbor Development Fund (USFWS, 2011).

Stressor: Road maintenance and construction (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Approximately one half of the occurrence records for dwarf lake iris mention proximity to roads or trails. Great threats are posed by road maintenance activities, such as mowing, grading, brush and tree removal, and herbicide spraying. Road construction projects under the jurisdiction of counties or municipalities can have much greater impacts on dwarf lake iris. There is currently no program for protecting dwarf lake iris growing along local roads either in Wisconsin or Michigan. Roads in proximity to dwarf lake iris populations also create risks to the species by providing access routes for construction of residences and driveways (Penskar, pers. comm. 1998). This development further destroys and fragments the species' habitat (USFWS, 2011). Survey efforts in the last 10 - 55 years have failed to find eight populations of dwarf lake iris that historically occurred in Michigan (Hackett et al. 2021, p. 27). All but one of these populations was near a roadside or a developing residential area, although it is unknown if anthropogenic stressors contributed to the decline in these populations. There are several seemingly stable populations of dwarf lake iris that continue to persist on residential property and along roadsides (Hackett et al. 2021, p. 27) (USFWS, 2022).

Stressor: Succession (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: The main natural threat to dwarf lake iris is forest succession. Specifically, the invasion of deciduous species can result in reduced light levels and increased leaf litter, which inhibits successful reproduction, as discussed in section 2.3.1.6. The long-term survival of dwarf lake iris requires some form of disturbance that alters or suppresses succession, which aids in maintaining occupied habitat as well as creating new areas of suitable habitat (Makholm 1986). Orange hawkweed (Hieracium aurantiacum L.), an exotic species, has similar ecological requirements and may compete with dwarf lake iris for its open habitat. This species has been observed invading existing dwarf lake iris colonies, and it occupies areas that could have potentially supported dwarf lake iris (Gibson and Makholm 1988) (USFWS, 2011).

Stressor: Climate change (USFWS, 2011)
Exposure:

Response:
Consequence:
Narrative: Regional warming may result in shifts in forest distribution (Kling et al. 2003). As the extent of canopy cover and leaf litter influence dwarf lake iris populations, changes to forest species composition and/or distribution of forest cover across the landscape could affect the long-term survival of the species. Drier conditions could also have a significant adverse effect on the suitability of microhabitats, particularly in open sites with constant solar exposure (Morgan 1989). How Great Lakes water levels may change and what effect this may have on habitat availability and suitability for dwarf lake iris is unclear (USFWS, 2011).

Stressor: Invasive Species (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: Many invasive species have been observed near dwarf lake iris populations, including spotted knapweed (Centaurea stoebe), invasive hawkweed (Hieracium spp.), reed canary grass (Phalaris arundinacea), honeysuckle (Lonicera morrowii, Lonicera x bella), multiflora rose (Rosa multiflora), autumn olive (Elaeagnus umbellate), wall lettuce (Mycelis muralis), common barberry (Berberis vulgaris), Japanese barberry (Berberis thunbergii), and common buckthorn (Rhamus cathartica) (Brotske 2018, p. 28; Hackett et al. 2021, p 30). Shading by invasive shrubs and taller grasses is likely the greatest threat posed by invasive species (Hackett et al. 2021, p. 30). Early detection and removal are the most cost-effective ways to address this threat. (USFWS, 2022)

Stressor: Erosion and Lake level rise (USFWS, 2024)
Exposure:
Response:
Consequence:
Narrative: the primary threats to the population are rising lake level and shoreline erosion (USFWS, 2024)

Stressor: non-native honeysuckle (USFWS, 2024)
Exposure:
Response:
Consequence:
Narrative:

Stressor: recreational activities (USFWS, 2024)
Exposure:
Response:
Consequence:
Narrative:

Recovery

Reclassification Criteria:
Recovery Priority Number: 8C

Delisting Criteria:

1. The species has a 95% probability of persistence within the next 20 years, based on data obtained from accepted standardized monitoring methods and on population viability analysis. In order to meet this criterion, the following must be verified: a. There is a sufficient number and geographical distribution of element occurrences required to ensure long-term persistence; b. Each element occurrence needed to ensure a 95% probability of persistence within the next 20 years must meet a minimum viable population size and exhibit an increasing or stable population trend over a 10-year period (USFWS, 2013).

2. Management plans have been developed and are being implemented to protect and manage the habitat associated with the element occurrences identified in Criterion 1.b. (USFWS, 2013).

3. A plan to provide public outreach and education for dwarf lake iris has been developed and is being implemented (USFWS, 2013).

Recovery Actions:

- Protect occurrences (USFWS, 2013).
- Manage and restore habitat (USFWS, 2013).
- Inventory and monitor known sites (USFWS, 2013).
- Conduct population viability analysis (USFWS, 2013).
- Develop an education program about dwarf lake iris, other federally listed shoreline species, natural communities, and their protection and management (USFWS, 2013).
- Improve understanding of baseline dwarf lake iris ecology (USFWS, 2013).
- Review and track recovery progress (USFWS, 2013).
- Complete the recovery plan for I. lacustris. This plan will identify objective recovery criteria and develop a recovery strategy (USFWS, 2011).
- Develop a monitoring schedule to ensure the continued health and stability of the known I. lacustris occurrences. An established monitoring system will aid in determining population trends within and among colonies (USFWS, 2011).
- Establish a public outreach program to increase public awareness of I. lacustris and to notify private landowners of the species' presence. This informative program will promote overall recovery of the species and decrease unintentional destruction on both public and private land (USFWS, 2011).
- Develop state and Federal management plans that address protection of I. lacustris in dedicated and multiple-use areas (USFWS, 2011).
- Develop Best Management Practices for use by State and County Highway Departments for roadside populations of I. lacustris (USFWS, 2011).
- Encourage research to better understand how vegetation management of existing sites can be designed to benefit I. lacustris (USFWS, 2011).

Conservation Measures and Best Management Practices:

- Michigan Natural Features Inventory received funding from the Great Lakes Restoration Initiative to evaluate dwarf lake iris populations in Michigan. A total of 58 dwarf lake iris element occurrences were visited from 2019 to 2021 (Hackett et al. 2021, entire). Efforts ranged from qualitative surveys (quick, presence/absence survey that can happen at any time in the growing season), to count surveys (must be conducted during flowering, more time consuming but provide more rigorous data on populations), to demographic surveys (most labor intensive but provide the most data), depending on the site. The Michigan Natural Heritage Database was updated to reflect new information on population status and threats, and this information was used to develop the PVAs (USFWS, 2022).

- Recommendations for future actions: • Develop and implement Site Management Plans (Recovery Plan Action 2.1) • Develop and implement an outreach program for schools, landowners, local communities, developers, utilities, and county road associations (Recovery Plan Actions 5.1, 5.2, and 5.3) • Conduct a SSA to inform the next 5-year review (Recovery Plan Action 7.1) • Plan and implement regular surveys and monitoring of occurrences to understand population status and inform a species level PVA (Recovery Plan Actions 3 and 4) (USFWS, 2022).
- Since the last 5-year review, three formal section 7 consultations have been conducted for projects affecting dwarf lake iris: development of a motor coach recreational park including construction of a boardwalk in Cheboygan County (Service 2014, entire), an overhead transmission line in Presque Isle and Cheboygan Counties, Michigan (Service 2019, entire), and a pipeline in Mackinac County, Michigan (Service 2020, entire). These projects used several conservation measures to minimize impacts to dwarf lake iris, including using existing roads and timber mats to minimize impacts to the population, cleaning all equipment to prevent invasive species, treating existing invasive species to prevent further establishment, and informing all workers about the unique characteristics and sensitivity of dwarf lake iris. For all three projects, at least a portion of the ramets that could not be avoided during construction were transplanted off site and monitored for at least 2 years (Service 2014, p. 4; Service 2019, pp. 13-14; Service 2020, pp. 7-10). Various methods have been used to transplant dwarf lake iris, including manual excavation and transplantation for small areas and the use of a mechanical sod cutter to relocate large areas of dwarf lake iris (Vande Water Natural Resource Services 2011, pp. 2-5). Monitoring of one relocation effort showed 83 – 91% of dwarf lake iris ramets that were transplanted continued to grow 2 years later (Barr 2013, p. 8). A similar transplantation method was used to move 550 ramets from a private site undergoing construction in Wisconsin to a new location with no known populations of dwarf lake iris but appropriate habitat conditions (Collins 2020, entire) (USFWS, 2022).
- Recommendation Team Meeting Information A recommendation team meeting was held on July 11 and 12, 2023. The outcome of the meeting was a recommendation to delist DLI because it no longer met the definition of an endangered or threatened species. This recommendation was the result of the following rationale: • The species currently has moderate to high resiliency, high representation, and moderate redundancy. The majority of populations (65%) are currently considered to be in medium or high condition. There are at least 144 populations of DLI spread across the range, and all representation groups have multiple populations currently ranked as high condition. • Recommenders identified in their rationale that less than 12% of DLI populations have been lost since the species was listed. Core team members added further that there have been new populations discovered since the time of listing. • About 60% of DLI populations are at least partially located on public land or land set aside for conservation purposes. • Of the 144 populations assessed in the Species Status Assessment, about 19% were reported to have active management. One recommender felt that this level of management was not sufficient to make management a dominant factor in species recovery. One recommender felt this was an important factor in species recovery, as additional management for other purposes, such as right-of-way management along roadways and transmission lines, may also benefit the species. • Under all future scenarios considered during the Species Status Assessment at least 63% of DLI populations were projected to have an estimated probability of persistence that exceeded 60%, and fewer than 38% of populations were projected to have an estimated probability of persistence below 60%. Under the different scenarios, five to six populations may become extirpated, but this is not expected to shrink the range of the species. • While the unknown ability of the species to adapt to wide-ranging fluctuations, the effects of climate change, and the threats to the unique coastal habitat some

populations occupy will likely continue to threaten the overall health of populations, DLI will likely be able to persist on the landscape under future conditions. • After reviewing the current population statuses, recommenders agreed no portion of the species rises to the definition of threatened or endangered. Based on this information, the recommenders concluded that DLI was not currently in danger of extinction and was not likely to become endangered within the foreseeable future throughout all or a significant portion of the species' range. (USFWS, 2024)

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SPECIES ACCOUNT: *Lilium occidentale* (Western lily)

Species Taxonomic and Listing Information

Listing Status: Endangered; 08/17/1994; Pacific Southwest (R8) (USFWS, 2017)

Physical Description

A perennial herb with a single stem that grows up to 1.8 m tall from an underground bulb. Narrow leaves grow singly or in whorls along the tall stem and 1-10, showy, nodding flowers bloom at the top of the stem from mid June to early August. The Flower petals are red or deep orange, strongly reflexed, with purple-spotted, yellow centers. (NatureServe, 2015)

Taxonomy

A member of the Liliaceae (lily family). There has been no change in taxonomic status of this species since it was described, although the existence of two forms of Lilium occidentale has been debated over the years. Past distinction of the varieties as “California” and “Oregon” appears in large part due to the fact that the largest population, which fits the “Oregon” form well, was not discovered in California until 1991. The best interpretation at this time seems to be that the variation seen between the forms often correlates with differences in environment, less often correlates with proximity to the similar congener species, and at the extreme southern end of the range (Table Bluff) is currently supported by defined genetic differences (USFWS, 2009).

Historical Range

Known from narrow strip along the coast in northern California and southern Oregon. Endemic to three counties. Historical occurrence in Coos County, Oregon and extant occurrences in Curry County, Oregon (NatureServe, 2015).

Current Range

Several extant occurrence in Humboldt County, California. California range extent covers about 146 sq mi in 3 main areas (NatureServe, 2015). It is restricted to a narrow strip along the immediate Pacific coast between Coos Bay, Oregon, and Eureka, California (USFWS, 2009) with a few new populations recently found in Coos Bay and Curry, Oregon (USFWS, 2019b).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: self-pollination, asexual (USFWS, 2009)

Lifespan

Adult: ~25 years (USFWS, 2009)

Breeding Season

Adult: June - August (see physical description)

Key Resources Needed for Breeding

Adult: Open conditions, hummingbirds, insects (USFWS, 2009)

Reproduction Narrative

Adult: Reproductive plants require relatively open conditions (Bencie and Kalt 2007, Imper 1997, Schultz 1989). Like other lilies, Lilium occidentale has hermaphroditic flowers (producing both pollen and seeds). Lilium occidentale appears relatively unique within the genus in being able to produce abundant self-pollinated seed (Skinner 1988). Hummingbirds are the primary pollinator of L. occidentale, but bees and other insects may also transfer pollen (Skinner 1988, Schultz 1989). Reproductive plants usually produce 1-3, but up to 25 pendant flowers (Imper et al. 1987). Natural seed set in a sample of 35 capsules at Bastendorff Bog, Hauser Bog, and Shore Acres ranged from 0 to 204 seeds per capsule with a mean of 132 seeds (Schultz 1989). The species reproduces primarily by seed, but asexual reproduction is possible from detached bulb scales. In cultivation, plants may flower in as little as 3 years (Skinner 1988); in the wild plants may live for 25 years or more (Imper et al. 1987) (USFWS, 2009).

Habitat Type

Adult: Early-successional coastal habitat (USFWS, 2019)

Habitat Vegetation or Surface Water Classification

Adult: Sphagnum bog, margins of ephemeral ponds and small streams, coastal scrub and prairie (NatureServe, 2015); spruce forest (USFWS, 2009)

Dependencies on Specific Environmental Elements

Adult: Ocean fog, poorly drained soil (NatureServe, 2015); seasonal inundation, early successional habitat (USFWS, 2009); fire (USFWS, 1998)

Geographic or Habitat Restraints or Barriers

Adult: Coastal (NatureServe, 2015); occurs up to 300 ft. in elevation and up to 4 miles inland, dense vegetation reduces survivorship (USFWS, 2009)

Environmental Specificity

Adult: Very narrow (Natureserve, 2015)

Habitat Narrative

Adult: Inhabits Pacific coastal wetlands. Mostly restricted to the edges of early successional, wet sphagnum bogs and forest or thicket openings along the margins of ephemeral ponds and small streams. Also in coastal scrub and prairie, and other poorly drained soils near the ocean where fog is common. The environmental specificity is very narrow; it is only known from northwestern coastal wetlands (NatureServe, 2015). Although the species often occurs in fens that are flooded for periods in the winter and spring, the species does not appear to tolerate year-round inundation. Populations occur from just above sea level at Crescent City Marsh, to a maximum 300 feet in elevation, and from ocean-facing bluffs nearly 4 miles inland. With the exception of spruce forest, all of the habitats are early successional in development, which provides the necessary conditions for growth and reproduction. In the case of spruce forest, the dark, moist, acid understory conditions are well suited for establishment of L. occidentale, but the plant remains vegetative. Very dense, tall shrub growth reduces reproduction and survivorship, and closure of the overstory canopy, although tolerated by young or small plants if it is moist, eventually may eliminate the population entirely (USFWS, 2009). Western lily populations appear to have been maintained in the past by occasional fires, at least at some sites in Oregon, and by grazing (USFWS, 1998).

Dispersal/Migration

Dispersal

Adult: Low (USFWS, 2009)

Dispersal/Migration Narrative

Adult: The genus has winged flat seeds that are wind-dispersed (NatureServe, 2015). Seeds are primarily dispersed by wind and gravity, mostly within a 13-foot radius (Skinner 1988) (USFWS, 2009).

Population Information and Trends

Population Trends:

Decline of 50-70% (NatureServe, 2015)

Number of Populations:

25 (USFWS, 2009; 2019)

Population Size:

9,000 - 10,000 individuals (NatureServe, 2015)

Adaptability:

Moderate (inferred from NatureServe, 2015)

Population Narrative:

Western Lily Is amazingly resilient when left undisturbed. However, it is vulnerable due to its attractive flowers and occurrence in wet habitats. Several populations are historical and have not been refound, especially on Fields Landing and Arcata South quads in Humboldt Co. This species has experienced a long-term decline of 50-70%. Estimated total population of 9,000-10,000 individuals known with about 7,200 in California and a few thousand in Oregon, including recently discovered populations. About 40-50 small, widely separated populations known (Endangered Species Tech. Bull., 1992). 16-22 occurrences in California (NatureServe, 2015) with restoration efforts in Crescent City Marsh Outlflow Restoration, in Del Norte County, CA, where the largest number of flowering plants of any population of L. occidentale occurs, expanding managed lands by 40 acres (USFWS, 2019). The 23 extant principle populations range in size from less than 0.1 acre to more than 6 acres, totaling about 40 acres of occupied habitat. Of the current 23 defined principle populations, 5 populations probably contain up to 50 plants; 8 likely range from 51-200 plants; 8 range from 201-600 plants, and 2 populations exceed 1,000 plants (USFWS, 2009). Restoration activities at Floras Lake State Natural Area in Curry County, Oregon have discovered additional L. occidentale in and adjacent to cleared areas, suggesting potential expansion of the population and population augmentation efforts have shown a survival rate of 19% of planted bulbs. Surveys in the Floras Lake State Natural Area indicate 47 and 50 individuals but without additional survey data, it is difficult to determine the overall trend in this area (USFWS, 2019). In 2017, a new population of 641 plants (300 in flower) was discovered on property adjacent to Floras Lake State Natural Area. Additionally, in 2013, a new population was discovered on private property on the South Slough estuary of Coos Bay in Coos County, OR and this population totaled 1,222 plants in 2018. In this location, the extent of viable habitat is defined by the extent of Blacklock soil with western Labrador tea (USFWS, 2019).

Threats and Stressors

Stressor: Habitat loss and modification (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: From the 1940's until the species was listed, conversion of habitat to cranberry farms, roads, and residential dwellings continued to eliminate L occidentale and suitable habitat between Bandon and Port Orford, Oregon, an area that likely contained the greatest concentration of the species in Oregon more than 50 years ago (Ballantyne 1980, Schultz 1989). Cranberry agriculture continues to eliminate a large amount of suitable habitat each year, currently accounting for the largest loss of suitable habitat. Many of the smaller roadside occurrences cited when Lilium occidentale was listed could not be relocated (Imper, unpubl. data 2008), often due to driveway construction, cranberry development, grading, non-native species, or other developments overrunning the general area. A new factor since it was listed, which threatens the largest population of L. occidentale range-wide, is the prolonged flooding of the Crescent City Marsh (USFWS, 2009).

Stressor: Collection (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Lilium occidentale is a very showy plant with great horticultural appeal. Horticultural collection was considered to be a significant threat at the time of listing, in part due to past publication of specific locations in professional journals. Ballantyne (1980) believed that repeated publication of the location of a California population in lily society yearbooks between 1934 and 1972 led to decimation of the population by lily growers and breeders. Given the frequent difficulty in detecting the majority of individuals within any one population, in most cases a single collection probably would not constitute a major threat. Nevertheless, there is good evidence that collection of plant parts has occurred frequently in the past, and such collections currently pose a threat to the smaller populations (USFWS, 2009).

Stressor: Predation (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Deer herbivory was identified as a threat for several Oregon and California populations at the time of listing, and continues to threaten, or at a minimum severely reduce the reproductive vigor of many populations. Even if not lethal, deer remove a considerable fraction of flowers and fruit, thus seriously reducing the reproductive output at many sites. In some cases small mammals, such as voles (Microtus spp.), have been observed browsing on

Lilium occidentale (Imper unpub. data 2008). However, measured impacts on L. occidentale from small mammal depredation overall appear relatively small compared to deer (Bencie and Kalt 2007; Imper, unpubl. data 2008). Grazing of leaves, buds, and flowers by Coleopteran (beetle) and Lepidopteran (butterfly, moth) larvae was observed in the past at one California site (Imper et al. 1987), but significant impact from these sources has not been reported or observed in recent years. Although cattle represent an obvious physical hazard to individual plants during the growth period, evidence indicates that its past categorical characterization as a major threat may be overstated. In contrast to deer and small mammals that are often very selective for Lilium occidentale, cattle often remove only the upper portion of the plant as a consequence of feeding on surrounding vegetation. Overall evidence suggests that while cattle grazing reduces individual reproductive potential, so long as there is adequate seed production and recruitment to offset mortality, that impact may be of little consequence compared to the benefits to its habitat (USFWS, 2009).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: In summary, the Endangered Species Act, in combination with the Clean Water Act, theoretically provide the greatest level of regulatory protection for Lilium occidentale. However, recent reinterpretation and the lack of enforcement of the Clean Water Act, particularly in Oregon, have resulted in little regulatory protection for the species. The Oregon Endangered Species Act, and in California, the California Coast Act and the California Environmental Quality Act, provide the greatest protection at the state level. However, protection under those laws is largely discretionary, and in Oregon there is essentially no prohibition of take on private property. The regulatory environment continues to be inadequate to protect this species, in large part due to a decline in the protection provided by the Clean Water Act (USFWS, 2009).

Stressor: Succession and nonnative plants (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The most significant long-term threat to Lilium occidentale is competitive exclusion by shrubs and trees. Heightened competition is a consequence of the rapid and uninterrupted progression of ecological succession resulting from lack of disturbance (e.g., fire, grazing) for the past one to three decades for most sites. Although L. occidentale seedlings and juvenile plants can in some cases survive under closed canopy greater than 90 percent, the species is unable to successfully reproduce under those conditions. Therefore, rather than overgrazing constituting a threat, it is the lack of appropriate levels of grazing, or other adequate disturbance regime, that poses the greatest threat for many sites in both California and Oregon. Invasion by the non-native shrub Ulex europaeus (common gorse) into habitat for Lilium occidentale was identified as a threat in the past near Floras Lake State Park (Ballantyne 1980). Invasive species such U. europeus, Cytisus scoparius (scotch broom), Rubus procerus (himalayaberry) and others continue to threaten several sites across the range, including Hauser, Morrison, and Hultin sites under the BPA powerline, and Boak Lane and Harris State Park sites (Imper, unpubl. data 2008). In addition, Phalaris arundinacea (reed canarygrass), while not a current threat, is poised to invade wetlands across the range, the most worrisome being Crescent City Marsh (USFWS, 2009).

Stressor: Stochastic events/small population size (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Since many populations of Lilium occidentale continue to be very small (e.g., less than 50 flowering plants), loss of genetic diversity due to inbreeding and/or random genetic drift may continue be a serious problem in some populations. Populations below an effective size of about 5,000 plants will generally maintain insufficient adaptive genetic variability for long-term adaptation to a changing environment, and those below 500 will experience accumulation of mildly deleterious mutations due to random genetic drift and inbreeding depression (Service 1998). Although this factor continues to be a threat due to the small population sizes, plants with genetic abnormalities observed during monitoring and other field work have not obviously increased since the species was listed (Imper, unpubl. data 2008) (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)
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. The species is restricted to habitats that provide adequate soil moisture, but are not inundated throughout the growing season. As a result, any change in the timing and amount of precipitation, or soil and air temperatures, could potentially render habitat unsuitable. In addition, the reproductive phenology of L. occidentale is closely linked to temperature. While the Service lacks adequate information to make accurate predictions regarding the effects of climate change on L. occidentale, we can say that the rarity of L. occidentale, combined with its relatively unique habitat and its demonstrated sensitivity to soil moisture conditions and temperature, suggest that it may be among the species affected by climate change. Another potential result of climate change is increased sea level, which potentially could impact the largest population of L. occidentale located at the Crescent City Marsh Wildlife Area (USFWS, 2009).

Recovery

Reclassification Criteria:
The western lily can be considered for downlisting to threatened when at least 20 viable populations are protected and managed to assure their continued existence. The 20 populations must be distributed among six recovery areas, with at least three in Area 1, five in Area 2, and four each in Areas 4, 5, and 6. For the purposes of this Recovery Plan, a viable population includes at least 1,000 flowering plants, and a population structure indicating stable or increasing plant numbers (USFWS, 2019).

Recovery Priority Number: 2

Delisting Criteria:
Trends at each of the 20 populations are determined to be stable or increasing for a minimum of 25 years. Trend determination will be based on the number of flowering (reproductive) individuals present (USFWS, 2019a).

A minimum of 20 viable populations are appropriately managed though either long-term landowner agreements (e.g., stewardship plans, easements, or memorandums of agreements), which identify maintenance of Lilium occidentale habitat as a primary management objective for the site or permanent conservation easement/covenant that commits both present and future landowners to the conservation of Lilium occidentale (USFWS, 2019a).

A monitoring plan to cover a minimum of 12 years post-delisting of Lilium occidentale has been approved by the Pacific Southwest Regional Director and is ready to be implemented at the time of delisting to ensure the ongoing conservation of the species and the continuing effectiveness of management actions (USFWS, 2019a).

Recovery Actions:

- On-site conservation that manages habitats to maintain habitat in appropriate seral stage (i.e., prevents or reverses encroachment by trees and shrubs) (USFWS, 1998).
- Establish seed bank and learn how to reintroduce or augment populations in the wild (USFWS, 1998).
- Enhance public awareness, understanding, and participation in western lily recovery (USFWS, 1998).
- Continue to support habitat restoration on state lands while encouraging, where feasible, a greater effort to expand occupied L. occidentale sites (USFWS, 2019b).
- The current grazing lease at Cape Blanco State Park should be managed to promote and maintain L. occidentale habitat. At Floras Lake State Natural Area, a broader, landscape level view should be taken in light of the widely distributed yet fragmented populations present and high availability of potentially suitable habitat (USFWS, 2019b).
- To support management decisions and recovery actions, repeatable, rigorous survey efforts should be conducted for each L. occidentale population. Survey schedules should be developed for each occupied site. Furthermore, data collection should follow established protocols, and data should be entered into a database housed by the Service (USFWS, 2019b).
- L. occidentale habitat should be conserved through conservation easements, and property acquisition should be pursued for populations on private lands that remain threatened by agriculture or development. Section 6 Non-traditional Recovery Grants may be used to secure conservation easements or acquire property, provided there is support from the Oregon Department of Agriculture and local land trust support. Obtaining endowment funds to cover land trust long-term expenses remains challenging, as does the challenge of negotiating a price for property acquisition (USFWS, 2019b).
- continue to work with the Bonneville Power Administration (BPA) to consult on actions occurring within BPA's right-of-ways that adversely affect L. occidentale. BPA's vegetation maintenance activities are credited with maintaining suitable habitat, yet much could be done to improve right-of-way management for L. occidentale. Examples include signage to inform powerline workers of sensitive habitats, training of workers in best management practices for those habitats, and better security to prevent trespass and damage by unauthorized vehicles (USFWS, 2019b).
- Hauser Bog – The Service should coordinate with the Oregon Departments of Agriculture and Transportation in order to: a) Implement negotiations with the two private landowners to allow construction of a fence along the east boundary of the habitat, and enable future vegetation management on their property in conjunction with the Department of

Transportation's management of their Sensitive Management Area. If possible, secure a conservation easement or other legal agreement for protection and management; b) Expand the recently completed mitigation area (Riley Ranch project) located south of the fen to include additional removal of tree overstory canopy around the wetland area and connecting it to the existing Lilium occidentale population (USFWS, 2009).

- Oregon State Parks – The Service should coordinate with the Oregon Department of Parks and Recreation to implement the following habitat restoration projects: a) Sunset Bay State Park: Continue manual clearing of the majority of the Bastendorff Bog parcel, and reconnect that population with former L. occidentale/Darlingtonia and/or former open Blacklock scrub habitat to the south and west of Bastendorff, near the sewer ponds and toward the park management office; b) Shore Acres State Park: Pursue restoration of a somewhat enlarged habitat area that includes, and connects the three existing colonies of L. occidentale south of the Simpson Gardens; c) Floras Lake State Park: Pursue restoration of large areas of habitat where suitable soils are known to occur, and which historically or currently supports Lilium occidentale, focused on two principle areas: the north end of the airport runway extending 300 feet or more north, east and west, and a second area starting at the main L. occidentale colony southwest of the hangers, and extending 500 feet or more north and west; d) Harris Beach State Park: Complete the fence around the full extent of the powerline site, and pursue restoration of the remainder of Lilium occidentale habitat there (USFWS, 2009).
- Point St George – The Service should coordinate with Del Norte County, and the Elk Valley and Smith River Rancherias to conduct an experimental burn in Lilium occidentale habitat, and then implement broad scale burn treatment of all suitable habitat on the Point (USFWS, 2009).
- Table Bluff Ecological Reserve – Continue research on the relationship between tree size and soil moisture, and Lilium occidentale mortality; subject to those results, implement broad scale removal of spruce within the occupied habitat as appropriate (USFWS, 2009).
- Crescent City Marsh: a) The Service, California Department of Transportation, California Coastal Commission, and the affected private landowner should move as quickly as possible to improve the drainage from Crescent City Marsh in order to prevent further decline in the largest population of Lilium occidentale range wide; b) CDFG should reintroduce livestock grazing as soon as possible into the Crescent City Marsh Wildlife Area (USFWS, 2009).
- Regulatory Enforcement – The Service should assist the USACE and the Oregon Division of State Lands to improve their enforcement of the Clean Water Act and the Oregon Fill and Removal Act, in order to stem the ongoing high losses of wetlands and potential Lilium occidentale habitat in Coos and Curry Counties (USFWS, 2009).
- Hauser Bog – The Service should coordinate with the Oregon Departments of Agriculture and Transportation in order to: a) Finalize a manual vegetation management plan for their portion of Hauser Bog, which ensures future treatment at a required interval (estimated 7-10 years); b) Negotiate access from the owners of wetland habitat directly across Highway 101, west of the Hauser Bog (formerly a part of Hauser Bog prior to highway construction), and conduct research necessary to determine suitability of that habitat for L. occidentale; c) Increase the propagated seedling bank at Shore Acres State Park nursery; after a minimum 3 years in the nursery, outplant a portion of the propagated plants to the mitigation area, and (subject to access by adjacent landowners) outplant to suitable locations west of Highway 101 (USFWS, 2009).

- Oregon State Parks – The Service should coordinate with the Oregon Department of Parks and Recreation in order to: a) Define management boundaries for Lilium occidentale, based on habitat requirements and practical limitations, that are adequate to attain one or more recovery level populations at each of the five parks in which it occurs. Where feasible, these management areas should represent an expansion of the currently occupied habitat, and creation of suitable corridors of suitable habitat connecting the existing colonies of L. occidentale; b) Determine the management strategy most appropriate to each park (manual or mechanical control, controlled burns, grazing), and the estimated treatment interval necessary to maintain the population at the minimum recovery level size; review the feasibility for modifying trailside maintenance methods to maximize suitable habitat for the plant (e.g., extended brush-cutting arm); c) Determine the necessary endowment funds or other funding mechanism needed to fund the periodic maintenance requirements in the future, and identify potential funding sources; d) Assist OPRD in developing specific Lilium occidentale conservation strategies for inclusion in each of the park management plans, which incorporate the above information; e) Cape Blanco State Park: Pursue restoration of formerly suitable habitat north and west of the existing population, and begin restoration of suitable habitat corridors connecting all of the high quality Blacklock scrub areas located generally west of the occupied habitat; in addition, at least a portion of the habitat within and surrounding the Darlingtonia fen at the south end of the park should support L. occidentale; that fen should be opened up and expanded through manual means, and if L. occidentale is not already present, the species introduced by seed and/or controlled propagation (USFWS, 2009).
- New River ACEC – The Bureau of Land Management should determine the extent of suitable habitat for Lilium occidentale within the ACEC and implement habitat restoration to include the nearby Darlingtonia fen (USFWS, 2009).
- Crescent City Marsh – CDFG should begin manual vegetation treatment within the Crescent City Marsh Wildlife Area, in a broad elevational zone surrounding the south portion of the marsh in order to restore suitable habitat at elevations above current summer high water levels (USFWS, 2009).
- General Landowner Agreements and Easements – The Service and both States should give increased focus to negotiating landowner agreements, and/or purchase of easements or fee title, in order to implement monitoring, protection and habitat restoration on all privately held populations, including in Oregon: properties under the BPA right-of-way, Webb/Sexton site, Boak Lane, Borax site, Fourmile Lane site, and in California: Hambro Industries, McMurray, Hiser and Christensen sites (USFWS, 2009).
- Coos County and Curry County Roads Departments – The Service should coordinate with these counties to facilitate roadside management along roads within suitable habitat for Lilium occidentale, which is conducive to the maintenance and spread of the species (USFWS, 2009).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS Here we provide recommendations which will aid in the recovery and conservation of western lily. The 2009 and 2019 5-year reviews provide a comprehensive list of recovery actions (Service 2009, Service 2019), which remain valid. High-priority actions that we would like to highlight in this review include: 1. Continuing Service support for habitat restoration while encouraging, where feasible, a greater effort to expand occupied sites. 2. Vegetation management and an analysis of the hydrology at the Crescent City Marsh. 3.

Development and implementation of a vegetation management and burn plan in cooperation with the California Department of Fish and Wildlife, Del Norte County, and the Del Norte County Regional Airport at Point St. George. 4. Conducting repeatable, rigorous surveys for each western lily population at least once every 3 years, to support management decisions and recovery actions. 5. Pursuing protection activities such as conservation easements and property acquisition for populations on private lands that remain threatened by agriculture or development. Section 6 Non-traditional Recovery Grants may be an option with Oregon Department of Agriculture and local land trust support. Obtaining endowment funds to cover land trust long-term expenses remains an obstacle, as does the challenge of negotiating a purchase price based on Yellow Book value (USFWS, 2024).

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SPECIES ACCOUNT: *Lilium pardalinum ssp. pitkinense* (Pitkin Marsh lily)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/21/1997; Pacific Southwest (R8)

Physical Description

An herbaceous, rhizomatous (underground stem) perennial in the lily family (Liliaceae). The slender, erect stems reach 1 to 2 m (3 to 6 ft) in height. Leaves are yellow-green, up to 14 cm (5.5 in) long, and 1 to 2 cm (0.4 to 0.8 in) wide. The leaves are generally scattered along the stem, but in some plants occur in 2 or 3 whorls of 3 to 6 leaves near the middle of the stem. The inflorescence is a terminal raceme. The flowers are large, showy, and nodding. The petals, which are reflexed from the middle, are red at the outer edge changing to yellow at the center with small, deep maroon dots mostly within the yellow zone. Anthers (pollen-bearing part of the stamen) are purple-brown. The fruit is an elliptical capsule containing many rounded seeds (CDFG 1993b). The species flowers from June to July. Lilium pardalinum ssp. pitkinense is distinguished from L. pardalinum ssp. pardalinum by generally shorter petals and anthers. (USFWS, 1997)

Taxonomy

Lawrence Beane and Albert M. Vollmer first collected Lilium pardalinum ssp. pitkinense on July 20, 1954, in Sonoma County, California. Beane (1955) described the plant as Lilium pitkinense. Mark Skinner (1993) subsequently treated the plant as a subspecies of L. pardalinum. (USFWS, 1997). - In Kartesz (1994), L. pitkinense was synonymized under L. pardalinum ssp. pardalinum. In Kartesz (1999), L. pardalinum ssp. pitkinense (Beane & Vollmer) Skinner is treated as distinct but with the combination not formally published ("comb. nov. ined."), whereas M. Skinner in Hickman (1993), Skinner and Pavlik (1994), and Best et al. (1996) treat that subspecific name as if the combination has already been formally made (as required by the International Code of Botanical Nomenclature). According to the International Plant Name Index (August 2004), the name Lilium pardalinum Kellogg subsp. pitkinense (Beane & Vollmer) M.W. Skinner was published in Novon 12(2):255 in 2002 (NatureServe, 2015). A member of the lily family (Liliaceae) (USFWS, 2009).

Historical Range

See Current Range

Current Range

In California, in southern Sonoma County. (USFWS, 2019)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual: vegetative (NatureServe, 2015); sexual (inferred from USFWS, 2009)

Lifespan

Adult: 2+ years (USFWS, 2009)

Breeding Season

Adult: June - July (USFWS, 2009)

Reproduction Narrative

Adult: This is a perennial plant. It flowers from June to July. In propagation, the species takes at least 3 years to mature into blooming plants from seed (B. Young, CNPS, pers. comm. 2009) (USFWS, 2009). It is also weakly clonal from an underground bulb (NatureServe, 2015).

Habitat Type

Adult: Wetland (NatureServe, 2015); riparian (USFWS, 2009)

Habitat Vegetation or Surface Water Classification

Adult: Freshwater marsh (NatureServe, 2015); fen, willow riparian woodland (USFWS, 2009)

Geographic or Habitat Restraints or Barriers

Adult: 115 - 200 ft. elevation (USFWS, 2009)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2009)

Habitat Narrative

Adult: This species grows only in marshy wetlands and edges of riparian areas that are 115 to 200 feet in elevation. The term "fen" is more accurate as its source of water is primarily from the ground and no bogs are found in California (Evens, in litt. 2008). Most of the occurrences in the southern marsh occur in the lower willow riparian woodland and riparian wetlands. At this locality, the species grows in soils that are seasonally saturated (Symonds, pers. Obs. 2008) (USFWS, 2009).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Declining (USFWS, 2019)

Resiliency:

Qualitatively, the Cunningham Marsh population is in low condition. Over the past 15 years, numbers at the site have fluctuated from as many as 489 to as few as 87 (Symonds in litt. 2019), and surveys show a declining trend in abundance (Service 2019a, p. 2). The number of capsules has decreased over time since more detailed data collection began in 2010 (Figure 9). Although the number of stems has remained relatively stable, the number of stems with capsules has decreased over that time period. Additionally, the number of occupied exclosures has decreased slightly since 2010. At that time there were 9 occupied exclosures, which dipped to a low of 4 from 2016 through 2019, and then increased to 8 by 2023 (USFWS, 2024a).

Representation:

The species currently has low representation, based on uncertainty regarding the conditions of the Pitkin Marsh populations and low resiliency in the Cunningham Marsh population. Low resiliency, particularly low abundance and unclear evidence of successful sexual reproduction, of the population at Cunningham Marsh, makes it less likely that the species can adapt to changing environmental conditions. Although we noted above that the Cunningham Marsh site has some variation in elevation (which could affect inundation period), it was also noted that the exclosure with the lowest elevation only contains a few plants (Gordon in litt. 2024); it is unclear if the elevation of this exclosure is related to the demographic condition of the plants within it. (USFWS, 2024a)

Redundancy:

Redundancy will always be limited for local, endemic species with a naturally limited range. Pitkin Marsh lily has three populations. Although we consider the two Pitkin Marsh populations to be extant, we acknowledge that only the Cunningham Marsh population has recently been confirmed to be extant. A catastrophic event impacting the population at Cunningham Marsh could lead to extirpation of the only protected site (or extinction in the wild, depending on the status of the Pitkin Marsh occurrences). Overall, the species currently has low redundancy. (USFWS, 2024a)

Number of Populations:

1 known, 2 others possible but status unknown (USFWS, 2019)

Population Narrative:

To date, there is a single, confirmed population of the Pitkin Marsh lily at Cunningham Marsh (CNDDB 2018). This site is on shared, private land protected by a 19-acre conservation easement held by CDFW (Baye 2005). Members of the Milo Baker chapter of CNPS have been stewards of the conservation easement for over 25 years (B. Young, in litt. 2018). The two other occurrences are documented on two parcels of private land several miles north of Cunningham Marsh. Access for botanical surveys have been denied at these northern properties since the 1980s and it is unknown if these populations are still extant (CNDDB 2018). (USFWS, 2019)

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Loss and disturbance of habitat from proposed residential development and changes in hydrology is a current threat. The northern marsh has become drier due to the addition of wells and other construction (B. Guggolz, in litt. 1993). Drying of the wetland also encourages the spread of blackberries (Rubus sp.), which have become dominant in other parts of the marsh that

have been drained (DFG 1993; B. Guggolz, in litt. 1993; CNDDB 1996) (USFWS, 2009).

Stressor: Collection (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The northern marsh occurrence was nearly extirpated from uncontrolled collection for horticultural uses in the early 1980s. Because of the past practices of collecting lilies for propagation for horticultural uses, material from Pitkin lilies and hybrids with other Lilium pardalinum species in the nursery trade is unsuitable for conservation purposes. Such material is unsuitable for conserving the wild strains because of the potential for genetic impurity through introgression with other lily species (USFWS, 2009).

Stressor: Nonnative plants (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Invasive, nonnative blackberries and grasses as well as native willow have encroached into the habitat of the species and appear to be increasing in density in recent years (Cooley, pers. Comm. 2008) (USFWS, 2009).

Stressor: Stochastic vegetation (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The habitat for this species is extremely limited and isolated throughout its range. Losses from residential and agricultural uses have further contributed to the fragmentation and isolation of occurrences. Such occurrences may be highly susceptible to extirpation die to inbreeding depression (Gilpin and Soule 1988; Gooman 1987), the potential for catastrophic wildlife with drier march conditions, and the potential for further displacement from introduction of previously unknown invasive vegetation (USFWS, 2009).

Stressor: Hybridization (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: An apparently natural hybrid of Lilium pardalinum and L. maritimum has been observed (Schwan, in litt. 2008; Skinner, in litt. 2008). The potential exists for horticultural varieties to be planted within the range of the wild populations (USFWS, 2009).

Stressor: Changing hydrology and climate (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: The Pitkin Marsh lily is threatened by changing hydrology and climate in the region (USFWS 2009). Significant declines in Pitkin Marsh lily abundance appear to be somewhat correlated with reductions in early winter rainfall (K. Symonds, in litt. 2018a). The Pitkin Marsh lily thrive best when they are seasonally inundated by water (K. Symonds, pers. comm. 2018) and

changes in hydrology appear to be affecting the community structure at Cunningham Marsh. There are several large pines (Pinus spp.) and oaks (Quercus spp.), which beneficially shade the understory of the marsh (Baye 2005). In recent years, several of these large trees have fallen, possibly due to low soil-moisture in the summer (K. Symonds, pers. comm. 2018). Falling trees could present a potential threat to the remaining Pitkin Marsh lilies; trunks and branches could physically crush individual plants. Additionally, opening the canopy and exposing the lilies to direct sunlight could prove fatal as well, as lilies seem to thrive in shade (K. Symonds, pers. comm. 2018). Additionally, if falling trees break exclosure fencing, the threat from deer browsing would increase. (USFWS, 2019)

Stressor: Random events (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: Due to its extremely narrow range and specific habitat requirements, the Pitkin Marsh lily is susceptible to random, environmental effects such as tree felling, fire, changes in climate, etc. Although many threats remain the same, others have intensified since they were last assessed (USFWS 2009). However, our understanding of the major threats influencing the viability of the Pitkin Marsh lily has not changed dramatically since the previous status review (USFWS 2009). (USFWS, 2019)

Stressor: Small mammal browsing (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: During the 2009 five-year review for the species, browsing by ungulates and urban development were no longer considered threats acting on the species, as all known, remaining individuals were protected by fenced exclosures at Cunningham Marsh. However, the implementation of conservation measures and the amount of available funding have lapsed for the Cunningham Marsh site since 2009, and it is possible that ungulate browsing at this location could occur if fencing is not maintained and/or the species occurs outside of the exclosures. Recent abundance surveys have seen herbivory on lilies increase within exclosures (K. Symonds, pers. comm. 2018) as evidenced by the increase of stems without seed capsules (Appendix C). The fences protecting lily populations are composed of large-gauge wire mesh. Rabbits or small rodents can access the exclosed area through the mesh or by burrowing underneath it, and are likely the cause of increased browsing (K. Symonds, pers. comm. 2018). The CNPS in Sacramento, California, has applied for a grant to install small-mesh fencing on the exclosures at Cunningham Marsh (B. Young, in litt 2018). Until this happens, small-mammal browsing remains a significant threat to the viability of the Pitkin Marsh lily (USFWS, 2019).

Stressor: Climate Change (USFWS, 2024a)
Exposure:
Response:
Consequence:
Narrative: Climate change is described as a potential threat in the previous two status reviews and will likely be an ongoing threat to the species (Service 2009, p. 22; Service 2019a, p. 2). 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). Climate models for the Bay Area of California, including Sonoma County, predict overall warming under various emissions scenarios of 1.8 to 2.4 degrees Celsius (3.3 to 4.4 degrees Fahrenheit) from 2040 to 2069, and 2.3 to 4.0 degrees Celsius (4.2 to 7.2 degrees Fahrenheit) from 2070 to 2100 (Ackerly et al. 2018, p. 14). Because these are predictions for mean warming, the expected high temperatures will likely rise even higher (Ackerly et al. 2018, p. 13). Climate change is also associated with changes in precipitation. Precipitation extremes are expected to increase, as evidenced by a prediction for higher frequency of both extremely wet and extremely dry years (Ackerly et al. 2018, pp. 17–20; Swain et al. 2018, pp. 427–433). Hotter temperatures are expected to increase the probability of drought in California whether or not average precipitation increases or decreases (USFWS, 2024a)

Recovery

Reclassification Criteria:
Recovery Priority Number: 6C

1. Occupied habitat includes at least three self-sustaining populations of Pitkin Marsh lily, with at least one population in either Pitkin or Cunningham Marshes. This total may include any of the three known occurrences, any newly discovered populations, or outplanted populations within the wetlands of Sonoma County. For the purposes of this recovery plan, populations shall be considered separate if they are separated by at least 0.25 mile (0.4 kilometer; km). (USFWS, 2025)

2. Each population described in downlisting criteria 1 has an average of at least 1,000 flowering stems within a minimum occupied area of 0.4 acre over a 10-year period of demographic monitoring (USFWS, 2025).

3. The occupied land inhabited by the populations in downlisting criterion 1 is protected via a conservation easement, deed restriction, by sale of fee title to a conservation organization, through a Memorandum of Understanding with the Service, or other durable agreement (USFWS, 2025)

4. Each of the three populations described in downlisting criterion 1 are being managed in a way, currently and into the future, that will support continued existence of Pitkin Marsh lily and its habitat, including management of non-native plant species and protection from herbivory (USFWS, 2025).

Delisting Criteria:
1. Occupied habitat includes at least four self-sustaining populations of Pitkin Marsh lily, with at least one population in either Pitkin or Cunningham Marshes. This total may include the three known occurrences, any newly discovered populations, or outplanted populations within the wetlands of Sonoma County. For the purposes of this recovery plan, populations shall be considered separate if they are separated by at least 0.25 mile (0.4 km). (USFWS, 2025)

2. Each population described in delisting criterion 1 has an average of at least 1,000 flowering stems within a minimum occupied area of 0.4 acre over a 10-year period of demographic monitoring. (USFWS, 2025)

3. The number of seed capsules in each population exhibits a stable or increasing trend throughout the monitoring period described in delisting criterion 2. (USFWS, 2025)

4. All occupied habitat of the populations in delisting criterion 1 is protected via a conservation easement, deed restriction, by sale of fee title to a conservation organization, through a Memorandum of Understanding with the Service, or other durable agreement. (USFWS, 2025)

5. Each of the four populations described in delisting criterion 1 is being managed in a way, currently and into the future, that will support continued existence of Pitkin Marsh lily and its habitat, including management of non-native plant species and protection from herbivory. (USFWS, 2025)

6. Seeds, representative of the breadth of the species' genetic diversity, are stored in a facility that maintains certification from the Center for Plant Conservation. Stored seeds are replenished every ten years in order to ensure seed viability, unless storage techniques and/or research show otherwise (USFWS, 2025)

Recovery Actions:

- Not available - this species does not have a recovery plan.
- Increase the size of existing protected habitat through conservation easement or, preferable, fee-title acquisition. Manage these properties to protect and enhance the habitat for and the occurrences of this species and other historically co-occurring rare and unique plant taxa. (USFWS, 2009)
- Evaluate the genetic status of the species to determine the validity or reaffirm the uniqueness of this taxon (USFWS, 2009).
- Prepare and publish a draft recovery plan and ultimately finalize the recovery plan for the species (USFWS, 2009).
- Work with willing landowners in or near historical occurrences to develop access agreements to conduct surveys, monitoring, and habitat enhancements, and provide them assistance to minimize their indirect land use impacts on occupied habitat (USFWS, 2009).
- Monitor and continue adaptive management of existing protected areas to control invasive vegetation, address excess sediment and nutrients in the marshes, and encourage growth of listed species and co-occurring rare plant taxa within their historical occurrences (USFWS, 2009).
- Continue to maintain viable, protected seed collection. Ensure sufficient seeds exist, preferably in more than one repository, to maintain genetic heterogeneity. For long term preservation of genetic diversity, and given L. pardalinum is a clonal perennial that regenerates from bulb scales, consideration should be given to having a clone bank as a supplement or alternative to seed storage. A clone bank would be a low-maintenance partial shade garden derived from either seed or bulb scales of the original occurrence (USFWS, 2009).
- Manage invasive species. Invasive, non-native plants currently grow in the exclosures protecting the Pitkin Marsh lily (K. Symonds, pers. comm. 2018). Himalayan blackberry (Rubus armeniacus) and velvet grass (Holcus lanthus) grow densely, outcompeting the Pitkin Marsh lily for light and space (Baye 2005). Continuous management of both species will allow Pitkin Marsh lily numbers to rebound. (USFWS, 2019)

- Propagation and out-planting. Pitkin Marsh lilies mature after three growing seasons (Baye 2005). In 2009, mature plants were out-planted in exclosures at Cunningham Marsh. Today, only a few of the out-plantings survive. More propagation effo1is would increase our ability to establish Pitkin Marsh lilies at additional locations and to supplement extant colonies. These techniques might be essential to ensure the long-term viability of the species. (USFWS, 2019)
- Maintenance and construction of browsing exclosures. There are cmTently 10 exclosures protecting Pitkin Marsh lily colonies from browsing by ungulates. However, many do not appear to contain Pitkin Marsh lilies any longer. Moving these structures, and/or establishing new ones along with refined propagation and out-planting techniques might be needed to establish new colonies and/or populations, which would increase redundancy for this species. (USFWS, 2019)
- Installation of small-mesh fencing. In recent years, browsing by small-mammals within exclosures has significantly decreased the number of reproducing Pitkin Marsh lilies (K. Symonds, pers. comm. 2018; Appendix B). The California Native Plant Society has applied for a grant to install small-mesh fencing, which would protect Pitkin Marsh lilies from browsing. This action could significantly increase the viability of the Pitkin Marsh lily in the near-future. (USFWS, 2019)
- 1. Protect extant populations and newly established or identified populations of Pitkin Marsh lily via a conservation easement, deed restriction, by sale of fee title to a conservation organization, through a Memorandum of Understanding with the Service, or other durable agreement (Priority 1). (USFWS, 2025)
- 2. Manage habitat that supports the species to reduce or eliminate threats throughout the range, including control of competitive native and non-native vegetation, and supplemental seeding or planting (Priority 1) (USFWS, 2025)
- 3. Monitor all known populations of Pitkin Marsh lily and ensure that the monitoring protocol informs management of the taxon and allows us to accurately assess population trends (Priority 2) (USFWS, 2025)
- 4. Conduct a genetic study to describe the genetic make-up and confirm taxonomic identity of the Cunningham Marsh population and any living collections at botanic gardens. Use this information to ensure that any seeds or bulbs to be used to establish new populations or augment existing populations are genetically appropriate (Priority 2). (USFWS, 2025)
- 5. Outplant seeds, seedlings, or bulbs to establish additional populations in appropriate habitat within the wetlands of Sonoma County (Priority 2). (USFWS, 2025)
- 6. Collect seeds from all populations and store in certified facilities. A subset of seed may be withheld and planted to establish additional populations (Priority 2). (USFWS, 2025)
- 7. Conduct experimental research to inform management actions that further Pitkin Marsh lily recovery. Examples include those that examine Pitkin Marsh lily habitat needs, propagation and germination techniques, and how to effectively use grazing for long-term vegetation management (Priority 3). (USFWS, 2025)
- Action 1. Protect extant populations and newly established or identified populations of Pitkin Marsh lily via a conservation easement, deed restriction, by sale of fee title to a conservation organization, through a Memorandum of Understanding with the Service, or other durable agreement (Priority 1). Activities 1-1 Conduct outreach to private landowners with Pitkin Marsh occurrences on their properties, and potentially willing partners with existing easements and/or other private landowners with suitable habitat in the vicinity of Pitkin/Cunningham Marshes, in regard to protection of the Pitkin Marsh lily populations; 1-2

Protect habitat supporting existing populations of Pitkin Marsh lily and habitat immediately surrounding these populations on private lands in Pitkin Marsh via land acquisition or conservation easement (from willing sellers), or other methods; 1-3 Protect habitat supporting newly identified or outplanted populations in Pitkin Marsh, Cunningham Marsh, or within the wetlands of Sonoma County via land acquisition or conservation easement (from willing sellers), or other methods. (USFWS, 2024)

- Action 2. Manage habitat that supports the species to reduce or eliminate threats throughout the range, including control of competitive native and non-native vegetation, and supplemental seeding or planting (Priority 1). Activities 2-1 Continue management of the Cunningham Marsh population; 2-2 Establish and maintain regular contact with landowners supporting Pitkin Marsh lily populations to determine population status, and discuss habitat management practices, monitoring, and protection of the respective populations; 2-3 Develop and implement site-specific management plans for habitat protected through Action 1; 2-4 Secure monetary commitments to ensure management plans are feasible into the future; 2-5 Evaluate management activities periodically and make adjustments as necessary to maximize the potential for survival, conservation, and recovery of Pitkin Marsh lily (i.e., adaptive management). (USFWS, 2024)
- Action 3. Monitor all known populations of Pitkin Marsh lily and ensure that the monitoring protocol informs management of the taxon and allows us to accurately assess population trends (Priority 2). Activities 3-1 Develop a monitoring protocol of both quantitative and qualitative methods that enables evaluation of long-term population trends and changes in distribution over time; update protocol over time as needed; 3-2 Monitor all populations, including the Cunningham Marsh population and those on lands protected through Action 1, and on private lands for which the landowner has allowed access, in accordance with the monitoring plan. (USFWS, 2024)
- Action 4. Conduct a genetic study to describe the genetic make-up and confirm taxonomic identity of the Cunningham Marsh population and any living collections at botanic gardens. Use this information to ensure that any seeds or bulbs to be used to establish new populations or augment existing populations are genetically appropriate (Priority 2). Activities 4-1 Collect samples from all known Pitkin Marsh lily plants, including wild plants in Cunningham Marsh, any plants growing in living collections at botanic gardens, and all voucher specimens; 4-2 Conduct a genetic study investigating the taxonomic status of all known Pitkin Marsh lily plants and voucher specimens. (USFWS, 2024)
- Action 5. Outplant seeds, seedlings, or bulbs to establish additional populations in appropriate habitat within the wetlands of Sonoma County (Priority 2). Activities 5-1 Identify property within the historical range where suitable habitat and compatible land use still exists, for potential establishment of new populations; 5-2 Develop a propagation and outplanting plan compliant with the Service's propagation policy (Service 2000, pp. 56916–56922) and the International Union for Conservation of Nature's (IUCN's) Guidelines for Reintroductions and Other Conservation Translocations (IUCN 2013, entire); include methods for improving climate change resilience and addressing any genetics concerns; update manual over time as needed; 5-3 Acquire permits for seed multiplication and outplanting; 5-4 Using seeds from Activity 6-1, establish greenhouse populations in order to conduct seed multiplication to maintain a fresh supply of seed for introduction efforts; 5-5 Introduce Pitkin Marsh lily within protected habitat. (USFWS, 2024)
- Action 6. Collect seeds from all populations and store in certified facilities. A subset of seed may be withheld and planted to establish additional populations (Priority 2). Activities 6-1 In years of high seed set, collect and bank seeds from all naturally occurring populations.

(USFWS, 2024)

- Action 7. Conduct experimental research to inform management actions that further Pitkin Marsh lily recovery. Examples include those that examine Pitkin Marsh lily habitat needs, propagation and germination techniques, and how to effectively use grazing for long-term vegetation management (Priority 3). Activities 7-1 Perform investigations into Pitkin Marsh lily life history and ecology, including what conditions encourage seed production and seed germination; habitat requirements and environmental tolerances, including response to precipitation extremes and soil with varying properties; seed bank dynamics; and response to environmental disturbance, including grazing; 7-2 Evaluate new information about Pitkin Marsh lily environmental tolerances in consideration of available downscaled climate models. (USFWS, 2024)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS • Conduct genetic analyses to better understand the species' taxonomy. Further genetic analyses may help resolve Pitkin Marsh lily's relationship with other Lilium pardalinum subspecies and potential hybrid origin. Additionally, specific studies of population genetics at Pitkin Marsh lily sites and of lilies in Lower Pitkin Marsh would help confirm the species genetic diversity, abundance, and distribution. • Encourage conservation and coordination between private landowners to gain access to the Pitkin Marsh populations and conduct coordinated surveys. Gaining access to the private lands where no surveying and monitoring has occurred will provide more information on the species. It is also possible that there are additional populations that exist on private properties that we are currently unaware of, and that with outreach and/or community awareness, willing landowners may come forward that are aware of the plants' existence. • Continue surveys of the Cunningham Marsh population. Continued surveys of the Cunningham Marsh population will assist with assessing status and trends for the species. Additional population data will help inform strategies to preserve and enhance populations. • Continue management at Cunningham Marsh through coordination with partners including the Plant Society and the Laguna Foundation. Continued management at Cunningham Marsh, including fencing repair when necessary and removal of non-native plant species, is necessary to maintain and increase resiliency of this population. • Collect and maintain a viable, protected seed collection from all populations and conduct seed germination tests on previously collected seeds. Pitkin Marsh lily seeds are currently stored at Rae Selling Berry Seed Bank, the California Botanic Garden, and the University of California Botanical Garden, which were collected in 1990, 2016, and 2019, respectively. Collecting a suitable seed bank can contribute to recovery strategies, such as outplanting to supplement existing populations or to establish new populations. • Using the results of the genetic analysis described above, develop a propagation and outplanting plan for Pitkin Marsh lily. Begin outplanting Pitkin Marsh lilies to establish additional populations within the historical range of the species and augment existing populations. Implement monitoring and management to ensure these populations become established to increase ecological representation. • Continue efforts to control and contain Phytophthora to limit the spread of the pathogen within and outside of Pitkin Marsh. In addition, research on more effective treatment options and control techniques is needed (USFWS, 2024).

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SPECIES ACCOUNT: *Neostapfia colusana* (Colusa grass)

Species Taxonomic and Listing Information

Listing Status: Threatened; 03/26/1997; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

The aquatic seedlings of N. colusana have only one or two juvenile leaves (Keeley 1998). The terrestrial stage consists of multiple stems arising in clumps from a common root system. The stems are decumbent and have a characteristic zigzag growth form (Crampton 1976). Overall stem length ranges from 10 to 30 cm (3.9 to 11.8 in). The entire plant is pale green when young (Davy 1898), but becomes brownish as the exudate darkens (Reeder 1982, Reeder 1993). Leaf length is 5 to 10 cm (2.0 to 3.9 in) (Hitchcock and Chase 1971). Each stem produces one dense, cylindrical inflorescence that is 2 to 8 cm (0.8 to 3.1 in) long and 8 to 12 mm (0.31 to 0.47 in) broad. Within the inflorescence, the spikelets are densely packed in a spiral arrangement; the tip of the rachis projects beyond the spikelets. (USFWS, 2005)

Taxonomy

Davy (1898) first described Colusa grass, giving it the Latin name Stapfia colusana. Davy soon realized that the name Stapfia had already been assigned to a genus of green algae and therefore changed the scientific name of Colusa grass to Neostapfia colusana (Davy 1899). The name Anthochloa colusana was used for decades after Scribner (1899) published the combination in the mistaken belief that Colusa grass was closely related to a South American species of that genus. However, Hoover (1940) evaluated the many differences between Anthochloa and Neostapfia and concluded that the latter should be considered a distinct genus. Since that time, the accepted name for Colusa grass has been Neostapfia colusana. No other species of Neostapfia are known (Reeder 1982, Reeder 1993). (USFWS, 2005)

Historical Range

In the 50 years after its initial discovery (Davy 1898), Neostapfia colusana was reported from only three sites other than the type locality; these sites were in Merced and Stanislaus Counties. By 1989, 51 occurrences were known, but 11 of those had already been extirpated (Stone et al. 1988, California Natural Diversity Data Base 2003). Through November 2003, the California Natural Diversity Data Base (2003) included 60 reported occurrences of N. colusana in Colusa, Merced, Solano, Stanislaus. and Yolo Counties. Five each were reported from the San Joaquin Valley and Solano-Colusa Vernal Pool Regions, and the remainder were from the Southern Sierra Foothills Vernal Pool Region. (USFWS, 2005)

Current Range

Currently, no more than 42 occurrences of Neostapfia colusana remain extant (Hogle 2002, California Natural Diversity Data Base 2005). At least one population remains in each of the vernal pool regions from which N. colusana was known historically. The majority of extant occurrences are in the Southern Sierra Foothills Vernal Pool Region, where they are concentrated northeast of the City of Merced in Merced County and east of Hickman in Stanislaus County. One or two occurrences remain in central Merced County, which is part of the San Joaquin Valley Vernal Pool Region. Four occurrences are extant in the Solano-Colusa Vernal Pool Region, with two each in southeastern Yolo and central Solano Counties (Stone et al. 1988, Keeler-Wolf et al. 1998, California Natural Diversity Data Base 2003). This species has apparently been extirpated from Colusa County (California Natural Diversity Data Base 2005). (USFWS, 2005)

Critical Habitat Designated

Yes; 8/11/2005.

Legal Description

On August 11, 2005, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Neostapfia colusana (Colusa grass) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes five critical habitat units (CHUs), in California (70 FR 46924-46999; 71 FR 7118-7316).

Critical Habitat Designation

The critical habitat designation for Neostapfia colusana includes five CHUs in Mariposa, Merced, Stanislaus, Tuolumne, and Yolo Counties, California. This species critical habitat encompasses approximately 152,093 acres (ac) (61,550 hectares (ha)) (70 FR 46924-46999; 71 FR 7118-7316).

Unit 1: Yolo County, California. From USGS 1:24,000 topographic quadrangles Davis and Saxon

Unit 4: Tuolumne and Stanislaus Counties, California.

Unit 5: Stanislaus County, California

Unit 6: Merced and Mariposa Counties, California. From USGS 1:24,000 topographic quadrangles Winton, Yosemite Lake, Snelling, Merced Falls, Haystack Mtn., Indian Gulch.

Unit 7A: Merced County, California. From USGS 1:24,000 topographic quad Sandy Mush and El Nido.

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 critical habitat for N. colusana are the habitat components that provide (70 FR 46924-46999; 71 FR 7118-7316):

(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

Critical habitat does not include manmade structures (such as buildings, aqueducts, airports, roads, and other paved areas) and the land on which they are located existing on the effective date of this rule and not containing one or more of the primary constituent elements.

Life History

Food/Nutrient Resources

Lifespan

Adult: 1 year (USFWS, 2008)

Breeding Season

Adult: May (USFWS, 2005)

Reproduction Narrative

Adult: Colusa grass is an annual plant in the grass family (Poaceae) and is in the Orcuttieae taxonomic tribe. Flowering individuals of N. colusana have been collected as early as May throughout the range of the species (California Natural Diversity Data Base 2005). (USFWS, 2005; USFWS, 2008)

Habitat Type

Adult: Riverine, palustrine, and terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Riverine- spring/spring brook; Palustrine- herbaceous wetland and temporary pools; Terrestrial- grassland/herbaceous, playa/salt flat (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Long periods inundated with water (USFWS, 2005)

Geographic or Habitat Restraints or Barriers

Adult: Requires water inundation for seed germination; restricted to temporary pools, springs, or playas; found at elevations between 5 and 105 m (USFWS, 2005)

Environmental Specificity

Adult: Moderate (USFWS, 2005)

Habitat Narrative

Adult: Neostapfia colusana has the broadest ecological range among the Orcuttieae. It occurs on the rim of alkaline basins in the Sacramento and San Joaquin Valleys, as well as on acidic soils of alluvial fans and stream terraces along the eastern margin of the San Joaquin Valley and into the adjacent foothills (Stone et al. 1988). Elevations range from 5 meters (18 feet) to about 105 meters (350 feet) at known sites (California Natural Diversity Data Base 2005). Neostapfia colusana has been found in Northern Claypan and Northern Hardpan vernal pool types (Sawyer and Keeler-Wolf 1995) within rolling grasslands (Crampton 1959). It grows in pools ranging from 0.01 to 250 hectares (0.02 to 617.5 acres), with a median size of 0.2 hectare (0.5 acre), and also occurs in the beds of intermittent streams and in artificial ponds (Stone et al. 1988, K. Fuller pers. comm. 1997, EIP Associates 1999). This species typically grows in the deepest portion of the pool or stream bed (Crampton 1959, Stone et al. 1988), but may also occur on the margins (Hoover 1937, Stone et al. 1988). It appears that deeper pools and stock ponds are most likely to provide the long inundation period required for germination (EIP Associates 1999). Several soil series are represented throughout the range of Neostapfia colusana. In the Solano-Colusa Vernal Pool Region, N. colusana grows on clay, silty clay, or silty clay loam soils in the Marvin, Pescadero, and Willows series. In the San Joaquin Valley Vernal Pool Region, soils are clay or silty clay loam in the Landlow and Lewis series (J. Silveira in litt. 2000). Neostapfia colusana habitat in the Southern Sierra Foothills Vernal Pool Region includes many soil series with textures ranging from clay to gravelly loam. The type and composition of impermeable layers underlying occupied vernal pools also varies, ranging from claypan to lime-silica or iron-silica cemented hardpan and tuffaceous alluvium (Stone et al. 1988). Neostapfia colusana usually grows in single-species stands, rather than intermixed with other plants. (USFWS, 2005)

Dispersal/Migration

Dispersal

Adult: Moderate (USFWS, 2005)

Dispersal/Migration Narrative

Adult: All are wind-pollinated, but pollen probably is not carried long distances between populations (Griggs 1980, Griggs and Jain 1983). Local seed (i.e., caryopsis) dispersal is by water, which breaks up the inflorescences (Reeder 1965, Crampton 1976, Griggs 1980, Griggs 1981). Long-distance dispersal is unlikely (U.S. Fish and Wildlife Service 1985a), but seed may have been carried occasionally by waterfowl (family Anatidae), tule elk (Cervus elaphus nannoides), or pronghorn (Antilocapra americana) in historical times (Griggs 1980). (USFWS, 2005)

Population Information and Trends

Population Trends:

Decline of 30 to 70% (NatureServe, 2015)

Number of Populations:

45 (USFWS, 2024)

Population Size:

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

Population Narrative:

Of the total 61 occurrences ever recorded, 23% (14 occurrences) are currently considered historical and 13% (8 occurrences) are considered extirpated. There are currently 43 presumed extant occurrences. Long-term population trends suggest a decline of 30-70%. The plant is an annual so population sizes can vary widely from year to year, sometimes over several orders of magnitude. (NatureServe, 2015). At the time of listing in 1997, Colusa grass had become fully extirpated from Colusa County and 40 occurrences remained extant in Yolo, Solano, Merced, and Stanislaus counties (Service 1997, p. 14339; Table 1). By 2008, when the previous 5-year review was conducted, the number of known extant occurrences reported in the Diversity Database had slightly increased to 43 occurrences, but the species had been extirpated from the Turlock core area (Service 2008, pp. 9, 14). Currently, there are 45 presumed extant occurrences of Colusa grass distributed across the same four counties (Yolo, Solano, Merced, and Stanislaus) (Diversity Database 2023; Figure 1; Table 1). The most recent documented visits to known occurrences of Colusa grass occurred in 2023 and Colusa grass has been confirmed at 12 occurrences since 2017. Overall, there have been seven new occurrences (occurrence # 72–78) added to the Diversity Database (2023) since 2008. These new occurrences are within the known extent of the species range and are located in proximity to previously known occurrences. Three occurrences (occurrence #15, #40, and #51) that were listed as extirpated or presumed extirpated in 2008 are now listed as extant due to detections during recent site visits. Seven additional occurrences (occurrence #11, #20, #47, #56, #57, #64, and #65) are now listed as extirpated in the Diversity Database, of which six have been extirpated due to habitat conversion to crop fields based on satellite imagery (Diversity Database 2023). Details of all presumed extant occurrences and recently extirpated occurrences are summarized in Appendix A. (USFWS, 2024)

Threats and Stressors

Stressor: Habitat loss and degradation (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: The 1997 listing rule determined that habitat loss and degradation due to urbanization, agricultural land conversion, livestock grazing, off-highway vehicle use, altered hydrology, and competition from weedy non-native plants imperiled the continued existence of this species (62 FR 14338). Habitat loss and degradation is still the primary threat to Colusa grass. Eighty-five percent of known Colusa grass occurrences are on Private land and are not protected (CNDDB 2008). The largest continuing threat to this species is agricultural conversion, especially in Stanislaus County, where 14 extant occurrences are known to occur (33 percent of the total extant occurrences) (CNDDB 2008). (USFWS, 2008)

Stressor: Predation (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: In regard to predation, the 1997 final rule states that livestock grazing and associated trampling may or may not adversely affect vernal pool plants depending on, among other things, the kind of livestock, stocking level, season of use, and grazing duration. One or two sites containing Colusa grass have been reported as threatened by foraging by grasshopper outbreaks (Stone et al. 1988). The magnitude of this threat is unknown at this time. (USFWS, 2008)

Stressor: Urbanization (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Urbanization is the second greatest threat, especially at the proposed University of California campus and associated community development in eastern Merced County. Four occurrences in the vicinity of the proposed campus are expected be developed within the next 15 years and two others are within the general "planning area" (EIP Associates 1999). Proposed construction of a new prison and a landfill also threaten other specific occurrences in Merced

County (Service 1997). Recent inundation by poultry manure is a threat to the occurrence at the Arena Plains parcel within the Merced NWR (D. Woolington, Service, personal communication, 2006). (USFWS, 2008)

Stressor: Drought and climate change (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Colusa grass is dependent upon vernal pool wetlands, which signifies the importance of water availability on the survival and recovery for this species. Drought conditions will place additional strains on vernal pool ecosystems. Where occurrences persist on only marginal habitat, the addition of drought conditions is likely to result in high rates of mortality in the short term with the effects of low reproductive output and survivorship persisting after the drought has ceased. It is unknown how quickly Colusa grass occurrences may rebound after severe climatic conditions. Climate is predicted to change in California within the 21st century (Cayan et al. 2005, Field et al. 1999). Even modest changes in warming could result in a reduction of the spring snowpack, earlier snowmelt, 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 the Colusa grass 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, 2008)

Stressor: Small, isolated populations (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Occurrences of this species can vary greatly from year to year, with some extant occurrences not appearing during certain years based on climatic conditions (Service 2005). Habitat for Colusa grass continues to be highly fragmented throughout its range due to conversion of natural habitat for urban and agricultural uses. This fragmentation results in small isolated occurrences of this species. Such occurrences may be highly susceptible to extirpation due to chance events, inbreeding depression, or additional environmental disturbance (Gilpin and Soule 1988; Goodman 1987). If an extirpation event occurs in a occurrence that has been fragmented, the opportunities for recolonization will be greatly reduced due to physical isolation from other source occurrences. (USFWS, 2008)

Stressor: Pesticides (USFWS, 2024)
Exposure:
Response:
Consequence:
Narrative: Research over the last 20 years has shown that contaminants may threaten vernal pool ecosystems and pose a significant risk to threatened and endangered vernal pool species within the agricultural matrix of the Central Valley (Johnson 2006, p. 11). Pesticides from agricultural runoff, drift, precipitation, and/or aerial deposition can contaminate vernal pools. Due to the ephemeral nature of vernal pools, contaminants may concentrate in vernal pools during the drydown phase, potentially exacerbating the ecological impacts of these contaminants (Cahill et al. 2001, p. 822). Modeling of pesticide concentrations in vernal pool habitats in Merced County within the San Joaquin Valley of California shows that vernal pools are under a high risk of

pesticide inputs via agricultural runoff from the surrounding landscape (Sinnathamby et al. 2020, p. 9). The actual concentrations of pesticides in vernal pools are not well-known because of the difficulty of accurately sampling these highly seasonal habitats. However, higher concentrations are typically observed in pools directly adjacent to agricultural lands. A study of vernal pools and streams found that atrazine and glyphosate (both herbicides) are detected in concentrations above the freshwater aquatic life standard even when the vernal pools themselves were located on protected lands (Battaglin et al. 2009, p. 301). It is unknown the extent to which pesticides (including insecticides, herbicides, and fungicides) may affect Colusa grass, but best management practices for weed control state that “if endangered grasses such as Sacramento Orcutt grass (Orcuttia viscida) are also present, a grass-specific herbicide should never be used” and to avoid broadcast application of glyphosate to control invasive plants in vernal pools (DiTomaso and Kyser 2013, p. 2, Waxy Mannagrass section). There is also evidence that fungicides may inhibit germination of Orcuttia seeds, as demonstrated by Keeley (1988, p. 1088), which indicated that fungicide inhibited germination of California Orcutt grass (O. californica) seeds but did not affect Greene’s tuctoria (Tuctoria greenei) seeds. Detailed germination studies have not been conducted for Colusa grass. 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 Colusa grass is poorly understood. Grasses within the Orcuttieae tribe are thought to be primarily wind pollinated; however, some insect pollination may occur, including by native bees (Halictidae sp.), which have been observed gathering pollen from other species in the Orcuttieae tribe including Sacramento Orcutt grass and hairy Orcutt grass (Orcuttia pilosa; Griggs 1974, as cited in Stone et al. 1988, p. 16). The Agency’s final biological evaluations determined that all three pesticides are highly toxic to invertebrate pollinators including bees, have the potential to result in bee brood and colony reductions, and if affected bee colony declines are near Colusa grass, 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 Section 7 consultation with the Agency is currently pending. (USFWS, 2024)

Stressor: Climate change (USFWS, 2024)
Exposure:
Response:
Consequence:
Narrative: California’s Fourth Climate Change Assessment was published in 2018 (Thorne et al. 2018, entire) and has included subsequent regional reports focused on the different regions of California, including the Sacramento Valley and San Joaquin Valley (Fernandez-Bou et al. 2021, entire; Houlton and Lund 2018, entire). These regions of California encompass the core range of the Colusa grass and are expected to experience significant impacts from climate change. In both regions, the projected annual average temperature is expected to increase by the end of the century under both of the considered emission scenarios (RCP 4.5 and RCP 8.5) (Fernandez-Bou et al. 2021, p. 19; Houlton and Lund 2018, p. 18). In addition, models of projected future precipitation in both regions show a similar trend towards fewer but more intense precipitation events each year (Fernandez-Bou et al. 2021, p. 8; Houlton and Lund 2018, p. 6). Natural wetlands may experience extended periods of drought, floods, increased water temperatures,

and higher evaporation rates (Fernandez-Bou et al. 2021, p. 10). Wetlands (including vernal pools) are expected to be more sensitive to climate change because precipitation is often their main water source (Winter 2000, p. 307), so alterations to precipitation regimes are likely to disproportionally affect these ecosystems. Pyke (2004, pp. 3– 4) reported that climate change and reduced frequency of suitable habitat might represent the greatest threat to vernal pool species. Modeling of vernal pool hydrology and plant community composition in northern California show that vernal pools will have shorter inundation times with little change in maximum depth under projections of altered climate change conditions (Montrone et al. 2019, p. 1010). However, this model was developed based on data from an isolated, snow-fed pool in the Modoc Plateau Vernal Pool Region, so the results may not be directly applicable to rain-fed pools throughout most of California (Montrone et al. 2019, p. 6). Vernal pool specialists are highly sensitive to inundation time, so shortened inundation time due to climate change is expected to cause declines in the number of vernal pool specialist species. While extended periods of drought are not expected to reduce seed bank viability (C. Witham, Biological Consultant, pers. comm. 2022), variation in annual weather exacerbated by climate change can contribute to changes in vernal pool plant abundance and community composition, often allowing invasion by non-native exotic species that can competitively exclude sensitive vernal pool species (Javornik and Collinge 2016, p. 66). For this reason, threatened or endangered vernal pool obligate plant species, such as Colusa grass, may experience increased risk from environmental and ecological changes from climate change (Bauder 2005, p. 2134). (USFWS, 2024)

Stressor: Habitat Loss (USFWS, 2024)
Exposure:
Response:
Consequence:
Narrative: The 1997 listing rule described Colusa grass habitat as having been reduced and fragmented throughout its historical range (Service 1997, pp. 14346–14347) and the Recovery Plan lists habitat loss and fragmentation as the primary threat to survival and recovery of this species (Service 2005, p. I–16). Primary causes attributed to the reduction and fragmentation of habitat include agricultural land conversion and urbanization (Service 2008, p. 15). Between the listing of the species in 1997 and the development of the Recovery Plan in 2005, approximately 36,068 acres (7.7% of mapped extent) of vernal pool habitat within the current range of the species (Stanislaus, Merced, Solano, and Yolo Counties) were converted to urban or agricultural land uses (Holland 2009, p. 8). Updated mapping of vernal pool habitat across California's Central Valley shows a net loss of 70,482 acres between 2005 and 2018, or approximately 5,848 acres per year of natural vernal pool habitat converted to other land uses (Witham 2021, p. 5). Most of this habitat loss is from conversion to agriculture, specifically the conversion to orchards, which total 56.6% of mapped acres lost (Witham 2021, p. 1). By contrast, habitat loss to urban or industrial development total 6.65% of mapped acres lost (Witham 2021, p. 1). Currently, no vernal pool habitat remains in the Waterford core area (Witham 2021, geodatabase). Potential future urban development includes the California Forever proposed development project near the Jepson Prairie Preserve (J. Westbrook, Solano Land Trust, pers. comm. 2023; California Forever 2024, p. entire). The project proposes to construct an approximately 17,500-acre new community in Solano County (California Forever 2024, p. 1) that could potentially affect known Diversity Database occurrences in the area (Witham in litt. 2023; Westbrook pers comm. 2023) (USFWS, 2024)

Recovery

Reclassification Criteria:
Reclassification criteria are not available.

Recovery Priority Number: 2C

Delisting 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. Reintroduction and introductions must be carried out and meet success criteria. Additional occurrences identified through future site assessments, GIS and other analyses, and status surveys that are determined essential to recovery goals if the occurrences 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, 2008)

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 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, 2008)

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, 2008)

3. 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 in the Habitat Protection section. Research necessary to determine appropriate parameters to measure population viability for each species have been completed. (USFWS, 2008)

4. A 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 1-4. (USFWS, 2008)

Recovery Actions:

- Recovery actions are not available.
- Once compiled, results from research on non-native invasive species control and population genetic studies should be incorporated into existing and future management plans for protected Colusa grass occurrences. (USFWS, 2008)
- A standardized monitoring method should be developed to monitor species status and population trends throughout the species range. Monitoring species status should be continued at the Jepson Prairie Preserve occurrence in Solano County, the Davis Communications Annex site in Yolo County, and the Arena Plains site, within the Merced NWR, in Merced County. Additional research should be conducted at these sites to incorporate research recommendations outlined in the Recovery Plan. Results from monitoring and research should be included in the management plans for these three areas. Sites also should be monitored within Merced and Stanislaus Counties, where the majority of extant occurrences are known. Currently, the Merced NWR's Arena Plains parcel is the only monitored occurrence within these two counties. Many occurrences reported in the CNDDB (2008) have not been visited in over a decade. (USFWS, 2008)
- Colusa grass should be reintroduced to vernal pool regions and soil types from which status surveys indicate the species has been extirpated. The Recovery Plan recommends introduction of Colusa Grass to Colusa County, the Arena Plains parcel of the Merced NWR, and the Farmington core area. Genetic studies proposed by Sonoma State may help to identify appropriate seed sources for use in introduction/reintroduction project. (USFWS, 2008)
- The Service should work cooperatively with landowners to preserve known occurrences of Colusa grass on properties adjacent to and within the proximity of the U.C. Merced Campus. The majority of known extant occurrences (42 percent) are at the Flying M Ranch, the Ichord Ranches, and the Virginia Smith Trust site (Vollmar 2002), all of which are within the vicinity of the U.C. Merced campus. These occurrences are likely to be lost as a result of development if they are not preserved in the near future. Although some portions of the Flying M Ranch in Merced County are currently protected by conservation easements, the known occurrences of Colusa grass within the ranch are not currently protected. (USFWS, 2008)
- It is possible that occurrences of Colusa grass exist on private lands that have not yet been surveyed, particularly in Merced and Stanislaus counties, where the majority of known

occurrences are found. Surveys should be performed in suitable habitat for Colusa grass on private lands throughout the species' range to determine if more occurrences exist. (USFWS, 2008)

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 Colusa grass. The recommendations put forth in the Recovery Plan (Service 2005, pp. ix–xii) and the previous 5-year review (Service 2008, pp. 21–22) are still relevant and are expanded upon in this section. Additional recommendations have been identified based on communication with species experts, a literature search, and a review of existing records. 1. Preserve additional, known extant occurrences to reach recovery goals outlined in the 2005 Recovery Plan. Preservation of large blocks of vernal pool habitat that contain complete or large portions of vernal pool complexes is needed to ensure the genotypic variation exhibited by this species is protected. The Service should work with private landowners to secure protection of Colusa grass populations through conservation easements or other methods, particularly in Stanislaus County where Diversity Database occurrences of Colusa grass have recently been considered extirpated from two additional core areas as a result of land conversion to agriculture, and the remaining extant occurrences in the county are unprotected. Identifying and protecting additional populations of Colusa grass will be critical for the long-term viability of the species (Service 2005, p. 30; Service 2008, p. 18). 2. Initiate a collaborative seed banking program with botanical gardens to collect and preserve Colusa grass seeds from across its range. Seed banking actions should ensure adequate collection from each population within the two biogeographical regions to preserve the genetic varieties as detected by Gordon et al. (2012, entire). 3. Develop regional and/or state-level working groups for vernal pool species. Initiating regional working groups will develop the partnerships needed to oversee regional recovery efforts for vernal pool species, including Colusa grass. 4. Develop and implement standardized population trend survey protocols to complete population status surveys and surveys for Colusa grass in potentially suitable habitat. Specific actions and research items to achieve this recommendation include: a. Digitize and assess the annual monitoring data for Colusa grass on the Jepson Prairie Reserve. b. Conduct surveys in habitats that have been identified as suitable within the historical range of the species. Surveying locations identified in the most recent vernal pool habitat mapping report (Witham 2021, entire) as potentially suitable habitat (i.e., large playa pools in the species range) could result in the discovery of additional occurrences of Colusa grass and/or identify suitable locations for future translocations or introductions of the species. c. Annual population monitoring of all known extant locations. Incomplete and infrequent monitoring of this species makes population status and trends difficult to assess. An effort should be made to conduct regular status surveys for Colusa grass (and other listed vernal pool plants, like Witham's 2013 survey) to make assessment of population trends possible. Without better understanding of the population dynamics of the species, we do not know the extent to which protected lands provide self-sustaining populations of this species within each vernal pool region. Furthermore, monitoring of annual trends and stability needs to assess short- and long-term fluctuations of individual localities which would assist in anticipating demographic changes in response to climate change over time. 5. Design and implement reintroduction experiments. Reintroductions should occur in the vernal pool regions and soil types from which the species is assumed extirpated and should be in accordance with preserving the unique genetic diversity detected by Gordon et al. (2012, entire; See Genetics section above). The Recovery Plan recommends prioritizing sites in Colusa County, the Arenas Plains parcel of the Merced National Wildlife Refuge, and the Farmington core area. 6. Conduct coordinated research on the impact certain threats and their management have on the Colusa grass: a. Assess the long-term effects from urbanization and agricultural-related alterations to vernal pool sub-watersheds on the hydrology of vernal pools. Efforts should lead to determinations of appropriate hydrology (or upland) buffers. Stone et al. (1988, pp. 4–5) also recommended research focused on assessing the range of inundation conditions necessary to maintain Colusa grass. b. Identify and understand the anticipated risks from climate change, specifically the effects of drought on the long-term viability of Colusa grass. c. Determine if and how pesticides may threaten Colusa grass population viability. Evaluate if fungicides inhibit germination of Colusa grass, as is the case for other species in the Orcuttieae tribe (Keeley 1988, p. 1088). Additional research is warranted on how pesticides impact sensitive vernal pool plants in conjunction with other stressors. Specifically, identify the potential need for agricultural buffer zones and evaluate the overall tolerances of vernal pools to pesticides (Johnson 2006, p. 5). (USFWS, 2024)

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SPECIES ACCOUNT: *Nolina brittoniana* (Britton's beargrass)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015) 4/27/1993

Physical Description

Perennial herb with thick underground rhizomes (stems). The long-lived, slender, arching leaves are 1-2 m [3-6 ft] long, 6-13 mm [0.2-0.5 in] wide, forming a rosette. The flowering stem grows at least 2 m (6 ft) high in April. The branches of its panicle are covered with many small white six-parted flowers. Plants are subdioecious (i.e. male and female flowers on separate plants). The plant is conspicuous when in flower. The fruits are triangular in cross section and are symmetrical (USFWS, 1996).

Taxonomy

The genus Nolina, which belongs to the agave family. Also referred to as scrub beargrass (USFWS, 1996)

Historical Range

See current range/distribution.

Current Range

The species distribution is central peninsular Florida and includes the following 12 counties: Hardee, Hernando, Highlands, Hillsborough, Lake, Manatee, Marion, Orange, Osceola, Pasco, Polk, and Seminole (USFWS, 2025)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

<u>Adult:</u> Abiotic and Biotic (NatureServe, 2015)

Breeding Season

<u>Adult:</u> Nolina brittoniana flowers from early March to mid-May (NatureServe, 2015).

Reproduction Narrative

<u>Adult:</u> Nolina brittoniana flowers from early March to mid-May. Thorne (1965) reported that the male plants shed pollen in early morning several hours after their flowers have opened. These are moderately fragrant, especially during the cooler evening hours. The pistillate flowers exude nectar about 24 hours after opening during the night or predawn hours. A stigmatic "droplet" signals the flowers' receptiveness to pollination. Thorne did not state what the pollinator is, but moths are known to pollinate the related genus Yucca (Baker, 1938; USDA Forest Service, 1974). The fruits mature from July to October and are evidently wind disseminated because of their inflated capsules (Thorne, 1965). The life history of the related genus Yucca has been studied in

the Southwestern U.S. Seedling plants begin flowering when about 5-6 years old under favorable environmental conditions. Pollination seldom occurs without the aid of the female yucca moth which gathers the pollen and Places it in the stigmatic tube. (The inflorescence shoots of capsular yuccas are highly palatable to wildlife and livestock.) Their seeds have some degree of hardseededness and germination can be speeded up by soaking them in water at room temperature for at least 24 hours before sowing. Germination usually begins in 1 to 2 weeks but may continue for 2 to 3 years. Most plants in botanical gardens have been transplanted from the wild (USDA Forest Service, 1974).; Nolina brittoniana is a fairly rare plant which occupies a larger habitat range than the strict scrub endemics. It is widely scattered and not abundant anywhere - populations usually occurring as small colonies of several isolated plants which frequently form clumps by underground suckering. Thorne (1965) studied Nolina in the field during the early 1960's and stated that vegetative reproduction accounts for the bulk of many populations. He often saw ten or more individuals forming a clump several feet in diameter - these were recognized as clones by the simultaneous elongation of their inflorescences in the spring. He observed populations ranging from the normal several hundred specimens on a few acres to sites having many thousand plants over several square miles (these larger populations are no longer extant). He thought that the usual condition of several plants growing in apparent isolation was the result of a more extensive population succumbing to the competitional pressure of succession. Nolina is entirely dependent on fire or some other mechanism to maintain an open successional stage in the scrub or sandhill. Fire exclusion has allowed taller plants to shade it out of otherwise suitable habitat. Thorne (1965) observed that leaves of Nolina were much shorter (often with burnt tips) in areas subjected to frequent burning. These scarcely flammable green leaves protect the central stem from fire damage (Ward, 1979).; Apomictic; ASEXUAL; Monoecious; Predominantly outcrossing; SEXUAL; Vegetative spread; ABIOTIC; Wind; BIOTIC; Lepidoptera; (NatureServe, 2015)

Habitat Type

Adult: Sandhills (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: Deep, fine-textured, well-drained sands of sand pine-evergreen oak scrub or longleaf pine-turkey oak sandhill. Other associated plants include Serenoa repens, Sabal etonia, Lyonia ferruginea, Ceratiola ericoides, Palafoxia feayi, Aristida stricta, etc. (Florida Natural Areas Inventory) (NatureServe, 2015). High ecological integrity of the population and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of this species. Nolina brittoniana is a habitat generalist and occurs in multiple xeric upland communities, including scrub and sandhill (Christman 1988, Christman and Judd 1990, Menges et al. 2007). The species resprouts post disturbance (fire) with relatively stable demography and low annual turnover (Thomas et al. 1998, Menges 2007). The plants spread vegetatively, so a group of rosettes may represent only a single genetic individual. Additional habitat information may be obtained in documents previously noted. (USFWS, 2025)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: The fruits mature from July to October and are evidently wind disseminated because of their inflated capsules (Thorne, 1965) (NatureServe, 2015).

Population Information and Trends

Population Trends:

Decreasing (NatureServe, 2015)

Resiliency:

Nolina brittoniana is a habitat generalist that is a long-lived perennial, is subdioecious (allowing for some degree of self-fertilization or cross fertilization) and clonal. These traits provide the species the ability to maintain demographic stochasticity because it can reproduce in different ways and survive periods of suboptimal conditions. Because it is long-lived and has been seen in some locations since prior to its listing over 30 years ago it has shown resiliency to past periods of disturbances. The species occurs in multiple xeric upland communities, including scrub and sandhill indicating the species shows less specialization than some other rare endemic species sharing similar geography (Menges et al. 2001), and the species has relatively stable demography and low annual turnover. These traits allow some populations to avoid some periods of suboptimal conditions (flood/storms, see additional discussion below under Redundancy). Many of these populations are within contiguous tracts of land that provide for connectedness between populations a trait that should allow for natural recovery from disturbance events to the species, its habitats, and pollinators/seed dispersers. The species is a disturbancedependent plant and readily resprouts post fire, suggesting some level of environmental stochasticity may not be detrimental and may actually be beneficial to the species. In one study seed density in the soil of disturbed sites (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. These characteristics provide the species with resiliency. (USFWS, 2025)

Representation:

Nolina brittoniana has been shown to have fairly high genetic variability relative to other scrub-endemic species, which is more typical of species that are long lived, have demographic stability, outcrossing, and longer pollinator movement distances (Menges et al. 2001; 2010). These traits indicate the species may have sufficient representation. The species' clonal nature may limit genetic diversity in places or at times; however, this enables the species to persist during times or in areas where additional plants will be unavailable for cross-pollination (see above). (USFWS, 2025)

Redundancy:

Nolina brittoniana inhabits a large area of central peninsula Florida occurring on 37 managed conservation lands that are considered secured populations (n=53) across 12 counties range wide. In addition to known, managed populations, there are additional populations (n=13) on private or unmanaged lands. Based on the widespread distribution and nature of the species along with its general biological characteristic, a single catastrophic event is unlikely to impact all individuals in all populations and the species should have sufficient redundancy to be viable in the foreseeable future. (USFWS, 2025)

Number of Populations:

53 (USFWS, 2025)

Additional Population-level Information:

Britton’s beargrass, Nolina brittoniana, is a perennial herbaceous plant that is a habitat generalist occurring in multiple xeric upland communities, including scrub and sandhill in 12 counties in central peninsular Florida. Range-wide there are 53 populations of N. brittoniana on 37 conservation lands occurring in 12 counties. The majority of these populations do not have current plant estimates (no survey data since 2000); however, 26 populations were reported at their last observation date to have a minimum of 50 plants. The numbers of plants present in these populations are often in the hundreds with the largest populations having over a thousand plants. These larger populations occur on 16 conservation lands in 6 counties. The loss of habitat and habitat degradation continues to be the greatest threat to N. brittoniana on private lands. The populations occurring on conservation lands are no longer threatened with destruction of their habitat since these locations are generally protected from development; however, habitat degradation can occur because of limitations of appropriate habitat management. This species and its habitat are dependent on natural or prescribed fire for longterm maintenance which may be limited even on conservation lands because of their proximity to urban centers or limitations of resources to conduct prescribed burns. All conservation lands have management plans for the long-term preservation and conservation of the species on their properties. The Service is not aware of any information to indicate that overutilization, disease, predation, or other natural or manmade factors pose a significant threat to the species. There are 94 documented populations with 53 (56 %) extant populations occurring on conservation lands. At least 13 (14%) populations are considered historic (extirpated), with the remaining 28 (30%) populations occurring on private lands of unknown status. Genetic studies have indicated that there appears to be no current concerns related to genetic bottlenecks or genetic diversity. Because of the significant number of populations within conservation lands and their geographic spread, the Service is recommending that N. brittoniana no longer meets the definition of an endangered species and should be considered for reclassification as threatened. (USFWS, 2025)

Population Narrative:

In conducting this 5-year review, best available data indicated 111 populations rangewide. Sixty-five percent (72 populations) are located on a minimum of 30 conservation lands. Destruction, modification or curtailment of its habitat or range is a likely threat to 35% of known populations because 35% of the populations exist on non-protected private land. Because 65% of the populations exist on public lands that are protected from habitat destruction, habitat destruction is not a likely current or future threat to those populations. These populations exist in eight counties. The number of individuals has been periodically assessed for the majority of the populations on conservation lands and demographic monitoring has been conducted at several of the sites. (USFWS, 2019)

Threats and Stressors

Stressor: Fire suppression (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The most pervasive threat to N. brittoniana on public land is habitat degradation due to fire suppression resulting in the lack of flowering needed for reproduction. 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 (Service 2006). Consequently, the difficulties land managing agencies currently face in implementing prescribed fires probably have resulted in the degradation of N. brittoniana habitat in some areas. Nolina brittoniana on private lands is also threatened long-term with fire suppression, but habitat destruction is a more immediate concern in many locations. 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 N. brittoniana habitat. At present, there are no incentives available that would encourage private landowners to undertake prescribed fire, especially those who own relatively small parcels embedded in urban matrices. As a result, we believe that many locality records for N. brittoniana on non-conservation parcels in private ownership are threatened with habitat modification due to fire suppression (USFWS, 2010).

Stressor: Development (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Nolina brittoniana that occur on non-conservation private lands also are vulnerable to destruction due to development, such as construction of roads; installation of utilities and other infrastructure; and residential, commercial, and industrial construction. N. brittoniana on each private parcel is vulnerable to this threat at any time (USFWS, 2010).

Stressor: Predation (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of individual plants
Narrative: Although more research is needed regarding predation on N. brittoniana, Weekley (1997) reported vertebrate predation rates over 30 percent in one population for one year on the Lake Wales Ridge State Forest. Post-dispersal fruit/seed predation might help explain the absence of seedling recruitment (Service 1999; C. Weekley, ABS, personal communication 2010). More information is needed to determine if the threat of vertebrate predation on this species has increased beyond what has naturally occurred and is causing a decline in the populations (USFWS, 2010).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2010)
Exposure:
Response:

Consequence: Loss of habitat
Narrative: On private properties, Federal or State laws provide little protection for N. brittoniana. Since the majority of extant N. brittoniana populations occur on unprotected private lands, we conclude that existing regulatory mechanisms are inadequate to protect this species (USFWS, 2010).

Stressor: Lack of recruitment (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of genetic diversity
Narrative: There are no records of seedling recruitment in any wild population even though genetic assessments indicate seedling recruitment must take place (Menges et al. 2010). Limited seedling recruitment will affect the long-term persistence of some populations and could affect the extent of genetic variation should habitat fragmentation continue (USFWS, 2010).

Stressor: Disease (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative:

Recovery

Reclassification Criteria:
3. Within the protected populations demographic monitoring is completed for five or more sites and must be located in Highlands, Polk, Orange/Osceola and Lake Counties (USFWS, 1996).

1. Eight populations protected at four or more sites (USFWS, 1996).

2. Genetic monitoring determines the number of individuals within protected sites (USFWS, 1996).

Recovery Priority Number: 8

Delisting Criteria:
For delisting, 20 viable populations at five or more sites, with sites in each of Highlands, Polk, Orange/Osceola, and Lake counties (USFWS, 1996).

Recovery Actions:
- Protect habitats of the plants. Maintain an inventory of sites and species, conduct surveys, continue land acquisition following plans adopted by governments and private conservations organizations, and pursue non-acquisition land conservation measures (USFWS, 1996).
- Manage protected habitat. Develop model fire management plans, initial inventory for each protected site, conduct initial conservation measures at each protected site, establish management objectives for each site, provide management services for each site, and monitor each site (USFWS, 1996).

- Ensure that recovery objectives are appropriate; plan for post-recovery monitoring (USFWS, 1996)
- Enforce available protective legislation. Initiate Section7 consultation when applicable. Enforce take and trade prohibitions (USFWS, 1996).
- Provide public information about scrub and its unique biota (USFWS, 1996).
- 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. Population viability analysis (modeling) should be conducted to assess the long-term persistence probability of populations (USFWS, 2010).
- Continue demographic monitoring on the Lake Wales Ridge and initiate demographic monitoring at other conservation lands where this species occurs. Conduct Level 2 (see Menges and Gordon 1996) monitoring on multiple sites using populations in different habitats and with different management regimes. Work with ABS on their Population Dynamics of Endangered Plants project which is conducting Level 2 monitoring at several sites across the range of N. brittoniana (USFWS, 2010).
- Conduct a range wide survey of genetic diversity in N. brittoniana. Such a survey could help in identifying populations that should be targeted for acquisition or included as a source for creation of new populations on sites undergoing restoration (USFWS, 2010).
- Implement management activities on public lands that contain N. brittoniana, including prescribed fire at return intervals and intensities necessary to restore and/or maintain the various xeric vegetative communities that support this species. Update natural community maps, which describe through field data collection (FNAI natural community mapping protocols, for example) community composition and structure along with management recommendations for managed areas where N. brittoniana occurs (USFWS, 2010).
- Purchase or otherwise protect large N. brittoniana populations on unprotected lands. Protection should target N. brittoniana populations that are sufficiently large, or could be large if adequately managed, as to be self-sustaining and viable long-term (USFWS, 2010).
- Encourage private landowners to conserve and manage property known to contain this species (USFWS, 2010).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS Increase demographic monitoring on conservation lands. Conduct a Species Status Assessment to evaluate species viability across its current range. Review recovery criteria and revise as appropriate based on best available data. (USFWS, 2019)
- RECOMMENDED FUTURE ACTIVITIES A. Perform systematic surveys at known locations to determine viability and population trends. B. Continue collaborating with land managers to increase beneficial habitat management in occupied habitat. (USFWS, 2025)

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SPECIES ACCOUNT: *Orcuttia californica* (California Orcutt grass)

Species Taxonomic and Listing Information

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

Physical Description

a tufted annual grass, 5 to 20 centimeters (cm) (2 to 8 inches (in)) tall. Its seeds germinate in the saturated and/or submerged soil of vernal pools and plants are at first nearly prostrate. The plants produce more erect glandular pubescent stems when they are exposed as the pool dries up and subsequently produce flowers and seeds. (USFWS, 2011)

Taxonomy

Orcuttia californica was described by George Vasey (1886, p. 219) based on a collection made in April 1886 by Charles Russell Orcutt near San Quintin Bay, Baja California, Mexico. Munz collected the first specimens of O. californica in the United States in 1922 in Menifee Valley, Riverside County, California (Munz 1924, p. 127). There have been no subsequent changes in the taxonomic classification of the species in systematic (e.g., Hoover 1941, pp. 149–156) or floristic (e.g., Reeder 1993, pp. 1276–1277) treatments. Orcuttia californica is still the accepted name for the plant. At least two other taxa at various times have been included under O. californica; however, they are currently recognized as separate species (USFWS, 2011).

Historical Range

First collected in the 1800s near San Quintin, Baja California, Mexico. Plants were first observed in the United States in 1922 near Menifee in Riverside County, and has since been found as far north as Ventura County, California. At the time of listing, O. californica was thought to be restricted to four general localities in California, located in Riverside and San Diego Counties. These localities were the Santa Rosa Plateau, Skunk Hollow, and Salt Creek (now identified as the Stowe Pools) in Riverside County, and Otay Mesa in San Diego County. It was thought to be extirpated from Los Angeles County at the time of listing. The species was likely never widespread, compared to other obligate plant species, because deeper pools with longer inundation times (longer seasonal ponding) are less common in southern California. Because of its small stature and lack of showy flowers to catch the eye, few collections were made in areas that probably supported the species. We know that vernal pool habitat was more extensive in southern California and has been reduced due to anthropogenic development in southern California (Mattoni and Longcore 1997, p. 88). (USFWS, 2011)

Current Range

California, Riverside Co. (Santa Rosa Plateau), San Diego Co. (Otay Mesa, Miramar Mesa), Los Angeles County, Mexico, Baja (near San Quintin). Range extent covers about 130 x 150 miles or about 20,000 sq miles, including Baja. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Wind pollinated (NatureServe, 2015)

Breeding Season

Adult: The plants flower, usually between April and June (USFWS, 2011).

Reproduction Narrative

Adult: Wind pollinated (NatureServe, 2015). The plant's stems become more erect as the ephemeral pool dries out by evaporation at which time the plants flower, usually between April and June, and set seed. It is doubtful that any significant amount of germination occurs in the absence of the pool being inundated. This habit relates to the species' more restricted habitat. Like most grasses, its flowers are wind pollinated; however, it relies on fungi to play a role in stimulating germination (Griggs 1976, pp. 57–63; Griggs 1981, p. 16; Keeley 1988, pp. 1086–1089). Orcuttia californica is less abundant at the shallow periphery of vernal pools that are subject to more rapid changes in moisture and are generally more abundant in portions of pools that retain water for the longest period of time (longer inundation time) (USFWS, 2011).

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 (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits beds of dried vernal pools typically in grassland or chaparral (Smith and Berg, 1988). Elevation 45-2000 ft., associated with Eryngium spp. and Eleocharis spp. (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the lof number of known populations and specific habitat requirements of the species.

Dispersal/Migration

Motility/Mobility

Adult: No information found

Population Information and Trends

Population Trends:

Decreasing (NatureServe, 2015)

Number of Populations:
25 extant/presumed extant (USFWS, 2023)

Population Size:
10,000 - 100,000 individuals (NatureServe, 2015)

Population Narrative:
Vulnerable since it is an annual grass, endemic to vernal pools in southern California. It does not consistently show large numbers every year. CNDDB thinks the current data do not reflect the true damage done to this species. It is likely that most sites, with the exception of those on TNC lands, are gone. Decline of 50-70% The population numbers for this winter annual are variable. Many sites have no counts. The ones that do add up to about 26,600 plants, but this is a rough estimate. 31 known EO's, at least 18 of which are historic and probably extirpated. (NatureServe, 2015). Orcuttia californica is currently extant in Ventura, Los Angeles, Riverside, Orange, and San Diego counties from 25 occurrences (Extant and Presumed Extant only) (Table 1). Orcuttia californica is variously associated with other federally listed vernal pool taxa including Eryngium aristulatum var. parishii (San Diego button celery), Pogogyne abramsii (San Diego mesa mint), Pogogyne nudiuscula (Otay mesa mint), Navarretia fossalis (spreading navarretia), San Diego fairy-shrimp (Branchinecta sandiegonensis), and Riverside fairy-shrimp (Streptocephalus woottoni) (USFWS, 2023).

Threats and Stressors

Stressor: Residential and agricultural Development (USFWS, 2011).
Exposure:
Response:
Consequence:
Narrative: Habitat loss from urbanization and agricultural development continues to impact Orcuttia californica and will not likely be reduced as a threat until more private lands, which support the species, are conserved. There are currently 11 occurrences protected from the direct effects of urbanization: 1 occurrence in Ventura County in a local preserve (EO 28; Lennar 2003), 5 occurrences in Riverside County (EOs 16, 18, 20, 21, 24), and 5 occurrences in San Diego County (EOs 11, 34, 37, 38, 39). Currently 9 of the 28 known extant occurrences are threatened by urban or agricultural development (EOs 3, 7, 9, 10, 27, 28, 29, 46 and 31) (Appendix 1) (USFWS, 2011).

Stressor: Highway construction (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Road development was identified as a threat to vernal pool habitat when Orcuttia californica was listed (USFWS 1993, p. 41387). In the listing rule the potential expansion of a road near the Stowe vernal pools (EO 27) was considered a threat (USFWS 1993, p. 41388). Since that time, a plan to change the road alignment has resulted in the elimination of this threat to the Stowe pools. 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. Road development and related construction

activities may still pose a threat to the species (USFWS, 2011).

Stressor: Off-road vehicle use (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: OHV use was described as a threat to vernal pool habitat in the listing rule (USFWS 1993, p. 42387). Since listing, OHV damage continues to impact habitat occupied by Orcuttia californica at many locations (EOs 6, 7, 9, 10, 27, 29). Damage to vernal pool habitat can be caused by motorcycles, quads, bicycles, and four-wheel drive vehicles. Bauder (1987, p. 209) indicated that some OHV damage may also occur in the course of legitimate activities including fire-fighting, security patrols, and military maneuvers. Bauder also stated that vehicles may impact the species by creating ruts, compacting soil, burying seeds, crushing plants, and altering pool hydrology. OHV use causing fragmentation, degradation, and destruction of vernal pools has been long noted as one of the key agents impacting listed species (Hilty et al. 2006, p. 157; Forman et al. 2003, pp. 113–138; Wilcove et al. 1998, pp. 607–615). Vehicles used to traverse between individual pools or complexes have the potential to alter the pool hydrology, artificially spread native species, and facilitate the invasion of nonnative taxa. To date, there are no recent clear assessments identifying or enumerating vernal pools where Orcuttia californica continues to be threatened by OHV use. Despite protective measures at Marine Corps Air Station (MCAS) Miramar, such as signage, regulations, and regular patrols, OHV damage to vernal pool habitat continues to impact the species (Kassebaum 2008, p. 1; Kassebaum 2009, pp. 1–8). Aerial photographs show numerous extant identified vernal pool basins with evidence of OHV tracks in or adjacent to them (City of San Diego 2004, pp. 16, 17, 22–24, 40, 54, 97). Bauder (1988, pp. 2–21) examined methods to repair damage caused by OHVs and nonnative species and to improve the quality of vernal pools. She (Bauder 1988, p. 19) found that hand weeding, decompaction, and recontouring of pool soils increased the pool quality; yet, fencing and keeping OHV vehicles out of vernal pool habitat is the best way to maintain the delicate habitat, i.e., “the most important element of their recovery is protection from future vehicle trespass.” Threats associated with OHVs are identified at six of the 28 extant occurrences and are likely at more (USFWS, 2011).

Stressor: Trampling (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Habitat trampling associated with humans or cattle, mowing or plowing, highway construction, drainage or watershed alterations, and military activities (USFWS 1993, p. 41388) (USFWS, 2011).

Stressor: Drainage or Watershed Alteration (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Water management activities were determined to be contributing threats to vernal pool habitat when Orcuttia californica was listed (USFWS 1993, p. 41387). Due to urbanization, hydrologic cycles have been affected near vernal pool complexes (Bauder 1987, pp. 209–213). Many vernal pool habitat areas are flanked by roads on naturally or artificially elevated

peripheries of the pool areas. Runoff from these roads or channelized flow under the roads may affect the hydrological conditions of the pool areas. This threat to O. californica has lessened since the time of listing due to development standards that are intended to prevent runoff from entering vernal pool basins (Wynn, pers. obs. 2010) (USFWS, 2011).

Stressor: Military Activities (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Military training activities near and adjacent to vernal pool habitat may cause site-specific impacts to vernal pool habitat and were considered to be a general threat to vernal pool habitat at the time of listing (USFWS 1993, p. 41387). Likewise, activities at MCAS Miramar ranging from construction and maintenance of installation infrastructure (roads, runways, and buildings, etc.) in correlation to increased use of training areas may adversely impact habitat occupied by Orcuttia californica during the development and expansion of the military mission (EOs 6, 43, 44). To minimize these impacts, activities on military installations are covered by Integrated Natural Resource Management Plans (INRMPs) that address habitat conservation and listed species protection (U.S. Marine Corps 2006, pp. 7-1–7-36). Current habitat restoration by the military of O. californica at MCAS Miramar has been among the best efforts with numerous acres restored; further work to note presence/absence of the species, as well as to affirm potential for long-term retention have been accomplished at MCAS Miramar (U.S. Marine Corps 2006, pp. 7-1–7-36) (USFWS, 2011).

Stressor: Predation (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Cattle grazing was identified in the listing rule as a specific threat to all of the vernal pools on Otay Mesa in San Diego County that supported Orcuttia californica (USFWS 1993, p. 41387). Grazing impacts have been reduced since listing, but remain as a threat at four occurrences (EOs 7, 9, 10, 27). Insect herbivory of Orcuttia californica was not listed as a threat when the species was listed, and though suggested, its impacts have been undocumented and remain unknown at this time (USFWS, 2011).

Stressor: Inadequacy of Existing Regulatory Mechanisms (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: The Act provides the greatest regulatory protection to Orcuttia californica. HCPs, and the related conservation actions arising from the Act have contributed to short and long-term conservation of O. californica. In Western Riverside County, five of the nine occurrences are conserved and protected from further loss by development. Seven occurrences are covered by the San Diego MHCP and two are conserved. Eight occurrences fall within the MSCP plan area and three of these are fully conserved. Additionally, the INRMP at MCAS Miramar has created policy mechanisms and partnerships that have restored and conserved vernal pool habitat; three O. californica occurrences are located at MCAS Miramar and are provided protection. Additional potential protection provided by other Federal, State, and local laws and ordinances is discretionary, incomplete, subject to funding availability and changing missions, and/or largely

dependent on the federally listed status of the O. californica. However, in absence of the Act, other Federal, State, and local laws and ordinances do not independently or collectively provide adequate regulatory protection to the species. Inadequacies in provisions or implementation of regulatory mechanisms are not considered a threat to the species, although inadequacies may permit or precipitate actual threats that are attributable to and described under Factors A, B, C, and E (USFWS, 2011).

Stressor: Nonnative Plant Species (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Nonnative plant taxa currently within San Diego County are altering natural landscapes and available habitat (Bauder 1987, pp. 209–213). Invasive nonnative plants have been considered a concern in vernal pool habitat (Appendix 1). Potential impacts include competition with Orcuttia californica for water, soil nutrients, and space above and below ground. Invasive plants have potential for lowering extant water tables and altering rates of sedimentation and erosion by altering soil chemistry, nutrient levels, and physical structure of soil. As such, they can often out-compete native species such as O. californica. Bauder (2005, p. 2133) indicated that Agrostis avenacea (Pacific bentgrass) and Polypogon monspeliensis (annual beard grass) invaded vernal pools in San Diego County since listing, and it was shown that they negatively impacted the survivorship and reproductive success of native species. Prevention of plant invasions and immediate removal of invasive plants has been noted as important to address and control nonnative species introduction and competition (Vitousek et al. 1997, pp. 1–16; Batten 2008, pp. 1–8). The four occurrences on the Santa Rosa Plateau in Riverside County are reportedly threatened by thatch buildup presumably from invasive nonnative plants. Because of the lack of site management, and ubiquitous nonnative plants in and near vernal pool ecosystems, invasive nonnative plants may constitute a rangewide threat to O. californica (USFWS, 2011).

Stressor: Loss of Pollinators (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Orcuttia californica is believed to be wind pollinated. To date, we are not aware of any studies on wind pollination or vector assisted pollination in O. californica. Changes in regional wind patterns per the Walker Circulation, and transition to a more arid climate are believed to be occurring due to climate change, with increases in aridity and decreased wind speeds noted for both modeled and empirically derived data for California (Zack et al. 2005, pp. 1–3; Vecchi et al. 2006; Seager et al. 2007, pp. 73–76; Pryor and Barthelmie 2010, pp. 430–437). Urbanization is believed to also contribute to decreased wind speeds (Zack et al. 2005, pp. 1–3), which may also contribute to an effect on pollination of O. californica. The relationship of any of these potential impacts to wind regimes and the wind regime at ground level that affects pollination of O. californica is unknown. Some ground nesting bees that are specialists on vernal pool plant taxa nest in vernal pool margins (Thorp 2007, p. 52). Loss of invertebrate pollinators may affect other vernal pool species, which combine to create a functional ecosystem that supports O. californica as a component. Diversity of insects, and insect pollinator presence and diversity in and near California vernal pools within the range of O. californica is virtually unknown (USFWS, 2011).

Stressor: Fire and Fire Suppression Activities (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: To the extent that vernal pools that support Orcuttia californica are vulnerable to the altered fire regimes of the surrounding vegetation, fire may be considered a rangewide non-imminent threat (USFWS, 2011).

Stressor: Small Population Size (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Small populations are highly vulnerable to demographic, genetic, and environmental stochastic events, and natural catastrophes (Caughley 1994, pp. 217–227; Asquith 2001, pp. 345–352). Genetic effects may further influence population demography via inbreeding depression and genetic drift (Lande 1988, pp. 1455–1460; Elam 1998, pp. 180–189; Whitlock and Bürger 2004, pp. 155–170; Barrett and Kohn 1991, pp. 3–30; Menges 1991, pp. 58–61). Allee (1931, pp. 17– 50) suggested small, single populations are vulnerable to extirpation when opportunities for reproduction diminish because of reduced opportunity of individuals to reproduce (Allee effect or depensation) (Courchamp et al. 2008, pp. vi– 216). Stephens et al. (1999, pp. 185–190), Dennis (2002, pp. 389–401), and Courchamp et al. (2008, pp. vi–216) suggest that the Allee effect is a density-dependent event that is inversely related to population size. Because of the distance between populations of Orcuttia californica, inbreeding depression and genetic drift may become a quandary for the species. The current small population size of Orcuttia californica may already be demographically or genetically limited where it may be difficult for the plant to persist long-term (Elam 1998, pp. 180-189; Whitlock and Bürger 2004, pp. 161, 167–170) without intensive site management, and potentially ex situ propagation and population augmentation, as allele adaptation in situ may be too long of a process for O. californica with small populations (Orr and Unckless 2008, pp. 163, 168; Bell and Gonzalez 2009, pp. 942–948). Forming and analyzing innovative conservation approaches using outside experts (Meffe et al. 1998, p. 268) will be necessary for the Service to continue to benefit the species, and move the species towards recovery. Addressing Orcuttia californica population demography and longterm population viability whether it is via small or declining population, paradigms will require careful analysis to balance short and long-term conservation strategies. Because of the spatial, ecological, and temporal distribution of O. californica, small population size is considered a rangewide non-imminent threat (Appendix 1) (USFWS, 2011)

Stressor: Drought/Climate Change (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Drought was noted as an unpredictable naturally occurring threat to Orcuttia californica at the time of listing (USFWS 1993, p. 41390). Climate change has been identified as a threat to natural environments since the species was listed (Karl et al. 2009, pp. 13–152; Alder et al. 2009, pp. 1–6). Periodic and successive droughts are considered an underestimated ecological stress and selection factor that impact biological diversity, shaped by species-specific ability to withstand these effects (Gutschick and BrassiriRad 2003, p. 37; Archaux and Wolters 2006, p. 645). The current extended drought effecting southern California may be having deleterious

effects on O. californica, comparable to other aquatic species (Rahel et al. 2008, pp. 551–561). Climate change is expected to affect plants and wildlife in southern California, as well as throughout the world, by altering natural conditions under which the biota evolved, and thereby potentially creating conditions where invasive species out-compete the endemics (Field et al. 1999, pp. 17–42; CEPA 2006, p. 33; IPCC 2007, pp. 2–18). Climate change also makes conserving endangered species cumulatively more difficult (Kostyack and Rohlf 2008, pp. 10203–10213). Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, unpredictable precipitation timing and amounts, and increased summer continental drying (Field et al. 1999, pp. 17–42; Cayan et al. 2005, pp. 3–7; IPCC 2007, pp. 2–18; Karl et al. 2009; Rockström et al. 2009, pp. 472–475). Predictions of short and long-term 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 more frequent El Niño or La Niña events (Pierce 2004, p. 31; Vecchi and Wittenberg, in press, pp. 1–16). Climate change related effects have not yet been studied for vernal pool ecosystems. From an ecological context, current models and scientific thought suggest that southern California vernal pools likely will be adversely affected by global climate change through prolonged seasonal droughts, and rainfall coming at unusual periods and different amounts (Pierce 2004, pp. 1–33; Cayan et al. 2005, pp. 3–7; CEPA 2006, p. 33). 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). Bauder (2005, p. 2134) indicated: "Climate changes would be expected to alter pool hydrology and in turn the distributions, population dynamics and interactions of these vernal pool plants and animals. Less obvious threats are related to the loss of structural habitat diversity and the concomitant impacts of such losses on hydrological diversity and in turn species responses." Direct and indirect impacts from changes in climate are potentially rangewide to Orcuttia californica and its habitat rangewide (Appendix 1) (USFWS, 2011).

Recovery

Reclassification Criteria:

Recovery criteria cooperatively prepared for the Service by Dr. E. Bauder (San Diego State University), A. Kreager (USFWS), and S. McMillan in 1998 were developed for four plant species (including Orcuttia californica) and two animal species (USFWS 1998, p. iii). Recovery criteria developed in recovery plans at the time were not threat-based. Recovery criteria for allowing consideration of reclassifying O. californica as threatened include (citing only those that apply to occurrences of O. californica): 1) "In order to maintain genetic diversity and population stability of the listed species and other sensitive species." • "Existing vernal pools currently occupied by Orcuttia californica, Pogogyne nudiuscula, and Riverside fairy shrimp and their associated watersheds should be secured from further loss and degradation in a configuration that maintains habitat function and species viability." • "Existing vernal pools and their associated watersheds within the Transverse and Los Angeles Basin-Orange Management Areas should be secured from further loss and degradation in a configuration that maintains habitat function and species viability." • "Existing alkali pools and alkali playas, and their associated watersheds within the Hemet complexes, that contain San Diego fairy shrimp, Navarretia fossalis, and Orcuttia californica, or any other vernal pool species, should be secured from further loss and degradation in a configuration that maintains habitat function and species viability." • "Existing vernal pools and associated watersheds located on Stockpen soils (Otay Mesa) should be secured from further loss and degradation in a configuration that maintains habitat function and species viability, to provide for the recovery of species restricted to this soil type...” • “Remaining vernal pools and their associated watersheds contained within complexes identified in Appendix F must be secured in a configuration that maintains habitat function and species viability (as determined by prescribed research tasks).” (USFWS, 2011).

2) “The existing vernal pools and their associated watersheds contained within the complexes identified in Appendix G are secured in a configuration that maintains habitat function and species viability (as determined by recommended research) (USFWS, 2011);

3) Secured vernal pools are enhanced or restored such that population levels of existing species are stabilized or increased (USFWS, 2011;

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, pp. 62–63) (USFWS, 2011).

Recovery Priority Number: 11C

Delisting Criteria:
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:
- 1) Work with partners, such as the Service’s Partners for Fish and Wildlife Program to identify opportunities for conservation or preservation for Orcuttia californica occurrences on private lands. Survey all known locations where O. californica is presumed extant, to determine persistence, habitat quality, and threats (USFWS, 2011).
- 2) Determine those specific vernal pool attributes associated with occurrence of Orcuttia californica (USFWS, 2011).
- 3) Coordinate with partners to develop a nonnative species prevention and eradication program for all vernal pool habitat where Orcuttia californica is extant (USFWS, 2011).

- 4) 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 (ENSO) (USFWS, 2011).
- 5) Develop a dynamic species-specific recovery outline or recovery plan for Orcuttia californica, based on analysis of current knowledge of the species, and a thorough threats analysis (USFWS, 2011).

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. The actions are intended to reduce threats to Orcuttia californica and provide information to better understand the biological and physical factors limiting the population growth and distribution. We recognize that conservation of O. californica 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 Orcuttia californica 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 O. californica habitat. 2) Adaptively manage Orcuttia californica occurrences to maintain, enhance, or restore habitat and reduce threats. a. Manage nonnative plant species in vernal pool habitat. b. Coordinate with partners to develop a nonnative plant species prevention and eradication program for all vernal pool habitat where O. californica is extant. c. Ensure the correct plant species pallet from a nearby source is being selected for areas during restoration projects inside and outside of the known range for O. californica. 3) Monitor occurrences (evaluate habitat quality, and threats) and assess management effectiveness. a. Conserve Orcuttia californica seed in an off-site seed bank. b. Work with partners in Baja California, Mexico to survey additional areas for O. californica and identify conservation opportunities. 4) Determine those specific vernal pool attributes associated with occurrence of Orcuttia californica. 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: *Orcuttia inaequalis* (San Joaquin Orcutt grass)

Species Taxonomic and Listing Information

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

Physical Description

Mature plants of Orcuttia inaequalis grow in tufts of several erect stems, each of which ranges from 5 to 30 centimeters (2.0 to 11.8 inches) in length. The entire plant is grayish-green, due to the long hairs on the stem and leaves, and the plant produces exudate. Terrestrial leaves are 2 to 4 millimeters (0.08 to 0.16 inch) wide. The oval lemmas are 4 to 5 millimeters (0.16 to 0.20 inch) long and their tips are divided into five teeth approximately 2 millimeters (0.08 inch) long; the central tooth is longer than the others, hence the name inaequalis ("unequal"). Each spikelet is flattened and contains 4 to 30 florets. Both rows of spikelets grow towards one side. The spikelets are crowded near the top one-third of the stem, producing a head-like inflorescence 2 to 3.5 centimeters (0.8 to 1.4 inches) long. Each caryopsis is 1.3 to 1.5 millimeters (0.05 to 0.06 inch) long (Hoover 1941; Crampton 1976; Reeder 1982, 1993). The seeds averaged 0.28 milligram (1 × 10-5 ounce) in one population, although seed weight likely varies among sites (Griggs 1980). Orcuttia inaequalis has a diploid chromosome number of 24 (Reeder 1980, 1982) (USFWS, 2005).

Taxonomy

USFWS misspelled the epithet as "inequalis" in the Federal Register (2/96); but, in the listing notice (3/97) it is spelled correctly: inaequalis. (NatureServe, 2015)

Historical Range

The historical range is believed to be in the Southern Sierra Foothills Vernal Pool Region, which includes parts of Stanislaus, Merced, Madera, Fresno and Tulare Counties (Keeler-Wolf et al. 1998; Service 2005). (USFWS, 2013)

Current Range

The current range of O. inaequalis includes portions of: Solano, Merced, Madera, Fresno, and Tulare Counties (USFWS, 2013).

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 Orcuttia inaequalis (San Joaquin Orcutt grass) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six critical habitat units (CHUs), in California (70 FR 46924-46999; 71 FR 7118-7316).

Critical Habitat Designation

The critical habitat designation for Orcuttia inaequalis includes six CHUs in Fresno, Madera, Mariposa, Merced, and Tulare Counties, California. This species critical habitat encompasses approximately 136,312 acres (ac) (55,164 hectares (ha)) (70 FR 46924-46999; 71 FR 7118-7316).

Unit 1: Merced and Mariposa Counties, California. From USGS 1:24,000 topographic quadrangles Snelling, Merced Falls, Winton, Yosemite Lake, Haystack Mountain, Indian Gulch, Merced, and Owens Reservoir.

Unit 2: Merced, Madera, and Mariposa Counties, California. From USGS 1:24, 000 topographic quadrangles Owens Reservoir, Plainsburg, Le Grand, and Raynor Creek.

Unit 3: Madera County, California. (i) Unit 3A: Madera County, California. From USGS 1:24,000 topographic quadrangle Kismet. (ii) Unit 3B: Madera County, California. From USGS 1:24,000 topographic quadrangles Daulton, Little Table Mountain, Gregg, and Lanes Bridge. (iii) Unit 3C: Madera County, California. From USGS 1:24,000 topographic quadrangle Lanes Bridge.

Unit 4: Fresno County, California. From USGS 1:24,000 topographic quadrangle Friant.

Unit 5: Madera County, California. (i) Unit 5A: Madera County, California. From USGS 1:24,000 topographic quadrangles North Fork and Millerton Lake East. (ii) Unit 5B: Fresno County, California. From USGS 1:24,000 topographic quadrangles Millerton Lake East and Academy.

Unit 6: Tulare County, California. (i) Unit 6A: Tulare County, California. From USGS 1:24,000 topographic quadrangle Monson. (ii) Unit 6B: Tulare County, California. From USGS 1:24,000 topographic quadrangle Monson. Unit 6C: Tulare County, California. From USGS 1:24,000 topographic quadrangle Ivanhoe. Unit 6D: Tulare County, California. From USGS 1:24,000 topographic quadrangle Woodlake.

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 Orcuttia inaequalis critical habitat consists of two components (70 FR 46924-46999; 71 FR 7118-7316):

(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 (2)(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

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: Wind pollinated (USFWS, 2013)

Breeding Season

Adult: Generally flowers from April to September (Vollmar 2002) (USFWS, 2013).

Reproduction Narrative

Adult: One reproductive quality observed in Orcuttia species that promotes high genetic variation among successive generations is the flowering pattern. O. inaequalis is wind-pollinated (Griggs and Jain 1983), and generally flowers from April to September (Vollmar 2002). The first two flowers on plants of these species open simultaneously and do not produce pollen until the ovaries are no longer receptive. Thus, fertilization for these flowers is solely a result of outcrossing from different plants (USFWS, 2013).

Habitat Type

Adult: Vernal pools (USFWS, 2013)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 2013)

Environmental Specificity

Adult: Narrow/specialist (USFWS, 2013)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 2013)

Site Fidelity

Adult: High (inferred from USFWS, 2013)

Habitat Narrative

Adult: O. inaequalis is a highly specialized C4 plant (an evolutionary adaptation that facilitates photosynthetic productivity in arid and semi-arid climates) that is dependent on deep vernal pools for survival (USFWS, 2013). Species inhabits mall, seasonal pools (NatureServe, 2015). High ecological integrity of the population and site fidelity as well as low tolerance ranges are inferred based on the specific habitat needs of this species and its relatively small geographic range.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Spikelets break apart and scatter their seeds when autumn rains arrive (Reeder 1965; Crampton 1976; Griggs 1980, 1981) (USFWS, 2005).

Population Information and Trends

Population Trends:

Not available

Number of Populations:

33 Presumed Extant (USFWS, 2023)

Population Narrative:

At least 16 populations have been extirpated. 23 populations remain, all within a 79 km-long range (NatureServe, 2015). There have been several changes to the occurrences of San Joaquin Valley Orcutt grass as listed in the Diversity Database since the 2013 5-year review. Forty seven occurrences of the species were discussed in the 2013 5-year status review (Service 2013, p. 5). While there are still a total of 47 occurrences of the species in the Diversity Database as of 2022, the identity and status of some occurrences has changed since 2013. The 2013 5-year status review described 12 occurrences as extirpated, 4 as possibly extirpated, and 31 as presumed extant. Currently, the Diversity Database describes 16 occurrences as extirpated, 1 as possibly extirpated, and 30 as presumed extant (Figure 2; Diversity Database 2022). There are at least three additional occurrences of San Joaquin Valley Orcutt grass that are not yet listed in the Diversity Database, which brings the total number of presumed extant occurrences to 33 (USFWS, 2023).

Threats and Stressors

Stressor: Urbanization and agricultural land conversion (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat

Narrative: The vast majority of land on the Central Valley floor has potential for urbanization and agricultural conversion due to flat topography and its vicinity to existing infrastructure. As previously described, O. inaequalis occurs under a variety of edaphic and geologic conditions. Each habitat type—lower and upper stream terrace, remnant alluvial fan, or tabletop lava flow—exhibits various potential for land conversion. All 13 sites located on lower terrace soils had been extirpated before listing, presumably because these soil types are relatively fertile and therefore more suitable to intensive agriculture (Stone et al. 1988). These occurrences include five in Stanislaus County, four in Madera County, three in Merced County, and one in Fresno County. Four other localities had also been eliminated prior to listing, through indirect links to agricultural conversion. These include hydrologic modifications, which likely eliminated two occurrences in Merced County and one in Fresno County (Stone et al. 1988), and irrigated runoff which likely caused the elimination of one occurrence in Madera County (Service 2005). Between 1997 (species listing) and 2005, approximately 36,068 acres (7.7% of mapped extent) of vernal pool habitat was converted to urban or agricultural land uses within the current range of the species (Holland 2009). The majority of this land conversion (28,613 acres) occurred within Merced and Madera Counties where 27 of the 31 extant CNDDB occurrences occur (Holland 2009 and CNDDB 2012). Of these 27 occurrences, 13 are protected from development by conservation easements or other land controls. A total of 14 CNDDB occurrences throughout the species range are currently protected in some form leaving 17 without any protection from urbanization and agricultural land conversion (USFWS, 2013).

Stressor: Hydrologic modifications (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Hydrologic modifications from human activities have both benefited and impacted O. inaequalis populations. Stone et al. (1988) stated that O. inaequalis may be benefited by increases in the depth of water or length of pool inundation period, as it is endemic to deep water pools. Vollmar (in litt. 2012) observed that the depth of water and the period of inundation in some vernal pools have increased as a result of road development and associated changes in topography. Conversely, the hydrologic regime for one population in a playa pool at the base of the spillway for Burns Creek dam in Merced County has been altered and is of marginal depth and inundation period to support the currently extant occurrence of O. inaequalis. Stone et al. (1988) reported another population located adjacent to a railroad grade in Merced County had been extirpated due to hydrologic alterations—a likely result of changes in culvert size under the grade (USFWS, 2013).

Stressor: Improper Grazing Regimes (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: While improperly timed grazing can negatively impact the plant and its habitat, research by Marty (2004 and 2005) indicates that livestock grazing plays an important role in maintaining species diversity in vernal pool grasslands through control of invasive species. Direct consumption of O. inaequalis by grazers in the winter and early spring may be limited, due to the fact that the majority of the plants have not emerged or are in the aquatic growth stage of the lifecycle. Nonetheless, impacts to O. inaequalis plants, as a result of improper grazing regimes, are still recognized as a threat to extant populations (USFWS, 2013).

Stressor: Predation (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: The Recovery Plan included foraging during grasshopper outbreaks as a potential reason for decline of the species in certain areas. Although grasshoppers have been observed on O. inaequalis plants at two localities (see Appendix A), this species appears to be only slightly susceptible to grasshopper predation. This characteristic has been attributed to the viscidaromatic (sticky, fragrant) exudate produced by Orcuttia species, which may act as an effective deterrent to grasshoppers (Stone et al. 1988) (USFWS, 2013).

Stressor: Inadequacy of Existing Regulatory Mechanisms (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The Service is not aware of any specific county or city ordinances or regulations that provide direct protection for the species (USFWS, 2013).

Stressor: Competition from invasive plant species (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Soil disturbance from overgrazing by cattle may adversely affect O. inaequalis indirectly by facilitating invasive plant species (Stone et al. 1988). Invasive species that have been reported to invade vernal pool habitat include Hordeum geniculatum (Mediterranean barley), Phalaris paradoxa (hood canarygrass), Polypogon monspeliensis (annual rabbitsfoot grass), Lolium multiflorum (Italian ryegrass), Sida hederacea (alkali mallow), and Lepidium latifolium (perennial pepperweed) (Stone et al. 1988 and Recovery Plan) (USFWS, 2013).

Stressor: Off-road vehicles (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: O. inaequalis occurrences on private lands may be threatened by off-road vehicle use. In addition, the repeated vehicle use of undeveloped roads and trails in vernal pool source areas results in compacted surface soils which can affect pool hydrology. According to CNDDB (2012), damage from off-road vehicle use is listed as a threat to two O. inaequalis occurrences (see Appendix A) (USFWS, 2013).

Stressor: Small population size (USFWS, 2013)
Exposure:
Response:
Consequence: Lack of genetic variability/extinction
Narrative: As described previously, annual precipitation affects both seed production and seed germination. Therefore the number of individuals that make up a given population of O. inaequalis can vary widely from year to year. In fact, some extant localities do not appear during dry years and appear the next year, under more favorable rainfall conditions, with plants

numbering in the thousands (Stone et al. 1988). Conservation biology literature commonly notes the vulnerability of taxa known from small populations. In particular, small population size makes it difficult for this species to persist while sustaining the impacts from competition from non-native plant species, intensive grazing, drought, and other unknown factors. Such populations may be highly susceptible to extirpation due to chance events, inbreeding depression, or additional environmental disturbance (Gilpin and Soule 1988; Goodman 1987). Populations that decline to zero individuals may not always be capable of rebounding from the soil seed bank and the population may become extirpated (Service 2005). Small population size is noted as a concern for CNDDB occurrence numbers 48, 50, 53 and 62 (USFWS, 2013).

Stressor: Climate change (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Pyke (2004) reported that climate change and reduced frequency of suitable habitat might represent the greatest threat to vernal pool species. Climate change scenarios for California predict changes in the hydrologic regime of many California landscapes (Cayan et al. 2005, Field et al. 1999) including Central Valley vernal pools (Pyke 2004). Even modest changes in warming have been predicted to result in a reduction of the spring snowpack, earlier snowmelt, greater winter runoff and flooding, and reduced spring-summer runoff, as well as less available soil moisture in the summer (Cayan et al. 2005, Field et al. 1999). However, while 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), 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, more intense 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, 2013).

Stressor: Pesticides and Herbicides (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Research over the last 20 years have shown that contaminants may threaten vernal pool ecosystems and pose a significant risk to threatened and endangered vernal pool species within the agricultural matrix of the Central Valley (Johnson 2006, p. 11). Pesticides from agricultural runoff, drift, precipitation, and/or aerial deposition can contaminate vernal pools. Due to the ephemeral nature of vernal pools, contaminants may concentrate in vernal pools during the dry-down phase, potentially exacerbating the ecological impacts of these contaminants (Cahill et al. 2001, p. 822). Modeling of pesticide concentrations in vernal pool habitats in Merced County within the San Joaquin Valley of California shows that vernal pools are under a high risk of pesticide inputs via agricultural runoff from the surrounding landscape (Sinnathamby et al. 2020, p. 9). The actual concentrations of pesticides in vernal pools are not well-known because of the difficulty of accurately sampling these highly seasonal habitats. However, higher concentrations are typically observed in pools directly adjacent to agricultural lands. A study of vernal pools and streams found that atrazine and glyphosate (both herbicides) are detected in concentrations above the freshwater aquatic life standard even when the vernal

pools themselves were located on protected lands (Battaglin et al. 2009, p. 301). It is unknown the extent to which pesticides (including insecticides, herbicides, and fungicides) may affect San Joaquin Valley Orcutt grass, but best management practices for weed control states that “if endangered grasses such as Orcuttia viscida (Sacramento Orcutt Grass) are also present, a grassspecific herbicide should never be used” and to avoid broadcast application of glyphosate to control invasive plants in vernal pools (DiTomaso and Kyser 2013, p. 2, Waxy Mannagrass section). There is also evidence that fungicides may inhibit germination of Orcuttia seeds, as demonstrated by Keeley (1988, p. 1088), which indicated that fungicide inhibited germination of O. californica seeds but did not affect Greene’s Tuctoria (Tuctoria greenei) seeds. Detailed germination studies have not been conducted for the San Joaquin Valley Orcutt grass (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. 1A. Suitable vernal pool habitat within each prioritized core area for the species is protected. 1B. 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. 1C. Reintroductions must be carried out and meet success criteria established in the recovery plan. 1D. 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. 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, a multi-year drought, and a minimum of 5 years of post-drought monitoring (USFWS, 2009).

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 1. A-E, as previously discussed (funding, personnel, etc). 2C. 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. 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, 2009).

3. Status Surveys: 3A. 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. 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, 2009)

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 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 sections 1A-E. 4C. Research necessary to determine appropriate parameters to measure population viability for each species have been completed (USFWS, 2009).

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 and incentive programs that develop partnerships contributing to achieving recovery criteria 1-4 (USFWS, 2009).

Recovery Priority Number: 8

Delisting Criteria:
(1) that 95 percent of Zone 1 and 85 percent of Zone 2 suitable species habitat be protected (USFWS, 2013).

Recovery Actions:
- It is unknown if the first criterion has been achieved. The amount of existing suitable habitat across the range has not been determined and the Service does not currently have sufficient information to quantify either the acreage of suitable habitat within each core area or the acreage of protected suitable habitat for O. inaequalis (USFWS, 2013).
- Recovery: Preserve additional, known extant occurrences to reach recovery goals outlined in the 2005 Recovery Plan. Preservation of large blocks of vernal pool habitat that contain complete or large portions of vernal pool complexes is needed to ensure the phenotypic and genotypic variation exhibited by this species is protected. The Service should also work with private landowners for the conservation of habitat for O. inaequalis populations through conservation easements or other methods (USFWS, 2013).
- Research: Conduct coordinated research for O. inaequalis on various topics including: 1) suitable habitat surveys within the historical range of the species, 2) annual population stability and trend monitoring of all known extant locations, and 3) the design and implementation of reintroduction experiments. Genetic research should also be conducted to refine our understanding of genetic diversity within and among extant populations, and

should be correlated with existing and anticipated (based on climate change models) environmental conditions. To date this type of research has only assessed genetic material from a small number of sites (Griggs 1980). Without better understanding of the population dynamics of the species, we do not know the extent to which protected lands provide self-sustaining populations of this species within each vernal pool region. Lastly, to date only one vernal pool creation project which incorporated O. inaequalis has been conducted. Since 1993, O. inaequalis populations have been confirmed at these creation sites. This experiment appears to be a successful method by which overall species stability on San Joaquin Valley landscapes could be augmented, and O. inaequalis populations expanded (USFWS, 2013).

- Monitoring: Develop and implement a standardized formal monitoring program that collects data in sufficient detail to evaluate species status and examine changes in population dynamics and community composition. Monitoring should be conducted in areas with known occurrences throughout the range of this species, including revisiting historical survey sites. Suitable habitat surveys need to be completed such that we have a clear understanding of the distribution of O. inaequalis populations. Monitoring of annual trends and stability needs to assess short- and long-term fluctuations of individual localities which would assist in anticipating demographic changes in response to climate change over time. Stone et al. (1998) recommended research focused on assessing the range of inundation conditions necessary to maintain O. inaequalis (USFWS, 2103).
- Habitat-related research: Assess the long-term effects on the hydrology of vernal pools from urbanization and agricultural-related alterations to vernal pool sub-watersheds. Efforts should lead to determinations of appropriate hydrology (or upland) buffers (USFWS, 2013).
- Habitat-related monitoring: Develop management indicators for identifying potential problems and assessing ecosystem health as it pertains to vernal pool species and establish requirements for appropriate management of vernal pool landscapes. Because of urban encroachment and resulting hydrological changes, conservation efforts should be focused on retaining natural surface and subsurface watersheds and on managing for unseasonable sources of water that infiltrate to vernal pool preserves both of which result in changed site hydrology (USFWS, 2013).

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 San Joaquin Valley Orcutt grass. The recommendations put forth in the Recovery Plan (Service 2005, p. ix–xii) and the previous 5-year review (Service 2013, p. 20–21) are still relevant and are expanded upon in this section. Additional recommendations have been identified based on communication with species experts, a literature search, and a status review of existing records. 1. Preserve additional, known extant occurrences to reach recovery goals outlined in the 2005 Recovery Plan. Preservation of large blocks of vernal pool habitat that contain complete or large portions of vernal pool complexes is needed to ensure the phenotypic and genotypic variation exhibited by this species is protected. The Service should also work with private landowners for the conservation of habitat for San Joaquin Valley Orcutt grass populations through conservation easements or other methods. Identifying and protecting additional populations of San Joaquin Valley Orcutt grass will be critical for the long-term viability of the species (Service 2005c; Service 2013). 2. Develop or reinitiate regional and/or state-level working groups for vernal pool species. Regional vernal pool working groups discussed in the previous 5-year review (Service 2013, p. 18) are not currently active. Reinitiating these regional working groups will develop the partnerships needed to oversee regional recovery efforts for vernal pool species, including San

Joaquin Valley Orcutt grass. 3. Conduct coordinated research for San Joaquin Valley Orcutt grass population status and population dynamics. Specific research items to achieve this recommendation include: a. Design and implement reintroduction experiments. b. Genetic research should be conducted to refine our understanding of genetic diversity within and among extant populations and should be correlated with existing and anticipated (based on climate change models) environmental conditions. The Service is aware of two research efforts on vernal pool grass genomics including San Joaquin Valley Orcutt grass. These studies aim to resolve species relationships, revisit the generic classification, and asses landscape-scale diversity of all currently recognized species (currently ongoing at U.C. Merced and the California Botanic Garden). c. Investigate the two different morphological variations of San Joaquin Valley Orcutt grass. It may be beneficial to look through scanned botanical collections to identify plants with mixed characteristics, to explore the geographic range of the characteristics, and the relative proportion of the two morphological types (Witham pers. comm. 2022). 4. Develop and implement a standardized formal monitoring program that collects data in sufficient detail to evaluate species status and examine changes in population dynamics and community composition. Specific actions to achieve this recommendation include: a. Conduct surveys in habitats that have been identified as suitable within the historical range of the species. Surveying locations identified in the most recent vernal pool habitat mapping report (Witham 2021) as potentially suitable habitat (i.e., large playa pools in the species range) could result in the discovery of additional occurrences of San Joaquin Valley Orcutt grass and/or identify suitable locations for future translocations or reintroductions of the species. b. Annual population stability and trend monitoring of all known extant locations. Without better understanding of the population dynamics of the species, we do not know the extent to which protected lands provide self-sustaining populations of this species within each vernal pool region. Monitoring of annual trends and stability needs to assess short- and long-term fluctuations of individual localities which would assist in anticipating demographic changes in response to climate change over time. Incomplete and infrequent monitoring of this species makes population status and trends difficult to assess. An effort should be made to conduct regular status surveys for San Joaquin Valley Orcutt grass (and other listed vernal pool plants, like Witham’s 2013 survey) to make future species status assessments possible. 5. Develop management indicators for identifying potential problems and assessing ecosystem health as it pertains to vernal pool species and establish requirements for appropriate management of vernal pool landscapes. Due to urban encroachment and resulting hydrological changes, conservation efforts should be focused on retaining natural surface and subsurface watersheds and on managing for unseasonable sources of water that infiltrate to vernal pool preserves both of which result in changed site hydrology. The development of management indicators and the establishment of vernal pool habitat management requirements will help land managers maintain functional vernal pool landscapes. 6. Conduct coordinated research for San Joaquin Valley Orcutt grass habitat requirements: a. Assess the long-term effects on the hydrology of vernal pools from urbanization and agricultural-related alterations to vernal pool sub-watersheds. Efforts should lead to determinations of appropriate hydrology (or upland) buffers. Stone et al. (1988, pp. 10–11) also recommended research focused on assessing the range of inundation conditions necessary to maintain San Joaquin Valley Orcutt grass. b. Identify and understand the anticipated risks from climate change, specifically the effects of drought on the long-term viability of San Joaquin Valley Orcutt grass. c. Determine the degree of threat from grasshopper foraging, identify factors contributing to grasshopper herbivory, and develop remedies if this is a significant threat (Service 2005c, p. II–70). d. Determine if and how pesticides may threaten San Joaquin Valley Orcutt grass population viability. Experiments evaluating if fungicides inhibit germination of San Joaquin Valley Orcutt grass, as is the case in other Orcuttia species (Keeley 1988, p. 1088), would be beneficial. Additional research is warranted on how pesticides, namely herbicides, impact sensitive vernal pool plants in conjunction with other stressors. Specifically, there is a need to identify the potential need for agricultural buffer zones and to evaluate the overall tolerances of vernal pools to pesticides (Johnson 2006, p. 5) (USFWS, 2023).

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SPECIES ACCOUNT: *Orcuttia pilosa* (Hairy Orcutt grass)

Species Taxonomic and Listing Information

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

Physical Description

A tufted, notably hairy, annual grass, about 5-20 cm tall. (NatureServe, 2015)

Taxonomy

Hairy Orcutt grass is in the tribe Orcuttieae of the grass family Poaceae (Reeder 1965). Hoover (1941) published the original scientific name Orcuttia pilosa for hairy Orcutt grass, which has remained unchanged since. He collected the type specimen in Stanislaus County, “12 miles east of Waterford” (Hoover 1941) in 1937. Hoover (1937) initially identified that specimen as Orcuttia tenuis, but later recognized that it represented a new species (Hoover 1941). This species also has been known by the common names hairy Orcuttia (Smith et al. 1980) and pilose Orcutt grass (U.S. Fish and Wildlife Service 1985c) (USFWS, 2005).

Current Range

O. pilosa occurs over a 490 km stretch on the eastern margin of the San Joaquin and Sacramento Valleys from Tehama County south through Merced and Mariposa Counties. (NatureServe, 2015)

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 Orcuttia pilosa (Hairy Orcutt grass) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes five critical habitat units (CHUs), in California (70 FR 46924-46999; 71 FR 7118-7316).

Critical Habitat Designation

The critical habitat designation for Orcuttia pilosa includes five CHUs in Butte, Fresno, Madera, Mariposa, Merced, Stanislaus, and Tehama Counties, California. This species critical habitat encompasses approximately 152,093 acres (ac) (61,550 hectares (ha)) (70 FR 46924-46999; 71 FR 7118-7316).

Unit 1: Tehama County, California. From USGS 1:24,000 topographic quadrangles Acorn Hollow and Richardson Springs NW.

Unit 2: Butte County, California. From USGS 1:24,000 topographic quadrangle Hamlin Canyon.

Unit 4: Merced, Mariposa, and Stanislaus Counties, California. (i) Unit 4A: Merced, Mariposa, and Stanislaus Counties, California. From USGS 1:24,000 topographic quadrangles Paulsell, Cooperstown, Le Grange, Montpelier, Turlock Lake, Snelling, and Merced Falls. (ii) Unit 4B: Stanislaus County, California. From USGS 1:24,000 topographic quadrangles Paulsell and Montpelier. (iii) Unit 4C: Merced County, California. From USGS 1:24,000 topographic quadrangle

Turlock Lake.

Unit 5: Madera County, California. (i) Unit 5A: Madera County, California. From USGS 1:24,000 topographic quadrangle Daulton. Unit 5B: Madera County, California. From USGS 1:24,000 topographic quadrangle Daulton.

Unit 6: Madera County, California. From USGS 1:24,000 topographic quadrangles Daulton, Little Table Mountain, Gregg, and Lanes Bridge.

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 Orcuttia pilosa critical habitat consists of two components (70 FR 46924-46999; 71 FR 7118-7316):

(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 (2)(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

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: Wind pollinated (Natureserve, 2015)

Breeding Season

Adult: blooms May - September (USFWS, 2024)

Other Reproductive Information

Adult: Hairy Orcutt grass blooms from May through September (Service 2005, p. II-75). Population sizes fluctuate dramatically year-to-year in response to weather conditions, and there is evidence that the seed bank can persist for several years until conditions are favorable (USFWS, 2024)

Reproduction Narrative

Adult: Other members of the genus are known to be wind pollinated and dispersed by water (floating) and adhering to fur and feet with the sticky exudate. Given the close similarity of congeners, it is likely O. pilosa does the same.; The genus Orcuttia forms a distinct group in the grass family with no apparent affinities to any other grasses. This genus is probably of very ancient origin. O. pilosa is associated with Eryngium spp., Eleocharis spp., Chamaesyce hooveri, Neostapfia colusana and Tuctoria greenei. O. pilosa germinates in standing water and flowers after pool bottom is dry. O. pilosa is often the only living plant remaining in the dry and cracked vernal pool bed in late summer. Appears to need fairly constant water levels during the winter. This seems to limit distribution more than the size of the vernal pool. O. pilosa seem to be poor competitors. Cocklebur (Xanthum sp.) competes directly by shading. In some years cocklebur forms 100% cover during the peak of O. pilosa. May tolerate light to moderate grazing. Plants require a well developed soil. Habitat creation is probably impossible because of soil requirements.; Predominantly outcrossing. (NatureServe, 2015)

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: Grows in Vernal Pools occurring on the eastern side of the Central Valley. Plant germinates underwater and blooms after drydown. (NatureServe, 2015). The hairy Orcutt grass is a small annual grass in the family Poaceae and is found in vernal pools throughout the Central Valley from Madera County to Tehama County. (USFWS, 2024)

Dispersal/Migration

Population Information and Trends

Number of Populations:

34 (USFWS, 2024)

Population Narrative:

Hairy Orcutt grass has been found in the Northeastern Sacramento Valley, Southern Sierra Foothills, and Solano-Colusa Vernal Pool Regions. The known Diversity Database occurrences of Hairy Orcutt grass are generally clumped in four locations in Tehama, Glenn, Stanislaus, and Madera Counties, with two more isolated occurrences in Merced County. The 1997 listing rule described a total of 34 known natural populations; 23 were presumed extant and 11 were presumed extirpated (Service 1997, p. 14339). One introduced population (occurrence #43) was also identified in the listing rule and was presumed extant (Service 1997, p. 14339). The known distribution of the species was similar at the time of the last status review in 2009. However, the 2009 status review noted that one occurrence in Stanislaus County had been extirpated following listing and that the habitat of another occurrence had been converted to vineyards in 2001 (Service 2009, p. 13). Currently, there are 34 occurrences of hairy Orcutt grass, excluding misidentified occurrence #29 (see Service 2009, p. 5; Ferguson, California Department of Fish and Wildlife, in litt. 2022), listed in the Diversity Database (see Appendix A; Diversity Database 2023). Nineteen occurrences are presumed extant and fifteen are presumed extirpated or possibly extirpated (Diversity Database 2023). Two occurrences (#30 and 32) have been removed from the Diversity Database due to misidentification since the last status review; as a result, the species is no longer thought to have occurred within the Oroville core area (Witham 2013, p. 16; Ferguson in litt. 2022; Diversity Database 2023). Since the 2009 status review, the status of four occurrences (#10, 22, 28, 40) has changed from extant to possibly extirpated as a result of habitat conversion (Diversity Database 2023). Due to the possible extirpation of occurrence #10, the species may now be extirpated from all known occurrences in Merced County (Diversity Database 2023). Furthermore, the possibly extirpated occurrences #22 and 28 currently represent the known southern extent of the species range. Extirpation of these occurrences may result in a range contraction of approximately 11 kilometers (7 miles) (Diversity Database 2023); however, the species may occur in other areas of suitable vernal pool habitat that have not been surveyed for the species.. (USFWS, 2024)

Threats and Stressors

Stressor: Urbanization (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Urbanization is listed as a threat to this species (USFWS, 2009).

Stressor: Agricultural conversion (USFWS, 2009)
Exposure:

Response:
Consequence: Loss of habitat
Narrative: Agricultural conversion remains a primary threat to this species habitat (USFWS, 2009).

Stressor: Highway expansion (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Highway expansion is listed as a threat to this species (USFWS, 2009).

Stressor: Off-road vehicle use (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Off-road vehicle use is listed as a threat to this species (USFWS, 2009).

Stressor: Livestock grazing (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Livestock grazing (and trampling) is listed as a threat to this species (USFWS, 2009).

Stressor: Invasive plants (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Invasive plants 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: Inadequacy of existing regulatory mechanisms is listed as a threat to this species (USFWS, 2009).

Stressor: Drought and climate change (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Drought and climate change are listed as a threat to this species (USFWS, 2009).

Recovery

Reclassification Criteria:
Reclassification will be appropriate when the species is no longer in danger of extinction throughout a significant portion of its range (USFWS, 2005).

Recovery Priority Number: 2C

Delisting Criteria:
All other threats to the survival of the species need to be ameliorated or eliminated prior to delisting (USFWS, 2005).

Recovery Actions:

- 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 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. 1C. Reintroductions must be carried out and meet success criteria established in the recovery plan. 1D. 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. 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, a multi-year drought, and a minimum of 5 years of post-drought monitoring (USFWS, 2009).
- 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 1. A-E, as previously discussed (funding, personnel, etc). 2C. 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. 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, 2009).
- 3. Status Surveys: 3A. 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. 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, 2009)
- 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 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 sections 1A-E. 4C. Research necessary to determine appropriate parameters to measure population viability for each species have been completed (USFWS, 2009).

- 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 and incentive programs that develop partnerships contributing to achieving recovery criteria 1-4 (USFWS, 2009).
- Protection of vernal pool habitat from being destroyed or modified by development, agriculture, or other activities should be the top priority (USFWS, 2009).
- The Service should encourage local and community governments to consider developing HCPs to include vernal pool species (USFWS, 2009).
- Private landowners can receive financial assistance, advice, and assurance from the Service to implement improvement projects to benefit Federal trust species, including vernal pool species listed under the Act (USFWS, 2009).
- Landowners, land managers, and the Service should realize that conservation of these species can be compatible with other land uses, such as grazing and other agricultural activities, if appropriately implemented (USFWS, 2009).
- Efforts to protect vernal pool species should include conservation efforts on a landscape scale (Volmar 2002). Knops et al (1995) found that ‘wounded landscapes’ (those which had a combination of disturbance to the hydrology of the vernal pools and fluctuating rainfall amounts) have an increased risk of infestation by invasive species and that had the disturbance not occurred, the infestation would not have happened. Where possible the Service should assess the effects of projects authorized pursuant to section 7 of the Act on a landscape scale in order to adequately analyze the additional potential indirect effects (USFWS, 2009).
- Preserve design studies on hairy Orcutt grass and other vernal pool species should consider the effects of climate change on existing and introduced occurrences, as discussed in section II.C.2.e. Also, hairy Orcutt grass numbers vary widely from year to year depending on habitat conditions and rainfall patterns (Vollmar 2002). Therefore, it is important to design monitoring studies to include enough seasons to account for years with varying precipitation levels and timing to get a good idea of how occurrences are truly faring (USFWS, 2009).
- Development of a Geographic Information System (GIS) will give planners the ability to spatially analyze potentially suitable habitat (using soils, topography, hydrology, and other data layers to determine suitability) and prioritize which habitats need to be protected because of an imminent threat of destruction by development or agricultural activities (USFWS, 2009).

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 hairy Orcutt grass. Some of these recommendations have already been discussed in the 2009 status review (Service 2009, pp. 20–21) and remain valid. 1. Protection of vernal pool habitat from destruction or modification by development or agriculture, especially within Madera, Merced, and Turlock core areas. 2. Systemic, range wide surveys for hairy Orcutt grass should be completed at vernal pools that have been previously occupied. Repeating the work of Witham (2013) would provide essential information to evaluate the recovery of the species. 3. Reintroductions or introductions of hairy Orcutt grass into previously occupied or suitable habitat should be considered to enhance existing populations and increase the redundancy of the species. 4. Genetic research to refine our understanding of the genomics of the Orcuttieae tribe and more specifically to investigate the genetic relatedness of hairy and Sacramento (Orcuttia viscida) Orcutt grasses. Hairy Orcutt grass occurs in a disjunct linear distribution from Tehama to Madera Counties. Sacramento Orcutt grass, a narrow endemic known only from Sacramento County, occurs about halfway between the farthest extents of the hairy Orcutt grass range. Additionally, phylogeographic studies are warranted to help determine if the four clusters of the species constitute four unique populations or if there are multiple populations within these clusters (USFWS, 2024)

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SPECIES ACCOUNT: *Orcuttia tenuis* (Slender Orcutt grass)

Species Taxonomic and Listing Information

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

Physical Description

A small 5-15 cm tall, loosely tufted, blue-green annual grass with slender, mostly smooth, erect stems that are covered with droplets of a sticky, aromatic, bitter-tasting secretion. (NatureServe, 2015)

Taxonomy

—Slender Orcutt grass is a member of the tribe Orcuttieae in the grass family Poaceae (Reeder 1965). Hitchcock (1934) first published the name Orcuttia tenuis for slender Orcutt grass, and this name has remained unchanged. Nonetheless, some confusion surrounds the taxonomy of the species. The type specimen of Orcuttia tenuis was collected in Goose Valley, Shasta County, in 1912. Before the initial collections had been recognized as a new species, they were mistakenly identified as Orcuttia californica and were used as the basis for illustrating the latter species in a 1920 publication (Hitchcock 1934). Another common name is slender orcuttia (Smith et al. 1980) (USFWS, 2005).

Current Range

Sacramento Valley (north central valley) and surrounding areas. Shasta and Tehama counties primarily; also in Sacramento and Lake counties, California. (NatureServe, 2015)

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 Orcuttia tenuis (Slender Orcutt grass (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). There were six critical habitat units designed for slender orcutt grass in California.
The critical habitat designation for Orcuttia tenuis includes areas that were determined by the Service to be occupied at the time of listing, that contain the primary constituent elements essential for the conservation of the species, and that may require special management or protection. The Service determined that no additional areas were essential to the conservation of Orcuttia tenuis.

Critical Habitat Designation

The critical habitat designation for Orcuttia tenuis includes six critical habitat units, including 22 subunits, which encompass approximately 94,213 acres (38,127 ha) in Lake, Lassen, Modoc, Plumas, Sacramento, Shasta, Siskiyou, and Tehama Counties, California. The unit descriptions below are derived from the 2006 Final Rule (71 FR 7118-7316), which contains maps and coordinates for each unit/subunit.

Unit 1, in Siskiyou, Modoc, Shasta, Lassen, and Plumas counties, comprises 10,780 ac (4,362 ha) divided into eleven subunits. Unit 1A is in Siskiyou County; Unit 1B is in Modoc and Shasta Counties; Units 1C, 1D, and 1E, 1F, and 1J are in Shasta County; Unit 1G is in Shasta and Lassen Counties; Units 1H and 1I are in Lassen County, and Unit 1K is in Plumas County.

Unit 2, in Shasta County, comprises 10,780 ac (4,362 ha) divided into four subunits located in the area east and south of the city of Redding near the Redding Municipal Airport encompassing Stillwater Plains to the confluence of the Sacramento River and Cow Creek.

Unit 3, in Shasta and Tehama Counties, comprises 48,114 ac (19,471 ha) divided into two subunits. Unit 3A occupies the area south of the Tehama/ Shasta County line south to Sevenmile Creek near the Tuscan Buttes. The eastern boundary encompasses the vernal pool habitats along the lower elevation bordering the Sacramento River. The western boundary roughly follows the Sacramento River. Table Mountain west of the Sacramento River north of Paynes Creek and Red Bluff is included in this unit. Unit 3B is a small unit just north of the Tehama/Shasta County line (along Battle Creek), straddling Gover Rd.

Unit 4, Tehama County Unit, comprises of 2,838 ac (1,149 ha), and occupies an area east of State Route 99; a portion of Deer Creek is within the unit boundary.

Unit 5, Lake County Unit , comprises 4,141 ac (1,676 ha) divided into two subunits that are both located south of Clear Lake. The southernmost subunit includes Little High Valley.

Unit 6, Sacramento County Unit , comprises 1,161 ac (470 ha) and occupies land northwest of the Hwy 16 (Jackson Road) and Excelsior Rd intersection southwest of Sacramento, south and southest of Mather Airport.

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 Orcuttia tenuiscritical habitat consists of two components (71 FR 7118-7316):

(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 (2)(ii) of this section, 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

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.

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: Wind pollinated (NatureServe, 2015)

Reproduction Narrative

Adult: Species is wind pollinated. Cross pollination is extensive within pools. probably no genetic drift between populations. Seed heads are covered with a sticky substance which presumably adheres to bird feet or feathers. Seed is distributed within pools by floating as pool fills in fall or winter.; The genus Orcuttia forms a distinct group within the grass family with no apparent affinities to any other grasses, probably of very ancient origin. The plant is covered with a sticky secretion which may have several functions; repelling herbivores, assisting in dispersal by sticking seeds to fur, feathers and feet, and reducing water loss. At higher (cooler) occurrences, exudate is less obvious. Associates include coyote thistle (Eryngium vaseyi), spike rush (Eleocharis palustrus), downingia spp., Tehema navarretia (navarretia heteranda), hairy orcutt grass (Orcuttia pilosa) and Green's orcutt grass (Tuctoria greenei). Each occurrence can vary in size from a few square meters to several hectares containing a very large number of plants. Populations of several thousand individuals have been observed. The seeds require enough standing water to allow the growth of a fungus over the seed coat to break dormancy. In dry years the seeds remain dormant and can be viable for many years. Seedlings tolerate the anaerobic conditions of submersion. As the water temperature rises the seedlings produce two long, floating leaves that collect sunlight, CO_2 and O_2 for photosynthesis. As the plant grows above the water level new, shorter leaves appear. As the pool dries completely and the conditions become xeric the plant switches to a C-4 photosynthetic pathway and all resources are dedicated to flowering and seed set. The plant sets seed in the hottest part of the summer and then dies. O. tenuis seems to be a poor competitor. The frequency and severity of weed competition is directly related to other impacts like heavy grazing, discing, damming and draining that effect pool hydrology. The alteration of the length and timing of inundation can severely impact O. tenuis populations. Less inundation may not allow the requisite fungal growth to break dormancy, while too much may allow marsh and aquatic species to invade. O. tenuis seems to tolerate light to moderate grazing. This is probably due to the high densities of plants which can form a dense sod. The exudate makes the plant unpalatable to cattle. Timing of the grazing season to keep cattle off germinating and young plants is more important than stocking rates. Sheep have even less impact as they don't venture into pools while they hold water (NatureServe, 2015).

Habitat Type

Adult: Vernal pool (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 vernal Pools with a very well developed soil profile. O. tenuis prefers clay soils which shrink and swell. As they dry, large cracks develop which allow seeds trapped deeply in the soil to float to the surface with the first inundation. Between 14 and 50 times as many seeds are in the soil as live plants, too deep to germinate. Habitat creation for this plant would probably not succeed because of its requirement for these well developed soils. Conversely, any activity which disturbs the soil profile will negatively effect O. tenuis (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the species unique habitat requirements and low number of known populations.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seeds are water dispersed (NatureServe, 2015)

Population Information and Trends

Population Trends:

Not available

Number of Populations:

21 - 80 (NatureServe, 2015)

Population Size:

2500 - 10,000 individuals (NatureServe, 2015)

Population Narrative:
Annual 90 total number of populations; approximately 70 are nonhistoric (NatureServe, 2015)

Threats and Stressors

Stressor: Urban development (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Urban development is listed as a threat to this species (USFWS, 2009).

Stressor: Infrastructure development (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Infrastructure development is listed as a threat to this species (USFWS, 2009).

Stressor: Agricultural development (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Agricultural development is listed as a threat to this species (USFWS, 2009).

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: Predation (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Predation by grasshoppers 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: Inadequacy of existing regulatory mechanisms is listed as a threat to this species (USFWS, 2009).

Stressor: Competition with native and nonnative plants (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat

Narrative: Competition with native and nonnative plants is listed as a threat to this species (USFWS, 2009).

Stressor: Off-highway vehicles (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat/loss of individuals
Narrative: Off-highway vehicles are listed as a threat to this species (USFWS, 2009).

Stressor: Vegetation succession (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Vegetation succession is listed as a threat to this species (USFWS, 2009).

Stressor: Fragmentation of population and small population size (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat/extinction
Narrative: Fragmentation of population and small population size are listed as a threat to this species (USFWS, 2009).

Stressor: Drought and climate change (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Drought and climate change are listed as a threat to this species (USFWS, 2009).

Stressor: Climate change (USFWS, 2024)
Exposure:
Response:
Consequence:
Narrative: California's Fourth Climate Change Assessment was published in 2018 (Thorne et al. 2018, entire) and has included subsequent regional reports on the different regions of California, including two regions overlapping the core range of slender Orcutt grass that are expected to experience significant impacts from climate change. The average annual maximum temperature in the North Coast region is projected to increase 5–9° F through the end of the 21st century with interior regions experiencing the greatest degree of warming (Grantham 2019, p. 6). Temperatures are similarly expected to rise by 6–9° F in the Sierra Nevada region (Dettinger et al. 2018, p. 5), although the slender Orcutt grass only occurs in the Northeast portion of this large region. Wetlands (including vernal pools) are expected to be more sensitive to climate change because precipitation is often their main water source (Winter 2000, p. 307), so alterations to precipitation regimes are likely to disproportionally affect these ecosystems. Pyke (2004, pp. 3–4) reported that climate change and reduced frequency of suitable habitat might represent the greatest threat to vernal pool species. Modeling of vernal pool hydrology and plant community composition in northern California show that snow-fed vernal pools will have shorter inundation times with little change in maximum depth under projections of altered climate change conditions (Montrone et al. 2019, p. 1010). Vernal pool specialists are highly sensitive to

inundation time, so shortened inundation time due to climate change is expected to cause declines in the number of vernal pool specialist species. Variation in annual weather exacerbated by climate change also contributes to changes in vernal pool plant abundance and community composition, often allowing invasion by non-native exotic species (Javornik and Collinge 2016, p. 66). Specifically, threatened or endangered vernal pool obligate plant species, such as the slender Orcutt grass, may experience an increased risk from environmental and ecological changes from climate change (Bauder 2005, p. 2134) (USFWS, 2024).

Stressor: Pesticides (USFWS, 2024)
Exposure:
Response:
Consequence:
Narrative: Research over the last 20 years has shown that contaminants may threaten vernal pool ecosystems and pose a significant risk to threatened and endangered vernal pool species within agricultural landscapes (Johnson 2006, p. 11). Pesticides from agricultural runoff, drift, precipitation, and/or aerial deposition can contaminate vernal pools. Due to the ephemeral nature of vernal pools, contaminants may concentrate in vernal pools during the dry-down phase, potentially exacerbating the ecological impacts of these contaminants (Cahill et al. 2001, p. 822). Modeling of pesticide concentrations in vernal pool habitats in Merced County within the San Joaquin Valley of California shows that vernal pools are under a high risk of pesticide inputs via agricultural runoff from the surrounding landscape (Sinnathamby et al. 2020, p. 9). The actual concentrations of pesticides in vernal pools are not well-known because of the difficulty of accurately sampling these highly seasonal habitats. However, higher concentrations are typically observed in pools directly adjacent to agricultural lands. A study of vernal pools and streams found that atrazine and glyphosate (both herbicides) are detected in concentrations above the freshwater aquatic life standard even when the vernal pools themselves were located on protected lands (Battaglin et al. 2009, p. 301). The extent to which pesticides (including insecticides, herbicides, and fungicides) may affect slender Orcutt grass is unknown, but best management practices for weed control states that “if endangered grasses such as Sacramento Orcutt grass (Orcuttia viscida) are also present, a grass-specific herbicide should never be used” and to avoid broadcast application of glyphosate to control invasive plants in vernal pools (DiTomaso and Kyser 2013, p. 2, Waxy Mannagrass section). There is also evidence that fungicides may inhibit germination of Orcuttia seeds, as demonstrated by Keeley (1988, p. 1088), which indicated that fungicide inhibited germination of California Orcutt grass (Orcuttia californica) seeds but did not affect Greene’s tuctoria (Tuctoria greenei) seeds. Detailed germination studies have not been conducted for slender Orcutt grass (USFWS, 2024).

Recovery

Reclassification Criteria:
Reclassification will be appropriate when the species is no longer in danger of extinction throughout a significant portion of its range (USFWS, 2005).

Recovery Priority Number: 8

Delisting Criteria:
All other threats to the survival of the species need to be ameliorated or eliminated prior to delisting (USFWS, 2005).

Recovery Actions:

- 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 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. 1C. Reintroductions must be carried out and meet success criteria established in the recovery plan. 1D. 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. 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, a multi-year drought, and a minimum of 5 years of post-drought monitoring (USFWS, 2009).
- 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 1. A-E, as previously discussed (funding, personnel, etc). 2C. 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. 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, 2009).
- 3. Status Surveys: 3A. 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. 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, 2009)
- 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 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 sections 1A-E. 4C. Research necessary to determine appropriate parameters to measure population viability for each species have been completed (USFWS, 2009).

- 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 and incentive programs that develop partnerships contributing to achieving recovery criteria 1-4 (USFWS, 2009).
- Develop and implement standardized population trend survey protocols to complete status surveys, especially for occurrences on private lands where trends have not been recently updated (USFWS, 2009).
- Conduct additional research to assess the long-term effects of hydrology of vernal pools from development-related alterations to vernal pool sub-watersheds. Efforts should lead to determinations of appropriate hydrology (or upland) buffers. Specific hydrological and physical requirements should be assessed for slender Orcutt grass in order to address the relationships between landform, soil chemistry, geographic location, and precipitation regimes; and the presence of slender Orcutt grass occurrences (USFWS, 2009).
- Conduct research on population viability parameters for slender Orcutt grass, especially where occurrences exhibit inter-annual fluctuations. Trends in soil seed banks and plant abundance, and length of seed viability, should also be rigorously assessed (USFWS, 2009).
- Conduct within-species genetic research to fully assess genetic differences between vernal pool regions, Prior genetics work has not included representation from all regions where the plant occurs, particularly the Lake-Napa Region, Southeastern Sacramento Valley Region, and the Modoc Plateau Region, so may not represent the full range of genetic structure or fully indicate genetic isolation between occurrences in different regions. Given the potential that additional localities may be documented on the Modoc Plateau where ecological conditions differ substantially from those in the Central Valley, genetic research should establish the relationship between these regions (USFWS, 2009).
- Manage invasive species on the preserves. Management should include research to determine effective eradication methods, and pool conditions that favor one plant over another. Research should be completed to define the conditions in which cattle grazing is either deleterious or beneficial to slender Orcutt grass populations, including study on the effects of trampling on seed banks and germination, and effects on competition between the native and non-native plants with which slender Orcutt grass coexists (USFWS, 2009).
- 1A: Percent suitable vernal pool habitat within each prioritized core area for the species is protected (Boggs Lake-Clear Lake 95%, Northwestern Modoc Plateau 85%, Western Modoc Plateau 85%, Southwestern Modoc Plateau 85%, Southern Modoc Plateau 85%, Dales 85%, Palermo 85%, Vina Plains 95%, Redding 85%, Millville Plains 85%, Mather 95%). 1B: 80% of the 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 introduction must be carried out and meet success criteria. 1D: Additional occurrences 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, a multi-year

drought, and a minimum of 5 years of post-drought monitoring (USFWS, 2024).

- 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 discussed in Criteria 1A–E above. 2B: Mechanisms are in place to provide for management in perpetuity and long-term monitoring of habitat protected in Criteria 1A–E (e.g., funding, personnel, etc.). 2C: Monitoring indicates that ecosystem function has been maintained in the areas protected (as previously discussed in Criteria 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. 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, 2024).
- 3A: 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. 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, 2024).
- 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 and results incorporated into habitat protection plans to ensure that within and among population genetic variation is fully representative by populations protected (as previously discussed in Criteria 1A–E), above. 4C: Research necessary to determine appropriate parameters to measure population viability for each species has been completed (USFWS, 2024).
- 5A: Recovery Implementation Team is established and functioning to oversee range-wide survey 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 regional working groups have developed and implemented outreach and incentive programs that develop partnerships contributing to achieving recovery criteria 1–4 (USFWS, 2024).

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 slender Orcutt grass. The recommendations put forth in the Recovery Plan (Service 2005, p. ix– xii) and the previous 5-year review (Service 2009, pp. 30–31) are still relevant and are expanded upon in this section. Additional recommendations have been identified based on communication with species experts, a literature search, and a review of existing records. 1. Preserve additional, known extant occurrences to reach recovery goals outlined in the

2005 Recovery Plan. Preservation of large blocks of vernal pool habitat that contain complete or large portions of vernal pool complexes is needed to ensure the phenotypic and genotypic variation exhibited by this species is protected. The Service should also work with private landowners for the conservation of habitat for slender Orcutt grass populations through conservation easements or other methods. Identifying and protecting additional populations of slender Orcutt grass will be critical for the long-term viability of the species (Service 2005; Service 2009). 2. Develop or reinitiate regional and/or state-level working groups for vernal pool species. Initiating regional working groups will develop the partnerships needed to oversee regional recovery efforts for vernal pool species, including slender Orcutt grass (see 5A in Table 4, above). 3. Develop and implement standardized population trend survey protocols to complete updated status surveys, especially for occurrences on private lands where trends have not been recently updated. Specific actions to achieve this recommendation include: a. Conduct surveys in habitats that have been identified as suitable within the historical range of the species. b. Annual population stability and trend monitoring of all known extant locations. Without better understanding of the population dynamics of the species, we do not know the extent to which protected lands provide self-sustaining populations of this species within each vernal pool region. Monitoring of annual trends and stability needs to assess short- and long-term fluctuations of individual localities which would assist in anticipating demographic changes in response to climate change over time. Incomplete and infrequent monitoring of this species makes population status and trends difficult to assess. 4. Develop management indicators for identifying potential problems and assessing ecosystem health as it pertains to vernal pool species and establish requirements for appropriate management of vernal pool landscapes. Efforts should lead to determinations of appropriate hydrology (or upland) buffers. The development of management indicators and the establishment of vernal pool habitat management requirements will help land managers maintain functional vernal pool landscapes. 5. Conduct coordinated research for slender Orcutt grass population status and population dynamics. Specific research items to achieve this recommendation include: a. Genetic research should be conducted to refine our understanding of genetic diversity within and among extant populations and should be correlated with existing and anticipated (based on climate change models) environmental conditions. The Service is aware of one research effort on vernal pool grass genomics including slender Orcutt grass. This study aims to resolve species relationships, revisit the generic classification, and asses landscape-scale diversity of all currently recognized species (currently ongoing at the California Botanic Garden). b. Conduct research on population viability parameters for slender Orcutt grass, especially where occurrences exhibit inter-annual fluctuations. Trends in soil seed banks, plant abundance, and length of seed viability should be assessed. 6. Conduct coordinated research on the impact certain threats and their management have on the slender Orcutt(Clark et al. 2008, p. 267): a. Determine effective eradication methods for managing invasive plants in slender Orcutt grass habitat. Research should continue to define the conditions in which cattle grazing is either deleterious or beneficial to slender Orcutt grass populations, including research on the effects of trampling on seed banks, germination, and competition between native and non-native plants that coexist with slender Orcutt grass. b. Identify and understand the anticipated risks from climate change, specifically the effects of drought on the long-term viability of slender Orcutt grass and its habitat. c. Determine if and how pesticides may threaten slender Orcutt grass population viability. Experiments evaluating if fungicides inhibit germination of slender Orcutt grass, as is the case in other Orcuttia species (Keeley 1988, p. 1088), would be beneficial. Additional research is warranted on how pesticides, namely herbicides, impact sensitive vernal pool plants in conjunction with other stressors. Specifically, there is a need to identify the potential need for agricultural buffer zones and to evaluate the overall tolerances of vernal pools to pesticides (Johnson 2006, p. 5). (USFWS, 2024)

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SPECIES ACCOUNT: *Orcuttia viscida* (Sacramento Orcutt grass)

Species Taxonomic and Listing Information

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

Physical Description

A tufted, hairy, annual grass, 2-10 cm tall. Plant strongly aromatic. Glume 3-lobed and awned. (NatureServe, 2015)

Taxonomy

Sacramento Orcutt grass is in the tribe Orcuttieae of the grass family Poaceae (Reeder 1965). Hoover (1941) first published the scientific name Orcuttia californica var. viscida for Sacramento Orcutt grass. He had collected the type specimen from "7 miles south of Folsom" in Sacramento County (Hoover 1941:155). Although Hoover recognized that Sacramento Orcutt grass differed from California Orcutt grass in several respects, he did not consider the former to represent a distinct species. However, Reeder (1980) determined that the differences in morphology, seed size, and chromosome number were sufficient grounds to elevate Sacramento Orcutt grass to the species level as Orcuttia viscida. Reeder's taxonomy has been accepted since that time. Other common names for this species include Sacramento orcuttia (Smith et al. 1980) and sticky Orcutt grass (California Department of Fish and Game 1987c) (USFWS, 2005).

Historical Range

See current range/distribution.

Current Range

Known only from Sacramento County, California in two main clumps. The two areas add up to about 22 sq mi of range extent. (NatureServe, 2015)

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 Orcuttia viscida (Sacramento Orcutt grass) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three critical habitat units (CHUs), in California (70 FR 46924-46999; 71 FR 7118-7316).

Critical Habitat Designation

The critical habitat designation for Orcuttia viscida includes three CHUs in Amador and Sacramento Counties, California. This species critical habitat encompasses approximately 33,273 acres (ac) (13,465 hectares (ha)) (70 FR 46924-46999; 71 FR 7118-7316).

Unit 1: Sacramento County, California. From USGS 1:24,000 topographic quadrangle Folsom.

Unit 2: Sacramento County, California. From USGS 1:24,000 topographic quadrangle Carmichael.

Unit 3: Sacramento and Amador Counties, California. From USGS 1:24,000 topographic quadrangles Sloughhouse, Carbondale, Clay, and Goose 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 Orcuttia viscida critical habitat consists of two components (70 FR 46924-46999; 71 FR 7118-7316):

The primary constituent elements of critical habitat for Orcuttia viscida (Sacramento Orcutt grass) 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)(12)(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

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: Wind pollinated (NatureServe, 2015)

Reproduction Narrative

Adult: Other members of the genus are known to be wind pollinated and dispersed by water and by adhering to feet and fur with the sticky exudate. Given the similarity between congeners, it is likely O. viscida shares these characteristics.; Genus Orcuttia form a distinct group within the grass family with no apparent affinities to any other grasses, probably of ancient origin. Common associates include coyote thistle (Eryngium spp.), spike rush (Eleocharis spp.), Carter's buttercup (Ramnunculus alveolatus), double-horned downingia (Downingia bicornata), white-flowered navarretia (Navarrettia leucocephala), and annual checkerbloom (Sidalcea calycosa). O. viscida requires enough standing water to allow the growth of an anaerobic fungus over the seed coat to break dormancy. In drier years the seeds remain dormant. Seeds may remain viable for many years. Orcuttia seem to be poor competitors and only grow in areas where prolonged (but not constant) inundation drowns out competitors.; Predominantly outcrossing (NatureServe, 2015).

Habitat Type

Adult: Vernal Pools (Natureserve, 2015)

Dependencies on Specific Environmental Elements

Adult: O. viscida requires a very well developed soil with a silica-iron hardpan layer 2-10 feet below ground level (NatureServe, 2015).

Environmental Specificity

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

Habitat Narrative

Adult: Known only from vernal pool habitats in a 22 square mi area in Sacramento County, California. O. viscida requires a very well developed soil with a silica-iron hardpan layer 2-10 feet below ground level. This impermeable hardpan causes water to perch above ground. Habitat creation for the genus Orcuttia is probably impossible because of its specific soil requirements. (NatureServe, 2015)

Dispersal/Migration

Dispersal

Adult: Seed dispersal by water (NatureServe, 2015)

Dispersal/Migration Narrative

Adult: Other members of the genus are known to be wind pollinated and dispersed by water and by adhering to feet and fur with the sticky exudate. Given the similarity between congeners, it is likely O. viscida shares these characteristics (NatureServe, 2015).

Population Information and Trends

Population Trends:

Decreasing (NatureServe, 2015)

Number of Populations:

10 extant populations (USFWS, 2024)

Adaptability:

Highly vulnerable. (NatureServe, 2015)

Additional Population-level Information:

The Diversity Database currently reports a total of 12 occurrences, 2 of which are presumed extirpated (Table 1; Diversity Database 2024, entire). Since the previous status review, the status of Diversity Database occurrence 20 at the Arroyo Seco Conservation Bank has been changed to extirpated (Diversity Database 2024, p. 15). The Diversity Database notes that no plants were observed when the entire Bank was surveyed in 2010 and 2011, and that the vernal pool is now a permanent marsh and no suitable habitat remains (Diversity Database 2024, p. 15). Since the last status review, Sacramento Orcutt grass has also been planted in five locations in the Mather vernal pool core area at the Kiefer Landfill Wetland Preserve, Sylva site, Kassis site, Mather Wetland Preserve, and Montelena Wetland Preserve (Table 1; Witham 2022, pp. 1–2). The Sylva and Kassis sites were inoculated with Sacramento Orcutt grass seeds in 2014 and 2016, and the Kiefer Landfill, Mather, and Montelena wetland preserves were inoculated in 2016. Except for the Kiefer Landfill Wetland Preserve, which contains a previously documented natural population of Sacramento Orcutt grass, these locations have not been incorporated into the Diversity Database (Witham 2022, p. 1). Finally, two additional occurrences of Sacramento Orcutt grass were identified within the Mather core area north of occurrence 19 and have been added to the Diversity Database (occurrences 21 and 22; Table 1). The four introduction sites and two new Diversity Database occurrences are within the previously known range of the Sacramento Orcutt grass and therefore, do not change our understanding of the overall distribution of the species (USFWS, 2024).

Population Narrative:

Highly vulnerable. Long term trend probably has been one of moderate to substantial decline. Decline of 30-70% In a good year, there can be as many as greater than 2 million total plants. But, plant numbers are not very informative here. Known from 9 total occurrences, one of which is historical and extirpated (NatureServe, 2015). Low redundancy, resiliency and representation are inferred based on the low number of populations and restricted geography of this species.

Threats and Stressors

Stressor: Urbanization (USFWS, 2008)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Urbanization continues to be the greatest threat to the single, unprotected occurrence, located east of Grantline Road. Urban development has been proposed for the 1,315-hectare (3,250- acre) property on which this occurrence is found. The proponent for the

proposed subdivision conducted two pre-application meetings with the U.S. Army Corps of Engineers in 2005; however, he has not submitted an application to the Corps for a permit to fill wetlands (W. Ness, Corps, in. litt., 2006). Sacramento County planning staff are in negotiations with the developer via the South Sacramento Habitat Conservation Plan to ensure that this occurrence will be protected (R. Radmacher, Sacramento County Planning and Community Development Department, pers. comm., 2006). All other known occurrences of the species are found on lands that are currently protected (USFWS, 2008).

Stressor: Landfill (USFWS, 2008)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Proposed expansion of Kiefer Landfill is listed as a threat to this species (USFWS, 2008).

Stressor: Mining (USFWS, 2008)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Proposed gravel and aggregate mining (62 FR 14338) is listed as a threat to this species (USFWS, 2008).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2008)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: There are currently no completed regional or county-wide Habitat Conservation Plans (HCPs) or Natural Community Conservation Plans (NCCPs) in Sacramento County, thereby leaving populations on private land without protection pursuant to the Endangered Species Act or the Natural Community Conservation Planning Act (USFWS, 2008).

Stressor: Nonnative plants (USFWS, 2008)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: It is estimated that if the Glyceria declinata populations in Orcuttia viscida habitat grow at the rate of the San Joaquin or Phoenix Park populations, O. viscida could be completely displaced by G. declinata in 10 years or less (J. Gerlach, ESA, in litt., 2006). Voluntary efforts to remove G. declinata at Phoenix Park by handpulling have been the only efforts to control the species in O. viscida habitat (J. Gerlach, ESA, in litt., 2006). At Kiefer Landfill Wetland Preserve, sticky bartsia (Parentucellia viscosa) is invading the upper edges of the vernal pools that surround the vernal pools supporting Orcuttia viscida (Carol Witham, pers. comm., 2006). The effects of this species on Orcuttia viscida are currently unknown; however, this species warrants observation (USFWS, 2008).

Stressor: Drought and Climate change (USFWS, 2008)
Exposure:
Response:

Consequence: Loss of habitat
Narrative: Climate is predicted to change in California during the 21st century (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 Orcuttia viscida 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, 2008).

Stressor: Small population size (USFWS, 2008)
Exposure:
Response:
Consequence: Extirpation
Narrative: Habitat for Orcuttia viscida continues to be highly fragmented throughout its range due to conversion of natural habitat for urban and agricultural uses. This fragmentation has resulted in small isolated populations of this species. For example, at least three occurrences are each found in single vernal pools (CNDDB 2008). Such populations may be highly susceptible to extirpation due to chance events, inbreeding depression, or additional environmental disturbance (Gilpin and Soule 1988; Goodman 1987). If an extirpation event occurs in a population that has been fragmented, the opportunities for recolonization will be greatly reduced due to physical isolation from other source populations (USFWS, 2008).

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 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. 1C. Reintroductions must be carried out and meet success criteria established in the recovery plan. 1D. 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. 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, a multi-year drought, and a minimum of 5 years of post-drought monitoring (USFWS, 2008).

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 1. A-E, as previously discussed (funding, personnel, etc). 2C. 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. 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, 2008).

3. Status Surveys: 3A. 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. 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, 2008)

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 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 sections 1A-E. 4C. Research necessary to determine appropriate parameters to measure population viability for each species have been completed (USFWS, 2008).

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 and incentive programs that develop partnerships contributing to achieving recovery criteria 1-4 (USFWS, 2008).

Recovery Priority Number: 5C

Recovery Actions:

- 1A: Three Zone 1 core areas are identified in the Recovery Plan as supporting occurrences of Orcuttia viscida and being important for recovery of the species: 1) Cosumnes/Rancho Seco, 2) Mather, and 3) Phoenix Field and Phoenix Park. The recovery criteria in the Recovery Plan are to protect 100 percent of all occurrences of the species and to protect 95 percent of suitable habitat rangewide within the three core areas. Currently, there are nine known extant occurrences (CNDDB 2006) (see Table 1). In 1981 an observation of Orcuttia viscida was reported from a property east of Excelsior Road, north of Calvine Road (Klotz Property) in Sacramento County; however, on further investigation the plants were found to be Orcuttia tenuis (T. Griggs, River Partners, in litt., 2006). Eight of the occurrences (88 percent) receive some level of protection, as described in section II.C.2.a. The amount of suitable Orcutia viscida habitat that exists rangewide has not yet been estimated; therefore, the percentage that has been protected rangewide is still unknown. This recovery criterion has been partially met; however, one known extant occurrence, located east of Grantline Road on land tentatively proposed for development, remains to be protected. The Service has only recently approved the Recovery Plan and does not yet have sufficient information to quantify either the acreage of suitable habitat within each core area or the acreage of protected habitat that is suitable for Orcuttia viscida. 1B: Orcuttia viscida has only been known historically and currently to occur in Sacramento County within the Southeast Sacramento Valley Vernal Pool Region. This criterion has been partially met because the northernmost occurrences at Phoenix Park and Phoenix Field and the southernmost occurrence at Rancho Seco Lake have been protected. However, the easternmost occurrence at the proposed Grantline 3250 development project has not been protected. 1C: The Recovery Plan recommends reintroduction to: (1) the location of the extirpated OrangevaleFolsom occurrence, and (2) Rancho Seco Lake. The Rancho Seco Lake occurrence is currently extant in one vernal pool but may be extirpated from a second previously occupied vernal pool (J. Buck, The Nature Conservancy, in litt., 2006). This recovery criterion has not been met. As of this review, reintroductions of Orcuttia viscida have not occurred. 1D: Additional occurrences of Orcuttia viscida may be found in potential habitat in Sacramento County, particularly on private lands which support suitable habitat and soil types but have not yet been surveyed. At this time, the Service is not aware of surveys of additional areas. No GIS or other analyses to identify areas of potential occurrence are known. This recovery criterion has not been met. 1E: Monitoring of hydrology has not occurred at any of the known extant populations; therefore this recovery criterion has not been met (USFWS, 2008).

- 2A: Habitat management and monitoring plans have been developed for six of the nine known extant occurrences. These occurrences are located on lands that are managed under the guidance of management plans. Management plans are in place for the Kiefer Landfill Wetland Preserve, Anatolia Conservation Bank, and Arroyo Seco Conservation Bank. The Rancho Seco occurrence is now protected under a temporary conservation easement; however, a management plan that specifically addresses Orcuttia viscida is not yet in place. A management plan has been written for the Phoenix Park and Phoenix Field occurrences but it has not been implemented (J. Gerlach, ESA Biological Resources, pers. comm., 2006; D. Burmester, CDFG, pers. comm., 2006). The occurrence in eastern Sacramento County is not protected or actively managed for the benefit of the species. Therefore, this criterion has not been met. 2B: Five occurrences of Orcuttia viscida have long-term funding for management and monitoring in perpetuity. These are the Kiefer Landfill Wetland Preserve (two occurrences), Anatolia Conservation Bank (two occurrences), and the Arroyo Seco Conservation Bank (one occurrence). SMUD states that their ultimate goal is to establish the Rancho Seco preserve as a wetlands mitigation bank (Sacramento Municipal Utility District 2006). Management and monitoring of the preserve is proposed to occur in the interim period, along with the development of a management plan. The Phoenix Park and Phoenix Field occurrences are protected; however, funding has not been secured for the management and monitoring in perpetuity for these properties (J. Gerlach, pers. comm., 2006). The occurrence in eastern Sacramento County is not protected or actively managed for the benefit of the species. Therefore, this criterion has not been met. 2C: Eight of the occurrences have received some level of monitoring; however, continuous monitoring of ecosystem function has not occurred during a time period that meets the requirements specified in the 2005 Recovery Plan (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). This criterion has not been met. 2D: The Recovery Plan recommends collection of seeds from all extant occurrences. No seed has been collected and accessioned to storage facilities from any of the occurrences. This criterion has not been met

- 3A: Although eight of the occurrences have periodically received some level of monitoring, status surveys and monitoring have not occurred over a time period that meets the requirements. 3B: Monitoring of Orcuttia viscida occurrences shows that the threat of competition from invasive, nonnative plants has increased since the time of listing. For example, Glyceria declinata (waxy manna grass), which was not included as a threat in the rule to list the species, is a nonnative, perennial grass that forms dense stands and is able to invade Orcuttia viscida habitat and displace the listed plant. In addition, if monitored occurrences are deemed to be threatened, there are no habitat management or rapid response measures planned. Habitat loss from urbanization also continues to be a threat to one of the occurrences. Although eight occurrences are now protected from land conversion, impacts from surrounding land use, adjacent road widening, and other human activities continue to threaten the species, especially if not periodically monitored. This criterion has not been met (USFWS, 2008). specified in the 2005 Recovery Plan (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). This criterion has not been met (USFWS, 2008).
- 4A: The Recovery Plan discusses a variety of research that would be beneficial to help refine recovery actions and criteria, and guide overall recovery and long-term conservation efforts (pages IV-53 to IV-63). The Recovery Plan recommends research on genetics, taxonomy, biology of vernal pool species, the effects of habitat management practices on vernal pool species and their habitat, and threats to vernal pool species and ecosystems. The majority of information needs discussed in the 2005 Recovery Plan are still outstanding. Currently, this criterion has not been met. However, Dr. Heather Davis, Department of Biology of Sonoma State University, began an investigation in 2007 on the population genetics of Orcuttia viscida and four other listed vernal pool plants to determine how pollination ecology interacts with population genetics to control the plant's reproductive success (Sonoma State University 2006). Seeds or plants remaining at the end of the study will be deposited at an appropriate seed storage facility. 4B: We are not aware of any genetic research relevant to the recovery criteria that has been conducted on Orcuttia viscida since the time of listing. This criterion has not been met. 4C: See 4B, above.
- 5A: The Recovery Plan discusses a variety of participation programs to achieve the goal of recovery of the listed species in the plan. An essential component of this collaborative approach is the formation of a single recovery implementation team overseeing the formation and function of multiple working groups formed at the vernal pool region level. The Service is currently in the preliminary stages of organizing both a recovery implementation team and multiple working groups. Service employees have met with various stakeholders to determine interest of stakeholders to be involved in working groups and/or the recovery implementation team. 5B: See 5A, above. 5C: This has not been initiated. 5D: This has not been initiated (USFWS, 2008).
- Conduct a study to identify methods to control the dispersal of the invasive grass, Glyceria declinata, in vernal pool habitat (USFWS, 2008).

- Develop and implement a management plan for control of nonnative, competitive plants, particularly Glyceria declinata. Phoenix Park, Phoenix Field, and Kiefer Landfill Wetland Preserve should be targeted for immediate control of Glyceria declinata. All remaining Orcuttia viscida occurrences should be surveyed for presence of Glyceria declinata and managed accordingly (USFWS, 2008).
- Introduce appropriate levels of grazing at the Rancho Seco site to benefit the Orcuttia viscida occurrence (USFWS, 2008).
- Work with SMUD to permanently protect the Orcuttia viscida plants and habitat, facilitate livestock watering improvements, and improve the cattle grazing regime to benefit Orcuttia viscida (USFWS, 2008).
- Conduct genetic research on Glyceria declinata to clarify its taxonomy (USFWS, 2008).

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 Sacramento Orcutt grass. Some of these recommendations have already been discussed in previous recovery documents (Service 2008, p. 17) and remain valid. 1. Conduct a Species Status Assessment for the next 5-year status review to assess the species status and determine whether downlisting is appropriate. Currently, most of the extant natural occurrences are permanently protected in perpetuity. 2. Conduct a study to identify methods to control the dispersal of the invasive waxy mannagrass in vernal pool habitat. 3. Develop and implement a management plan for control of invasive plants, particularly waxy mannagrass. Phoenix Field, Phoenix Park, and Kiefer Landfill Wetland Preserve should be targeted for control of waxy mannagrass. All remaining Sacramento Orcutt grass occurrences should be surveyed for waxy mannagrass and managed accordingly. Recovery Criteria 2008 Status 2024 Status 5A. Recovery Implementation Team is established and functioning to oversee rangewide recovery efforts. Partially met Partially met. The Service has established an internal vernal pool working group within the Sacramento Fish and Wildlife Office to assess and work towards the goals outlined in the Recovery Plan. This team will not function as the official recovery implementation team as it will only consist of Service employees, but the hope is that this internal working group will eventually provide the basis for creating a true Recovery Implementation Team as well as regional working groups. 5B. Vernal pool regional working groups are established and functioning to oversee regional recovery efforts. Not met Not met. The internal vernal pool working group has currently not expanded to a regional working group effort, but that is the intent. 5C. Participation plans for each vernal pool region have been completed and implemented. Not met Not met. This action has not been initiated; participation plans have not been developed for each vernal pool region. 5D. Vernal pool region working groups have developed and implemented outreach and incentive programs that develop partnerships contributing to achieving recovery criteria 1–4. Not met Not met. Regional vernal pool working groups have not yet been formed. 4. Implement appropriate levels of grazing at the Rancho Seco site to benefit Sacramento Orcutt grass. 5. Work with partners and private landowners to secure protection of the remaining unprotected occurrences of the species. Currently there are only two unprotected occurrences, one of which is within the footprint of a proposed preserve (USFWS, 2024)

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SPECIES ACCOUNT: *Piperia yadonii* (Yadon's piperia)

Species Taxonomic and Listing Information

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

Physical Description

A perennial herb with only 1-2 basal leaves, dying back each winter, visible above ground for the first few years of its growth. After several years, the plant produces a single flowering stem, up to 8 dm tall, with white and green flowers arranged in a narrow, dense cluster, generally 5-15 cm long. Blooms in summer. (NatureServe, 2015). Piperia yadonii (Yadon’s piperia) is a slender perennial herb in the orchid family (Orchidaceae). (USFWS, 2019)

Taxonomy

Piperia yadonii (Figure 5) was first collected by Leroy Abrams in 1925 in open pine forest near Pacific Grove. It was originally identified as a polymorphic (having or occurring in several distinct forms), wide-ranging species in the western United States known as Piperia unalascensis (Morgan and Ackerman 1990). At least two naturalists (i.e., George Henry Grinnel and Leroy Abrams) who collected from the Monterey region in the 1920's noted the uniqueness of the plants from this locality (Coleman 1995). In the most recent treatment of the genus Piperia, Ackerman (1977) segregated out several long-spurred taxa from the P. unalascensis complex but attempted no analysis of the short-spurred forms (which would eventually include P. yadonii). Subsequently, Morgan and Ackerman (1990) segregated out two new taxa from the P. unalascensis complex on the basis of floral markings, inflorescence type, and partly on geographic range. One of these taxa (i.e., Piperia yadonii) was named after Vernal Yadon, Director Emeritus of the Museum of Natural History in Pacific Grove, Monterey County (USFWS, 2004).

Historical Range

Since preparation of the listing rule, Piperia yadonii has been found at one location about 15.5 miles (mi) (25 kilometers (km)) south of the Monterey Peninsula near Palo Colorado Canyon in maritime chaparral (Norman, in litt. 1995). Maritime chaparral is uncommon along this region of the Big Sur coastline, but a few scattered patches do occur south to Pfieffer Point, located about 25 mi (40 km) from the Peninsula (Norman, pers. comm. 1997). Piperia yadonii has been found only 4 to 6 mi (6 to 10 km) inland (Allen 1996; Yadon, in litt. 1997) despite searches of lands farther east (Allen 1996). (USFWS, 2009)

Current Range

Occurs in three distinct groups of sites. It is endemic to Monterey Co., California. (NatureServe, 2015)

Critical Habitat Designated

Yes; 10/24/2007.

Legal Description

On October 24, 2007, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Piperia yadonii (Yadon's piperia) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes eight critical habitat units (CHUs), in California (72 FR

60410-60450).

Critical Habitat Designation

The critical habitat designation for Piperia yadonii includes eight CHUs (including 18 sub-units) in Monterey County, California. This species critical habitat encompasses approximately 2,117 acres (ac) (857 hectares (ha)) (72 FR 60410-60450).

Unit 1: Blohm Ranch: Unit 1 consists of 128 ac (52 ha) of private lands in northern Monterey County in the Elkhorn Slough watershed. It is divided into two ridgeline subunits, separated by intervening agricultural fields. The two subunits support similar plant communities and need similar types of special management considerations or protection; therefore, we discuss them as a unit, except to define land ownership or acreage. Unit 1 was occupied at the time of listing (Service 1998) and is currently occupied. It supports one of the two largest occurrences of Piperia yadonii plants in the Prunedale Elkhorn area (several thousand plants (Allen 1996 unpaginated)) and the northernmost occurrences in the known range of the species. This unit contains features that are essential for the conservation of P. yadonii, including soils from weathered marine sediments that are classified as an Arnold Santa Ynez complex on the ridgetops and as Arnold series soils on the slopes (PCE 1). Vegetation is primarily high quality maritime chaparral, with ridgetops dominated by low-growing Hooker’s manzanita. This unit provides habitat that supports germination, growth, and reproduction of P. yadonii. It contains ridgetop habitat openings, between and among patches of P. yadonii, to allow for population expansion and for shifts in population location, should successional vegetation or other changes occur that alter microhabitat conditions. Features essential to the conservation of P. yadonii in this unit may require special management considerations or protection due to: the growth and spread of invasive plant species (such as jubata grass); erosion from old roadbeds or past earth-moving activities; and herbivory (PCE 1, PCE 2). Herbivory of flowering stalks was 36 percent in 1999, although predators (mountain lion (Puma concolor)) of herbivores were recently sighted on these lands (Doak and Graff 2001, p. 28; Graff 2006, Appendix IV). Given that pollen deposition rates and seed production were low for the one site studied in this unit, special management may also be needed to ensure that the abundance of potential pollinators, such as moths or bees, are maintained or enhanced PCE 2). Subunit 1a: This subunit consists of 72 ac (29 ha) of private land owned by the Elkhorn Slough Foundation and The Nature Conservancy. Although restoration and removal of nonnative invasive plant populations are ongoing, a management plan specifically addressing Piperia yadonii on properties owned by the Elkhorn Slough Foundation and The Nature Conservancy has not yet been developed (Hayes 2006). Subunit 1b: This subunit consists of 56 ac (23 ha) of land owned by The Nature Conservancy and managed by the Elkhorn Slough Foundation, or owned and managed by the Elkhorn Slough Foundation. A management plan specifically addressing Piperia yadonii has not yet been developed.

Unit 2: Manzanita Park: Unit 2 consists of 498 ac (201 ha) of Monterey County lands north of Prunedale. It is divided into 3 subunits that support similar soils and vegetation communities and need similar types of special management considerations or protection; therefore, we discuss these characteristics for the whole unit. Unit 2 was occupied at the time of listing (Service 1998) and is currently occupied. The lands in this unit support several thousand Piperia yadonii plants scattered along the ridges, separated by intervening lower-elevation areas of oak woodland, farmed lands, and residential development (Allen 1996 unpaginated; Environmental Science Associates 2003; CNDDB 2005; Graff 2006 appendix IV). This unit contains features that are essential for the conservation of P. yadonii, including soils from weathered marine sediments that are classified as an Arnold–Santa Ynez complex on the ridgetops and as Arnold series soils on the slopes and on more undulating topography within Manzanita County Park (PCE 1). Vegetation within the subunits is primarily maritime chaparral, with some coast live oak woodland at the lower elevations. The ridgetops are dominated by low-growing Hooker's manzanita. This unit contains the PCEs for P. yadonii that promote germination, growth, and reproduction (PCE 1). This unit encompasses a cluster of three ridgelines primarily oriented east-west that rise in elevation from west to east, which support P. yadonii and which may be close enough for genetic exchange via wind-dispersed seed. In conjunction with the Blohm Ranch unit (Unit 1), this unit encompasses the majority of the P. yadonii plants known in the northern half of the range of P. yadonii. The ridgetop habitat openings, between and among patches of P. yadonii, allow for population expansion and for shifts in population location, should successional vegetation or other changes occur that alter microhabitat conditions. This unit is the central of the three in the Elkhorn Prunedale geographic area. This unit supports one of the two largest occurrences in the species' northern range, and the subunits of Unit 2 include the largest occupied ridgelines relatively unfragmented by residential development in the heart of the species' northern distribution. Due to their relatively unfragmented condition, lands in this unit may support dormant plants among the patches of currently known P. yadonii. Features in this unit may require special management considerations or protection due to: the growth and spread of invasive plant species, such as jubata grass, French broom, and eucalyptus; elimination or further fragmentation of habitat from residential, recreational, or agricultural development; vegetation removal for fuel reduction purposes; disease; and herbivory (PCE 1, PCE 2). Habitat with features essential to the conservation of P. yadonii in this unit may require special management considerations or protection to ensure the abundance of potential pollinators, such as moths or bees, are maintained or enhanced, to ensure the production of sufficient viable seed (PCE 2). Subunit 2a: This subunit consists of 231 ac (93 ha) of land owned and managed by the Elkhorn Slough Foundation. Subunit 2b: This subunit consists of 83 ac (34 ha) of private lands. Some of the lands in this subunit were proposed for a 10-lot subdivision, residential development, and open space designation in 2000 (Mercurio 2000, p. 2); this project may be moving forward in the near future (Schubert 2006). Subunit 2c: This subunit consists of 183 ac (74 ha) within Manzanita County Park, owned and managed by the County of Monterey. Part of the park has been developed into a sports complex and is not part of the designation. A portion of the park within the unit is used for hiking and equestrian use. Although volunteers have recently begun removing nonnative invasive plants from the park, we are not aware of the existence of any management plan that specifically addresses Piperia yadonii on properties owned by Monterey County.

Unit 3: Vierra Canyon: Unit 3 consists of 50 ac (20 ha) consisting primarily of State lands in northern Monterey County north of Prunedale. It is divided into 3 subunits with similarities in vegetation and special management considerations or protection needs. Unit 3 was occupied at the time of listing (Service 1998) and is currently occupied (Childs 2004). The easternmost Piperia yadonii occurrences in unit 3 (subunits 3b and 3c) are reported to be small, with fewer than 10 flowering individuals; this likely represents up to several hundred individuals, based on the observed proportion of flowering to vegetative individuals (Doak and Graff 2001). This unit contains features that are essential for the conservation of P. yadonii, including the following: Lands in this unit support soils from weathered marine sediments that are classified as an Arnold-Santa Ynez complex on the ridgetops and the Arnold series on the slopes (PCE 1). Vegetation is primarily maritime chaparral, with coast live oak woodland in the lower elevation areas. The ridgetops are dominated by lowgrowing Hooker's manzanita. Analysis of aerial photographs suggests that chaparral vegetation on the ridgetops in this region maintains a more open canopy than in areas to the west, in the areas of Units 1 and 2 (Van Dyke 2006). Therefore, these areas may support openings that are more persistent, and can be occupied by P. yadonii for a longer time, than areas to the west, even in the absence of fire (Van Dyke 2006). The lands surrounding these subunits are more extensively developed for residential use than are those to the west, severing the once continuous maritime chaparral that dominated the ridges. Consequently the subunits are smaller and lack the additional habitat for population expansion found in the other northern units. This unit contains the PCEs for P. yadonii that promote germination, growth, and reproduction. It supports the easternmost occurrences of P. yadonii in the Elkhorn'Prunedale region, on the northeast periphery of the species' range. Features essential to the conservation of P. yadonii in this unit may require special management considerations or protection due to elimination or further fragmentation of habitat from development, grading or other vegetation removal (e.g., for fuel reduction purposes or roads), and the spread of invasive plant species (PCE 1, PCE 2). Subunit 3a: This subunit consists of 17 ac (7 ha) of private lands that are overlain by a Pacific Gas and Electric Company easement. The occurrence in this subunit is the largest documented in Unit 3, numbering several thousand plants (Childs 2004). Subunit 3b: This subunit consists of 12 ac (5 ha) of State lands (California Department of Transportation (Caltrans)). The lands in this subunit and in subunit 3c were part of a previous study area for a highway alignment. This alignment was eventually excluded from further consideration and the State retains the lands (Robison 2006). We are not aware of any management plan that addresses Piperia yadonii on these State properties. Subunit 3c: This subunit consists of 21 ac (8 ha) of State lands, owned by Caltrans.

Unit 4: Aguajito: Unit 4 consists of 108 ac (44 ha) of private land east of the Monterey Peninsula and north of Jack's Peak County Park. It is divided into 2 subunits separated by lower elevation lands. Unit 4 was occupied at the time of listing (Service 1998) and is currently occupied. Piperia yadonii occurs in these subunits on ridgetops, where it grows with Hooker's manzanita (EcoSystems West 2006, p. 61). This unit contains features that are essential for the conservation of P. yadonii, including the following: Soils in this unit are classified as the Santa LuciaReliz Association, where Reliz series soils occur on the ridgetops and Santa Lucia series soils on surrounding slopes (PCE 1). Reliz series soils are characterized as excessively drained shaley clay loams underlain by shale or sandstone (USDA 1978, p. 64). The vegetation in the unit is a mix of Monterey pine forest and maritime chaparral. Griffin (1978, p. 69) commented that this area was one of the only ones in the Monterey Bay area where maritime chaparral grows on shale. He also noted that sandstones exist within the shale beds and produce sandy loam soils. A related species, Piperia elegans, is more abundant in the surrounding Monterey pine forest (EcoSystems West 2005b, p. 7). This unit provides habitat that supports germination, growth, and reproduction. Unit 4 represents one of only two units in the region interior to the Monterey Peninsula. It supports the largest undeveloped easternmost occurrence of P. yadonii in the central and southern half of the species' range. Its preservation will help avoid range collapse. Features essential to the conservation of P. yadonii in this unit may require special management considerations or protection due to fragmentation of habitat from development and the colonization and spread of invasive plant species (PCE 1, PCE 2). We are also excluding 49 acres (20 ha) from this subunit as a result of the Pebble Beach Company's conservation agreement. Subunit 4a: This subunit consists of 49 ac (20 ha) of private lands (owned by the Pebble Beach Company). Lands in and/or adjacent to this subunit and subunit 4b are proposed for preservation in the Pebble Beach Company's recent development plan, but the configuration of the preservation areas is not yet determined (Monterey County 2005, pp. 2–89, 2–90). Subunit 4b: This subunit consists of 56 ac (24 ha) of private lands (owned by the Pebble Beach Company) and proposed for preservation (see above), and 3 ac (1ha) of Monterey County road right-of-way.

Unit 5: Old Capitol: Unit 5 consists of 16 ac (7 ha) of private land (owned by the Pebble Beach Company) east of the Monterey Peninsula. Unit 5 was occupied at the time of listing (Service 1998) and is currently occupied. Surveys in 2005 revealed that the dominant Piperia species at this location is P. elegans, which number in the thousands; however, several hundred P. yadonii cooccur with P. elegans throughout the unit (EcoSystems West 2005b, pp. 5–7). This unit contains features that are essential for the conservation of P. yadonii, including the Chamise shaley clay loam (PCE 1) soil type. The vegetation is Monterey pine forest and coast live oak woodland. This unit provides habitat that supports germination, growth, and reproduction of P. yadonii. It is the only unit designated between the Monterey Peninsula (Unit 6) and Aguajito (Unit 4) to the east and, therefore, provides connectivity between these other two units. Features essential to the conservation of P. yadonii may require special management considerations or protection in this unit due to: Fragmentation or loss of habitat from development, habitat degradation by motorized vehicles and encampments, debris dumping, and competition from nonnative invasive plants (PCE 1, PCE 2). The land in Unit 5 is proposed for preservation in the Pebble Beach Company's recent development plan (Monterey County 2005, pp. 2–89, 2– 90).

Unit 6: Monterey Peninsula: Unit 6 consists of 920 ac (372 ha) of private and City lands on the Monterey Peninsula. This unit is divided into 5 subunits due to intervening development. Most of the lands surrounding this unit are developed for residential and recreational (golf) use. The similarities among the subunits in soils and vegetation community are discussed here; subunit specific details are discussed below. Unit 6 was occupied at the time of listing (Service 1998) and is currently occupied. It supports the greatest abundance and largest aerial extent of Piperia yadonii in the species' range, with close to 100,000 vegetative plants (Zander Associates and WWD Corporation 2004, all pp.; EcoSystems West 2004, pp. 1–9; EcoSystems West 2005a, 2005b, all pp.). This unit contains features that are essential for the conservation of P. yadonii including sands or sandy loam soils that belong to at least 5 soil series on the Monterey Peninsula unit (Baywood sands, Narlon loamy fine sands, Sheridan coarse sandy loams, Tangair fine sands, and Santa Lucia shaley clay loam). Vegetation in this unit is primarily Monterey pine forest, with maritime chaparral, and Bishop pine/Gowen cypress forest in two subunits (PCE 1). Pollinator observations and collections were made on lands in this unit (PCE 2) (Doak and Graff 2001). This unit provides habitat that supports germination, growth, reproduction, and space for shifts in the location of P. yadonii, as microhabitat conditions change. Features essential to the conservation of P. yadonii may require special management in this unit due to: Adverse effects from adjacent existing and future development, including the loss of adjacent forest canopy, increased trampling, potential hydrologic changes, overspray of pesticides, the introduction of pathogens or disease, mowing, and the introduction and spread of invasive plant species; continuing high and/or increasing deer populations resulting in high herbivory levels; and increased growth of understory vegetation due to exclusion of wildfire (PCE 1, PCE 2). Subunit 6a: This subunit consists of 810 ac (328 ha) of private lands owned by the Pebble Beach Company and other private owners, including 17 ac (7 ha) owned by the Del Monte Forest Foundation (DMFF). Protected lands in this subunit include the SFB Morse Botanical Reserve (owned by the DMFF) and the Huckleberry Hill Natural Reserve (easement held by the DMFF). It also includes lands identified in the Pebble Beach Company's most recent development proposal for preservation or conservation: Areas PQR, G, H, I, the Corporate Yard Preservation Area, and Area D (Monterey County 2005). The Department of the Army's Presidio of Monterey is contiguous with the northeastern edge of this subunit; those lands are exempted from this designation, as described later in this rule. We have also excluded 54 acres (22 ha) from this subunit as a result of the Pebble Beach Company's conservation agreement and 6 ac (2.4 ha) from the Stevenson School property. We have also removed 35 acres (including Area D) because they do not support the PCEs. Please see the section Relationship of Critical Habitat to Approved Management Plans— Exclusions Under Section 4(b)(2) of the Act and our responses to Comments 12 and 13, for a discussion of these exclusions. Plant communities in the Huckleberry Hill Natural Area and SFB Morse Botanical Preserve are Gowen cypress/ Bishop pine forest, maritime chaparral, and Monterey pine forest. The remaining lands support primarily Monterey pine forest. Lands in this subunit support about 90,000 vegetative Piperia yadonii plants (Zander Associates and WWD Corporation 2004 all pp.; EcoSystems West 2004, pp. 1– 9; EcoSystems West 2005a, 2005b, all pp.). Although the DMFF conducts some monitoring and removal of nonnative invasive plant populations, a management plan specifically addressing P. yadonii on properties owned by the DMFF has not been developed. Subunit 6b: This subunit consists of 6 ac (2 ha) of private lands. It is identified in the Pebble Beach Company's most recent development proposal as the Bristol Curve Conservation Area (Monterey County 2005 Fig. ES–2). This subunit is part of a larger area identified by the Pebble Beach Company as Area MNOUV, which supports about 116 ac (47 ha) of Monterey pine forest and one of the two largest known occurrences of Piperia yadonii (about 57,000 plants (Zander Associates and WWD Corporation 2004)). The Monterey pine forest of MNOUV outside the proposed Bristol Curve conservation area is proposed for development as a golf course (Monterey County 2005). Vegetation in this subunit is Monterey pine forest with an herbaceous understory. We are excluding 1 acre (1 ha) from this subunit as a result of the Pebble Beach Company's conservation agreement, and as a result of boundary adjustments, we have not included 2 acres of proposed critical habitat within this subunit that do not support the PCEs. Please see the section Relationship of Critical Habitat to Approved Management Plans— Exclusions Under Section 4(b)(2) of the Act and our responses to Comments 12 and 13, for a discussion of these exclusions. Subunit 6c: This subunit consists of 31 ac (13 ha) of private lands, of which about 23 acres (9 ha) are owned by the DMFF. Lands within this unit are referred to as Indian Village (owned by the DMFF) and, in the Pebble Beach Company's recent development proposal, as Conservation Area K and Preservation Areas J and L (Monterey County 2005 Fig. ES–2). Adjacent lands (Part of Area K) that are proposed for development are not included in this subunit. We are excluding 37 acres (15 ha) from this subunit as a result of the Pebble Beach Company's conservation agreement, and we have removed 2 acres (1 ha) as a result of boundary adjustments to account for areas that do not support the PCEs. Please see the section Relationship of Critical Habitat to Approved Management Plans— Exclusions Under Section 4(b)(2) of the Act and our responses to Comments 12 and 13, for a discussion of these exclusions. The vegetation in this subunit is primarily Monterey pine forest. This subunit supports several thousand Piperia yadonii plants (Zander Associates and WWD Corporation 2004). Along with subunits 6b and 6d, it encompasses lands in the westernmost region of the Monterey Peninsula. Subunit 6d: This subunit consists of 12 ac (5 ha) of private lands owned by the DMFF. It encompasses the Crocker Grove, an area of Monterey cypress forest with some adjacent Monterey pine forest (PCE 1). This is the westernmost subunit on the peninsula, closest to the ocean, and lands it occurs on are mapped as marine terrace 2 (Jones and Stokes 1994b, p. 11). It has been documented to support about 50 flowering Piperia yadonii plants (Van Dyke et. al. 2006), which typically equates to several hundred vegetative plants. Subunit 6e: This subunit consists of 42 ac (17 ha) of private lands and 19 ac (7 (ha) owned by the City of Pacific Grove. About 29 ac (12 ha) of the private lands are owned by the DMFF. Lands within this unit are referred to as the Navajo tract and as Preservation Area B in the Pebble Beach Company's most recent development proposal (Monterey County 2005 Fig. ES–2). We are excluding 2 acres (1 ha) from this subunit as a result of the Pebble Beach Company's conservation agreement. Please see the section Relationship of Critical Habitat to Approved Management Plans—Exclusions Under Section 4(b)(2) of the Act for a discussion of this exclusion. The vegetation in this subunit is a mix of coast live oak and Monterey pine forest (PCE 1). It is the northernmost unit we are designating on the Peninsula. It supports several hundred plants of Piperia yadonii (Zander Associates and WWD Corporation 2004).

Unit 7: Point Lobos Ranch: Unit 7 consists of 228 ac (92 ha) of State land south of the Monterey Peninsula on the Big Sur coast, and 97 ac (39 ha) owned by the Big Sur Land Trust that are intended to be added to the State Parks system in the future. Unit 7 was occupied at the time of listing (Service 1998) and is currently occupied. The lands in this unit support several thousand Piperia yadonii plants (Graff et al. 2003, Nedeff et al. 2003). This unit contains features that are essential for the conservation of P. yadonii, including the sandy loam soils in the Sheridan, Narlon, Junipero Sur complex series, underlain by granitic substrates from which terrace sands have been eroded (Griffin 1978, p. 69, USDA 1978 map no. 35). Vegetation is a composite of Monterey pine forest, maritime chaparral, Gowen cypress Bishop pine forest, with some redwood forest. Piperia yadonii occurs in this unit in Monterey pine forest; on exposed granitic soils in maritime chaparral dominated by Hooker's manzanita; and under a canopy of Monterey pine, Gowen cypress, and redwood (Sequoia sempervirens) (PCE 1). This unit provides habitat that supports germination, growth, and reproduction of P. yadonii, as well as population expansion and shifts in population location. This unit supports P. yadonii growing on soils not found in other units and in association with a varied mix of forest tree species. This is the second highest unit in elevation and supports the largest occurrence of P. yadonii south of the Monterey Peninsula (Graff 2006). Features essential to the conservation of P. yadonii may require special management in this unit due to: the growth and spread of invasive plant species, such as French broom; loss of habitat from residential development; and erosion (PCE 1, PCE 2). Access by park visitors may need to be managed to avoid creation of trails in Monterey pine forest populations and use of herbicides should be controlled to avoid or minimize effects to P. yadonii (PCE 1).

Unit 8: Palo Colorado: Unit 8 consists of 73 ac (29 ha) of private land on the Big Sur coast. Unit 8 was occupied at the time of listing (Service 1998) and is currently occupied. The lands in this unit were reported to support 38 flowering Piperia yadonii plants (Norman 1995), which likely represents a population of several hundred to several thousand vegetative individuals, based on the observed proportions of flowering to vegetative individuals (Doak and Graff 2001). This unit contains features that are essential for the conservation of P. yadonii including the following: A mix of sandy loam soils, shallow soils less than 20 inches deep, and rock outcrops classified as the Junipero-Sur complex and Rock Outcrop—Xerorthents Association (PCE 1) (USDA 1978, p. 38). Vegetation in this unit has been described as a unique association of maritime chaparral, with low-growing hybrid Arctostaphylos glandulosa as the dominant manzanita under which P. yadonii occurs (Norman 1995). This unit provides habitat that supports germination, growth, and reproduction of P. yadonii. This unit supports the most southern and highest elevation (1,000 to 1,400 feet (300 to 430 m)) occurrence in the species' range. Features essential to the conservation of P. yadonii may require special management in this unit due to habitat fragmentation and habitat degradation from road and trail grading and from future development, such as the introduction and spread of nonnative plants, removal of native vegetation, erosion, and hydrologic changes (PCE 1, PCE 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 Piperia yadonii critical habitat consists of two components (72 FR 60410-60450):

(i) A vegetation structure providing filtered sunlight on sandy soils: (A) Coastal pine forest (primarily Monterey pine) with a canopy coverof 20 to 70 percent, and a sparse herbaceous understory on Baywood sands, Narlon loamy fine sands, Sheridan coarse sandy loams, Tangair fine sands, Santa Lucia shaly clay loams and Chamise shaley clay loams underlain by a hardpan; or (B) Maritime chaparral ridges with dwarfed shrubs (primarily Hooker's manzanita) on Reliz shaly clay loams, Sheridan sandy loams, Narlon sandy loams, Arnold loamy sands and soils in the Junipero–Sur complex, Rock Outcrop–Xerorthents Association, and Arnold–Santa Ynez complex, often underlain by rock outcroppings.

(ii) Presence of nocturnal, shorttongued moths in the families Pyralidae, Geometridae, Noctuidae, and Pterophoridae.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the occupied areas contain the features essential to the conservation of the species that may require special management considerations or protection. Many of the known occurrences of Piperia yadonii are threatened by one or a combination of the following: habitat fragmentation or loss due to residential, commercial, or recreational development; competition with nonnative plants for light, space, or water; deer and rabbit herbivory; vegetation cutting for fire prevention; changes in light, space, and soil moisture availability due to loss or alteration of adjacent vegetation or forest canopy; changes in fecundity (number and viability of offspring) or genetic variability resulting from loss and fragmentation of populations or potentially low pollinator abundance or activity; disease; and trampling (PCE 1, PCE 2). In maritime chaparral associations of the Prunedale-Elkhorn region where fire has not occurred in many decades, shrub diversity appears to be declining as coast live oak or largecanopied manzanitas become dominant (Van Dyke et al. 2001, pp. 225–227). This conversion may be slow in the shallow ridgetop soils where P. yadonii occurs, but increasing development surrounding these ridgetops reduces the opportunity to use fire as a management tool should it be deemed necessary to maintain the open, low-canopy conditions of P. yadonii's preferred habitat (PCE 1). These threats may require special management and are addressed under the critical habitat unit descriptions below.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: As in other orchids, germination of P. yadonii seeds probably involves a symbiotic relationship with a fungus. Following germination, orchid seedlings typically grow below ground for 1 to several years before producing their first basal leaves. Plants may produce only vegetative growth for several years, before first producing flowers (Rasmussen 1995). In mature plants of P. yadonii, the basal leaves typically emerge sometime after fall or winter rains and wither by May or June, when the plant produces a single flowering stem. Consistent with what is known of other orchid species, Allen (1996) observed that only a small percentage of the Piperia yadonii plants in a population may flower in any year. Individual orchids that flower in one year may not have the necessary energy reserves to flower in the following year, so size and flowering are not necessarily age-dependent (Wells 1981, Rasmussen 1995). Although Piperia yadonii is capable of self-pollination, the rate of production of viable seeds is higher in plants pollinated by insects (Doak and Graff 2001). Doak and Graff (2001) found that pollinators of Piperia yadonii are predominantly nocturnal, short-tongued moths. In order to maintain adequate seed production to support long-term persistence of the species, suitable habitat of sufficient size and connectivity for these pollinators also needs to be maintained (USFWS, 2009). Yadon’s Rein orchid is a later successional species, taking up to 15 years after habitat disturbance before colonizing or re-colonize a site (Allen 1996). It's ability to sustain and re-colonize after habitat disturbance is dependent upon changes to the habitat, mostly due to edge effects (United States Fish and Wildlife Service 2009). Mycorrhizal fungal associations do not seem to limit colonization or it's range because it associates with a number of fungal families (Pandey et al. 2013) (NatureServe, 2015).

Habitat Type

<u>Adult:</u> Forest/chaparral (NatureServe, 2015)

Environmental Specificity

<u>Adult:</u> Narrow/specialist (NatureServe, 2015)

Habitat Narrative

<u>Adult:</u> Species inhabits monterey pine forest and maritime chaparral communities, primarily on poorly drained sandstone and sandy soils. (NatureServe, 2015)

Dispersal/Migration

Population Information and Trends

Population Trends:

Decreasing (NatureServe, 2015)

Number of Populations:

21 - 80 (NatureServe, 2015)

Population Size:

10,000 - 100,000 individuals (NatureServe, 2015)

Additional Population-level Information:

The blooming season is brief, usually starting in mid-June and ending in early August (Coleman 1995, Doak and Graff 2001) (USFWS, 2009).

Population Narrative:

As observed with other orchids, germination of seeds is believed to involve a symbiotic relationship with a fungus. The blooming season is brief, usually starting in mid-June and ending in early August (Coleman 1995, Doak and Graff 2001). Individuals that flower in one year may not flower the next, and a portion of the population may be completely dormant in any given year (USFWS, 2009). This localized endemic is an orchid which is not always visible throughout its life cycle. It is therefore highly vulnerable. Long term trend is assumed to have been sharply downwards due to the high rate of development over the past 200 yrs in the plant's habitat. Decline of 30-50% About 47000 plants known from 28 sites (CNDDB 2014). One site contains about 80% or 39000 plants. 29 known EO's; 1 is extirpated (CNDDB 2014) (NatureServe, 2015). Moderate resiliency, representation and redundancy are based on the number of known populations and individuals.

Threats and Stressors

Stressor: Development (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitatt
Narrative: Urban and recreational developments, specifically golf courses on the Monterey Peninsula, continue to threaten this plant’s existence. Golf course development is less of a threat than at the time of listing due to the Coastal Commission’s denial of Pebble Beach Company’s plans for development of a new golf course on the area containing the largest population of Piperia yadonii within the range of the species in 2007 (USFWS, 2009).

Stressor: Predation (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Although the Service is not aware of any quantitative data on mule deer populations on the Monterey Peninsula, anecdotal evidence, such as sightings and reports of health, suggest that the number of deer on the Peninsula is high (Matthews, California Native Plant Society, in litt. 1996; Steeck, USFWS, pers. obs. 1996). If the loss of 85 percent of flowering stems calculated by Allen (1996) is close to actual herbivory rates on the Monterey Peninsula, predation could continue to have a substantial effect on the reproductive success of the species, particularly if populations are reduced by large-scale habitat loss and fragmentation due to development. Graff (2006) suspected that populations of Piperia yadonii occurring in forests surrounded by large areas of high-quality habitat may have herbivory rates above 70 percent compared to around 40 percent in populations in chaparral. High rates of herbivory could severely impact Piperia yadonii populations by reducing individual plant survivorship as well as reproduction (EcoSystems West 2008) (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 Piperia yadonii included: the California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA), and the Act in those cases where Piperia yadonii occurs and is incidentally protected in habitat occupied by a listed wildlife species. The listing rule (74 FR 12878) provides an analysis of the level of protection that was anticipated from those regulatory mechanisms. This analysis appears to remain valid. The Act is the primary Federal law that provides protection for this species since its listing as endangered in 1998. The California Coastal Commission, in cooperation with Monterey County, conducts periodic reviews of the

implementation and effectiveness of Monterey County's Local Coastal Program in carrying out the goals and policies of the California Coastal Act. Corrective actions or recommendations are provided by the Commission to the County and will be integrated into Monterey County's 21st Century General Plan Update. 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 Act (USFWS, 2009).

Stressor: Stochastic extinction (USFWS, 2009)
Exposure:
Response:
Consequence: Extinction
Narrative: At the time of listing, Piperia yadonii was threatened with extinction from natural random acts by virtue of the limited number of individuals and range of the existing populations. Small populations are also vulnerable to extinction by a single human-caused or natural event. Inbreeding may affect small or isolated populations if it results in inbreeding depression. Since the time of listing, the known range of the species and number of individuals and populations has increased as a result of extensive survey efforts. Our current assessment is that the risk of stochastic extinction is less than at the time of listing due to the increase in the size of several of the populations. However, other populations continue to be at risk due to their small size and isolation from surrounding suitable habitat (USFWS, 2009).

Stressor: Competition with non-native species (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The Piperia yadonii listing rule states that Cortaderia jubata (pampas grass) and Genista monspessulana (French broom) are two non-native plant taxa that invade forests and meadows on the Monterey Peninsula. In addition, Acacia spp. (acacia) and Briza maxima (rattlesnake grass) have been listed as threats in the Del Monte Forest populations (Ecosystems West 2008). The Pebble Beach Company has an on-going eradication program for these taxa (Pebble Beach Co. 2008). Due to aspects of the life history of Piperia yadonii, such as dormancy, more monitoring will be necessary to determine the response of the species after non-native species removal (Ecosystems West 2008). Invasion of non-native plants is a continuing threat and could increase in severity if the remaining populations are reduced in size, dissected into many smaller parcels, or become isolated by surrounding development (USFWS, 2009).

Stressor: Fire prevention and fire suppression activities (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: At the time of listing, maintenance of firebreak roads in Monterey pine forest was described as providing open habitat for invasive, non-native species. It was believed that these species could never be eradicated from the area due to the necessity of maintaining the firebreak roads. Clearing and maintaining exposed ground that could allow the establishment or persistence of non-native species continues to pose a threat to Piperia yadonii. Fire suppression activities could pose a threat to Piperia yadonii. Periodic fire could remove dense vegetation and

reduce organic accumulation on the ground to provide better habitat for Piperia yadonii (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. Coastal populations will be particularly vulnerable to habitat loss and degradation due to sea level rise and storm surges. 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 Piperia yadonii at this time (USFWS, 2009).

Recovery

Reclassification Criteria:

Secure and protect areas throughout the present range of Piperia yadonii that contain populations of sufficient size to ensure the long-term survival and recovery of the species (USFWS, 2009).

Protected areas are adequately maintained, such that encroachment by non-native plants, excessive herbivory, edge effects from road maintenance, fuel modification activities, or other threats do not directly or indirectly adversely affect Piperia yadonii and its habitat (USFWS, 2009).

Results of monitoring activities have determined that the protected populations of Piperia yadonii are of adequate size to be self-sustaining and to ensure their long-term persistence. This species is a perennial that exhibits dormancy, spending an undetermined period underground between seed germination and emergence of first leaf aboveground. The duration of dormancy specific to Piperia yadonii is not known but data on similar species indicate may be up to 4 years (Hutchings 1987). The 2004 Recovery Plan states that a minimum of 10 to 15 years of monitoring will likely be needed in order to define a population trend (USFWS, 2009).

Recovery Priority Number: 2C

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 species (especially grasses and broom), and b) control of herbivory by deer and small mammals. (USFWS, 2019).

Delisting Criterion 2) a seed bank has been established at a recognized institution certified by the Center for Plant Conservation. (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. Based on recent research by Graff (2006), we expect above-ground population size to fluctuate somewhat on an annual basis, based on response to amount and timing of rainfall. 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:

- Secure and protect existing populations and habitats that occur on private or unprotected lands (USFWS, 2004).
- Manage private and secured lands to control or eliminate threats to existing populations and their habitat (USFWS, 2004).
- Stimulate research on the biology of these species. Develop management strategies based on life-history research and species responses to vegetation management (USFWS, 2004).
- Determine other potentially suitable habitat areas that should be surveyed for additional populations, or that can be used for reestablishment or reintroduction of populations (USFWS, 2004).
- Use monitoring, research results, and assessment of potential threats to determine effectiveness of management actions (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).
- We recommend land managers continue monitoring of all known populations of Piperia yadonii and manage land uses for conservation of the species. More monitoring is necessary to determine any population trends due to the variability in above ground expression of the species. Long-term monitoring will aid in distinguishing between true population trends and changes in dormancy from year to year (Graff 2006) (USFWS, 2009).
- We recommend the County of Monterey develop a set of best management practices to work with private land owners to protect populations of Piperia yadonii and manage for the species (USFWS, 2009).
- We recommend research be undertaken to identify ways to reduce and minimize herbivory on the Monterey Peninsula (USFWS, 2009).
- We recommend continued efforts by landowners and land managers to reduce and remove non-native species (USFWS, 2009).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Secure funding for annual surveys and invasive species management for occurrences in each recovery area that are currently protected from development, but for which funding is absent or expected to be reduced in the future. 2. Promote the establishment of Yadon's piperia through seeding following the methodology of JMC and EWCG (2016, p. 3-7). Results of seeding are likely to take four or more years to determine success, and then require long term management of invasive species and litter. Seeding should be conducted proactively. 3. Create and maintain at least one deer exclusion area in each protected occurrence to ensure reproductive output of at least small portions of larger populations. (USFWS< 2021)

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SPECIES ACCOUNT: *Platanthera integrilabia* (White fringeless orchid)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/13/2016; Southeast Region (R4) (USFWS, 2017)

Physical Description

White fringeless orchid is a perennial herb with a light green, 60 centimeter (cm) (23 inches (in)) long, stem that arises from a tuber. The leaves are alternate with entire margins and are narrowly elliptic to lanceolate in shape. The lower leaves are 20 cm (8 in) long and 3 cm (1 in) wide. The upper stem leaves are much smaller. The white flowers are borne in a loose cluster at the end of the stem. The upper two flower petals are about 7 millimeters (mm) (0.3 in) long and the lower petal (the lip) is about 13 mm (0.5 in) long. The epithet integrilabia refers to the lack of any prominent fringe on the margin of the lip petal. The plants flower from late July through September and the small narrow fruiting capsule matures in October (Shea 1992, page 23).

Taxonomy

White fringeless orchid was first recognized as a distinct taxon in 1941 when D.S. Correll described this plant as a subspecies of Habenaria (Platanthera) blephariglottis (Correll 1941, pages 153-157). C.A. Luer elevated the taxon to full species status in 1975 (Luer 1975, page 186). The currently accepted binomial for the species is Platanthera integrilabia (Correll) Luer.

Historical Range

U.S.: Alabama, Georgia, Kentucky, Mississippi, South Carolina, North Carolina, Tennessee. Platanthera integrilabia was originally known seven states.The species has been extirpated from North Carolina (Henderson and Cherokee Counties), and a population has been extirpated from one county in Georgia (Cobb County). We previously have reported that P. integrilabia historically occurred in Virginia, but based on information from Townsend (pers. comm. 2012), we no longer consider Virginia to be within the historic distribution of this species.

Current Range

U.S.: Alabama (9), Georgia (8), Kentucky (8), Mississippi (2), South Carolina (1), Tennessee (37). The species currently occurs within the Appalachian Plateau Physiographic Province in Kentucky, Tennessee, Georgia, and Alabama; the Coastal Plain Physiographic Province in Alabama and Mississippi; the Blue Ridge Province in Georgia and Tennessee (Shea 1992, page 19); and primarily in the Piedmont Physiographic Province in Georgia (Medley 1980; White 1998, pers. com. 1999; A. Shea pers. com. 1999; McCoy 2008, 2012; and Patrick pers. com. 2012).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual; R-selected

Dependency on Other Individuals or Species

Adult: Research on the mycorrhizal fungal relationships of P. integrilabia suggests that the symbiont's, specifically Epulorhiza inquilina, presence may play a key role in the rate of seed germination (Currah, Zettler and McInnis 1997; Yoder et al. 2000). Platanthera integrilabia is considered to be pollinated by diurnal Lepidoptera, especially swallowtails and/or sphingid moths.

Breeding Season

Adult: The plants flower from late July through September and the small narrow fruiting capsule matures in October (Shea 1992, page 23).

Reproduction Narrative

Adult: Platanthera integrilabia flowers from late July through early September but as early as June in the southern portion of its range (Alabama). Fruits usually mature in October (Luer 1975; Gleason & Cronquist 1991; Shea 1992). Each plant grows from a single rootstock or tuber. In the winter season, two tubers can be found on one plant; one large tuber and a smaller more recently formed tuber. By spring, the tuber from the previous season (larger) will die back, and the new smaller tuber will supply energy for the upcoming growing season. The formation of the "same" plant from a new tuber can cause the vegetative shoot to "move" up to 15 cm from the previous year's locale (Shea 1992; Zettler & Fairley 1990). The percentage of individuals flowering within a population is generally very low. Like many Orchids, P. integrilabia has pollinia (pollen sacs which adhere to pollinators) that transfer pollen from plant to plant. The primary chemical attractant, which is common, in orchid nectars with strong evening odors is linalool (Hill 1968). Only about 3% of the wind-dispersed seeds germinate, which means plants have to produce copious amounts of seeds to overcome the high seed/seedling mortality. Recent studies of the other factors leading to low reproductive capacity are herbivory, inbreeding depression, and lack of effective pollinators (Zettler & Fairley 1996 and Bailey 2001). Additionally, research on the mycorrhizal fungal relationships of P. integrilabia suggests that the symbiont's, specifically Epulorhiza inquilina, presence may play a key role in the rate of seed germination (Currah, Zettler and McInnis 1997; Yoder et al. 2000).

Habitat Type

Adult: Platanthera integrilabia is generally found in wet, flat, boggy areas in acidic muck or sand, and in partially, but not fully shaded areas at the head of streams or seepage slopes.

Habitat Vegetation or Surface Water Classification

Adult: Riverine habitat: Spring/Spring brook; Palustrine habitat: Bog/fen, Forested wetland, Herbaceous wetland, Riparian (NatureServe)

Geographic or Habitat Restraints or Barriers

Adult: Typical barriers for this species include uplands and bodies of water without margins that support shallow wetlands (NatureServe 2009; Major 2002).

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2012)

Habitat Narrative

Adult: Platanthera integrilabia grows in wet, boggy areas at the heads of streams and on seepage slopes. It is often associated with Sphagnum in partially, but not fully, shaded areas. Other common associates include: cowbane (Oxypolis rigidior), grass-of-Parnassus (Parnassia asarifolia), primrose-leaf stemless white violet (Viola primulifolia) and other orchids, particularly green wood orchid (Platanthera clavellata) and yellow-fringe orchid (Platanthera ciliaris)(Patrick pers. com. 2012).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Successful germination and establishment of P. integrilabia could be limited by dispersal of seeds into suitable sites where hyphae of appropriate fungal species are present to support a symbiosis that could be critical in the orchids early life cycle (Birchenko 2000, p. 36).

Population Information and Trends

Population Trends:

Declining

Species Trends:

Declining

Resiliency:

Current Resilience: Resilience refers to the ability of populations to withstand stochastic events, whether demographic, environmental, or anthropogenic. For this SSA, empirical data are not available to associate resilience categories with specific quantitative extinction risks or probabilities of persistence. Rather, we are limited to providing qualitative definitions of each resilience category based upon assumptions about population size, flowering, and connectivity, which are based on general plant population dynamics rather than actual research on P. integrilabia. Populations with low resilience are highly vulnerable to stochastic events and face a high risk of extirpation within the next few decades. Populations with moderate resilience are less likely to be extirpated within the next few decades, but require additional population increases (with help of regular habitat management and/or restoration) to become more self-sustaining and resilient to stochastic events. Populations with high resilience are unlikely to be extirpated within the next few decades in the absence of catastrophes or significant declines in habitat quality. Populations with very high resilience are the most robust and resistant to stochastic fluctuations. Summaries of the 50 delineated populations and their resilience categories are provided in Table 5.3. Twenty-two percent of the assessed populations were classified as having high or very high resilience while 66 percent of the populations were classified as having low resilience (Table 5.4). Approximately one third of the populations have no protection or management and the majority (76 percent) of those have low resilience (Table 5.4). (USFWS, 2021)

Representation:

Representation describes the ability of a species to adapt to changing environmental conditions. Representation can be measured by the breadth of genetic or environmental diversity within and among populations and gauges the probability that a species is capable of adapting and/or acclimating to environmental changes. The more representation, or diversity, a species has, the more capable it is of adapting to changes (natural or human caused) in its environment. In the absence of species-specific genetic and ecological diversity information, we evaluate representation based on the extent and variability of habitat characteristics across the geographical range. To do this, we evaluated representation of P. integrilabia using EPA Level III Ecoregions (Omernik 1987, entire). Ecoregions are delineated based upon areas with similar biotic and abiotic phenomena including geology, landforms, soils, vegetation, climate, land use, and hierarchical level. P. integrilabia populations occur in five Level III Ecoregions: Blue Ridge (6); Piedmont (7); Ridge and Valley (1); Southeastern Plains (5); and Southwestern Appalachians (31) (Fig. 5.1; Table 5.5). Redundancy is greatest in the Southwestern Appalachians, which includes the Cumberland Plateau where the majority of P. integrilabia populations occur. Redundancy in the other ecoregions is comparatively lower; however, it is unclear how much this distribution has changed compared to the historical distribution of P. integrilabia. In addition to the low number of populations in the Blue Ridge, Piedmont, and Ridge and Valley ecoregions, all but three of these populations have low resilience; populations in the Southeastern Plains generally have low resilience and lack habitat protection with few exceptions (Figs. 5.1 and 5.2; Table 5.5). (USFWS, 2021)

Redundancy:

Redundancy describes the ability of a species to withstand catastrophic events. Measured by the number of populations, their resilience, and their distribution, redundancy gauges the probability that the species has a margin of safety to withstand or recover from catastrophic events (such as a rare destructive natural event or episode involving many populations). Catastrophic events could include, among others, frequent or severe fires, droughts, disease outbreaks, or prolonged flooding, each of which cause impacts at different spatial scales. It is worth noting that no information is currently available about soil seedbank formation or resilience for this species; lacking such data, it is difficult to predict long-term impacts of catastrophes. For P. integrilabia to maintain viability in the long term, the species needs to exhibit some degree of redundancy. As stated previously, there are 50 populations of P. integrilabia that have been observed within the past 20 years, and resilience of these populations is as follows: 5 – Very High; 6 – High; 6 – Moderate; and 33 – Low. The populations are spread across the range, although the majority are distributed in Tennessee and Kentucky (Fig. 5.1). P. integrilabia still occurs in most of the counties from which it is historically known. However, there are many low resilience populations in the eastern and southern parts of its range which may lead to reductions in the future redundancy (Fig. 5.1). Birchenko (2001, p. 37) determined there is currently no current indication of restricted gene flow between populations. However, genetic exchange between populations may be constrained in the future for a couple of reasons: (1) 54 percent of the populations exhibit low connectivity with other populations (i.e., no other populations within 10 kilometers) and (2) 30 percent of the populations have low or no flowering. Given the low numbers of individuals already occurring in many of these populations, especially in the southern and eastern populations (Fig. 5.1), it is far less likely that these populations can withstand acute catastrophic events. Redundancy is further threatened due to the lack of habitat protection for many of the populations occurring in the southwestern portion of the species range (Fig. 5.2). Limited redundancy of populations outside of the Southwestern Appalachians, many of which have low levels of resilience, suggests there is a greater risk of losing representation within these geographic regions, along with any potentially unique genetic or morphological traits these populations possess that might not be present in populations of the Southwestern Appalachians. Populations in these regions with conservation ranks of medium or higher could provide opportunities for focusing habitat and population management efforts to increase their resilience, reducing the relatively higher level of extinction risk facing P. integrilabia at the edges of its geographic range. (USFWS, 2021)

Number of Populations:

65 occurrences over 6 states

Population Size:

Unknown

Additional Population-level Information:

Birchenko (2000, pp. 18-23, 47-48) analyzed genetic structure among 25 populations of P. integrilabia, distributed across Alabama, Georgia, Tennessee, and Kentucky. The majority (79 percent) of the genetic variation was present as variation within populations, while about 21 percent of the variation was attributable to differences among populations (Birchenko 2000, p. 29). While these results alone do not demonstrate that genetic variability in populations of P. integrilabia has been eroded by restricted gene flow, Birchenko (2000, pp. 34-40) cautioned that interactions between demographic and ecological factors could be a cause for some of the declines in P. integrilabia population sizes and could ultimately cause declines in the species genetic variation and increase differentiation among populations of P. integrilabia. Zettler and Fairey (1990, pp. 212-216) reported that only 2.8 percent to 4.6 percent of the plants within apopulation flower in any given year and of these, only 6.9 percent to 20.3 percent will set seed. This results in a very low production of seeds and, consequently, a limited ability to reproduce at most sites. Low reproductive potential combined with often small population sizes, likely contributes to low (potentially negative) population growth rates and increases potential for inbreeding depression and genetic bottlenecks. As noted above, herbivory (especially when targeted upon inflorescences, as is often the case) would further compound the threat of low reproductive potential and low seed set.

Population Narrative:

Due to different sampling techniques and count methods (flowering vs vegetative stems from year to year) trends are hard to detect. General observations of declines in plant numbers and numbers of flowering plants are reported from Kentucky, Georgia, and Tennessee (decline in the number of flowering plants at some of the largest sites) (USFWS 2013). Historically, there were at least 90 populations of P. integrilabia. Today the species is known or presumed extant at some 65 sites across its range. The majority of known sites consist of fewer than 100 plants, although some sites have been reported to contain 500-1000 plants at some point in their history. Reports of sites containing over 1000 plants are not unprecedented, but are rare. Direct comparisons of historical and current population size estimates are difficult for the majority of known sites, in that observations are frequently reported as flowering stems one year, and vegetative plants the next, with many years elapsing in between observations made by different individuals. Also complicating direct comparisons within sites among years is the fact that conclusive identification of P. integrilabia requires flowers therefore vegetative counts (depending upon the observers familiarity with the species) may be suspect and could potentially include other species of Platanthera which sometimes co-occur with P. integrilabia. Nonetheless, some apparent trends form the basis of sustained and some heightened concerns about the species status. In Alabama, declines have been reported at three of eight known sites, and a fourth has not been observed despite repeated surveys (A. Schotz pers. com. 2009; S. Miller pers. com. 2008). Four sites in this state have not been observed since the early 1990s (A.

Schotz, pers. com., 2009); though, a new occurrence was discovered on private lands in Clay County in 2010 (A. Schotz, pers. com., 2011). In Kentucky, D. White (pers. com., 2005 and 2007) reported declines across most of the eight known populations in that state, often with no clear indication of what had caused the decline. D. White (pers. com., 2009) provided the following synopsis: while there is concern about the degrading habitat where these plants occur, the site ranks have not significantly declined [with the exception of] (one site); populations are at about the same level of viability as 10 years ago.

Threats and Stressors

Stressor: Development
Exposure:
Response:
Consequence:
Narrative: Shea (1992, pp. 25-28) reported that several P. integrilabia populations have been lost to habitat altering activities such as road construction, residential and commercial construction, and soil and site hydrology altering projects that reduced site suitability for the species. Shea estimated that these activities continued to threaten at least 50 percent of the remaining populations in 1992. In Tennessee, three of 48 known occurrences have been extirpated from the construction of small private lakes (McCoy 2008, p. 3). Loss of sites to residential and other construction activities remains a potential threat to privately owned populations not managed for conservation.

Stressor: ATV traffic
Exposure:
Response:
Consequence:
Narrative: Shea (1992, p. 28) concluded that all-terrain vehicles (ATVs) damaged or killed some plants at three sites in Tennessee, and identified ATVs as a potential threat at three additional sites across the species range.

Stressor: Collection (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Collecting for scientific, recreational, or commercial purposes has been determined to be the cause for extirpation of the white fringeless orchid at its type locality (Ettman and McAdoo 1979 cited in Zettler and Fairey 1990, p. 212), and recent evidence demonstrates that collection remains a threat to this species (USFWS, 2016).

Stressor: Disease (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Fungal pathogens have been identified as a threat to white fringeless orchid (USFWS, 2016).

Stressor: Herbivory (USFWS, 2016)

Exposure:
Response:
Consequence:
Narrative: Inflorescence herbivory is presumably by deer (Zettler and Fairey 1990, p. 212–214). Flower herbivory has been reported at over onethird of extant occurrences and likely is a factor threatening most white fringeless orchid occurrences (Shea 1992, pp. 27, 61, 71–77, 95–97; TDEC 2012, p. 3; KSNPC 2014; TDEC 2014), especially where low numbers of plants are present. Tuber herbivory or soil disturbance by feral hogs has been reported at multiple occurrences, including the site harboring the largest known white fringeless orchid population (Zettler 1994, p. 687; USFS 2008, p. 54) (USFWS, 2016).

Stressor: Small population size (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Small population sizes characterize a majority of occurrences throughout the species' geographic range, due to their diminished capacity to recover from loss of individuals or low reproductive output resulting from other threats (Zettler et al. 1996, p. 22) (USFWS, 2016).

Stressor: Species dependencies (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: The species' dependence on a limited number of Lepidoptera (Zettler et al. 1996, p. 16) and a single species of fungi (Currah et al. 1997, p. 30) to complete its life cycle make it vulnerable to disturbances that diminish habitat suitability for these taxa as well (USFWS, 2016).

Stressor: Climate change (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Climate has changed in recent decades in the southeastern United States, and the rate of change likely will continue to increase into the future (Karl et al. 2009, pp. 111–112). The potential for adverse effects to the white fringeless orchid, either through changes in habitat suitability or effects on populations of pollinators or mycorrhizal fungi, is likely to increase as climate continues to change at an accelerating rate (USFWS, 2016).

Stressor: Logging (USFWS, 2021)
Exposure:
Response:
Consequence:
Narrative: Logging is a risk to P. integrilabia populations because it changes canopy cover, increases likelihood of invasive plant species encroachment, causes direct habitat destruction, and alters local hydrology and soil moisture. In order to assess the risk of logging to each P. integrilabia population, we summed loss of forest cover (i.e., deciduous, mixed, and woody wetlands) in each county occupied by P. integrilabia using National Land Cover Database (NLCD) change, a raster data set which displays changes in major land cover class from 2006 to 2011 (NLCD 2011). In order to avoid double counting potential impacts from urbanization (see above),

we did not include any change from forest cover that occurred due to urban development. (USFWS, 2021)

Recovery

Reclassification Criteria:
Recovery Priority Number: 8

Delisting Criteria:
1. Monitoring over a 10-year period demonstrates stable or increasing population growth rates for at least 26 protected populations with resilience levels of moderate to very high (as described in the SSA). To ensure adequate representation and redundancy, these populations must be distributed among Environmental Protection Agency (EPA) Level III Ecoregions as shown in the following table. (Addresses Factors A and E.) (USFWS, 2023).

2. Written management agreements have been reached with partners/landownersthat allow for sustained monitoring and management of white fringeless orchid populations that demonstrate moderate to very high resilience. (Addresses Factor A.) (USFWS, 2023).

3. Alternatively, the species could be considered for delisting if 40 populations with resilience levels of moderate to very high (as described in the SSA), protected or unprotected, are distributed among EPA Level III Ecoregions where the species occurs. At least half of these populations must have resilience levels of high or very high. (Addresses Factor A and E.) (USFWS, 2023).

Recovery Actions:
- 1. Work with partners to protect, restore, and manage habitat where populations are extant or could be restored (USFWS, 2023).
- 2. Conduct monitoring and research to increase knowledge about biology and ecology of white fringeless orchid to facilitate the development of scientifically sound management plans and models for conducting population viability analyses (USFWS, 2023).
- 3. Conduct surveys to identify new populations and assess occupancy at historically occupied sites (USFWS, 2023)
- 4. Increase the representation and genetic diversity of ex situ collections of white fringeless orchid in seedbanks (USFWS, 2023).
- 5. Using seeds or propagated plants, augment protected populations that are unable to grow in response to habitat management due to low population size, or introduce populations into suitable, but unoccupied, managed habitat on conservation lands (USFWS, 2023).
- 6. Coordinate with partners to promote white fringeless orchid recovery and increase public awareness of the species and its conservation (USFWS, 2023).

Conservation Measures and Best Management Practices:
- Recovery Strategy: The primary recovery strategy for white fringeless orchid is to ensure that resilient populations exist throughout the species' range. To achieve this the Service must cooperate with partners to carry out recovery actions listed below in Actions Needed. The purposes of completing these actions are to: • reduce threats to the species' long-term viability by protecting,

restoring, and managing habitat where populations are extant or could be restored • conduct monitoring and research to increase knowledge of reproductive biology, life history, and ecological factors regulating population growth • survey potential habitat to identify new populations • maintain germplasm using ex situ conservation methods and propagate plants for augmenting or restoring populations • increase public awareness of the species and its conservation (USFWS, 2021a)

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SPECIES ACCOUNT: *Platanthera leucophaea* (Eastern prairie fringed orchid)

Species Taxonomic and Listing Information

Listing Status: Threatened

Physical Description

This plant is 8 to 40 inches tall and has an upright leafy stem with a flower cluster called an inflorescence. The 3 to 8 inch lance-shaped leaves sheath the stem. Each plant has one single flower spike composed of 5 to 40 creamy white flowers. Each flower has a three-part fringed lip less than 1 inch long and a nectar spur (tube-like structure) which is about 1 to 2 inches long.

Taxonomy

The western prairie white-fringed orchid (Platanthera praeclara) is now distinguished from P. leucophaea. Platanthera leucophaea is primarily east of the Mississippi River and P. praeclara is essentially west of that river. (NatureServe, 2015)

Historical Range

In addition to the current rante, historically occurred in New York; is extirpated in Pennsylvania where it once also occurred.

Current Range

U.S. States: Illinois, Indiana, Iowa, Maine, Michigan, Missouri, Ohio, Oklahoma, Virginia, Wisconsin; Canada. The eastern prairie fringed orchid's distribution has not changed appreciably since 1991, however, three newly discovered populations were added since the last 5-year review in 2016 (USFWS 2016). (USFWS, 2020)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Dependency on Other Individuals or Species

Adult: Three species of hawkmoths (Eumorpha pandorus, Eumorpha achemon, and Sphinx eremitis) have been verified as eastern prairie fringed orchid pollinators (Cuthrell 1994, Crosson et al. 1999, Cuthrell et al. 1999, Pollack 2009).

Breeding Season

Adult: peak flowering season in June or July and again when fruits were mature in September (USFWS, 2016)

Key Resources Needed for Breeding

Adult: Zettler and others (2001, 2005) determined that the mycorrhizal fungus Ceratorhiza goodyerae-repentis promotes germination of eastern prairie fringed orchid seed (Zettler et al.

2005) and can sustain mature plants (Zettler et al. 2001). The fungus C. pernacatena has also been recovered from mature eastern prairie fringed orchids (Zettler et al. 2001). Zettler et al. (2005) also determined that photosynthesis is supplemented by mycrotrophy throughout adulthood by C. goodyerae-repentis and C. pernacatena, and Epulorhiza to a lesser degree.

Reproduction Narrative

Adult: The plant has capacity for annual regeneration of the tuber rootstock and associated buds, making individual plants potentially long-lived. The underground tuber develops a bud and the precursors of a flowering stalk during the growing season the year before flowering (see Figure 4). The leaves and a developing flower cluster begin to emerge above ground in May of the following growing season. Night flying hawkmoths pollinate the nocturnally fragrant flowers of the white-fringed orchids (Bowles 1983, 1985). Reproduction by vegetative spread is apparently rare. Visiting hawkmoths receive pollen on their proboscises as they ingest nectar from the flower's long nectar spurs. A 1998 survey of large sites in Michigan and Ohio identified the following species carrying eastern prairie fringed orchid pollen: Eumorpha pandorus, Eumorpha achemon, and Sphinx eremitis (D. Cuthrell, Michigan Natural Features Inventory, in litt.1998). Some Illinois records of larval host plants for Eumorpha pandorus and Eumorpha achemon are Ampelopsis spp., and Vitis spp.; and for Sphinx eremitis are Monarda spp., Mentha spp., Lycopsis spp., and Salvia spp. The garden pest tomato and tobacco hornworms have been observed visiting the orchids. A number of additional moth species have been identified as potential pollinators by correlating their proboscis length with the depth to nectar in the eastern prairie fringed orchid's nectar spur. Additional field surveys are needed to confirm their status as pollinators. White-fringed prairie orchid blossoms often rise just above the height of the surrounding grasses and sedges. The more exposed flower clusters are more likely to be visited by the hawkmoth pollinators (Bowles 1985), though they are also at greater risk of being eaten by deer. Following pollination, white-fringed orchid seed capsules produce thousands of minute, lightweight seeds, that are dispersed by the wind after the capsules dry out and crack open, and release the seeds. (USFWS, 1999) Dr. Bell found that based on the demographic transition matrix pooled over all populations and years, the eastern prairie fringed orchid (in Illinois) has an increasing population growth rate ($\lambda = 1.1391$) (Bell et al. 2015). The mean generation time (or average age for first reproduction of a cohort) for the eastern prairie fringed orchid is 3.95 years (Bell et al. 2015). However, only about 30% of plants live more than one year after entering the demographic dataset (Bell et al. 2015). Survival and flowering probability differ among plant stages (juvenile, flowering, and vegetative (vegetative plants are nonflowering plants that flowered at least once before)) and generally increase with plant size. Most plants stay in a respective stage for about 1 year, however some plants (< 1%) can repeatedly flower for up to 6 years (Bell et al. 2015). Additional research results (Bell et al. 2015) include: Most plants live only 1 year, or they live one year after they are found at a site and also included in the demographic dataset. Specifically, 98% of plants live five years or less and 2% live 6 to 12 years. Most plants stay in a respective stage only for 1 year. Flowering and vegetative (nonflowering plants that flowered at least once before) plants can stay in that stage for up to 6 years. Most plants are never dormant (94%). Of those that are dormant (6%), 67% are dormant for a year, 20% are dormant for 2 years, 9% are dormant for 3 years, 2% are dormant for 4 years, 0.5% are dormant for 5 years. Survival is the highest in relatively large plants. Large juveniles are most likely to flower the following year. Plants that are hand pollinated have a slightly higher pod production rate ($p = 0.42$). There is estimated to be 4,500 seeds in each seed capsule. If all of the offspring of one plant were found, we would expect to find 22 juveniles. The proportion of survival for this orchid by herbivory level: Five categories were determined (none, slight leaf damage, slight flower damage, severe flower damage, entire inflorescence destroyed). Plants with no herbivory had lower survival than those with slight flower damage. Herbivory does not appear to present a problem based on overall survival information. The effects of herbivory on flowering the following year does not appear to have a clear effect. Prescribed burning increases population survival and does not affect the number of flowering plants or pods. Populations with low management needs have a higher mean survival rate. (USFWS, 2016)

Habitat Type

Adult: Mesic to wet prairies and wet sedge meadows. Peripheral habitat includes sedge-sphagnum bog mats around neutral pH kettle lakes, and fallow agricultural fields. Wet ditches and railroad rights-of-way also serve as refugia. This species' winter-dormant tubers are adapted to dormant-season prairie fires; such fires and high precipitation levels appear to promote flowering.

Dependencies on Specific Environmental Elements

Adult: Susceptible to changes in water table; populations along the shores of the Great Lakes are threatened by high water levels. This species' winter-dormant tubers are adapted to dormant-season prairie fires; such fires and high precipitation levels appear to promote flowering.

Habitat Narrative

Adult: The eastern prairie fringed orchid occurs in a wide variety of habitats, from mesic prairie to wetland communities such as sedge meadows, marsh edges and even bogs. It requires full sunlight for optimum growth and flowering, which restricts it to grass- and sedge-dominated plant communities. The substrate of the sites where it occurs ranges from more or less neutral to mildly calcareous (Case 1987, Sheviak 1974, Bowles 1983). These habitats occur across six physiographic regions. The unglaciated Ozark region supports sedge meadow habitat, from which the eastern prairie fringed orchid is apparently extirpated. Kansan glacial soils support prairie habitat, primarily west of the Mississippi River. East of the Mississippi River, Wisconsinan glacial soils support prairie, sedge meadow, and peatland habitat. The lake plains of the Lake Michigan, Lake Huron, and Lake Erie basins support prairie habitat. Disjunct populations also occur in unglaciated sedge meadow, and formerly occurred in unglaciated prairie in Oklahoma. (USFWS, 1999)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Following pollination, white-fringed orchid seed capsules produce thousands of minute, lightweight seeds, that are dispersed by the wind after the capsules dry out and crack open, and release the seeds. (USFWS, 1999)

Population Information and Trends

Population Trends:

Stable. Inferred from information (USFWS, 2020)

Species Trends:

Decline

Population Growth Rate:

Slow

Number of Populations:

96 (USFWS, 2020)

Resistance to Disease:

Low

Adaptability:

Low

Population Narrative:

Three new populations have been recorded since the last review resulting in a total of ninety-six populations range wide (USFWS, 2020). Per state, Illinois supports forty-two P. leucophaea populations (five are highly viable), Indiana supports one population, Iowa supports five populations, Maine supports one population, Michigan supports eighteen populations (one is highly viable), Missouri supports one population, Ohio supports ten populations, Virginia may support one population, and Wisconsin supports seventeen populations (six are highly viable). (USFWS, 2020)

Threats and Stressors

Stressor: Present or threatened destruction, modification or curtailment of its habitat or range (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Most eastern prairie fringed orchid populations have been lost through conversion of habitat to cropland and pasture. Drainage and development pose threats to this species' habitat. In addition, late-successional (i.e., high quality natural areas free of invasive species) prairie remnants supporting this species require management to reduce cover of woody vegetation. Fire and other management techniques that mimic natural disturbance may be required to control or eliminate invasive species and to maintain stable late successional vegetation. Most sites within the species range need continual management. In addition, if past actions have destroyed some ecosystem function (i.e., natural drainage) then management may be needed to mimic the lost function. Lack of appropriate natural areas management threatens populations regardless of their legal protection status (USFWS 1989). (USFWS, 2016)

Stressor: Overutilization for commercial, recreational, scientific, or educational purposes (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Native terrestrial orchids are rarely grown from seed. Adult plants are often sought for scientific and commercial purposes or, for gardens and therefore are susceptible to collection. Smaller populations of eastern prairie fringed orchids can be negatively impacted by collecting.

Due to high human population densities in some parts of the range of the eastern prairie fringed orchid, it can be subject to collection pressures. In the past, populations of eastern prairie fringed orchids in Michigan and Illinois have been impacted by removal of plants (USFWS 1989). (USFWS, 2016)

Stressor: Disease or predation (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Although no threats were identified under this listing factor when the species was listed (USFWS 1989), an increase in deer populations in portions of the species range (e.g. Illinois) has resulted in an increased impact from herbivory of eastern prairie fringed orchid flowers which reduces or eliminates the plants ability to reproduce. In Illinois, deer cages are provided by the Fish and Wildlife Service if the volunteer stewards believe their blooming eastern prairie fringed orchid plants would benefit from deer caging. In recent years, destruction of adult flowering plants later in the season (after seed production and before seed dispersal) from voles has been documented at many Illinois populations. Efforts to cage for voles has provided limited success. (USFWS, 2016)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Protection of threatened plants on privately-owned lands is extremely limited in most states throughout the eastern prairie fringed orchid's range, leaving those populations vulnerable to habitat destruction and extirpation (USFWS 1989). Currently and range wide, 43 of 98 existing populations, have full legal land protection (USFWS 2014). (USFWS, 2016)

Stressor: Other natural or manmade factors affecting its continued existence (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: The eastern prairie fringed orchid's dependence upon hawkmoths for pollination makes it vulnerable to changes in these insect populations. The status of most hawkmoth species is poorly known. Pollinator populations may be adversely affected by pesticides and loss of habitat (USFWS 1989). (USFWS, 2016)

Stressor: Climate Change (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Climate change will be a particular challenge for endangered, threatened and other at-risk species because the interaction of additional stressors associated with climate change and current stressors may push them beyond their ability to survive (Easterling and Karl 2000). In addition, populations of some species that are near the southern end of the range may be at particular risk (IPCC 2014). While there is uncertainty about the exact nature and severity of climate change related impacts anticipated within the eastern prairie fringed orchid'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 (Easterling and Karl 2000; Ebi and Meehl 2007; Hall and Stuntz 2007; IPCC 2014; NCA 2014). Research has suggested that climate change may also negatively impact pollinator species if the plants and their pollinators respond differently to climate change (NRC 2007; Earthwatch Institute 2006). These climatic changes may threaten the eastern prairie fringed orchid in a variety of direct and indirect ways. However, climate changes will likely affect phenological timing, availability of suitable habitat, inter-specific relationships with pollinators and mycorrhizae associates, and threats from invasive species. Specific predictions of vulnerability or ability to shift ranges to suitable habitat in response to climate change based on life-history traits are frequently found to be species specific, and not widely applicable (Angert et al. 2011). In an effort to predict the potential range shift of the eastern prairie fringed orchid under climate change, Dr. Pati Vitt (2007) used modeling to predict the climate in Illinois in 2095. Dr. Vitt's (2007) research suggests that the predicted range of the eastern prairie fringed orchid will be concentrated northwest of its current range (Vitt 2007). The current areas of concentration for this species are around the Great Lakes. In the future, Michigan and Canada may be the best locations for this species considering climate change (Vitt 2007). The range is predicted to shift out of the Midwest and up towards the northeast (Vitt 2007). Close monitoring of P. leucophaea populations will help detect the species response to climate change and allow for consideration of management options. (USFWS, 2016)

Recovery

Reclassification Criteria:
Recovery Priority Number: 8

Delisting Criteria:
1. Twenty-two populations are distributed across plant communities and physiographic regions within the historic range of the species (See Table 5 for distribution of these populations). (USFWS, 1999)

2. Each of these 22 populations is highly viable. A highly viable population typically has more than 50 flowering plants; a population trend that is stable or increasing over a monitoring period of 5 years; available habitat of at least 50 hectares (125 acres) in size; assurances of ongoing management to reduce impacts from drainage, invasive non-native plant species or woody vegetation encroachment; and protection through long-term conservation easements, legal dedication as nature preserves, or other means. (USFWS, 1999)

Recovery Actions:

- 1. Protect habitat: The highest priority recovery actions for the eastern prairie fringed orchid are acquiring legal protection of habitat, and managing habitat. Protecting habitat through legal designation is recovery action 1 and identified as a priority 1 action (i.e., an action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future) (USFWS 1999). In most states, the highest available form of legal protection consists of conservation easements under state nature preserve acts (Pearsall 1984). Because only 43 of the 98 (44%) extant eastern prairie fringed orchid populations have legal land protection status, protection under state nature preserve acts should be pursued for the remaining populations. For states that do not have active nature preserve acts (e.g., Michigan), other forms of conservation easements that can be held by private organizations should be sought. Another option available to private landowners is conveyance of property rights to public or private conservation agencies that will provide legal protection and management. (USFWS, 1999; USFWS, 2016)

- 2. Manage habitat to support stable or increasing populations of the orchid:Because sites supporting orchid populations may require varying degrees of active management to maintain or enhance orchid populations, habitat management was identified in the species recovery plan as a priority 1 action. Only 4 of the 98 extant sites are considered without management need, a decrease from 13 in 2007. Currently, only 22 of the 98 known sites are in a late-successional stage. Management techniques needed may include prescribed burns, or brush and invasive species removal depending on the site condition. While habitat is being managed at many eastern prairie fringed orchid sites across the species range, habitat management is an ongoing activity that will have varying degrees of need based on the level of woody species encroachment and invasion by non-native plant species. (USFWS, 1999; USFWS, 2016)
- 3. Increase the size and number of existing population: Recovery action 3 (increasing the size and number of populations) needs to be implemented continuously. As discussed above, through the removal of encroaching woody vegetation, eastern prairie fringed orchid habitat may be increased which, in turn, may lead to population expansion. The number of pollinator visits to small orchid populations may be a limiting factor for seed production at a particular site. Handpollination should be used where natural pollination is believed to be infrequent or absent in order to maximize seed production. Hand-pollination and seed dispersal appear to provide cost effective methods for augmenting existing populations (action 3.1) and reintroducing or introducing new populations (action 3.2) in appropriate habitat that is legally protected (USFWS 1999). (USFWS, 1999; USFWS, 2016))
- 4. Monitor the status of known populations. (USFWS, 1999)
- 5. Conduct research needed to identify recovery actions: Much has been learned about the eastern prairie fringed orchid since its listing and completion of the Federal recovery plan. However, there is still a need for greater understanding of the species life history requirements, specifically the species' pollinators and seed germination. Three species of hawkmoths (Eumorpha pandorus, Eumorpha achemon, and Sphinx eremitis) have been verified as eastern prairie fringed orchid pollinators (Cuthrell 1994, Crosson et al. 1999, Cuthrell et al. 1999, Pollack 2009). However, little is known about the hawkmoths' distribution, population levels, management needs, or reproduction. Research to gain greater understanding of these aspects of the pollinators will assist in the recovery of the eastern prairie fringed orchid (USFWS 1999, action 5.2). Research to date has determined that the mycorrhizal fungus Ceratorhiza goodyeraerepentis promotes the germination of eastern prairie fringed orchid seed (Zettler et al. 2005) and can sustain mature plants (Zettler et al. 2001). In addition, the fungus C. pernacatena has also been recovered from mature eastern prairie fringed orchids (Zettler et al. 2001), suggesting that the species may associate with both C. goodyerae-repentis and C. pernacatena when mature (Zettler et al. 2005). Further research is needed to determine the extent that eastern prairie fringed orchids require these fungal species throughout its range. In addition, research to determine if C. goodyerae-repentis can be used to inoculate seedlings, introduce these orchids into potential restoration sites, and propagate eastern prairie fringed orchids ex situ is needed (USFWS 1999, action 5.3). (USFWS, 1999; USFWS, 2016)
- 6. Update population ranks and identify populations to be restored to higher levels of viability: The three population viability assessments cited in this review are based on field

surveys conducted between 1990 and 1998, from 1999 to 2007, and from 2008-2014 (USFWS 1999, Bell 2008, USFWS 2014). The data collected in the population viability assessments provide an accurate and distinct update of the status of the eastern prairie fringed orchid across the range of the species and are integral in completing this review. Assessment of the progress toward recovery through updates to the population viability assessment rankings should be completed annually, as described under action 6.1 (USFWS 1999). (USFWS, 1999; USFWS, 2016)

- 7. Track the progress towards recovery. (USFWS, 1999)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: The Service provides the following recommendations: 1. Protect habitat. 2. Manage habitat to support P. leucophaea populations through prescribed burning, control of exotic invasive species, etc. 3. Annual census (counting the number of blooming plants per year) of all P. leucophaea populations range wide. 4. Recruit Volunteers to annually census 17 of the 18 P. leucophaea populations in Michigan. 5. Increase the size and genetic diversity of existing populations through cross pollinating between populations and moving seed between populations. 6. Continue research to identify and evaluate the effectiveness of recovery actions.

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SPECIES ACCOUNT: *Platanthera praeclara* (Western prairie fringed orchid)

Species Taxonomic and Listing Information

Listing Status: Threatened; 09/28/1989; Great Lakes-Big Rivers Region (R3) (USFWS, 2016)

Physical Description

A perennial herb with stems that can grow to 1.2 m tall from an underground tuber. Inflorescences are large and showy, with up to 2 dozen white flowers arranged on a spike up to 7.5 dm long. Each flower has 3 petals, the lowest one much larger than the others and divided into 3 conspicuously fringed lobes (NatureServe, 2015).

Taxonomy

Platanthera, included in the genus Habenaria by some taxonomists, comprises approximately 200 species of temperate and tropical North Africa, North America, Central America, and Eurasia (Airy Shaw 1973, Luer 1975). There are 24 species, 36 taxa, and 5 named hybrids of Platanthera in North America, north of Mexico (Luer 1975). Previously, the species was included in a broader taxonomic concept of P. leucophaea (USFWS, 1996).

Historical Range

Published accounts and herbarium records suggest P. praeclara was widespread and perhaps locally common prior to European settlement (Bowles and Duxbury 1986). Historically, Brownell (1984) and Lobeck (1957) suggest western prairie fringed orchid was distributed throughout much of the western Central Lowlands and eastern Great Plains physiographic provinces of the central United States and Interior Plains in extreme south-central Canada (USFWS, 2009).

Current Range

Inhabits the Red River Valley of northern Minnesota, south in the Great Plains through the eastern Dakotas, central Nebraska, eastern Kansas, and northeastern Oklahoma; eastward through southern Minnesota, Iowa, and northern Missouri and in Manitoba. The eastern limit roughly corresponds to the Mississippi River (Watson, 1989; Bowles and Duxbury, 1986) (NatureServe, 2015). Minor changes to the spatial distribution of the species have occurred since the previous five-year review was published (Fig. 1, USFWS 2009). Fox et al. (2015) suggest there may be a northward shift in the range of the western prairie fringed orchid due to the relative success of the Canadian and United States populations in the Red River Valley (251A in Figure 1 below) and Lake Agassiz-Aspen Parklands ecoregions (222N) (p. 1000). Currently, there are 299 extant western prairie fringed orchid populations across Iowa, Kansas, Minnesota, Missouri, Nebraska, and North Dakota. Orchid populations were documented in three additional counties (two in Nebraska and one in Minnesota); however, the orchid is now presumed extirpated from five counties (two in Iowa, one in Nebraska, and two in Kansas) since the previous 5-year review. (USFWS, 2021)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: sexual (USFWS, 2021)

Lifespan

Adult: 3 - 8 years (USFWS, 1996)

Dependency on Other Individuals or Species

Adult: Wild cherry sphinx (Sphinx drupiferarum) (Larval Host: Prunus sp., Malus sp.), Hermit sphinx (Lintneria eremitus) (Larval Host: Mentha sp.), Achemon sphinx (Eumorpha achemon) (Larval Host: Vitis sp.), Spurge hawkmoth (Hyles euphorbiae) (non-native) (Larval Host: Leafy spurge (Euphorbia esula), Bedstraw hawkmoth (Hyles gallii) (Larval Host: Evening Primrose Family (Onagraceae), Madder Family (Rubiaceae)), White-lined sphinx (Hyles lineata) (Larval Host: Evening Primrose Family (Onagraceae), Four-o'clock Family (Nyctaginaceae)), Plebian sphinx (Paratraea plebeja) (Larval Host: Unknown). (USFWS, 2021)

Breeding Season

Adult: June - July (USFWS, 1996)

Key Resources Needed for Breeding

Adult: Mycorrhizal fungi, insect pollinators - especially sphinx moths (USFWS, 2016)

Other Reproductive Information

Adult: Friesen and Westwood (2013, p. 14) found a significant positive correlation between percent pollinaria removed and two meteorological variables that influence sphinx moth activity, wind speed and temperature; pollinaria removal was reported to be highest when wind speeds were 2.94 m/s. While Friesen and Westwood found no apparent relationship between sphinx moth activity and weather conditions, Eisikowitch and Galil (1971) found that effective sphinx moth pollination flights did not occur when wind speeds were greater than 3 m/s (p. 675). Because orchid populations are generally in open, exposed prairie areas, sphinx moths may prefer to seek nectar in sheltered areas during times of high winds. If high winds occur during the short bloom period of the orchid, there may be an insufficient number of sphinx moth visits required for seed capsule production (Borkowsky and Westwood 2009, p. 116). Winds across much of North America have been increasing since 2010 (Zeng et al. 2019, p. 979), which may have implications for western prairie fringed orchid seed production if sphinx moth pollination activities are negatively impacted by wind speeds greater than 2.5 m/s. Finally, in contrast to effects of wind and temperature, a significant negative correlation between percent pollinaria removed and relative humidity was also observed (Friesen and Westwood 2013, p. 14). (USFWS, 2021)

Reproduction Narrative

Adult: There is some evidence of vegetative reproduction (plants growing very close to each other), but based on examination of below ground structures vegetative reproduction is probably a rare event and relatively unimportant (NatureServe, 2015). This species is dependent on mycorrhizal fungi, especially for seed germination and for nutritional support before plants are capable of photosynthesis. Pollination is required for seed production. Western prairie fringed orchid is pollinated by a few species of sphinx moths. Some observations suggest that non-sphingid moths may cause pollination in P. praeclara. Annual mortality rates of monitored plants were as low as 1.2 % and, in a drought year, as high as 13.5 % (Sather 1997) (USFWS 2009). Two months of vegetative growth may pass before an inflorescence will fully develop on a flowering plant. Plants bloom from mid-June in the southern portion of the range to late July in the northern portion. Most plants observed over a 7-year period that included both droughty conditions and flooding in this study area were present aboveground less than three years, and once absent, plants rarely reappeared (Sieg and King 1995). Although a small number of orchids on the Sheyenne National Grassland appeared aboveground every year for eight years, a predictable pattern in life states was not apparent (USFWS, 1996). Fox et al. (2013, p. 321) confirmed that western prairie fringed orchids do not produce seed capsules asexually or via self-fertilization. As such, pollinators are essential for seed capsule production and population growth. Pollinaria are often removed from the flowering orchid when the sphinx moth feeds on the nectar, but they can also be removed when wind is strong enough to brush the orchid against nearby vegetation (Borkowsky and Westwood 2009, p. 116). When pollinaria are brushed against nearby vegetation, fertilization does not occur, and seed capsules are not produced. (USFWS, 2021)

Habitat Type

Adult: Terrestrial, wetland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Tallgrass prairie, sedge meadow (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Periodic disturbance, full sunlight (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Flooding (USFWS, 2009)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from NatureServe, 2015)

Dependency on Other Individuals or Species for Habitat

Adult: Mycorrhizal fungi, especially Ceratorhiza spp. (USFWS, 2009)

Habitat Narrative

Adult: This species is most commonly found in full sun on moist to wet calcareous (calcium-rich, or alkaline) tallgrass prairies and sedge meadows (many flooded for 1 - 2 weeks per year). It most often grows in relatively undisturbed grassland, but can also be found in moderately disturbed sites such as roadside ditches. (NatureServe, 2015). The persistence of western prairie fringed orchid is dependent on periodic disturbance by fire, mowing, or grazing (USFWS, 2016). Flooding decreases survival of all affected western prairie fringed orchid plants (Sieg and Wolken 1999). Western prairie fringed orchid may preferentially associate with Ceratorhiza species (Sharma et al. 2003a), which "appear to be the dominant orchid mycobionts in

Midwestern prairies" (Sharma 2002) (USFWS, 2009). Habitat conditions vary across the geographic range of the orchid. Populations in northwestern Minnesota may occur in areas where standing water is present, whereas a few populations in southern Minnesota are found on shallow soils over bedrock where standing water is not present in the spring (Biederman et al. 2014, p. 106). The location of western prairie fringed orchids at extant sites may be influenced by depth to groundwater. Knudson (2014) found that annual fluctuations in groundwater depth may influence the amount of moisture available to orchids and result in spatial shifts of orchid populations on the landscape (p. 71). (USFWS, 2021)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seeds are wind-dispersed and may also be adapted for dissemination through the soil profile by water (USFWS, 2016).

Population Information and Trends

Population Trends:

Unknown. Inferred from information (USFWS, 2021)

Species Trends:

Unknown. Inferred from information (USFWS, 2021)

Resiliency:

Resiliency describes the ability of populations to withstand stochastic events, arising from random factors. Due to the wide distribution of the orchid, it is not likely that a range-wide environmental or stochastic event would affect all the extant populations on the landscape. Stochastic events (e.g., extreme drought or agricultural practices) could impact individual populations. Habitat quality has been reduced over time due to land conversion, hydrologic changes, and encroaching dominant vegetation (native plants and non-native, invasive plant species). (USFWS, 2021).

Representation:

Representation influences the ability of a species to adapt to changing environmental conditions over time. Representation refers to the breadth of genetic diversity within a species; however, environmental diversity may be used as a surrogate for genetic diversity. Orchid populations are currently found in eight ecoregions (Fig. 1) that represent a range of ecological settings. Recent genetic research on the orchid suggests that the species may be vulnerable to inbreeding depression in the future (Ross and Travers 2016; Travers et al. 2017). Northern populations sampled by Ross and Travers (2016) exhibited moderate genetic diversity. Overall, the species occupies numerous ecoregions but genetic diversity across ecoregions is unknown. Additionally, as described above, the recovery criteria outlined in the recovery plan have not been met. Three out of nine ecoregions have occupied habitat protected at protection levels 4 through 9 (The Nature Conservancy 1996) that harbor 90% or more of the total plants in each ecoregion. Additionally, no sites are managed in accordance with Service-approved management plans or guidelines. Orchid populations are also exhibiting stable (relative to the previous review), declining, or undeterminable population trends as a result of hydrologic changes and the expansion of non-native, invasive plant species. (USFWS, 2021).

Redundancy:

Redundancy influences the ability of a species to survive catastrophic events and is often assessed in terms of the number of populations of a species and distribution of those populations across the landscape. Historically, western prairie fringed orchid was found in nine states. Currently, there are 299 extant western prairie fringed orchid populations across 6 states. Twenty-nine new orchid sites have been documented since the last review and nineteen sites are now considered extirpated. Six of the eight ecoregions with extant orchid sites contain more than ten populations except for the Minnesota and Northeast Iowa Morainal-Oak Savannah (222M) and Central Dissected Till Plains (251C) ecoregions. The Minnesota and Northeast Iowa Morainal-Oak Savannah ecoregion contains 6 populations spread across 130 miles (209 km) and the Central Dissected Till Plains ecoregion contains 1 population. The orchid sites in these ecoregions are separated by at least 168 miles (270 km). The populations in these ecoregions are at a higher risk from a catastrophic event (e.g., a multi-year ecoregion-wide drought) (USFWS, 2021).

Number of Populations:

172 (NatureServe, 2015)

Population Size:

~15,000 (inferred from NatureServe, 2015)

Population Narrative:

Platanthera praeclara has experienced over a 60% decline according to county records (Harrison, 1989). It is known from 172 extant occurrences. There are four large populations with 1000+ individuals each. All populations in the southern half of the range are small. The three largest known, extant populations are found in the northern half of the range and occur near Vita, Manitoba (3000 - 5000 plants), Pembina Trail Preserve in Minnesota (several thousand plants), and Sheyenne National Grassland, North Dakota (approximately 3000 plants) (NatureServe, 2015). Additionally, as described above, the recovery criteria outlined in the recovery plan have not been met. Three out of nine ecoregions have occupied habitat protected at protection levels 4 through 9 (The Nature Conservancy 1996) that harbor 90% or more of the total plants in each ecoregion. Additionally, no sites are managed in accordance with Service-approved management plans or guidelines. Orchid populations are also exhibiting stable (relative to the previous review), declining, or undeterminable population trends as a result of hydrologic changes and the expansion of non-native, invasive plant species. (USFWS, 2021)

Threats and Stressors

Stressor: Nonnative species (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Inter-seeding of non-native species, especially Garrison creeping foxtail (a cultivated variety of Alopecurus arundinaceus Poir), into wet prairie or wet meadows to increase livestock forage is now promoted in Nebraska (G. Steinauer, pers. comm., 2005; Volesky et al. 2003). This grass may pose a previously unrecognized threat if it is introduced into sites inhabited by western prairie fringed orchid (G. Steinauer, pers., comm. 2005). Exotic, cool season grasses also are

invading and increasing in western prairie fringed orchid habitats in Nebraska – a long-term trend that may be exacerbated by annual mid-summer haying (G. Steinauer, pers. comm., 2005) (USFWS, 2009). Invasive, non-native plant species continue to spread at western prairie fringed orchid locations throughout the species' geographic range. Although the Service has not compiled a complete list of threats to western prairie fringed orchids for each site, invasive plant species are noted as a current threat to at least 32% of extant sites. The previous review noted approximately 20% of extant sites had invasive species present with leafy spurge and reed canary grass (Phalaris arundinacea) the two most frequently reported threats (USFWS 2009). Smooth brome (Bromus inermis Leyss.), an invasive grass species becoming increasingly common in northern tall grass prairies, threatens orchid sites in southern Minnesota (Biederman et al. 2014, p. 105). Queen Anne's lace (Daucus carota) and wild parsnip (Pastinaca sativa) have been observed in or adjacent to western prairie fringed orchid populations in Minnesota (Anderson, Minnesota Biological Survey, January 21, 2021, pers. comm.). Invasive species documented at sites in Nebraska include leafy spurge, reed canary grass, and yellow bedstraw (Galium verum), which is currently present at one site but expected to invade other orchid sites in the future (Steinauer 2013). Invasive and hybrid cattail (Typha spp.) threaten western prairie fringed orchid sites on the Sheyenne National Grassland (Swenson, Sheyenne National Grasslands, February 19, 2021, pers. comm.). Reed canary grass continues to spread at extant orchid sites and reduces the amount of suitable habitat available for orchids. The previous review identified Garrison creeping foxtail (Alopecurus arundinaceus) as a non�native, invasive species posing a threat to orchid populations on and near Valentine National Wildlife Refuge in Nebraska (USFWS 2009). The foxtail does not appear to be spreading aggressively and is currently contained to one unit. Reed canary grass poses a larger threat, in addition to encroaching native woody vegetation (Nenneman, Valentine National Wildlife Refuge, December 16, 2020, pers. comm.) (USFWS, 2021)

Stressor: Herbivory (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Although herbivore impacts may be significant locally in some years (Borkowsky 2006:62), it is not clear whether native herbivores threaten any populations. The recovery plan (p. 13) mentions several herbivores that have fed on western prairie fringed orchids. Since completion of the recovery plan, at least one additional taxon, rose chaffer beetles (assumed to be Macrodactylus subspinosus, Scarabaeidae), was found feeding on western prairie fringed orchid. Rose chaffer beetles fed on a significant number of western prairie fringed orchid plants in Nebraska's Pierce and Madison counties in 2002 and the affected plants later exhibited fungal infections. Levels of this herbivory decreased after 2002, but persisted at least until 2005 (Gerry Steinauer, Nebraska Game and Parks Commission, pers. comm., 2005). Watson (2001b) found predated seed capsules that contained unidentified insect pupae at Kalsow Prairie in Iowa in 2001 (USFWS, 2009).

Stressor: Land use activities (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: In its recovery plan (U.S. Fish and Wildlife Service 1996) the Service mostly reiterated the threats it described in the final listing rule, but emphasized that conversion of habitat to

cropland was the greatest remaining threat to southern populations. It also emphasized that little was known about how to ensure that burning, grazing, and mowing are conducted in a manner not adverse to western prairie fringed orchid populations and pointed out that actions that directly or indirectly lower water levels in the rooting zone of plants “have the potential of serious adverse impacts.” In addition, it implied that potential impacts of pesticides to western prairie fringed orchid and its pollinators were also a threat (U.S. Fish and Wildlife Service 1996:17) (USFWS, 2009). Since the previous 5-year review, researchers have examined the impact of management actions on western prairie fringed orchids. The spread of invasive, non-native species and encroaching woody vegetation at orchid sites requires management that could negatively impact western prairie fringed orchids if conducted during active growth periods. Management actions at known orchid sites include prescribed burns, mowing or haying, and cattle grazing (Alexander et al. 2010b, Biederman et al. 2014, Bleho et al. 2015, Morrison et al. 2015). Periodic burns conducted every two or three years may benefit western prairie fringed orchids (Bleho et al. 2015, p. 191). Prescribed burns conducted during the spring (e.g., early May) or prior to the growing degree day threshold of 199 days would minimize direct negative impacts to the orchid (Morrison et al. 2015, p. 253; Biederman et al. 2018, p. 6). Fire to manage invasive plant species could also occur in the fall, when western prairie fringed orchid plants are not in the rapid growth stage and invasive plant species (e.g., smooth brome) can still be effectively targeted (Biederman et al. 2014, p. 107). Fall burns should occur in October or November to avoid negatively impacting seed pod maturation and or seed dispersal that occurs in mid-late September (Alexander et al. 2010a, p. 59; Morrison et al. 2015, p. 253). Cattle grazing and mowing may negatively impact western prairie fringed orchids (Alexander et al. 2010a,b, Bleho et al. 2015). Alexander et al. (2010b) noted that cattle grazing may negatively impact orchid height, ability to survive to seed capsule maturity, and carbohydrate storage (p. 47-48). In their study, individual orchids that survived to seed capsule maturity produced 20% fewer seed capsules than individuals in un-grazed pastures (Alexander et al. 2010b, p. 47). Grazing may reduce carbohydrate stores individual plants require to overwinter (Alexander et al. 2010b, p. 48). By deferring mowing and grazing actions until after mid-September, orchid embryos may reach full size and seeds may be dispersed (Alexander et al. 2010a, p. 59). (USFWS, 2021)

Stressor: Collection (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Watson (2001b) reported that trails made by humans wound through Sheeder Prairie in Iowa and seemed to ‘converge on areas where flowering orchids were located’ and coincided with observations of missing flowers (USFWS, 2009).

Stressor: Herbicides and Insecticides (USFWS, 2021)
Exposure:
Response:
Consequence:
Narrative: The Nebraska Natural Heritage Inventory identified four major threats to orchid populations, 1) conversion of suitable habitat to cropland, 2) other land use or land management changes, 3) inappropriate application of herbicides and insecticides, and 4) non-native, invasive species encroachment (Steinauer 2013; Stansberry, U.S. Fish and Wildlife Service, February 19, 2021, pers. comm.). Seed capsule formation or production in western prairie fringed orchids may be linked to several factors including habitat quality, herbivory, wind speed, and the abundance

of sphinx moths in the areas surrounding orchid populations. Habitat fragmentation and herbicide or pesticide use may reduce the amount of suitable habitat for sphinx moth pollinators (Borkowsky and Westwood 2009, p. 111). A decline in sphinx moth pollinators may ultimately lead to a decrease in orchid seed capsule production. (USFWS, 2021)

Recovery

Reclassification Criteria:
Not applicable.

Recovery Priority Number: 8C

Delisting Criteria:
1. Sites that include occupied habitat harboring 90 percent of plants in each ecoregion are protected at protection codes 4 through 9 &public ownership or higher level of protection), and managed in accordance with a Service-approved management plan or guidelines (USFWS, 1996).

2. This plan must assure implementation of management practices that provide the range and spatial distribution of successional and hydrologic regimes required to maintain the species and its pollinators in self-sustaining, naturally occurring populations, and must remain in effect following delisting (USFWS, 1996).

Recovery Actions:
- Maintain habitat of known populations as native prairie (USFWS, 1996).
- Provide the highest level of state legal protection appropriate for all populations (USFWS, 1996).
- Develop and implement habitat management plans that sustain and enhance P. praeclara populations (USFWS, 1996).
- Conduct appropriate research and monitoring (USFWS, 1996).
- Identify and search potential habitat (USFWS, 1996).
- Disseminate information about the species to a variety of audiences (USFWS, 1996).
- Revise the recovery criteria to include clear and measurable standards to determine whether western prairie fringed orchid plants are part of a viable population. The recovery criteria require that plants be under protective ownership or control and appropriately managed to count towards recovery in each ecoregion. There are no standards within the criteria, however, to assess whether these plants are part of populations that are viable. Although not addressed by the recovery criteria, actions 42 (Determine parameters required to maintain viable self-sustaining populations) and 424 (Conduct a population viability analysis for the species) do address this issue and a preliminary population viability analysis has been completed based on demographic monitoring (USFWS, 2009).
- Ensure that any revised recovery criteria are objective and measurable and address the following threats, as appropriate: Drainage and other actions that directly or indirectly lower water levels in the rooting zone of plants; Isolation and low reproduction of small populations; Herbicide and pesticide impacts to western prairie fringed orchid and its pollinators; Collection of plants from small populations; Effects of invading exotic species and actions to control those species; Inter-seeding of non-native species into wet prairie in Nebraska, especially creeping foxtail (Alopecurus arundinaceus Poir, also called Garrison

creeping foxtail) (USFWS, 2009).
- Describe a process by which the Service will evaluate management plans for the purposes of measuring progress towards recovery. This should include a description of the Service's review process (e.g., who will conduct and approve these reviews for the Service) and the basis for evaluating the adequacy of each plan (USFWS, 2009).
- Compile existing management plans for sites where western prairie fringed orchid is extant and protected from conversion and determine whether they are adequate to ensure the conservation of the respective western prairie fringed orchid populations (USFWS, 2009).
- Implement recovery action 33 – Develop or maintain appropriate mowing regimes (U.S. Fish and Wildlife Service 1996:20). Steinauer (2000:4) briefly summarized the importance of the Nebraska's eastern Sandhills region for the conservation of western prairie fringed orchid and suggested that significant progress towards the species' conservation could be made by modifying haying practices at some sites (USFWS, 2009).
- Conduct additional surveys in the Nebraska Sandhills when soil moisture levels may be suitable for significant levels of flowering. Additional surveys in this region may identify additional populations of western prairie fringed orchid (Steinauer 2000:4), but significant surveys have not been conducted since 2000 (recovery action 52 – Identify and search potential new sites [U.S. Fish and Wildlife Service 1996:22]) (USFWS, 2009).
- Improve tracking of invasive species threats for each site, in cooperation with the states and others, to determine the relative range-wide harm of each invasive species. Invasive species should be identified as a threat at a site if they are present and if current or anticipated management is unlikely to be sufficient to control invasives to the extent that the invasive(s) will no longer pose a threat to western prairie fringed orchid (USFWS, 2009).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: The Service provides the following recommendations: • Revise the recovery plan to include clear and measurable standards to determine whether western prairie fringed orchid populations are viable and to address current threats to the continued existence of the western prairie fringed orchid. See the previous 5-year review for a list of threats to include (USFWS 2009). • Coordinate survey efforts across the geographic range of the species (e.g., compile existing survey protocols) and assess the status of populations that have not been monitored for over 25 years (1995 or earlier). • Expand survey efforts in the Red River Valley (251A) and the Lake Agassiz-Aspen Parklands (222N) ecoregions to search for new or undocumented western prairie fringed orchid sites. • Examine western prairie fringed orchid responses to management activities and develop a best management practices fact sheet with species experts for land managers and project proponents across the orchid's geographic range. • Increase the percentage of protected sites in ecoregions where the protection criterion has not been met. This may include implementing and/or increasing outreach efforts with private landowners. • Describe a process by which the Service would approve management plans for the purpose of measuring progress towards recovery, which should include a description of the Service's review process (e.g., who would conduct and approve these reviews for the Service) and the basis for evaluating the adequacy of each plan. • Compile existing management plans for sites where western prairie fringed orchid is extant and protected from conversion and determine whether they are adequate to ensure the conservation of the respective western prairie fringed orchid populations. • Manage habitat to support western prairie fringed orchids through practices that duplicate the natural processes of the tallgrass prairie ecosystem (e.g., prescribed burns, control of non-native invasive species and/or encroaching woody vegetation). • Encourage and support research focused on western prairie fringed orchid pollinators. This may include research examining hawkmoth distribution, population levels, management needs, or reproduction (USFWS, 2021).

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SPECIES ACCOUNT: *Poa napensis* (Napa bluegrass)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/21/1997; Pacific Southwest (R8)

Physical Description

Poa napensis is an erect, tufted perennial bunchgrass in the grass family (Poaceae) that grows to 1 dm (4 in) in height. Leaves are folded, stiffly erect, 1 mm (0.04 in) wide, with the basal leaves 20 cm (8 in) long and upper stem leaves to 15 cm (6 in) in length. A few stiff, erect flowering stems appear in May and grow 7 dm (27 in) in height. Flower clusters occur as a pale green to purple, condensed, oblong-oval panicle 10 to 15 cm (4 to 6 in) long and 2 to 5 cm (0.8 to 2.0 in) wide. Poa napensis most closely resembles P. unilateralis (ocean bluff bluegrass), but differs in leaf and panicle form and habitat. (USFWS, 1997)

Taxonomy

Alan Beetle first described Poa napensis in 1946 from specimens that he collected in a meadow moistened by seepage from hot springs, 3 km (2 mi) north of Calistoga at Myrtledale Hot Springs, Napa County, California. This treatment was retained by Soreng (1993). (USFWS, 1997)

Historical Range

See current range/distribution.

Current Range

Known only from 3-kilometer (2-mile) radius of Calistoga, in Napa County, California. (USFWS, 2010)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: A few erect flowering stems appear in May and grow as much as 69 centimeters (27 inches) in height (USFWS, 2010).

Reproduction Narrative

Adult: A few erect flowering stems appear in May and grow as much as 69 centimeters (27 inches) in height. Pale green to purple flowers bloom in condensed, round-shaped clusters at the end of the few flowering stems (USFWS, 2010).

Habitat Type

Adult: Moist meadows (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: Poa napensis is typically found in alkaline meadows and grasslands, mesic areas including vernal pools, next to and fed by hot springs and small geysers. The 2009 WRA survey identified Poa napensis growing in short, sparsely vegetated areas as well as in tall and densely vegetated upland grassland and wetland swales on the airport property. Although P. napensis is known to grow in wetlands, it occurs on the airport property in sparsely vegetated bare soil ‘scald’ areas which are associated with Plagiobothrys strictus (WRA 2009). (USFWS, 2010)

Dispersal/Migration

Population Information and Trends

Population Trends:

Decreasing or unknown (inferred from USFWS, 2010)

Number of Populations:

2 (USFWS, 2010)

Population Size:

~250 invidiuals in one population; unknown for other population (USFWS, 2010)

Population Narrative:

At the time of listing, Poa. napensis was only known from two populations in the vicinity of Calistoga (California Native Plant Society 2008b). A 2008 survey conducted by Glenn Lukos Associates identified approximately 520 P. napensis plants at 26 locations on the airport property. A March 9, 2009 EcoSystems West Consulting Group survey identified 244 individual Poa napensis plants at 31 locations on the airport property (WRA 2009). The second population of Poa napensis is scattered over a 4 hectare (10 acre) area bisected by an asphalt road on private land in Calistoga. In recent years, the landowner has denied access to the site, and no current information on the size of this population is available (Symonds, pers. comm. 2008). During the airport property observations in April and May 2008, Ms. Symonds also confirmed Poa napensis was present. She noted that plants were growing on the rim of a vernal pool as well as along the property fence line. Formal protocol-level, botanical surveys to assess plant abundance were not conducted during the April and May 2008 visits (Symonds, pers. comm. 2008). Additional observations by Ms. Symonds and other biologists in September 2008, confirmed P. napensis is present on the edge of the property and was observed growing on either side of the property fence line (Kasparian, pers. obs. 2008). (USFWS, 2010). Historically, Napa bluegrass likely had larger populations before hot spring resources were developed in the

Calistoga region (Department 1989, p. 2). The Napa bluegrass population at the airport property was thought to be extirpated due to construction activities that took place in 1981. However, prior to listing hundreds of Napa bluegrass plants were counted at the airport property from 1987 to 1996 (Service 1997, p. 55799). Prior to the 2010 status review, in 2008, approximately 520 Napa bluegrass plants at 26 locations on the airport property were identified and in 2009 a survey during the blooming period found 244 plants at 31 locations on the airport property (WRA 2009, p. 1; Service 2010, p. 6). There have been no surveys of the Napa bluegrass on the airport property since the 2010 status review. In the early 1980s prior to listing, the Napa bluegrass population at the hot spring property was comprised of several thousand plants (Service 1997, p. 55799). Access to the hot spring property has been denied since the years preceding listing (Service 1997, p. 55799; Service 2010, p. 6), so surveys have not been carried out at the property (USFWS, 2023).

Threats and Stressors

Stressor: Airport activities (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: One of the populations of each species occurs at the airport property, and future development at this site could threaten these populations (USFWS, 2010).

Stressor: Alteration of hydrology (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Poa napensis is dependent on hot springs and geysers for its survival. Alterations in the hydrology of the hot springs or geysers overland flow would pose a threat to this plant by removing the supply of acidic water which maintains the suitability of the habitat. Such alterations would include, but not be limited to, new water well drilling into underground water sources or increasing the draw-down from existing wells (Service 1997) (USFWS, 2010).

Stressor: Urbanization (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: 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. Because Poa napensis and Plagiobothrys strictus occur at both the airport property and on another private property, the threats from urbanization, including possible future development, are the same for both species. Future development at either site could threaten either or both species (USFWS, 2010).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: In summary, 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, 2010)
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: Extinction/loss of genetic variability
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) (USFWS, 2010).

Stressor: Invasive 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:
Not defined; a recovery plan or outline has not been completed. (USFWS, 2010)

Recovery Priority Number: 5C

Delisting Criteria:
Not defined; a recovery plan or outline has not been completed. (USFWS, 2010)

Recovery Actions:
- Not defined; a recovery plan or outline has not been completed. (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).
- 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)

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: *Rhynchospora knieskernii* (Knieskern's Beaked-rush)

Species Taxonomic and Listing Information

Listing Status: Threatened; 07/18/1991; Northeast Region (Region 5) (USFWS, 2015)

Physical Description

This grass-like plant has been considered an annual; however, recent information suggests that the plant may be a perennial or semi-perennial (W. Brumback, New England Wild Flower Society, pers. comm. 1993). R. knieskernii grows from 1.5 to 60 cm high (0.6 to 24 in), has slender culms (stems) branching from the base, and short, narrowly linear leaves. Small spikelets (flower clusters) are numerous and occur at distant intervals along the entire length of the culm. The achene (fruit) is obovate, narrow at the base, 1.1 to 1.3 mm long (0.04 to 0.05 in), and equal in length to the six downwardly-barbed, or rarely, upwardly-barbed attached bristles. A tubercle (beak), which is the persistent base of the two-cleft style on top of the achene, is about one-half the length of the achene. (USFWS, 1993)

Taxonomy

Distinct member in genus of around 200 species. (NatureServe, 2015)

Historical Range

Rhynchospora knieskernii has always been considered rare (Knieskern 1857, Robinson and Fernald 1908, Stone 1911). Historically, the species was known to occur in Atlantic, Burlington, Camden, Monmouth, and Ocean Counties in New Jersey. (USFWS, 1993)

Current Range

This species is now endemic to 5 counties within the New Jersey Pine Barrens, where fewer than 40 recent occurrences have been documented. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Key Resources Needed for Breeding

Adult: Knieskern's beaked-rush seeds were found to require cold/wet stratification and light to germinate. (USFWS, 2008)

Reproduction Narrative

Adult: Knieskern's beaked-rush seeds were found to require cold/wet stratification and light to germinate. (USFWS, 2008). Culms develop in May with most plants supporting a single culm (stem) with three to four spikelets (clusters of seeds); however, it is not unusual for some plants to have multiple culms in addition to the main stem. Typically, spikelets begin to form on culms in June and flower early August. Achenes (seeds) begin to form in late August and are dispersed from mid-September until late December. During the dispersal period, leaves senesce and winter buds develop, which remain photosynthetic until March. (USFWS, 2019).

Habitat Type

Adult: Palustrine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Bog/fen, forested wetland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Soil moisture (USFWS, 2008)

Geographic or Habitat Restraints or Barriers

Adult: Restricted to early successional habitats in pitch pine lowland forests within pine barrens

Spatial Arrangements of the Population

Adult: Dense, local patches (NatureServe, 2015)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2019)

Habitat Narrative

Adult: Restricted to early successional habitats in pitch pine lowland forests within pine barrens. Substrates are highly acidic, nutrient poor, fine grained mineral soils, frequently over clay deposits, but sometimes found on bog iron deposits. Soil composition primarily consisted of sand (87 to 92%), with a small proportion of clay (7 to 13%), and silt (5 to 10%). Soil is acidic, nutrient poor, and generally retains more water in the top organic horizon than lower alluvial horizon. Sites typically have fluctuating water regimes. Species tends to occur in dense, local patches. The species is a poor competitor and is usually found on bare or sparsely vegetated sites that are maintained open through natural disturbances such as fire or flood scouring, or through human-caused disturbances such as roadside, railroad, or powerline right-of-way maintenance, or in inactive sand or clay pits. Soil moisture appears to be a limiting factor determining the establishment of Knieskern's beaked-rush. (USFWS, 2008; NatureServe, 2015). Experimental data determined that soil moisture between 10 and 12.5 percent was optimal for growth (Sobel 2015), and populations where the soil moisture remained either above or below 10 to 12.5 percent had lower densities (Bien and Sobel 2015). (USFWS, 2019).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seed dispersal mechanisms are not documented; however, bristles on the achenes could assist in animal dispersal. (USFWS, 1993)

Population Information and Trends

Population Trends:

Declining (USFWS, 2008)

Number of Populations:

57 extant occurrences (USFWS, 2024)

Population Size:

105 (USFWS, 2024).

Additional Population-level Information:

Current results suggest KBR populations show high spatial variability at the plot scale and year-to-year spatial variability (Palmer and Baumgarten pers. comm. 2012). (USFWS, 2019).

Population Narrative:

The number of known occurrences of Knieskern's beaked-rush increased from 50 in 1993 to 73 in 2007, due to additional survey efforts and likely increased reporting of the species. During field studies conducted from 1994 to 1996, over 60 percent of extant occurrences visited were found to be declining. (USFWS, 2008). Data from the 2022 rangewide survey and recent additional positive surveys show there are an estimated 57 extant EOs, including 6 previously unidentified EOs discovered in New Jersey. An additional previously unidentified EO was discovered in New Jersey in 2018 (EO # pending, Tuckerton RR at South Branch), although there was no KBR found at the site in 2022, and the habitat was degraded. This brings the total number of nationwide EOs to 105: 38 historic, 57 extant, and 10 occurrences unconfirmed. The presence of all 57 extant occurrences were surveyed and confirmed within the last 6 years. The 10 EOs categorized as “occurrences unconfirmed” did not have KBR present at the time of the survey (USFWS, 2024).

Threats and Stressors

Stressor: Habitat loss and degradation due to development (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Wetlands within the range of Knierskern's beaked-rush continue to be lost, but at a slowing rate. From 1972 to 2001, New Jersey lost about 190,000 acres of wetlands, a decline of about 20 percent. (USFWS, 2008)

Stressor: Habitat succession (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Habitat succession and resulting competition with woody and herbaceous species continues to be a major cause of loss of Knieskern's beaked-rush habitat, particularly at disturbed sites (Radis, 1995; Gordon, 1996). Erosion, soil compression, and rut creation caused by off-road vehicles also continues to be a significant threat causing degradation of habitat (Radis, 1995). (USFWS, 2008)

Stressor: Road maintenance (USFWS, 2008)
Exposure:
Response:
Consequence:

Narrative: Road maintenance, particularly bulldozing and mowing, were identified as major threats to roadside occurrences (Gordon, 1996; Dodds and Cartica, 1998). (USFWS, 2008)

Stressor: Trash dumping (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Dumping of trash directly onto plants, at roadsite sites or within clay pits was also identified as a concern. In some cases trash dumping was to a degree that the plants and or habitat were buried (Radis, 1995; Dodds and Cartica, 1998).

Stressor: Alterations in hydrology (USFWS, 1993)
Exposure:
Response:
Consequence:
Narrative: R. knieskernii appears to require relatively constant damp- to-wet soil conditions throughout most of the growing season. Human activities that alter site hydrology, or natural events such as drought, could eliminate site suitability for R. knieskernii. In addition, subtle changes that result in drier site conditions could promote vegetative succession, thereby eliminating R. knieskernii. (USFWS, 1993)

Stressor: Fire (USFWS, 1993)
Exposure:
Response:
Consequence:
Narrative: Fire can create suitable conditions for the species; however, Gordon (1993) noted that a previously unreported occurrence of the species within a burned pitch pine lowland was no longer extant due to invasion by other plant species following a subsequent fire. Fire can, therefore, be beneficial or detrimental to the establishment and maintenance of R. knieskernii depending on the timing, duration, and intensity of the burn. (USFWS, 1993)

Recovery

Reclassification Criteria:
Reclassification criteria are not available.

Recovery Priority Number: 14

Delisting Criteria:
1. Permanent habitat protection is secured for a minimum of nine occurrences. This number represents the sum of known populations that are (1) either self-sustaining or will require minimal management for long-range maintenance, and (2) already occur on public lands or meet any of the biological criteria, stated below, that would warrant land acquisition for the primary objective of protecting the population. Habitat will be considered permanently protected when the R. knieskern's site, including an adequate buffer that ensures maintenance of the hydrological regime, is secured either through acquisition or conservation easement, and a formal commitment to long-range management is made by a government agency or conservation organization. (USFWS, 1993).   Not met as of 2019 (USFWS, 2019).

2. The species is proven to be an efficient colonizer, as indicated by monitoring results, life history information, and/or the results of experimental introductions. (USFWS, 1993). Ongoing in 2019 (USFWS, 2019).

3. A post-delisting strategy for monitoring the species' population dynamics, as well as introducing (if and when necessary) the plant to suitable habitats, is in place. (USFWS, 1993). Not met as of 2019 (USFWS, 2019).

4. No evidence of decline in the species' status is seen by 1996. This time frame takes into account the apparent stability or improvement in the status of the species seen since its listing two years ago. (USFWS, 1993). Not achieved as of 2019 (USFWS, 2019).

Recovery Actions:

- Provide protection to populations and their habitat at a level needed to achieve recovery objectives. (USFWS, 1993)
- Monitor the species' rangewide status. (USFWS, 1993)
- Determine the capacity of the plant to colonize new sites and establish populations. (USFWS, 1993)
- Develop a post-delisting strategy for maintaining the species in suitable habitats. (USFWS, 1993)
- New in 2019 - 1: Secure Protection of Occurrences - Re-evaluate the status and protection needs of the occurrences currently known from public or otherwise-protected lands (including but not limited to the 13 sites listed in Table 1). Priority 2; Task Numbers 1.1 and 1.3. - Pursue formal, long-term KBR protection and management agreements with landowners to include, as appropriate. Priority 2; Task Numbers 1.1 and 1.3 o Establish buffer zone; o Conduct prescribed burns to open canopy and cycle nutrients into soil; o Trim manually of woody species encroaching KBR populations; and o Create some human-induced disturbance to maintain early successional status. - The microsite requirements are generally within pitch pine lowland habitats adjacent to wetlands, so protection agreements could be associated with wetland buffers and other wetlands protection mechanisms. - Conduct a study to determine any correlations between protective buffer width and changes in population size and vigor. Priority 2; Task Number 3.3 - Determine impact of groundwater withdrawals or changes in surface runoff on KBR populations. Priority 2; Task Number 3.3 - Characterize the type and degree of habitat disturbance (i.e., fire) that is beneficial to the species. Priority 2, Task Number 3.3 - Conduct applied habitat management to determine the effects of fire on the species. Priority 2, Task Number 3.3 - Establish protective buffers and / or restrictions on groundwater withdrawal to ensure maintenance of hydrological regime for KBR wetlands. Priority 3; Task Number 1.6 - Develop Best Management Practices to protect KBR habitat, and encourage their adoption by Federal and State regulatory agencies, local governments, and public and private landowners. Priority 3; Task Number 1.6 - Incorporate protection of KBR into local planning efforts, especially where multiple occurrences are clustered in small watersheds. Priority 3; Task Number 1.6 - Continue to protect KBR sites through various regulatory processes as necessary and appropriate. Priority 3; Task Number 1.6 (USFWS, 2019).
- New in 2019 - 2: Continue to Characterize Species' Biology and Life History - Conduct research on the ability of seeds to remain viable in the seedbank over long time periods.

Priority 3; Task Number 3.2 - Investigate KBR root anatomy and hormonal response to varying soil conditions to determine adaptive mechanisms. Priority 3; Task Number 3.2 - Conduct research to determine if edaphic factors or association with other plant species in the community influence the degree of mycorrhizal colonization. Priority 3; Task Number 3.2 - Investigate the impact of climate change on the species and its habitat. Priority 2; Task Number 3.3 (USFWS, 2019).

- New in 2019 - 3: Monitor Population and Track Recovery - Develop a protocol for monitoring and assessing trends to determine if KBR is a naturally ephemeral species. Such information would be relevant to whether the species' status is more appropriately measured by the balance of increasing and declining sites than by whether known sites are stable or improving. Priority 2; Task Number 2.3 - Survey KBR sites to obtain updated information on the species' status and trends, applying the aforementioned protocol, and ensure information is entered into Natural Heritage Program databases. Priority 2; Task Number 2.3. - Develop a method to distinguish new discoveries from recently established populations. Priority 2; Task Number 2.3 (USFWS, 2019).
- Identify sites suitable for long-term protection agreements, ensuring sites are representative of Knieskern's beaked-rush historical range limits and / or genetic variability. (USFWS, 2008)
- Pursue formal, long-term Knieskern's beaked-rush protection agreements with landowners. (USFWS, 2008)
- Conduct a study to determine any correlations between protective buffer width and changes in population size and vigor. (USFWS, 2008)
- Determine impact of groundwater withdrawals or changes in surface runoff on Knieskern's beaked rush populations. (USFWS, 2008)
- Establish recommended protective buffers and / or restrictions on groundwater withdrawal to ensure maintenance of hydrological regime for Knieskern's beaked-rush wetlands. (USFWS, 2008)
- Develop Best Management Practices to protect Knieskern's beaked-rush habitat, and encourage their adoption by Federal and State regulatory agencies, local governments, and public and private landowners. (USFWS, 2008)
- Incorporate protection of Knieskern's beaked-rush into local planning efforts, especially where multiple occurrences are clustered in small watersheds. (USFWS, 2008)
- Continue to protect Knieskern's beaked-rush sites through various regulatory processes as necessary and appropriate. (USFWS, 2008)
- Conduct applied habitat management to determine the effects of fire on the species. (USFWS, 2008)
- Study seed dispersal mechanisms. (USFWS, 2008)
- Conduct research on the ability for seeds to remain viable in the seed bank over long time periods. (USFWS, 2008)
- Measure fluctuations in hydrology throughout an entire growing season and across years with different climatic conditions to better characterize optimal habitat conditions for the species. (USFWS, 2008)
- Characterize the type and degree of habitat disturbance that is beneficial vs. deleterious to the species. (USFWS, 2008)
- Investigate Knieskern's beaked-rush root anatomy and hormonal response to varying soil conditions to determine adaptive mechanisms. (USFWS, 2008)
- Investigate the impact of climate change on the species and its habitat. (USFWS, 2008)

- Develop a scheme for monitoring and assessing trends to determine if Knieskern's beaked-rush is a naturally ephemeral species. Such information would be relevant to whether the species' status is more appropriately measured by the balance of increasing and declining sites than by whether known sites are stable or improving. (USFWS, 2008)
- Survey Knieskern's beaked-rush sites to obtain updated information on the species' status and trends, applying the aforementioned scheme, and ensure information is entered into the Natural Heritage Program databases. (USFWS, 2008)
- Develop a method to distinguish new discoveries from recently established populations. (USFWS, 2008)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS • Complete process for removal of ESA protections • Develop post-delisting monitoring plan in collaboration with State agencies (USFWS, 2024)

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SPECIES ACCOUNT: *Sagittaria fasciculata* (Bunched arrowhead)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015) 8/31/1979

Physical Description

An aquatic perennial herb with erect, emergent leaves, 1.5-3.5 dm long. In May and June, 1-several flowering stems appear bearing white flowers arranged in whorls; female flowers on the lowest whorls, males on the upper ones (NatureServe, 2015).

Taxonomy

The concept of Sagittaria fasciculata in Kartesz (1994) is narrower than that in Kartesz (1999). Kartesz (1994) recognized S. graminea var. macrocarpa. However, Kartesz (1999) includes S. graminea var. macrocarpa as S. fasciculata; Weakley (2012) and Flora North America vol. 22 also recognize that material called var. macrocarpa was mostly misapplied and is appropriately attributed to S. fasciculata (NatureServe, 2015).

Historical Range

Historical in Henderson and Buncombe Cos., North Carolina. (NatureServe, 2015)

Current Range

Endemic to North Carolina and South Carolina. Extant in Henderson Co., North Carolina and Greenville Co., South Carolina. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual (NatureServe, 2015)

Lifespan

Adult: <2 years? (USFWS, 2014)

Breeding Season

Adult: Flowers April - May (USFWS, 2025)

Reproduction Narrative

Adult: According to Cooper et al., 1977 (B77COO01HQUS), this species may be limited to vegetative means of reproduction as no seedlings have been found. However, Newberry, 1987 (U87NEW01HQUS) reported seed set in the populations she studied, though the presence of seedlings was not noted.; Sagittaria fasciculata typically is found in very gently sloping areas with slow, continuous seepage of cool, clear water. The continuous seepage appears to be the most important factor in the ecology of the species. Canopy closure may differ greatly in different populations but the slow continuous seepage is one factor that is always present. ASEXUAL (NatureServe, 2015). There is only a single effort to obtain demographic level information for S. fasciculata (Newberry, 1991a). Newberry followed the survival of 100 marked plants during 1985- 1987. It is unclear at what frequency these plants were monitored; however, Newberry states that only 10% of the marked plants could be relocated two years after first being marked (in March, 1985). From this, she concludes that S. fasciculata plants may not live longer than two years – however this hypothesis requires further investigation before it can be generally accepted (USFWS, 2014).

Habitat Type

Adult: Seeps (NatureServe, 2015)

Environmental Specificity

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

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits very gently sloping areas with some standing water refreshed by slow continuous seepage of cool clear water. Appropriate habitat for this species is typically found in a narrow band at the bluff-floodplain ecotone. The seeps originate at the base of the bluffs and Sagittaria fasciculata is generally found near, but not at, the origin of the seep (water flow at the seep origin is usually too swift or too heavy to allow for colonization). Appropriate habitats often continue along the edge of the bluff downslope from the seep, but generally do not extend far into the floodplain proper because there the seepage tends to spread out and the water stagnates (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance range are inferred based on the low number of known populations and the specific habitat requirements of the species.

Dispersal/Migration

Population Information and Trends

Population Trends:

Decreasing to Stable (NatureServe, 2015)

Number of Populations:

13 populations; 43 colonies (USFWS, 2025)

Population Size:

10,000 - 1,000,000 individuals (NatureServe, 2015)

Additional Population-level Information:

Currently, 13 populations comprising 43 colonies are known across its range, with only 16 colonies under some degree of protection. (USFWS, 2025)

Population Narrative:

Can withstand timbering, but not grazing or drainage of habitat. Locally abundant in upper Piedmont, in Greenville County, SC. The entire species population size is estimated to be between 97,500-120,000 rosettes (USFWS 2014). The USFWS Recovery Plan and 5 Year Review (2014) recognize 11 populations, where a population is defined as colonies of plants connected by drainage and in close proximity to one another < 2 km). 37 colonies are recognized in these 11 populations as of 2014. Element Occurrences (EOs) fall within these 11 populations; and between North Carolina and South Carolina Natural Heritage Programs there are 44 EOs including extirpated occurrences (NatureServe, 2015). NatureServe (2015) also estimates that there are between 10,000 – 1,000,000 total individual rosettes and between 6 and 80 populations. Moderate resiliency is inferred based on the species ability to withstand timbering and the use of herbicides on right-of-ways and other maintained areas that may harm individual plants but may also help in limiting succession (USFWS, 2014). Moderate representation and redundancy are inferred based on the number of individuals and populations. Short-term Trend: Decline of <50% to Relatively Stable Short-term Trend Comments: The 5 year review of this species by the USFWS (2014) summarizes what information is available on population trends. Most populations in North Carolina were visited at least once in the late 1990's through the mid 2000's, many of the colonies within the populations weren't revisited more than once if any. For those that were revisited, declines were noted due to stagnation of the water, sedimentation, drying substrate or insufficient waterflow. Populations in South Carolina haven't been revisited since initial work in 2000 (USFWS 2014) (NatureServe, 2015).

Threats and Stressors

Stressor: Conversion to pasture/livestock trampling (USFWS, 2014)
Exposure:
Response:
Consequence: loss of habitat/loss of individuals
Narrative: Conversion to pasture and/or cattle trampling is listed as a threat to this species (USFWS, 2014).

Stressor: Powerline clearing (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of habitat/Loss of individuals
Narrative: Powerline clearing is listed as a threat to this species (USFWS, 2014).

Stressor: Siltation (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Siltation is listed as a threat to this species (USFWS, 2014).

Stressor: Weather (USFWS, 2014)
Exposure:

Response:
Consequence: Loss of habitat
Narrative: Increases and decreases in the flow of surface water were correlated with declines in the number of plants. However, most declines were associated with decreased flow and partial drying of the substrate. In a subsequent unpublished report, Newberry (1991b) described “significant changes” to habitat resulting from nutrient runoff, flooding, and sedimentation following heavy rains. Populations located adjacent to streams typically suffer scouring and sedimentation during heavy flows, while seeps tend to improve as a result of increased hydration, reduced stagnation and increased suitable habitat area. The weather-related threats are likely to be intensified under most general circulation climate change models (Karl et al. 2009) (USFWS, 2014).

Stressor: Invasive exotics (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of habitat/Competition
Narrative: Invasive exotics (esp. Ligustrum spp. and M. keisak, ten sites) are listed as a threat to this species (USFWS, 2014).

Stressor: Encroachment by competitive native vegetation (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of habitat/Competition
Narrative: Encroachment by native competitive vegetation (six sites) is listed as a threat to this species (USFWS, 2014).

Stressor: Herbicide drift (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Across the range of the species, several colonies of S. fasciculata occur in managed road, railroad, or utility rights-of-way (ROW) where overspray or drift from herbicides poses a threat to S. fasciculata (Bunch, M., SCDNR, pers. comm. 2010; Geosyntec, 2009; Newberry, 2000). Overspray or drift has been implicated in at least temporary reductions in the number of S. fasciculata plants in a given area, however in some instances these declines may have been offset by a reduction in the density of encroaching vegetation (primarily woody), which also poses a threat to S. fasciculata (Bunch, M., SCDNR, pers. comm. 2010; Worton, A., Geosyntec, pers. comm. 2010; Geosyntec, 2009). Despite attempts by SCDNR to inform utility companies about consistent, appropriate management practices to benefit S. fasciculata, managed right-of-ways continue to be an impediment to conservation efforts for this species (Bunch, M., SCDNR, pers. comm. 2010) (USFWS, 2014).

Stressor: Poaching (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of populations/Loss of individuals
Narrative: This was not known to be a significant threat to S. fasciculata at the time of listing, but in March 2012, this plant was poached from the Bunched Arrowhead Heritage Preserve in South

Carolina. SCDNR staff discovered a 2' x 2' section of S. fasciculata plants missing. Whoever stole the plants came prepared with tools to cut, dig and remove the plants en masse. SCDNR offered a reward to anyone who provided information regarding this theft, but they never received any information (SCDNR 2012). Although this new evidence of poaching is concerning and the Service will closely monitor this potential threat with partners, we do not have evidence to suggest it is a significant threat at this time (USFWS, 2014).

Stressor: Development (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The North Carolina Plant Conservation and Protection Act (NC State Code Article 19B, § 106-202.12) provides limited protection from unauthorized collection and trade of plants listed under that statute. However, this statute does not protect the species or its habitat 13 from destruction in conjunction with development projects or otherwise legal activities. Plant species are afforded less protection in South Carolina, where they are protected only from disturbance at South Carolina Heritage Preserves (SC State Code of Regulations Part 123 § 200-204). There are no other statutes that afford significant protections to S. fasciculata. In South Carolina, one colony is afforded some protection through a registration agreement between the landowner (Furman University) and SCDNR Heritage Trust Program. This agreement, signed in 1981, recognizes the natural heritage significance of the property, and acknowledges the mutual interests of SCDNR and the landowner in preserving its habitat. The agreement is non-binding but remains in effect. Despite the University authorizing activities that threaten the long-term viability of this S. fasciculata population (Newberry, 2000), faculty of Furman University Biology Department have been instrumental in increasing awareness among the University administration staff about the significance of the site and activities that adversely affect it (Dr. Joe Pollard, Furman University, pers. comm. 2010) (USFWS, 2014).

Recovery

Reclassification Criteria:
Recovery Priority Number: 5C

Delisting Criteria:
Protect existing populations and essential habitat. Survey to determine population/colony priority and land ownership patterns. Obtain the most appropriate and highest protection for each population or colony. Manage the populations to ensure survival of the plants (USFWS, 1983).

Conduct population and ecological studies. Conduct studies on the abiotic factors of the species habitat. Conduct studies on the biotic factors of the species habitat. Conduct demographic studies. Search for additional populations. Utilizing the data obtained in this section, determine the species essential habitat. Support further studies of the species (USFWS, 1983).

Conduct transplant and propagation studies. Transplant studies. Propagation studies (USFWS, 1983).

Monitor colonies, populations, permanent plots, transplanted colonies, and propagation facilities at regular intervals. Develop censusing techniques and monitoring schedule. Monitor at least twice yearly. Appoint local individuals to regularly monitor the sites (USFWS, 1983).

Enforce laws and regulations protecting the species and its essential habitat (USFWS, 1983).

Inform public of species status and recovery plan objectives. Prepare and distribute brochures on recovery plan objectives. Provide information for press release. Prepare articles for popular and scientific publications (USFWS, 1983).

Recovery Actions:

- Obtain the most appropriate and highest protection for each population or colony (Recovery Task 12, Priority 1). Once updated information on the size and vigor of extant colonies is obtained, protection efforts should be undertaken immediately. The current number of protected colonies/populations is far less than that specified in the current set of recovery criteria (USFWS, 2014).
- Estimate current colony and population size and vigor (Recovery Task 111, priority 2). Updated information on the size and vigor of extant colonies/populations is critically needed in order to assess and refine protection priorities. It would be particularly useful to include detailed mapping of the spatial extent of occupied habitat (USFWS, 2014).
- Monitor colonies, populations, permanent plots, transplants and propagation facilities (Recovery Task 4, priority 3). The lack of monitoring data hinders objective assessments of colony/population trends. Anecdotal observation suggests that this species exhibits considerable fluctuation in response to drought and heavy rainfall events; monitoring would help to determine the range of acceptable fluctuations in colony/population size, and critical thresholds for management intervention.

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: The 2014 5-year review included a list of recommendations to improve recovery of the species. These actions, listed below, remain applicable to species recovery. Once updated information on the size and vigor of extant colonies is obtained, protection efforts should be undertaken immediately. The current number of protected colonies/populations is far less than that specified in the current set of recovery criteria. Updated information on the size and vigor of extant colonies/populations is critically needed in order to assess and refine protection priorities. It would be particularly useful to include detailed mapping of the spatial extent of occupied habitat. The lack of monitoring data hinders objective assessments of colony/population trends. Anecdotal observation suggests that this species exhibits considerable fluctuation in response to drought and heavy rainfall events; monitoring would help to determine the range of acceptable fluctuations in colony/population size, and critical thresholds for management intervention. In light of new information, additional future actions are recommended below: Work with partners and species experts to develop a standardized monitoring protocol that could be used on many different types of bunched arrowhead sites. Work with partners and land managers to conduct range-wide monitoring. Provide support and, if feasible, pool resources for management and monitoring. Prioritize unprotected sites critical for recovery and work toward permanent protection. Develop a plan for conserving the species in situ collections – through either conservation gardens or seed banking. As staff time and office resources allow, consider the need to reevaluate the recovery criteria and amend the recovery plan. If deemed necessary, work with the Regional Office to include recovery plan updates and/or amendments into the regional workplan. Work with and support

Furman University to complete genetic investigations.

- RECOMMENDED FUTURE ACTIVITIES The 2014 and 2020 5-year reviews include a list of recommendations to improve recovery of the species. These actions remain applicable to species recovery: • Work with partners and species experts to develop a standardized monitoring protocol that could be used on many different types of bunched arrowhead sites. • Work with partners and land managers to conduct range-wide, consistent monitoring. • Provide support and, if feasible, pool resources for management and monitoring. • Prioritize unprotected sites critical for recovery and work toward permanent protection. • Develop a standardized plan for conserving the species in ex situ collections – through either conservation gardens or seed banking. Additional future actions are recommended below: • Prioritize genetic research to assess the size and extent of current populations and colonies therewithin. • Support genetic monitoring research that seeks to understand the longevity of genotypes and assess whether genetic patterns reflect long-term trends within the species. • Investigate the factors driving high clonal reproduction and low genetic variation in NC compared to SC populations. • Identify ecological and environmental factors contributing to the success at Blackwell Sites in SC. • Study the pollination biology and ecology of bunched arrowhead and assess seed set success rates in the species. • Monitor and control invasive plant species that may outcompete bunched arrowhead. • Assess the effectiveness of invasive species management techniques and their targeted outcomes. • Develop a standardized protocol for propagation and transplantation. (USFWS, 2025)

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SPECIES ACCOUNT: *Sagittaria secundifolia* (Kral's water-plantain)

Species Taxonomic and Listing Information

Listing Status: Threatened; Southeast Region (R4) (USFWS, 2015) 4/13/1990

Physical Description

An aquatic perennial herb with 2 types of leaves: in swift shallows, the leaves are linear, rigid, and sickle-shaped, 5-8 cm long; in quiet, deep waters, leaves can be up to 3 dm long and are more quill-shaped. Flowering stems are erect, emergent, and bear separate male and female flowers near the apex. Only the white petaled male flowers are conspicuous. Blooms infrequently from May into the fall. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Known from the Little River drainage of northeast Alabama and northwest Georgia, Sipsey Fork of the Black Warrior River in northwest Alabama, and Hatchet Creek in north-central Alabama (Chafin 2007). The Town Creek population in northeast Alabama is believed to have been destroyed (USFWS 1991). (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: Although infrequent, flowering occurs from May into July, and intermittently into the fall (Kral 1982, 1983) (USFWS, 2014).

Reproduction Narrative

Adult: Kral’s water-plantain is clonal and reproduction is primarily asexual, which suggests there may be low genetic variability within the isolated populations. Although capable of sexual reproduction, Kral’s water-plantain spreads primarily by growth of its underwater stems (rhizomes). Female and male flowers occur separately on the same plant, with male flowers held on upper branches, female on lower. Plants flower only in full sun and where low water levels permit growth of above water leaves. Bees are likely pollinators but little is known about Kral’s water-plantain reproduction. Whetstone (1988) observed flowering in only 1 percent of this Sagittaria and only in areas of direct sunlight and at a water level that allowed emergent leaves. Many of the sites supporting local populations are in less than these optimum conditions for flowering: therefore, it is important to maintain as much suitable habitat as possible to encourage reproduction by sexual means. Sexual reproduction increases genetic variability, which enables species to adapt to changing conditions (USFWS, 2014). Although infrequent, flowering occurs from May into July, and intermittently into the fall (Kral 1982, 1983) (USFWS, 2014).

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Undammed riverine reaches on exposed shoals or rooted among loose boulders in sands, gravels, and silts in pools up to 1 m deep. Stream bottoms are typically narrow and bounded by steep slopes (NatureServe, 2015).

Dispersal/Migration

Population Information and Trends

Population Narrative:

At the time of listing, Kral’s water-plantain was known from only a single population in the Little River system in northeast Alabama (DeKalb and Cherokee counties) and northwest Georgia (Chattooga County) (55 FR 13907). A historical population from Town Creek (DeKalb County, Alabama) is likely extirpated from the area (Godwin and Schotz 2017b). On August 11, 1993, biologists noted a population of Kral’s water-plantain in shoals at the confluence of Caney Creek and Sipsey Fork in the Bankhead National Forest, Winston County, Alabama (Reichert 1993). On July 26, 2001, Kral’s water-plantain was found growing with Cahaba lilies in crevices along Hatchet Creek, Coosa County, Alabama (Threlkeld 2001). On April 16, 2005, two clusters of Kral’s water-plantain were discovered attached to bedrock at the bottom of Brushy Creek, Winston County, Alabama (Threlkeld 2005). On October 1, 2015, a population of Kral’s water-plantain was discovered in Rush Creek, a tributary to Brushy Creek, on the Bankhead National Forest, Winston County, Alabama (John Moran, pers. comm. 2019). Additional occurrences of the species were discovered in the Brushy and Sipsey forks in 2015–2017 surveys, for nine total sites in the Bankhead National Forest. (USFWS, 2020)

Threats and Stressors

Stressor: Mining (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Mining can directly impact water quality and hydrology (USFWS, 2014).

Stressor: Agriculture (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Agriculture can directly impact water quality and hydrology (USFWS, 2014).

Stressor: Development (USFWS, 2014)
Exposure:
Response:
Consequence:

Narrative: Development of private land near Little River Canyon can directly impact water quality and hydrology (USFWS, 2014).

Stressor: Impoundments (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Impoundments exist over large areas of presumed suitable habitat on the Little River and may have destroyed undocumented populations (Department of the Interior 1990). Four large impoundments exist along a five mile stretch of the West Fork of the Little River and two are present below the Georgia locality on the East Fork. The impoundment of Lake Weiss in Cherokee County, Alabama, in the 1960s flooded suitable habitat along Yellow Creek and several miles of the Little River. In the past, dams along two creeks, which flow into the Little River, have broken and flooded portions of suitable habitat. Cracks and leaks have been observed on the dam above DeSoto Falls and a portion of a dam near the Georgia population has deteriorated (Whetstone 1988). Several existing populations are threatened by unstable impoundments that could break and eliminate or degrade populations and suitable habitat (McCartney 1999) (USFWS, 2014).

Stressor: Inadequacy of existing regulations (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: There are no State laws, in Alabama, that are protective of Kral's water plantain and its habitat. Therefore, the only protection afforded to this species in Alabama is on Federal land or on Federal projects under Section 7 of the ESA. Bankhead National Forest management practices do not apply to the potential development of private inholdings within the Forest. ESA take provisions also do not apply to plants on private lands, where a significant portion of the Kral's water plantain population is found. State protections are in place for the species in Georgia but do not provide for the protection against habitat destruction. In Georgia, listed plants, or those proposed for listing, are protected by the Wildflower Preservation Act of 1973. This legislation prohibits taking of plants from public lands without a permit and regulates the sale and transport of plants within the State. This statute does not provide protection against habitat destruction, which is the principal threat (USFWS, 2014).

Stressor: Recreation (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Increased recreational use of streambed habitats on Federal land, particularly by off-road vehicles during low-flow periods, is a threat that warrants further study and possible management actions Use of stream channels by recreational off-road vehicles on National Park Service and U.S. Forest Service lands is a growing problem (Mary Shew, NPS, pers. comm. March 2014). Destruction of habitat from off-road vehicle (ORV) is also likely occurring in streams on public land. Both the Forest Service and National Park Service recognize this as a potential problem and will be attempting to manage ORV usage (Ryan Shurette, USFS, pers. comm., February 2014, Mary Shew, NPS, pers. comm., March 2014) (USFWS, 2014).

Stressor: Sewage (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Siltation, impoundments, and eutrophication due to sewage are threats to this species. Activities that increase stream turbidity or siltation from erosion pose a threat to this species by reducing the amount of light reaching this submersed plant and burying it under silt. Eutrophication may lead to algal growth on the plant and result in degraded water quality (USFWS, 2014).

Recovery

Reclassification Criteria:
Recovery Priority Number: 8

Delisting Criteria:
Species will be considered for delisting when viable populations have been documented in three or more river basins within the Cumberland Plateau and within three or more tributaries of each river basin. A viable population is a reproducing population of sufficient size and genetic variability to sustain itself in perpetuity (USFWS, 2014).

Each population has been found to be viable through periodic monitoring for 15 or more years (USFWS, 2014).

Populations and supporting habitat in each river basin have sufficient long-term protection that the species no longer qualifies for protection under the Endangered Species Act (USFWS, 2014).

Recovery Actions:
- Gather base-line data on all populations and initiate long-term monitoring on sites, particularly on the secure, protected sites (USFWS, 2014).
- Develop habitat suitability indices using GIS to predict potential locations of additional populations (USFWS, 2014).
- Conduct additional field surveys to locate additional populations (USFWS, 2014).
- Since the discovery of the Hatchet Creek population, new surveys should be conducted in the Piedmont Region (USFWS, 2014).
- Work to obtain protection for sites adjacent to privately-owned lands (USFWS, 2014).
- Assess the threat of increased off-road vehicle use in stream channels where Kral's water-plantain is found (USFWS, 2014).
- Implement tasks identified in the recovery plan, except for number 6, related to reintroduction of the plant (USFWS, 2014).
- Revise recovery plan to address changes in known distribution (USFWS, 2014).
- Assist ADCNR in implementing State legislation that provides protection of Krals' water plantain (USFWS, 2014).

Conservation Measures and Best Management Practices:
- RECOMMENDATIONS FOR FUTURE ACTIONS We arranged the following recommendations for future conservation actions by general priority. 1. Gather baseline data on all populations and initiate long-

term monitoring on sites, particularly on the secure, protected sites. 2. Develop habitat suitability indices using GIS to predict potential locations of additional populations. 3. Conduct additional field surveys to locate additional populations. 4. Since the discovery of the Hatchet Creek population, conduct new surveys in the Piedmont Region. 5. Work to obtain protection for sites adjacent to privately owned lands. 6. Assess the threat of increased off-road vehicle use in stream channels with Kral's waterplantain occurrence. 7. Implement tasks identified in the recovery plan, except for number 6, related to reintroduction of the plant. 8. Assist ADCNR in implementing State legislation that provides protection of Kral's water-plantain. 9. Revise recovery plan to address changes in known distribution. (USFWS, 2020)

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SPECIES ACCOUNT: *Scirpus ancistrochaetus* (Northeastern bulrush)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/07/1991; Northeast Region (Region 5) (USFWS, 2015)

Physical Description

Scirpus ancistrochaetus, first described as a new species by A.E. Schuyler in 1962, is a leafy, perennial herb approximately 80-120 cm in height. The lowermost leaves are up to 8 mm wide and 40-60 times as long as wide, while the uppermost leaves are 3-5 mm wide and 30-50 times as long as wide (Schuyler 1962). Flowering culms (stems) are produced from short, woody, underground rhizomes. The umbellate inflorescence has distinctly arching rays, which bear clusters of brown spikelets (small, elongated flower clusters) (Figure 1). Each of the minute flowers has six small (1.1-1.7 mm long), rigid perianth bristles, and each bristle is armed with thick-walled, sharply pointed barbs projecting downward. Flowers have 0-3 stamens and a 3-parted style. The yellow-brown achenes (Figure 2) are 1.10-1.35 mm long, obovate, and tough and thickened above the seed (Schuyler 1962). Flowering occurs from mid-June to July, and fruit sets between July and September (Crow 1982). (USFWS, 1993)

Taxonomy

The northeastern bulrush is one of 18 members (in North America) of a natural group of “leafy bulrushes” within the genus Scipus. Not all botanists consider S. ancistrochaetus to be a distinct species, e.g., Gleason and Cronquist (1991) do not categorize the plant as a separate species in their authoritative guide to the vascular plants of the northeastern United States. However, based on the morphological and genetic evidence, as well as the botanical expertise ofA.E. Schuyler with the genus Scirpus, the U.S. Fish and Wildlife Service recognizes S. ancistrochaetus as a species. Scirpus ancistrochaetus is morphologically similar to S. atrovirens, S. hattorianus, and S. georgianus, but can be readily distinguished from them by the strongly arching rays of its inflorescence and the rigid, retrorse (turned backward or downward) barbs on its six perianth bristles. In contrast to S. ancistrochaetus, S. atrovirens has less ascending inflorescence rays, smaller achenes, and flowers with 4-6 delicate, wrinkled bristles covered with round-tipped, retrorse teeth (Schuyler 1962, 1963). (USFWS, 1993)

Historical Range

Historical collections of S. ancistrochaetus have been documented from Pennsylvania and New York, and possibly Virginia, but to date no historical collections have been confirmed from the other states within the species’ range. (USFWS, 1993)

Current Range

Extant populations of S. ancistrochaetus are currently known from Maryland (1 population), Massachusetts (1), New Hampshire (1), Pennsylvania (22), Vermont (2), Virginia (4), and West Virginia (2). As of 2007, there were 113 extant populations range-wide, most of which were found in Pennsylvania and Vermont. (USFWS, 1993)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual and asexual (vegetative) (NatureServe, 2015)

Breeding Season

Adult: July to September (USFWS, 1993)

Reproduction Narrative

Adult: It is known that Scirpus ancistrochaetus reproduces both vegetatively and sexually, but the relative importance of each is unknown. Qualitative observations suggest that once a population is established, vegetative reproduction is the primary means of recruitment (Bartgis 1991, U.S. Fish and Wildlife Service 1991). In addition, Bartgis has observed large numbers of new plants being produced sexually (germination is observed in March, when the seeds are still attached to the original seedheads), but sexually produced plants seem to have less vigor than vegetatively produced plants. In addition to these observations, W. Brumback (pers. comm.) has had success germinating seeds that had been in storage for at least four years. Flowering occurs in mid-June to mid-July; fruits appear from July to September. Seeds germinate in March in the southern portion of the plant's range, and likely later in the north. Some plants may simply fail to flower or fruit in certain years. (NatureServe, 2015)

Habitat Type

Adult: Palustrine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Herbaceous wetland, temporary pool (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Water levels: requires saturation or inundation; needs ample sunlight (USFWS, 1993)

Geographic or Habitat Restraints or Barriers

Adult: Closed canopy may limit populations (USFWS, 1993)

Spatial Arrangements of the Population

Adult: Clumps (USFWS, 1993)

Environmental Specificity

Adult: Moderate (USFWS, 1993)

Habitat Narrative

Adult: The northeastern bulrush typically grows in palustrine emergent wetlands or vernal ponds surrounded by woodlands in aggregative clumps. In general, the northeastern bulrush tends to grow in acidic to circumneutral natural ponds, shallow sinkholes, or wet depressions (wet meadows and marshes) found in hilly country (U.S. Fish and Wildlife Service 1991). These ponds typically experience a mid-summer drawdown, depending on annual precipitation quantities. This species is commonly found on mountain benches where water collects at a common drainage point. Often it grows at the water's edge, or in a few centimeters of water, but it may also be in fairly deep water (0.3-0.9 m) or away from standing water. In the southern part of its range, the most common habitat is sinkhole ponds, usually in sandstone. Water levels in these ponds tend to vary both with the season and from year to year. Common associates of northeastern bulrush are Dulichium arundinaceum, Scirpus cyperinus sens. lat., Glyceria canadensis, and Triadenum virginicum. The habitat seems to vary geographically, although there are not enough sites to allow generalizations to be made. However, one does observe that in the south, sinkhole ponds are the most common habitat for the plant, and in the north, other kinds of wetlands, including beaver-influenced wetlands, provide suitable habitat. Wetland influenced by substantial canopy closure could have weaker bulrush populations (USFWS, 2009; NatureServe, 2015)

Dispersal/Migration

Dispersal

Adult: High (inferred from USFWS, 1993)

Dependency on Other Individuals or Species for Dispersal

Adult: Wildlife including waterfowl and beaver (USFWS, 1993)

Dispersal/Migration Narrative

Adult: Also, while it is assumed that seeds may disperse by wind or water (especially if flooding occurs before the seeds have become lodged in the substrate), nothing is known about the effectiveness of seed dispersal under natural conditions. Due to the presence of barbs, the seeds readily adhere to clothing and would presumably adhere well to fur (R. Bartgis and J. Kunsman pers. comm.). Wildlife that may act as dispersal agents, including waterfowl and beaver, are down in numbers from historical levels in many areas. (USFWS, 1993)

Population Information and Trends

Population Trends:

Declining (NatureServe, 2015)

Resiliency:

The northeastern bulrush currently exhibits good resiliency rangewide (USFWS, 2019).

Representation:

Although the northeastern bulrush exhibits some genetic diversity, especially in the Appalachian region, the species has a low sexual reproduction, and populations are genetically isolated and have poor dispersal success rate (Cipollini et al. 2013, pp. 692-693; 2017, pp. 73-74), which functionally isolates populations. In addition, populations often reproduce clonally. These factors reduce the species' ability to adapt to changing environmental conditions (USFWS, 2019).

Redundancy:

The northeastern bulrush's redundancy is based on its 148 known extant occurrences distributed over a large geographic area, including several distinct environmental settings (i.e., physiographic provinces and habitat types). In addition, 60.8 percent of populations have excellent or good resiliency, and 89.2 percent have excellent to fair resiliency (USFWS, 2019).

Number of Populations:

113 (USFWS, 2009)

Population Size:

2500 - 100,000 individuals (NatureServe, 2015)

Population Narrative:

As of 2007, there were 113 extant populations range-wide, most of which were found in Pennsylvania and Vermont. Most populations are in Pennsylvania (70) and Vermont (22) (USFWS 2008). The other populations are in Massachusetts (1), Maryland (1), New Hampshire (9), Virginia (7), and West Virginia (3) (USFWS 2008). Approximately half of the populations appear to be declining; long-term monitoring is needed (USFWS 2008). (NatureServe, 2015; USFWS, 2009)

Threats and Stressors

Stressor: Habitat destruction and degradation (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Habitat destruction and degradation continues to be a threat to this species. Approximately half of the northeastern bulrush populations occur on publicly owned land – primarily Federal or State lands subject to multiple uses, including timber production, oil and gas leasing, and recreation. Threats to these populations include habitat destruction or degradation due to logging operations, oil and gas development, road construction, and off-trail vehicle use. Threat levels on public land are probably less than they were at the time of listing due to the awareness of land managers and use of screening procedures prior to undertaking projects involving earth disturbance. The other populations occur on privately-owned land, where threats include residential and commercial development, road construction, logging operations, agricultural activities, pipeline and power line maintenance, and off-trail vehicle use. These populations could be affected by activities occurring in or adjacent to wetland habitats. Additionally, because habitat may be seasonally dry, it may not be obvious that a wetland is present. Only one site on private land receives protection via a conservation easement. Threat levels on private land are estimated to be the same or greater than threat levels at the time the species was listed. (USFWS, 2009)

Stressor: Herbivory (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Deer browsing/trampling has become an increasingly notable problem. Deer browsing was documented at a few sites (6) in Pennsylvania and, based on field experiments, clipping plants to simulate white-tailed deer grazing in 0 and 30 percent shading led to a taller plant with less biomass (Lentz and Cipollini 1998). Herbivory can adversely affect plant fitness, and future herbivory of this species could result in a population decline, especially at locations where the species population is already threatened. (USFWS, 2009)

Stressor: Hybridization (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Disease has not been documented as a factor in the decline of the species. However, the northeastern bulrush often hybridizes with Scirpus atrovirens, which may occur in or immediately adjacent to habitat occupied by the northeastern bulrush. This hybrid is highly sterile (Schuyler 1963) leaving it weaker and more susceptible to disease. (USFWS, 2009)

Stressor: Hydrological changes (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The northeastern bulrush and its habitat are susceptible to floods, droughts, and general water table fluctuation. However, beaver activity may have the greatest effect on the hydrology of wetlands occupied by this species. For example, beaver influenced hydrology has been documented at four of the nine sites in New Hampshire, and at 14 of the 22 northeastern bulrush sites in Vermont. It is known that small differences in water depth affect plant height, leaf life span, and root to shoot mass in Scirpus ancistrochaetus (Lentz and Dunson 1998). Specifically, studies suggest a decrease in lifespan in response to increased water level. However, it is still uncertain whether beavers have a beneficial or negative overall impact on northeastern bulrush habitat. (USFWS, 2009)

Stressor: Small population size (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Additionally, there are many small populations of this species that are vulnerable to natural, genetic, and human threats. Small, isolated populations also carry a high probability of extinction due to geographic distance, ecological factors/reproductive strategy, which may limit introduction of new genetic material. This can result in a highly inbred population with low viability and/or fecundity (Chesser 1983). (USFWS, 2009)

Recovery

Reclassification Criteria:
1. Long-range protection is secured for 20 populations. (USFWS, 1993)

2. Annual monitoring over a 10-year period shows that a sample of 20 representative populations is stable or increasing. (USFWS, 1993)

3. Life history and ecological requirements are understood sufficiently to allow for effective protection, monitoring and, as needed, management. (USFWS, 1993)

Recovery Priority Number: 14

Delisting Criteria:
Delisting criteria are not available.

Recovery Actions:

- Protect existing populations and their habitat through land protection, regulatory means, and education. (USFWS, 1993)
- Search for and protect additional populations. (USFWS, 1993)
- Monitor population trends and habitat conditions. (USFWS, 1993)
- Investigate the species' life history and reproductive strategy. (USFWS, 1993)
- Characterize the habitat and determine the environmental requirements of the species. (USFWS, 1993)
- Investigate the genetic variability and viability of the species. (USFWS, 1993)
- Secure, and store or propagate, genetic material from each genotype. (USFWS, 1993)
- Re-survey populations that have not been recently assessed (within the past 5 years). (USFWS, 2009)
- Secure protection for sites on public and private land. (USFWS, 2009)
- Conduct periodic surveys of a representative sample of northeastern bulrush populations to determine trends and threats. (USFWS, 2009)
- Implement management tools to reduce threats and monitor the effectiveness of these recovery actions. (USFWS, 2009)
- There is also a significant need for additional protections for this species. Since it is now known that over half of the extant populations occur on public lands, establishing management and habitat protection agreements with State and Federal agencies would secure the permanent protection of this species on those lands. Also, partnering with non-governmental organizations, such as the Fall Mountain project in New Hampshire, can lead to additional protection of the species. These partnerships could help reach a recovery objective of long-range protection for 20 populations. (USFWS, 2009)
- Surveys of appropriate habitat (e.g., characteristic vernal pools) should be conducted in New York. As previously discussed, the lack of documented occurrences in New York probably reflects a lack of surveys rather than a true break in the species' range. Finding more extant occurrences of this species would assist in securing its eventual recovery, especially if these populations receive permanent protection. Additionally, if the species were to be found in New York, its habitat would include a 100foot buffer, since that State mandates buffers around all wetlands. (USFWS, 2009)
- Another recovery objective listed in the Recovery Plan is to better understand the life history and ecological requirements of this species, so it can be better protected, monitored and managed. There is a need for better understanding of the role genetic variation between populations, herbivory, shading, and seed bank formation, among other things, and funding for these studies would facilitate species recovery. (USFWS, 2009)

Conservation Measures and Best Management Practices:

- Conservation measures: There are conservation measures in progress that benefit northeastern bulrush viability: 1. Since listing, every state in the species' range has conducted ongoing surveys of known occupied and suitable habitat, which resulted in a dramatic increase in the number of known populations and the species' known occupied range. 2. In Pennsylvania, there is a long-term monitoring effort being conducted in an attempt to understand population dynamics and environmental control mechanisms, and how they can be applied to successful management strategies. 3. Some targeted habitat management is occurring. For example, a population in Pennsylvania had been declining for several years likely due to increased overstory canopy shading.

Once canopy thinning occurred through active management of the site, the population gradually increased, though it is not yet at its maximum recorded numbers (M. Furedi, PNHP, pers. comm. October 2018). 4. In New York, the Wetland Trust and the Upper Susquehanna Coalition have implemented a pilot program for the propagation and transplantation of the northeastern bulrush. The effort has been at least moderately successful to date, with a 40 percent plant survival rate after 2 years and a population that appears to be self-sustaining. However, because the success of the recent propagation is uncertain, and the population has not been surveyed and evaluated under the same protocols as other populations (e.g., it does not have an EO rank), we did not consider this population as contributing to the species viability. 5. In Vermont, the Service is implementing measures to control glossy buckthorn affecting a population in Putney (USFWS, 2019).

- The future scenario results in moderate negative effects on resiliency, a slight decline in representation and in redundancy, and extirpation of 13 populations from seasonal wetlands—2 in the New England region and 11 in the Appalachian region. Approximately 135 populations are predicted to remain in 2050, although this number would be higher if offset by discovery of new populations. The species likely will retain low genetic diversity, especially in the New England region, and over the long term, may have difficulty adapting to changing environmental conditions. Low genetic representation will continue to be mitigated by diversity of habitat type and physiographic provinces. The species is predicted to retain its redundancy driven by a wide geographic distribution and variety of environmental settings, although the species' apparent dispersal difficulty will limit its ability to shift its range in response to changing climate. (USFWS, 2019)
- Appalachian - Although 11 percent of the Appalachian populations will be lost, some of this loss may be offset by discovery of previously unknown populations. Populations will be extirpated in two states—Pennsylvania (11), which has many populations with a similar haplotype/genotype, but also has at least one population of unique representative value (Cipollini et al. 2017, p. 692); and Virginia (1). Eightysix Appalachian populations will remain in seasonal wetlands. (USFWS, 2019)
- In addition, the number of known populations has increased dramatically since listing, with the newest known populations discovered as recently as 2019. We expect survey efforts to occasionally detect new populations and offset some of the redundancy lost with the most vulnerable populations. (USFWS, 2019)
- In addition, the number of known populations has increased dramatically since listing, with the newest known populations discovered as recently as 2019. We expect survey efforts to occasionally detect new populations and offset some of the redundancy lost with the most vulnerable populations. (USFWS, 2019)
- Tables 5-1 and 5-2 summarize projected trends in the future condition of the northeastern bulrush in the context of resiliency (decline), representation (slight decline), and redundancy (slight decline). We predict that approximately 135 populations of the northeastern bulrush will remain in 2050, assuming loss of populations that currently have poor resiliency. This number would be slightly higher if offset by discovery of a few new populations. The species likely will retain low genetic diversity, especially in the New England region, and over the long term, may have difficulty adapting to changing environmental conditions. Low genetic representation will continue to be mitigated by diversity of habitat type and physiographic provinces. The species will retain its redundancy driven by a wide geographic distribution and variety of environmental settings, although the species' apparent dispersal difficulty will limit its ability to shift its range in response to changing climate. (USFWS, 2019)

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SPECIES ACCOUNT: *Spiranthes diluvialis* (Ute ladies'-tresses)

Species Taxonomic and Listing Information

Listing Status: Threatened; 01/17/1992; Mountain-Prairie Region (R6) (USFWS, 2016). Proposed for delisting on Jan 7, 2025.

Physical Description

Ute ladies'-tresses was first described as a species in 1984 by Dr. Charles J. Sheviak from a population discovered near Golden, Colorado (Sheviak 1984). The species is a perennial orchid (member of the plant family Orchidaceae) that first emerges above ground as a rosette of thickened leaves that is very difficult to distinguish from other vegetation, especially given the dense herbaceous vegetation in which the species often grows. Its leaves are up to 1.5 cm (0.6 in.) wide and 28 cm (11 in.) long; the longest leaves are near the base. The usually solitary flowering stem is 20 to 50 cm (8 to 20 in.) tall, terminating in a spike of 3 to 15 white or ivory flowers. Flowering is generally from mid-July through August. However, in some locations it may bloom in early July or may still be in flower as late as early October. Ute ladies'-tresses looks most similar to hooded ladies'-tresses (Spiranthes romanzoffina), but differs in the detailed characteristics of the individual flowers. In hooded ladies'-tresses (which is more common), each individual flower has petals and sepals that are fused to form a covering, or "hood". In Ute ladies'-tresses, these floral parts are not fused, appearing instead to be widely spread, or "gaping" open.

Historical Range

The total number of historical occurrences is 75, and out of those we have enough recent information to deem 62 still occupied, 13 are extirpated, and the remainder do enough have any recent enough observations or other information to assume occupancy. (USFWS, 2024)

Current Range

When it was listed under the Act in 1992, Ute ladies'-tresses was known from 10 extant populations within portions of only two states (Colorado and Utah, USFWS 1992a). At that time, these 10 populations were estimated to encompass approximately 170 ac of occupied habitat. At listing, the species was presumed extirpated in Nevada. Since listing, Ute ladies'-tresses was rediscovered in Nevada, and new populations were discovered in southern Idaho, southwestern Montana, western Nebraska, central and northern Washington, and southeastern Wyoming (Fertig et al. 2005, Figure 1 of this Biological Opinion), and south central British Columbia (Bjork 2007). In 2005, 53 populations (encompassing 674-784 ac of habitat) were considered extant across the range of the species (Fertig et al. 2005); the British Columbia locations were discovered the following year (Bjork 2007). Utah had the most populations (23), the largest amount of occupied habitat (234-308) ac, and the highest number of reported plants (47,859 individuals) of any state (Fertig et al. 2005). The Spanish Fork watershed in Utah was assessed as having the highest recorded population estimate (28,825 plants), whereas the Upper Green-Flaming Gorge Reservoir population (which spans the Colorado-Utah border) spanned the most extensive area (117-126 ac). The majority of known populations (66 percent) occupied between 0.1 and 10 ac, whereas relatively few (4.9 percent) occupied more than 50 ac. The total number of historical occurrences is 75, and out of those we have enough recent information to deem 62 still occupied, 13 are extirpated, and the remainder do enough have any recent enough observations or other information to assume occupancy. (USFWS, 2024)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Key Resources Needed for Breeding

Adult: Pollinators: Mainly bees (USFWS, 2023)

Reproduction Narrative

Adult: Flowering is generally from mid-July through August. However, in some locations it may bloom in early July or may still be in flower as late as early October. Ute ladies'-tresses is a perennial plant species that blooms in the late summer to early fall and requires pollinators, mainly native bees, for reproduction. Seeds are extremely small and easily spread by wind or water. The exact details of the Ute ladies'-tresses life cycle are not fully understood, but it can remain dormant underground for 11 or more years, and that it is likely dependent on symbiotic mycorrhizae during all life stages. In addition to mycorrhizae, individual plant survival and recruitment depends on the presence of adequate ground or surface water during the growing season, the presence of appropriate pollinators, and adequate sunlight for photosynthesis (USFWS, 2023)

Habitat Type

Adult: Ute ladies'-tresses occurs in a variety of human-modified and natural habitats, including, seasonally flooded river terraces, sub-irrigated or spring-fed abandoned stream channels and valleys, and lakeshores

Environmental Specificity

Adult: Moderate (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Ute ladies'-tresses occurs in a variety of human-modified and natural habitats, including, seasonally flooded river terraces, sub-irrigated or spring-fed abandoned stream channels and valleys, and lakeshores (Jennings 1989, USFWS 1992a, Fertig et al. 2005). Numerous populations also occur along irrigation canals, behind berms, within abandoned roadside borrow pits, along reservoir edges, and other human created or modified wetlands. Streamside populations of Ute ladies'-tresses typically occur on shallow alluvial soils overlying permeable cobbles, gravels, and sediments. Across the range of the species, populations occur at elevations ranging from 220 to 558 m (720 to 1,830 ft) in Washington and British Columbia to 2,134 m (7,000 ft) in northern Utah. Most Ute ladies'-tresses sites have mid-successional vegetation (well-established grasses and forbs) communities that are maintained by human disturbances such as livestock grazing, mowing, ditch and irrigation maintenance, prescribed fire (Allison 2001, Fertig et al. 2005). Ute ladies'-tresses may persist for some time in the grassy understory of woody riparian shrublands, but does not appear to thrive under these conditions (Ward and Naumann 1998). Nearly all streambank, floodplain, and abandoned ox-bow sites occupied by Ute ladies'-tresses have a high water table (usually within 12.5 to 45 centimeters (5 to 18 inches) of the surface) augmented by seasonal flooding, snowmelt, runoff, and often irrigation (Jennings 1989, Arft 1995, Black et al. 1999, Riedel 2002). Soils must be sufficiently stable and moist in the summer flowering season to support the species (Ward and Naumann 1998). Sites located in springs or sub-irrigated meadows appear to be fed by groundwater rather than surface flows; less is known about the average depths to groundwater in these locations, but it is reasonable to assume that (as with locations where groundwater depths have been quantified) groundwater must remain relatively close to the surface in order to sustain the moist soils consistently associated with Ute ladies'-tresses.

Dispersal/Migration

Population Information and Trends

Number of Populations:

18 Extant AUs (USFWS, 2023)

Population Size:

~80,000

Population Narrative:

Ute ladies'-tresses is a long lived perennial herb that is thought to reproduce exclusively by seed (Fertig et al. 2005). Bees are the primary pollinators; however because Ute ladies'-tresses provides only nectar as a food reward, other pollen-providing plant species must be present to attract and maintain pollinators (Sipes and Tepedino 1995, Sipes et al. 1995, Pierson and Tepedino 2000). The life cycle of Ute ladies'-tresses consists of four main stages—seedling, dormant, vegetative, and reproductive (flowering or fruiting) (Fertig et al. 2005). Ute ladies'-tresses seedlings may develop slowly into larger, dormant mycorrhizal roots or grow directly into above ground vegetative shoots (Wells 1981), but neither has been confirmed in the wild. The Cincinnati Zoo and Botanical Garden has grown plants from seed under laboratory and greenhouse conditions; germination took 6-8 months and development from a protocorm into a plant was slow (Pence 2009). Long term demographic monitoring studies indicate that vegetative or reproductive Ute ladies'-tresses plants can revert to a below ground existence for as many as four consecutive growing seasons before reemerging above ground (Arft 1995, Allison 2001, Heidel 2001). Flowering individuals are necessary to reliably distinguish Ute ladies'-tresses from other similar-looking plant species (esp. other Spiranthes species), and surveys during flowering season also maximize the likelihood of detecting Ute ladies'-tresses among dense stands of other herbaceous plant species. However, surveys in which only flowering stems are tallied are of limited value for assessing population trends, given that individual Ute ladies'-tresses plants do not flower consistently from one year to the next, and the relative proportion of individual Ute ladies'-tresses plants in each of the four life stages (seedling, dormant, vegetative, reproductive) can vary widely within and among years and between different colonies (Arft 1995, Pierson and Tepedino 2000, Allison 2001, Heidel 2001, Fertig et al. 2005). Population trends are less variable when inferred from datasets in which all life stages are counted (Arft 1995, Heidel 2001). However, because non-reproductive individuals are inherently difficult and laborious to detect, most surveys tend to focus on the detection (and counting) of flowering individuals (Fertig et al. 2005). As a result, knowledge of Ute ladies'-tresses population trends is severely hindered; this also suggests that available estimates (derived solely from flowering stem counts) are likely to represent conservative estimates of total population size. With these and other caveats (discussed further in Fertig et al. 2005) in mind, the following statements can be made regarding rangewide abundance and trends in Ute ladies'-tresses: when the species was listed under the Act in 1992, the rangewide population was estimated to contain fewer than 6,000 individuals (USFWS 1992). In 1995, the draft recovery plan increased this estimate to 20,500 individuals, primarily the result of 21 new populations discovered over the previous 3 years (USFWS 1995). As of 2005, 53 populations were estimated to collectively contain more than 80,000 (83,316) individuals (Fertig et al. 2005). For these populations, available population estimates ranged in size from 1 to more than 28,000 plants. More than 80 percent of these populations contained fewer than 1,000 individuals; 38 percent contained fewer than 100 individuals. In summary, Ute ladies'-tresses occurs in more than 50 populations distributed across 8 U.S. states and 1 Canadian province; these populations collectively contain some 80,000 individuals. Approximately 80 percent of known populations are associated with lands managed for agriculture or recreation, rivers regulated by dams, or other human-modified habitats (Fertig et al. 2005). Research, monitoring and management activities have demonstrated that ongoing patterns of land use across the range of the species are capable of mimicking or providing the conditions required for the species' persistence. At the time of listing in 1992, Ute ladies'-tresses was known to occur only in Utah and Colorado. Today, it is known to occur in eight states – Colorado, Idaho, Montana, Nebraska, Nevada, Utah, Washington, and Wyoming – as well as in southern British Columbia (Figure 1). We believe this expanded known range is primarily due to the increased survey effort that occurred after listing. We know of at least 71 historical occurrences spread across 19 watershed basins, at the 6-digit hydrological unit code (HUC) level (Figure 1). Due to the wide distribution and complex life history of the species, we used 6-digit HUC watershed basins as surrogates for populations, called analytical units (AUs), for the purposes of the SSA analysis (USFWS, 2023). Ute ladies'-tresses currently is extant in 18 out of 19 historical AUs (Table 2). The Upper Arkansas AU is considered extirpated due to the complete habitat destruction of the only known occurrence. Of the 18 extant AUs, 5 AUs currently have high resiliency, 8 have moderate resiliency, and 5 have low resiliency. (Table 2). The 18 AUs are distributed broadly across the species' historical range, and represent a variety of habitat types, environmental conditions, and ecological settings (Figure 2) and the species current level of redundancy reduces risk from stochastic and catastrophic events. Representation for the species is currently captured by the 18 AUs distributed across 12 different ecoregions with the species occurring within 7 habitat types, illustrating the species' potential to adapt to short- and long-term changes to environmental conditions, except for those novel changes that may eliminate wetland habitats, such as changes in the climate regime, water management, urbanization, and development (USFWS, 2023A).

Threats and Stressors

Stressor:
Exposure:
Response:
Consequence:
Narrative: At the time of listing, we identified habitat loss and modification as the primary threat to the species, but also noted that small population sizes and low reproductive rates rendered Ute ladies'-tresses vulnerable to other threats (USFWS 1992a). Our listing rule identified several specific forms of habitat loss and modification as threats to Ute ladies'-tresses, including: urbanization, water development and conversion of lands to agriculture, excessive livestock grazing, excessive or inappropriate use of herbicides or other chemicals, and the proliferation of invasive exotic plant species. In addition, we concluded that the species may be subject to over-

collection, given its status as an orchid and inquiries from orchid enthusiasts and wildflower collectors. We characterized existing regulatory mechanisms as inadequate to ensure the long-term persistence of Ute ladies'-tresses, given these threats. Today, many of these same threats affect Ute ladies'-tresses at least at the site-specific level (Figure 2; Fertig et al. 2005), and some newer threats have emerged. For example, whereas over-collection had not materialized as a specific threat to Ute ladies'-tresses, vegetation succession and losses or reductions in pollinators appeared to be new threats (although they characterize pollinator availability as more of a potential threat). Current threats include competition from invasive species, vegetative succession, road and infrastructure construction, and changes in hydrology. Conversion of irrigation water to municipal use, flood control (includes riverbank stabilization), water development or redevelopment, and restoration projects targeting stream and riparian corridors (includes in-stream and habitat alteration) contribute to altered hydrologic regimes across the species' range. However, Ute ladies'-tresses has proliferated in areas with greatly altered, but stable and predictable hydrology (Fertig et al. 2005). Prominent examples include the Green River along the Colorado-Utah border (Ward and Naumann 1998); Diamond Fork Creek in the Spanish Fork watershed of Utah (Black and Gruwell 2004); the Columbia River in Washington (Cordell-Stine and Pope 2008); and the South Fork Snake River in Idaho (Idaho Conservation Data Center 2007). The species is also frequently encountered along streams and canals and in wet hay pastures in the Uinta Basin of eastern Utah, even though an extensive irrigation canal system was constructed in the early 1900s and natural streams are nearly dry all summer (Fertig et al. 2005, Kendrick 1989). Ute ladies'-tresses has colonized wetlands left behind when peat was mined, and also occurs in drainage ditches alongside roads and railroad tracks (Fertig et al. 2005). In the summer of 2012, the species was rediscovered in Salt Lake County, Utah, after decades of unsuccessful attempts to relocate an historical collection of the species in this county dating from 1953. The county property on which the orchid was recently found has been managed as a flood control basin with permitted horse grazing for the past 50 years. In summary, Ute ladies'-tresses occurs in more than 50 populations distributed across 8 U.S. states and 1 Canadian province; these populations collectively contain some 80,000 individuals. Approximately 80 percent of known populations are associated with lands managed for agriculture or recreation, rivers regulated by dams, or other human-modified habitats (Fertig et al. 2005). Research, monitoring and management activities have demonstrated that ongoing patterns of land use across the range of the species are capable of mimicking or providing the conditions required for the species' persistence.

Recovery

Reclassification Criteria:
Recovery Priority Number: 14C

Recovery Actions:

- Define, manage and restore watersheds
- Implement interim recovery actions for orchid populations associated with natural stream systems
- Identify, protect and manage populations in disjunct habitats
- Develop orchid population and habitat recovery goals and delisting criteria
- Inventory potential remaining habitat
- Conduct genetic, life history, ecology and habitat management studies

- Reintroduce Ute ladies'-tresses into appropriate sites
- Conduct public education on watershed and riparian ecosystem management, use of recovery and interdisciplinary teams, and orchid ecology

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SPECIES ACCOUNT: *Spiranthes parksii* (Navasota ladies'-tresses)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/06/1982; Southwest Region (Region 2) (USFWS, 2016)

Physical Description

Spiranthes parksii is an erect, slender stemmed perennial up to 30 cm tall; leaves mostly basal, linear, usually absent when flowering; inflorescence a slender, solitary spike of small flowers surrounded by conspicuously white-tipped bracts; petals rounded or ovate with a green central stripe; lateral petals conspicuously shorter than the sepals; lip margin distinctly ragged (Mahler, 1980). The most unusual characters for identification of S. parksii in the field are the short, wide lateral petals, cream colored perianth, and a tendency for the floral bracts, and sometimes the stem bracts to be white-tipped. The small, fragrant flowers bloom from late October-early November. (USFWS, 1984; NatureServe, 2015)

Taxonomy

S. parksii is clearly defined as a taxonomic species, its association with other elements of the genus is not clear at the present time. On the basis of a recent, biosystemic study, there is little doubt that S. parksii is clearly within Spiranthes s. str., possibly associated with the S. cernua complex of species (Sheviak, 1982). (USFWS, 1984)

Historical Range

When Navasota ladies'-tresses was listed in 1982, it was known only from Brazos County. (USFWS, 2009)

Current Range

Texas endemic found in eastern Texas along the Navasota River, primarily in Grimes and Brazos counties. This species has recently been found at Angelina National Forest, in Jasper County, 114 miles east of the nearest population in Madison County. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

<u>Adult:</u> Although genetic evidence (Manhart and Pepper 2006, pp. 38, 50) indicates that rare instances of outcrossing occur, the vast majority of seeds are produced through apomixes (genetic cloning) (USFWS, 2018).

Dependency on Other Individuals or Species

<u>Adult:</u> Spiranthes parksii flowers are visited by bumblebees and other insects, but produce polyembryonic seeds even when the flowers have not been pollinated (Catling and McIntosh 1979). The species requires mycorrhizal fungi (Epulorhiza, specifically) for successful reproduction and germination (U.S. Fish and Wildlife Service 2009, Walters 2005, and Wonkka

et al. 2012). (USFWS, 2009)

Breeding Season

Adult: October to November (USFWS, 2009)

Reproduction Narrative

Adult: Charles Sheviak (in. litt. 1986) reported that all polyploid species within the Spiranthes cernua complex (including S. parksii) are facultatively agamospermic, through adventitious embryony; but the rare occurrence of apparent hybrids between S. parksii and S. cernua indicate that parksii is capable of sexual reproduction. The species requires mycorrhizal fungi (Epulorhiza, specifically) for successful reproduction and germination (U.S. Fish and Wildlife Service 2009, Walters 2005, and Wonkka et al. 2012). Spiranthes parksii flowers are visited by bumblebees and other insects, but produce polyembryonic seeds even when the flowers have not been pollinated (Catling and McIntosh 1979). (USFWS, 2009; NatureServe, 2015)

Habitat Type

Adult: Habitats are intact post oak savannas that are influenced by periodic wildfire (USFWS, 2018).

Habitat Vegetation or Surface Water Classification

Adult: Associated with stream banks and drainages in post oak savanna (USFWS, 2018).

Spatial Arrangements of the Population

Adult: Navasota Ladies'-tresses are distributed through habitats in relatively small, scattered colonies, and it is difficult to delineate populations (USFWS, 2018).

Environmental Specificity

Adult: Moderate (USFWS, 2009)

Tolerance Ranges/Thresholds

Adult: Low (NatureServe, 2015)

Habitat Narrative

Adult: This terrestrial orchid is found in sandy soil in the post oak savanna of central-east Texas, often along the naturally eroded slopes of the upper reaches of drainages and ephemeral streams, or occasionally near the margins of seeps and swales. Within the post oak savanna, S. parksii typically occurs in a specific topographic position where permeable fine sand or sandy loam shallowly overlies less permeable clay. Along these narrow contours of shallow topsoil, where there may be less competition from more robust herbaceous and woody plants, available moisture may be sustained by seepage along the upper surface of the clay stratum. Often in areas where edaphic or hydrologic factors (such as high levels of aluminum in the soil or a perched water table) limit competing vegetation in the herbaceous layer. Besides post oak, associated species include water oak (Q. nigra), blackjack oak (Q. marilandica), and yaupon (Ilex vomitoria). Species does not readily recover from significant disturbance to its habitat or colonize areas with extensive disturbance (Pine 2003). (USFWS, 2009; NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Long-term trends are unknown but short-term trends indicate a decline of 10-30% (NatureServe, 2015)

Number of Populations:

64 element occurrences (USFWS, 2009). 13 (USFWS, 2022)

Population Size:

<5,780 individuals (USFWS, 2022)

Minimum Viable Population Size:

Estimated to be approximately 1,500 individuals (USFWS, 2018)

Additional Population-level Information:

S. parksii is endemic to east-central Texas with 24 documented sites occurring across 13 Texas counties, Bastrop, Brazos, Burleson, Freestone, Fayette, Grimes, Jasper, Leon, Limestone, Madison, Milam, Robertson, and Washington (USFWS, 2022)

Population Narrative:

Long-term population trends are unknown but short-term trends indicate a decline of 10-30%. The total "high count" of 3,651 for all EOs represents the total population size. From this number, 510 individuals have been lost in three large elemental occurrences (EOs), leaving a potential surviving known population of 3,141. The total number of EOs recorded is 64. (USFWS, 2009; NatureServe, 2015). Navasota ladies'-tresses occurs in seven HUC 8-digit units: Navasota HUC8 12070103, Lower Brazos - Little Brazos HUC8 12070101, Lower Trinity-Tehuacana HUC8 12070204, Lower Trinity-Kickapoo HUC8 12030202, Yegua HUC8 12070102, Lower Colorado-Cummins HUC8 12090301, and the Lower Angelina HUC8 12020005 (USFWS, 2018).

Threats and Stressors

Stressor: Habitat loss and modification (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The primary threats to the continued existence of Navasota ladies'-tresses are habitat loss and modification (Wilson 1993). Approximately 14 percent of the known SPIPAR population has been lost to development of two lignite mines, a landfill, pipelines and highway construction and improvement. An unknown amount of habitat and individuals have undoubtedly been consumed by development projects that did not require Section 7 consultation with USFWS. Diamond and True (2000) documented a loss of 5.8 percent of the forest cover within the post oak savanna region from 1987 to 1997. However, the species is now protected in 24 small reserves, 21 of which resulted from the reasonable and prudent alternatives and measures approved during Section 7 consultation with USFWS. Five of these reserves are owned by TMPA

and may be sold after the final release of their bond by the Texas Railroad Commission, scheduled for 2015. Even where the species' habitat remains secure, habitat quality declines as the herbaceous component of the post oak savanna is replaced by a dense woody understory. This "thicketization" has occurred throughout the post oak savanna region, and elsewhere, and is attributed to a greatly reduced frequency of wildfire, and to poor rangeland management techniques. A team of researchers from TAMU, with support from BVSWMA, is currently creating an adaptive habitat management plan based on their investigations of S. parksii ecology. (USFWS, 2009)

Stressor: Herbivory (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Deer, squirrels, and perhaps other herbivores cause a significant amount of damage to flower stalks. Hammons et al. (2009) reported that 30 percent of the flower stalks in one trial were browsed by herbivores before they could mature. Although these fauna are native throughout the species' range, white tailed deer are now far more abundant than during pre-settlement times. Introduced feral hogs and native armadillo also cause significant damage to S. parksii habitat (Hammons et al. 2009). (USFWS, 2009)

Stressor: Climate change (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: According to the Intergovernmental Panel on Climate Change (IPCC) (2007, p. 1) "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, p. 1). 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, p. 1). 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). The Service does not know whether the changes that have already occurred have affected Navasota ladies'-tresses populations or distribution, nor can the Service predict how the species will be affected by the type and degree of climate changes forecast by a range of models. The known populations of Navasota ladies'-tresses are almost entirely restricted to post oak savanna in central east Texas. Rising temperatures might enable the species to survive further north that at present, but might also reduce the southern limit of the range. However, the discontiguous nature of the populations and potential habitat, and the existence of new, anthropogenic barriers to migration, could impede the spontaneous extension of the range. 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 is an edaphic endemic dependent on ephemeral seeps, increasing or decreasing rainfall could alter its competitive advantage in the unique microhabitats it now inhabits. Regardless of how changes in temperature and rainfall amounts and patterns may affect the autecology of Navasota ladies'-tresses, the altered synecology may be far more significant. The possible effects of climate change on the synecology of Navasota

ladies'-tresses 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)

Recovery

Reclassification Criteria:
1. One or more viable populations or metapopulations occur in each of the seven HUC 8- digit watersheds within its known range. To be considered viable, each population or metapopulation will consist of at least 1,500 mature individuals, and will total at least 10,500 individual plants across the seven HUCs (USFWS, 2018).

2. The populations or metapopulations that meet criterion 1 occur in 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 Navasota ladies'-tresses must be managed in a manner that promotes the continued survival of this species (USFWS, 2018).

Recovery Priority Number: 8C

Delisting Criteria:
1. The criteria for downlisting to threatened, described above, have been met: One or more populations or metapopulations, each consisting of consisting of 1,500 or more mature individuals, occur in protected natural areas within each of the 7 HUC-8 watersheds of the species' geographic range (USFWS, 2018).

2. Periodic monitoring indicates that the minimum viable population level of 1,500 individuals within each protected natural area remains stable or increases over a period of at least 39 years. Monitoring (censuses) of each protected natural area must be conducted annually for the first 10 years and subsequently every 5 years up to the 39 year timeline (USFWS, 2018).

Recovery Actions:
- Continue monitoring and surveying within the 24 established protected reserves. (USFWS, 2009)
- Conduct surveys of high-potential habitat within the known range of the species, focusing on sites that have not previously been surveyed. (USFWS, 2009)
- Continue to investigate ecology and management, with special emphasis on woody plant control and prescribed burning. (USFWS, 2009)
- Apply sound management, as needed, to protected sites. (USFWS, 2009)
- Seek permanent protection for existing reserves; establish new reserves, using LBJWC conservation fund and other resources. (USFWS, 2009)
- Investigate mycorrhizal symbionts. (USFWS, 2009)
- Obtain peer review and seek consensus on taxonomic status. (USFWS, 2009)

- Collect seeds of representative populations for propagation and seed banking, establish germ-plasm (live plant) refugia, and develop techniques for successful propagation and reintroduction. (USFWS, 2009)
- Establish cooperative efforts to promote the conservation of the post oak savanna ecosystem. (USFWS, 2009)
- Conduct public outreach efforts to encourage conservation of the species and its habitat on private lands. (USFWS, 2009)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS • Continue to survey and monitor known populations of S. parksii. • If possible given workloads, recommend conducting an up-to-date census of the accessible populations and revise the TXNDD Elemental Occurrence records database. • If possible given workload constraints, additional surveys may be conducted in areas (including outside of the current range) where habitat suitability models indicate S. parksii habitat may occur, but the species has never been previously documented. • Work cooperatively with private landowners who are interested in conserving and managing the species on their lands. • Work with our partners including federal, state, tribal, non-profit, and private landowners to establish long-term protection for known occupied sites via conservation easements with long term management plans. (USFWS, 2022)

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SPECIES ACCOUNT: *Tuctoria greenei* (Greene's tuctoria)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest Region (R8)

Physical Description

A small annual grass with several stems from the base, erect or usually reclining, 0.5-3 dm long. Stems and leaves are loosely covered with long, fine hairs. Slightly viscid and aromatic. Flowers from May to July. (NatureServe, 2015)

Taxonomy

The genus Tuctoria is in the grass family (Poaceae), subfamily Chloridoideae, and is a member of the Orcuttieae tribe, which also includes Neostapfia and Orcuttia (Reeder 1965, Keeley 1998). Vasey (1891:146) originally assigned the name Orcuttia greenei to this species, from a type specimen collected in 1890 “on moist plains of the upper Sacramento, near Chico, California,” presumably in Butte County (Hoover 1941, Crampton 1958). Citing differences in lemma morphology, arrangement of the spikelets, and other differences (see “Description” below), Reeder (1982) segregated the genus Tuctoria from Orcuttia and created the new scientific name Tuctoria greenei for this species. Subsequent research suggests that Tuctoria is intermediate in evolutionary position between the primitive genus Neostapfia and the advanced genus Orcuttia (Keeley 1998, L. Boykin in litt. 2000). Several other common names have been used for this species, including Chico grass (Scribner 1899), awnless Orcutt grass (Abrams 1940), Greene’s orcuttia (Smith et al. 1980), and Greene’s Orcutt grass (California Department of Fish and Game 1991, U.S. Fish and Wildlife Service 1985c) (USFWS, 2005).

Historical Range

After its initial discovery in Butte County in 1890, Tuctoria greenei was not reported again for over 40 years. However, during extensive surveys in the late 1930s, Hoover (1937, 1941) found the species at 12 sites in Fresno, Madera, Merced, San Joaquin, Stanislaus, Tehama, and Tulare Counties (Figure II-19). In fact, he described it as the most common of all Orcuttia species, with which it was classified at the time (USFWS, 2005).

Current Range

Endemic to the Central Valley of California. Occurs in three Vernal Pool Regions: the Northeastern Sacramento Valley Vernal Pool Region (Tehama Co. and Butte Co.), particularly in the Vina Plains; the Modoc Plateau Vernal Pool Region to the north (Shasta Co.); and the Southern Sierra Foothills Vernal Pool Region some distance to the south (eastern Merced Co., with one historical occurrence in Madera Co.). Considered historical in Tulare, Fresno, San Joaquin, and Stanislaus Cos., and extirpated from Glenn Co. Current range is estimated to be about 17,000 square km.

Critical Habitat Designated

Yes; 8/11/2005.

Legal Description

On August 11, 2005, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Neostapfia colusana (Colusa grass) under the Endangered Species Act of 1973, as amended

(Act). The critical habitat designation includes six critical habitat units (CHUs), in California (70 FR 46924-46999; 71 FR 7118-7316).

Critical Habitat Designation

The critical habitat designation for Neostapfia colusana includes six CHUs in Butte, Maderra, Mariposa, Merced, Shasta, Stanislaus, Tehama and Tuolumne Counties, California. This species critical habitat encompasses approximately 145,118 acres (ac) (58,727 hectares (ha)) (70 FR 46924-46999; 71 FR 7118-7316).

Unit 1: Shasta County, California. From USGS 1:24,000 scale quadrangle Murken Bench.

Unit 2: Tehama County, California. From USGS 1:24,000 scale quadrangles Acorn Hollow, Richardson Springs NW.

Unit 3: Butte County, California. From USGS 1:24,000 scale quadrangle Hamlin Canyon.

Unit 6: Stanislaus County, California. (i) Unit 6A: Stanislaus County, California. From USGS 1:24,000 scale quadrangles Paulsell. Unit 6B: Stanislaus County, California. From USGS 1:24,000 scale quadrangles Waterford, Paulsell. (iii) Unit 6C: Stanislaus County, California. From USGS 1:24,000 scale quadrangles Paulsell. Unit 6D: Stanislaus County, Tuolumne County, California. From USGS 1:24,000 scale quadrangles Paulsell. Keystone, Cooperstown, La Grange. Unit 6E: Calaveras County and Tuolumne County, California. From USGS 1:24,000 scale quadrangles Knights Ferry, Keystone.

Unit 7: Merced County and Mariposa County. USGS 24,000 topographic quadrangles Winton, Yosemite Lake, Snelling, Merced Falls, Haystack Mountain, Indian Gulch, Planada, Owens Reservoir, Illinois Hill, Le Grand, Raynor Creek:

Unit 8: Madera County. (i) Unit 8A: Madera County. USGS 24,000 topographic quadrangle Kismet. (ii) Unit 8B: Madera County. USGS 24,000 topographic quadrangle Daulton: (iii) Unit 8C: Madera County. USGS 24,000 topographic quadrangle Daulton:

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 Neostapfia colusana critical habitat consists of two components (70 FR 46924-46999; 71 FR 7118-7316):

(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 (2)(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

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

Breeding Season

Adult: Tuctoria greenei flowers from May to July (Skinner and Pavlik 1994), with peak flowering in June and July (Griggs 1981, Broyles 1987) (USFWS, 2005).

Reproduction Narrative

Adult: Optimum germination of Tuctoria greenei seed occurs when the seed is exposed to light and anaerobic conditions after stratification (Keeley 1988). Germination occurs about 2 months following inundation (Keeley 1998). Tuctoria seedlings do not develop floating juvenile leaves, as does Orcuttia (Griggs 1980, Keeley 1998). The plants apparently do not tolerate inundation; all five T. greenei plants in a Glenn County pool died when the pool refilled during late spring rains in 1996 (J. Silveira in litt. 1997). Tuctoria greenei flowers from May to July (Skinner and Pavlik 1994), with peak flowering in June and July (Griggs 1981, Broyles 1987) (USFWS, 2005).

Habitat Type

Adult: Vernal pools (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Vernal pools (USFWS, 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 and USFWS, 2005)

Site Fidelity

Adult: High (inferred from NatureServe, 2015 and USFWS, 2005)

Habitat Narrative

Adult: Species grows in the bottom of dried Vernal Pools on the eastern side of the Sacramento and San Joaquin Valleys. Occurs in Northern Basalt Flow, Northern Claypan, and Northern Hardpan vernal pools (Sawyer and Keeler-Wolf 1995) on both low and high terraces within grassland communities, or, rarely, pine forest (one Shasta Co. occurrence). Plants have been documented on clay, loam, and stony clay loam soils, and pools are underlain by iron-silica cemented hardpan, tuffaceous alluvium, or claypan. Occupied pools range in size from 50 square meters to 3.4 hectares (median size 0.6 hectares). Tends to grow in shallower pools than its relatives (Neostapfia and Orcuttia) or on the shallow margins of deeper pools. Associated species include Eryngium castrense, Marsilea vestita, Eryngium vaseyi, Plagiobothrys stipitatus, Alopecurus saccatus, Chamaesyce hooveri, Orcuttia pilosa, O. inaequalis, O. tenuis, Neostapfia colusana, and Gratiola heterosepala. 30-135 m in Central Valley; 1100 m in Shasta Co. (one occurrence) (NatureServe, 2015). Tuctoria greenei has been found in three types of vernal pools: Northern Basalt Flow, Northern Claypan, and Northern Hardpan (Sawyer and Keeler-Wolf 1995) on both low and high terraces (Stone et al. 1988). Occupied pools are or were underlain by iron-silica cemented hardpan, tuffaceous alluvium, or claypan (Stone et al. 1988). Of pools where the species was known to be extant in 1987, the median size was 0.6 hectare (1.5 acres), with a range of 50 square meters (0.01 acre) to 3.4 hectares (8.4 acres) (Stone et al. 1988). Stone et al. (1988) noted that T. greenei grew in shallower pools than other members of the tribe or on the shallow margins of deeper pools, but they did not quantify pool depth. At the Vina Plains, T. greenei grew in pools of “intermediate” size, which dried in April or early May of 1995 (Alexander and Schlising 1997). The Central Valley pools containing T. greenei are (or were) in grasslands; the Shasta County occurrence is surrounded by pine forest (California Natural Diversity Data Base 2003). Occupied pools in the Central Valley are (or were) at elevations of 33.5 to 134 meters (110 to 440 feet) (Stone et al. 1988), whereas the Shasta County occurrence is at 1,067 meters (3,500 feet) (California Natural Diversity Data Base 2003) (USFWS, 2005). High ecological integrity of the population and site fideilty 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 are stored in the soil seed bank until favorable conditions are met (USFWS, 2005).

Population Information and Trends

Population Trends:

Not available

Number of Populations:

39 extant (USFWS, 2024)

Population Size:

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

Additional Population-level Information:

Besides the two new localities in Modoc County, the current distribution of Greene's tuctoria is similar to what the Service described in the final listing rule, the Recovery Plan, and the previous 5-year review (Service 1997, p. 14340; Service 2005, pp. II-99–II-104; Service 2008, pp. 2–3). At the time of listing, Greene's tuctoria was known to occur in Fresno, Madera, Merced, San Joaquin, Stanislaus, Tehama, Tulare, Butte, Glenn, and Shasta Counties with a species range described as extending 567 kilometers (258 miles) within California (Service 1997, p. 14340). The final listing rule described 39 populations of Greene's tuctoria: 20 that were extant and 19 that were considered extirpated. The Recovery Plan used the Diversity Database element occurrences to describe the distribution of the species. The Department (2020, pp. 9–10) defines an element occurrence (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 (e.g., multiple interconnected pools within a single vernal 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). The Recovery Plan described 41 occurrences with 9 occurrences considered extirpated and 10 other occurrences possibly extirpated (Service 2005, p. II-99). For the 2008 status review, Greene's tuctoria was known from 42 known occurrences located within the same 10 counties as reported at listing, with 21 occurrences presumed to be extant (Service 2008, pp. 3, 6). Since the 2008 review, eight previously undocumented occurrences of Greene's tuctoria have been added to the Diversity Database (occurrence numbers 51–58; Figure 2). In addition, Greene's tuctoria has been detected at eight localities that are not yet processed in the Diversity Database. An occurrence record (number 51) was added to the Diversity Database for a historical locality in Butte County that was originally noted from 1973 and 1974 herbarium collections (Diversity Database 2023, p. 46). This occurrence was revisited during the 2010 comprehensive survey and determined to be extirpated due to lack of extant habitat (Witham 2013, pp. 34, 51; Diversity Database 2023, p. 46). Two new occurrences (numbers 52 and 53) have been reported in Modoc County approximately 35 miles northeast of the closest previously known occurrence of the species (number 41) (see Figure 2). These new occurrences are on National Forest land outside of the recovery core areas identified in the Recovery Plan. A new occurrence (number 54) was identified within the Great Valley Conservation Bank footprint (near previously known occurrence numbers 13 and 28). Further, an introduction study (Gottschalk Fisher 2013, p. entire) took place in created vernal pools at occurrence numbers 55 and 56 in Butte County at the Sacramento National Wildlife Refuge, Llano Seco Unit (Diversity

Database 2023, pp. 102–109). The introduction study is addressed in more detail in the Conservation section. Occurrence numbers 57 and 58 in Merced County were initially identified during a survey conducted on privately owned ranch land that was noted by species experts as containing very high-quality habitat for Greene's tuctoria (Diversity Database 2023, pp. 52–53; K. Ferguson, California Department of Fish and Wildlife, in litt. 2023, pp. 19–28; RD. Stone, California Botanic Garden, in litt. 2024, p. entire). Additionally, five more occurrences have been reported for Greene's tuctoria but are not yet processed in the Diversity Database (Unprocessed1 through Unprocessed8). The unprocessed occurrences include a cluster of seven observations of the species near occurrence numbers 57 and 58 on private ranchland that has been proposed for protection as a conservation bank in Merced County (S. Larson, Land Conservation Resources, Inc., in litt. 2024, p. 1). The other unprocessed occurrence is on privately owned land in Madera County (Ferguson in litt. 2023, p. entire). In addition, mapping of predicted suitable habitat by geologic formation within the Central Valley vernal pool regions has been completed for Greene's tuctoria (Vollmar et al. 2023, pp. 3, 124–232) and not all suitable habitat has been surveyed for the species. The predicted suitable habitat mapping is described in more detail in the Conservation section. As of September 2023, there are 58 occurrences for Greene's tuctoria including the 8 unprocessed new occurrences, with 39 occurrences presumed extant, 6 occurrences possibly extirpated, and 13 occurrences extirpated. Nine previously known occurrences (numbers 8, 10, 19, 21, 23, 24, 27, 28, 39) have changed status since the 2008 status review as a result of additional survey efforts and review of aerial imagery (Diversity Database 2023, p. entire). For a breakdown of occurrences that have been surveyed or changed status since the 2008 status review, see Appendix A. (USFWS, 2024)

Population Narrative:

Of the total 43 occurrences ever recorded, 49% (21 occurrences) are currently considered historical and 5% (2 occurrences) are considered extirpated. Decline of 50-70% Population sizes can vary widely from year to year, sometimes over several orders of magnitude. At the occurrences considered extant, the total number of plants can be over 1,000,000 in good years, but might be considerably less (100,000 or less) in poor years. In total, 20 occurrences are believed extant, a further 21 occurrences are considered historical, and 2 occurrences are extirpated. Recent genetic study suggests that the number of populations may be less than this (i.e. some mapped sites should be lumped into the same occurrence, suggested by high gene flow/genetic similarity) (S. Gordon pers. comm. 2009). Of the occurrences currently mapped, 13 extant occurrences are in the Northeastern Sacramento Valley Vernal Pool Region (9 in Tehama Co. and 4 in Butte Co.); this region also contains 4 historical and 1 extirpated occurrence. 6 extant occurrences are in the Southern Sierra Foothills Vernal Pool Region (eastern Merced Co.), along with 6 historical occurrences (5 in Merced Co. and one in Madera Co.). 1 extant occurrence is in the Modoc Plateau Vernal Pool Region (Shasta Co.). Only historical occurrences are known from Tulare, Fresno, San Joaquin, and Stanislaus Cos., and the Glenn Co. occurrence is considered extirpated (USFWS 2005, CNDDB 2008). (NatureServe, 2015)

Threats and Stressors

Stressor: Habitat fragementation (NatureServe, 2015)
Exposure:
Response:
Consequence: Loss of habitat

Narrative: The largest threat to California and southern Oregon vernal pools is habitat loss and fragmentation (NatureServe, 2015).

Stressor: Agricultural conversion (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: According to the 1997 listing rule, the remaining extant localities of this species were threatened by conversion to irrigated agricultural lands, intensive grazing practices, and competition from invasive plants (see Section II.C.2.e. for a discussion of grazing and competition from invasive plants) (USFWS, 2007).

Stressor: Housing/commercial development (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: There are four localities of Greene's tuctoria within the U.C. Merced Campus project area, in Merced County (Jones and Stokes 2007). Although build-out of the U.C. Merced campus does not currently involve specific plans to destroy vernal pool habitat with known Greene's tuctoria, it is unknown at this time if future proposed development of the campus would indirectly affect the proximal Greene's tuctoria habitat. In addition, the U.C. Merced campus has contributed to an increase in development of commercial and residential subdivisions in the area. The City of Merced predicts that population growth will expand to 239,210 people by 2035 within the City, an increase from 60,900 individuals in 1990 (City of Merced 1997). Even if development does not result in the destruction of known localities of this species, this development will occur in areas adjacent to known occurrences of Greene's tuctoria. There is potential for development projects within close proximity to occupied Greene's tuctoria habitat to cause indirect effects resulting from increases deleterious substances (i.e., fertilizers, herbicides, and oil based products), human intrusion, habitat fragmentation, and modification of hydrology, even if the actual vernal pools are not filled (USFWS, 2007).

Stressor: Grasshoppers (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Predation by grasshoppers is listed as a threat to this species (USFWS, 2007)

Stressor: Invasive plants (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Competition from invasive plant species poses a primary threat to this species. The non-native swamp pickle grass threatens multiple localities within the Vina Plains Preserve (R. Schlising, in litt., 2007a, 2007b) and the native alkali bulrush, along with other factors, has likely contributed to the disappearance of Greene's tuctoria at the Sacramento NWR (USFWS, 2007) since 1996 (J. Silveira, in litt., 2007). Stone et al. (1988) report multiple localities that are threatened by competition from non-native invasive plants such as Italian ryegrass (Lolium multiflorum), hood canary grass (Phalaris paradoxa), and rabbitsfoot (Polypogon monspeliensis),

as these plants typically are found along the margins of vernal pools, where Greene’s tuctoria is also commonly found. All localities in Merced County are also threatened by invasive plant species (Vollmar 2002) (USFWS, 2007).

Stressor: Grazing (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of habitat/loss if individuals
Narrative: Intensive cattle grazing regimes are one of the primary causes of extirpation among known localities of Greene’s tuctoria (Stone et al. 1988; CNDDB 2007). Stone et al. (1988) noted that improper grazing management was responsible for the extirpation of at least eight localities during field visits in 1986 and 1987, and they found that even under a moderate grazing regime many extant localities of this species were damaged or declining. Greene’s tuctoria is more susceptible to negative grazing impacts compared to other species in the tribe Orcuttieae, as Greene’s tuctoria is more commonly found along the marginal edges of vernal pools, while other species in this tribe are more tolerant of inundation and are found in the deeper portions of vernal pools (Stone et al. 1988). Because Greene’s tuctoria is commonly found along the edges of pools, this makes this species more susceptible to livestock trampling, especially early in the season when cattle are still present (Stone et al. 1988). In this event, cattle may severely trample the drying mud of the pool bed, causing soil disturbance and, indirectly, reduce the density of Greene’s tuctoria seedlings (Stone et al. 1988). This phenomenon is exacerbated during low rainfall years (Stone et al. 1988). In addition, trampling by cattle may also contribute to the establishment of weedy, non-native plants (Stone et al. 1988). Greene’s tuctoria at Vina Plains increased in numbers when cattle were removed from vernal pool areas before May or June, when Greene’s tuctoria begins to seed (Griggs 2000). Cattle on the Vina Plains Preserve and Drayer Ranch Conservation Bank are managed for the protection of Greene’s tuctoria. Heavy cattle grazing is cited as a threat for the locality at Murken lake, in Shasta County (CNDDB 2007). The Service is not aware of how grazing management practices are conducted at other localities (USFWS, 2007).

Stressor: Climate change/drought (USFWS, 2007)
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, 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). Greene’s tuctoria is dependent upon vernal pool wetlands, which signifies 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 Greene’s tuctoria may increase, which would benefit the species. However, if California enters into a drying trend, the resulting droughts could adversely affect Greene’s tuctoria. It is common for this species not to appear during below-average rainfall years (Griggs 1980; Griggs and Jain 1983; Stone et al. 1988; Vollmar 2002). 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

Greene's tuctoria, and would place additional strains on vernal pool ecosystems. Where populations persist on only marginal habitat, the addition of drought conditions is likely to result in high rates of mortality in the short term, with the effects of low reproductive output and survivorship persisting after the drought has ceased. It is unknown how quickly Greene's tuctoria populations may rebound after a severe drought; however, seed dormancy is apparently well developed in this species, and at most locations seed storage in the soil probably represents an effective barrier to local extinction from extended drought (Griggs 1980; Griggs and Jain 1983; Stone et al. 1988). In addition, this plant is highly adaptable to differing climatic conditions and will successfully grow in different portions of a pool (i.e., the margin or center) depending on the amount of water present in the vernal pool during a given year (Griggs 1980; Griggs and Jain 1983). However, a severe drought, if compounded by other factors such as grasshopper outbreaks, improper grazing regimes, invasive plant species, and other unforeseen circumstances, could contribute to the local extirpation of this species (USFWS, 2007).

Stressor: Small population size (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of genetic variability
Narrative: Populations of Greene's tuctoria can vary greatly from year to year, with some extant localities not appearing during dry years and appearing the next year, under more favorable rainfall conditions, with plants numbering in the thousands (Stone et al. 1988). In many instances, localities of this species occur in relatively low numbers for consecutive years due to climatic conditions or other factors (Stone et al. 1988; Griggs 1980). 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 2006; Groom et al. 2006). In particular, small population size makes it difficult for this species to persist while sustaining the impacts from competition from non-native plant species, intensive grazing, drought, grasshopper predation, or other unknown factors. Such populations may be highly susceptible to extirpation due to chance events, inbreeding depression, or additional environmental disturbance (Gilpin and Soule 1988; Goodman 1987). If a locality of Greene's tuctoria has several consecutive years of poor rainfall, excessive grasshopper predation, intensive grazing, 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 may become extirpated (Service 2005). For example, CNDDB locality number 39, in Stanislaus County, numbered fewer than 100 plants in 1973, dropped to two the following year, and remained at zero for the next three years (Griggs 1980; Griggs and Jain 1983). Plants were not observed at this locality in 1986 or 1987, although other Orcutt species were present (Stone et al. 1988). This locality is now assumed to be possibly extirpated (CNDDB 2007). The locality at the Sacramento NWR serves as another example of this phenomenon. Greene's tuctoria was detected within the Sacramento NWR in a single vernal pool in 1994 (60 plants). It was present in 1995 (1 plant) and 1996 (5 plants). In 1996, late spring rains filled the pool during flowering and no plants survived. Since then, this species has not been located in the NWR and the vernal pool has become populated by alkali bulrush, which has likely out-competed the Greene's tuctoria (J. Silveira, in litt., 2007) (USFWS, 2007).

Stressor: Poor Colonizing/Recolonizing Ability (USFWS, 2007)
Exposure:
Response:

Consequence: Loss of genetic variability
Narrative: If any species is to persist, it must have the ability to colonize new localities (Griggs 1980). In addition, if a locality is extirpated from a vernal pool, recolonization would be necessary. Because of the isolated nature of the various localities of this species, the opportunities for recolonization are greatly reduced due to physical isolation from other source populations (Griggs 1980; Griggs and Jain 1983). Griggs (1980) introduced abundant Greene's tuctoria and slender Orcutt grass seeds in an artificially constructed vernal pool at U.C. Davis (plastic sheets were used to simulate a hardpan) and at two human-made impoundments along a gravel road in Chico, Butte County. Slender Orcutt grass successfully grew at all locations (although in very small numbers at both pools in Chico), but Greene's tuctoria plants did not survive to an advanced stage at any of the three sites. Although not conclusive, these experiments suggest that it may be more difficult for Greene's tuctoria to establish itself in new localities compared to other species in the tribe Orcuttieae. Griggs (1980) determined Greene's tuctoria has a lower degree of morphological plasticity (variation related to environmental conditions) compared to that of slender Orcutt grass, which allowed the slender Orcutt grass to mature and survive long enough to set seed. Slender Orcutt grass, for example, possesses the ability for aquatic seedling growth and Greene's tuctoria does not (Griggs 1980) (USFWS, 2007).

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, p. entire; Agency 2022b, p. entire; Agency 2022c, p. 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. Greene's tuctoria is thought to be a predominantly wind-pollinated species (Griggs and Jain 1983, p. 183; Stone 1988, p. 16) as are other grasses within the Orcuttieae tribe: however, some insect pollination may occur. This includes pollination by native bees (Halictidae sp.), which have been observed gathering pollen from other species in the Orcuttieae tribe including Sacramento Orcutt grass (Orcuttia viscida) and hairy Orcutt grass (Orcuttia pilosa) (Griggs 1974, as cited in Stone et al. 1988, p. 16). The Agency's final biological evaluations determined that all three pesticides are highly toxic to invertebrate pollinators including bees, have the potential to result in bee brood and colony reductions, and if affected bee colonies or populations of other invertebrate pollinators decline near Greene's tuctoria, 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:
1A. Suitable vernal pool habitat within each prioritized core area for the species is protected (Western Modoc Plateau 85%, Oroville 95%, Richvale 85%, Vina Plains 95%, Sacramento NWR 95%, Fresno 85%, Madera 95%, Merced 95%, Waterford 85%). 1B. 80% of the 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. 1C. Reintroductions must be carried out and meet success criteria established in the Recovery Plan. The Recovery Plan recommends reintroduction to vernal pool regions and soil types from which the status surveys show the species has been extirpated. 1D. 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. 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, a multi-year drought, and a minimum of 5 years of post-drought monitoring. (USFWS, 2024)

2A. 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, as previously discussed in 1A–E above. Plans should be developed and implemented within 5 years of individual parcels/properties/ areas to ensure stable or increasing populations and progress towards recovery is being made. 2B. Mechanisms are in place to provide for longterm management and monitoring. 2C. Monitoring indicates ecosystem function has been maintained in the areas protected 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, 2024)

3A. 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. 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, 2024)

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 and results incorporated into habitat protection plans to ensure that within and among population genetic variation is fully represented by populations protected in 1A–E. 4C. Research necessary to determine appropriate parameters to measure population viability for each species has been completed. (USFWS, 2024)

5A. Recovery Implementation Team is established and functioning to oversee range wide 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 Regional working groups have developed and implemented outreach and incentive programs that develop partnerships. (USFWS, 2024)

Recovery Priority Number: 2C

Delisting Criteria:
The Recovery Plan discusses a variety of research that would be beneficial to help refine recovery actions and criteria, and guide overall recovery and long-term conservation efforts (pages IV-53 to IV-63). The Recovery Plan recommends research on genetics, taxonomy, biology of vernal pool species, the effects of habitat management practices on vernal pool species and their habitat, and threats to vernal pool species and ecosystems. Currently, this criterion has been initiated, although the majority of information needs discussed in the Recovery Plan are still outstanding. Dr. Heather Davis, Department of Biology of Sonoma State University, began an investigation in 2007 on the population genetics of Greene’s tuctoria and four other listed vernal pool plants to determine how pollination ecology interacts with population genetics to control the plant’s reproductive success (Sonoma State University 2006) (USFWS, 2009).

Recovery Actions:
- 1. The five localities within the Nature Conservancy’s Vina Plains Preserve in Tehama and Butte counties, and the one locality at the Drayer Ranch Conservation Bank in Merced County currently are protected and managed for the benefit of this species. If more localities of Greene’s tuctoria are protected and managed properly, the probability of stochastic catastrophes wiping out the species will decrease (Griggs and Jain 1983). Protection of additional localities of this species is necessary to recover this species. Protecting localities in the San Joaquin Valley (Merced County) should be a priority over the next five years, as this is the southern extent of the species range, and only one locality (Drayer Ranch) is protected at this time. The occurrence at Murken Lake, Shasta County should also be a priority over the next five years for protection as this is the northern extent of this species range (USFWS, 2007).
- 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 (USFWS, 2007).
- 3. 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 invasive weedy plant species to determine the most appropriate methods to control these plants and increase population numbers of Greene’s tuctoria and other Orcuttia grasses. c. Conduct research on the genetic structure of the species to determine the feasibility of introducing Greene’s tuctoria to biologically appropriate vernal pool regions and soil types from which status surveys indicate the species has been extirpated (USFWS, 2007).

- 4. Regional vernal pool working groups should be created in regions where Greene's tuctoria is known to occur to aid with monitoring and management efforts (USFWS, 2007).

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 Greene's tuctoria. Some of these recommendations have already been discussed in previous recovery documents (Service 2005; Service 2008) and remain valid. 1. Habitat Acquisition, Management, and Restoration. All sites with Greene's tuctoria should be protected. Acquisition and restoration of the Richvale vernal pools occurrence (located within the Richvale core area) should be considered. This site is at the distal end of the alluvial terrace in Butte County and supports soils that have otherwise been converted to agriculture in that area (Witham 2013, p. 22). 2. Determine Population Status and Monitor at Occupied Sites. Develop standardized monitoring plans. Standardized monitoring should be included in management plans for the protected sites. Focus on predicted remaining habitat for surveys and include priority sites such as occurrence number 21 in Stanislaus County and unprocessed occurrences in eastern Merced County ranchland (contains some of the largest known plant numbers (Stone in litt. 2024)), both of which occur on private property. 3. Applicable Research. Research how grazing outcomes vary with environmental and management characteristics to identify what sites are likely to best benefit from changes, removal, or introduction of grazing regimes and management practices and how Greene's tuctoria responds. 4. Research on Genetic Structure. Conduct additional surveys on extant occurrences to inform the species' phylogeographic structure. 5. Increased Reintroductions and Eventual Introductions. Continue to conduct reintroductions of Greene's tuctoria to vernal pool regions and core areas, using updated habitat preferences based on geologic formations and data on extant predicted suitable habitat. Prioritize reintroductions to the known occurrences that have been extirpated, as well as to Fresno, San Joaquin, Stanislaus, and Tulare Counties. Introductions should include the Farmington and Madera core areas (Service 2005, p. III-100). (USFWS, 2024)

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SPECIES ACCOUNT: *Tuctoria mucronata* (Solano grass)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/29/1978; California/Nevada Region (R8) (USFWS, 2016)

Physical Description

An annual grass that germinates in temporary pools, producing slender leaves that float on the water's surface, and then, when the pools dry out for the summer, producing shoots and flowers (the inflorescence is 1.5-6 cm long). Seed set occurs during the hottest part of June and July, after which the plants die. (NatureServe, 2015)

Taxonomy

Solano grass is in the Orcuttieae tribe of the grass family Poaceae (Reeder 1965). Solano grass was originally described under the name Orcuttia mucronata, based on specimens collected “12 miles due south of Dixon, Solano County” (Crampton 1959:108). Reeder (1982) transferred this species to a new genus, Tuctoria, resulting in the currently accepted name Tuctoria mucronata. Other common names are Crampton’s Orcutt grass (Griggs 1977b), mucronate orcuttia (Smith et al. 1980), and Crampton’s tuctoria (Skinner and Pavlik 1994) (USFWS, 2005).

Current Range

Endemic to California, known only from Olcott Lake and vicinity. Solano grass is known only from the Northern Claypan vernal pools (Sawyer and Keeler-Wolf 1995, p. 363) within annual grassland habitat in Solano and Yolo Counties (USFWS, 2024).

Critical Habitat Designated

Yes; 8/11/2005.

Legal Description

On August 6, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Tuctoria mucronata (Solano grass) (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 Tuctoria mucronata includes one critical habitat unit (CHU), in California.

Critical Habitat Designation

The critical habitat designation for Tuctoria mucronata includes one CHU in Yolo County, California. This species critical habitat encompasses approximately 440 acres (ac) (178 hectares (ha)) (68 FR 46684 - 46867; 70 FR 46924-46999; 71 FR 7118-7316).

Unit 1, Davis Communications Annex and Grasslands Area Unit, Yolo County (440 ac (178 ha))
This unit is an important representative of the geographic distribution of the species (criterion 1) because it represents the northern extent of the species’ range, and because it is one of only two areas where Tuctoria mucronata is known to occur (CNDDB 2002). It also includes the largest remaining T. mucronata occurrence (CNDDB 2002). Tuctoria mucronata within the unit grows in Northern Claypan vernal pools on Pescadero soils (CNDDB 2002). This unit is located southeast of

the City of Davis and south of the South Fork of Putah Creek. Its western boundary lies along the border between Solano and Yolo Counties. The unit contains land owned by Yolo County and by the DOD (310 (125 ha)) (68 FR 46684 - 46867).

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 Tuctoria mucronata (Solano grass) are the habitat components that provide (70 FR 46924-46999; 71 FR 7118-7316):

(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 (2)(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.

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: Wind pollinated

Breeding Season

Adult: The germination period for Tuctoria mucronata seeds is not known, but is presumed to be in May or June (U.S. Fish and Wildlife Service 1985a). Tuctoria seedlings do not produce floating juvenile leaves (Griggs 1980). This species typically flowers in June and sets seed during July (Holland 1987) (USFWS, 2005).

Other Reproductive Information

Adult: Solano grass is wind-pollinated and blooms from June to July. Its seeds can remain dormant for an undetermined length of time (but at least 3 to 4 years) and germinate underwater after they have been immersed for prolonged periods (USFWS, 2024).

Reproduction Narrative

Adult: The germination period for Tuctoria mucronata seeds is not known, but is presumed to be in May or June (U.S. Fish and Wildlife Service 1985a). Tuctoria seedlings do not produce floating juvenile leaves (Griggs 1980). This species typically flowers in June and sets seed during July (Holland 1987). The demography of Tuctoria mucronata has not been investigated in detail. Annual estimates or counts at Olcott Lake (Holland 1987, California Natural Diversity Data Base 2005) indicated that population sizes for this species fluctuate dramatically from year to year, as do other members of the Orcuttieae. Tuctoria mucronata was not observed at Olcott Lake from 1976 through 1980, then reappeared in 1981 (Holland 1987), indicating that viable seeds can persist in the soil for at least 5 years. Apparently both drought years and years of excessively high rainfall are unfavorable for T. mucronata; the largest populations were observed after seasons of 45 to 60 centimeters (17.7 to 23.6 inches) of precipitation (Holland 1987) (USFWS, 2005).

Habitat Type

Adult: Vernal pools (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Vernal pools (Natureserve, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015 and USFWS, 2005)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015 and USFWS, 2005)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015 and USFWS, 2005)

Site Fidelity

Adult: High (inferred from NatureServe, 2015 and USFWS, 2005)

Habitat Narrative

Adult: Germinates in warm, turbid, somewhat alkaline vernal pools; these dry out by early summer (NatureServe, 2015). Tuctoria mucronata has been found only in the Northern Claypan type of vernal pool (Sawyer and Keeler-Wolf 1995) within annual grassland (California Natural Diversity Data Base 2005). Pools where T. mucronata occurs tend to be milky from suspended sediments (Holland 1987). The pools that are occupied in Solano County are more properly described as alkaline playas or intermittent lakes, due to their large surface area (Crampton 1959, U.S. Fish and Wildlife Service 1985a), whereas those at the Yolo County site are “relatively small” (C. Witham in litt. 2000a). Soils underlying known T. mucronata sites are saline-alkaline clay or silty clay in the Pescadero series (Crampton 1959, California Natural Diversity Data Base 2003). Known occurrences are at elevations of about 5 to 11 meters (15 to 35 feet) (California Natural Diversity Data Base 2005) (USFWS, 2005). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred by this species specific habitat requirements and its limited number of populations.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Long-distance dispersal is unlikely (Service 1985), but seed may be carried occasionally by waterfowl (family Anatidae), or by tule elk (Cervus elaphus nannoides), or pronghorn (Antilocapra americana) in historical times (Griggs 1980) (USFWS, 2009).

Population Information and Trends

Population Trends:

Decreasing (USFWS, 2009)

Additional Population-level Information:

As described above, Solano grass was only known from Olcott Lake (occurrence #1) at the time of listing and the final listing rule did not describe the abundance of the species at the single locality (Service 1978, p. 44811). Solano grass was considered extirpated from Olcott Lake at the time of the 2009 5-year review as the species had not been observed at the site since 1993 when four individual plants were documented (Service 2009, p. 13). At the time of the 2009 5-year review, approximately 5,600 individual plants were recorded on the Davis Air Force Communication Facility (occurrence #3) and the population size was found to vary substantially each year depending on inter-annual climatic conditions (Service 2009, p. 13). In addition, the 2009 5-year review reported that a 2005 census provided a count of five individual plants at the Hamilton Ranch occurrence (occurrence #2, Service 2009, p. 13). Solano grass was seeded into restored vernal pools at Yolo Grasslands Regional Park (occurrence #4) in 2008 as part of a remediation project (J. Gerlach, Private Consultant, in litt. 2024). In October 2008, one spike from 270 Solano grass plants were collected from the Davis Air Force Communication Facility (occurrence #3), of which 220 seeds were used to seed the restored vernal pools in Yolo Grasslands Regional Park (Gerlach 2009, p. 16). Two years after seeding, during the 2010–2011 season, Solano grass was found within the Grasslands Regional Park and that was the last sighting reported in the Diversity Database (Diversity Database 2024; Gerlach 2011, p. 6). Percent cover of Solano grass at both Davis Air Force Communication Facility (occurrence #3) and Yolo Grasslands Regional Park (occurrence #4) was estimated at 10%, but a 2024 visit to these sites showed no Solano grass individuals (T. Meyer, Yolo County Resource Conservation District, in litt. 2024a; T. Meyer, Senior Program Manager, in litt. 2024b). Variation in precipitation and resulting vernal pool inundation times may make Solano grass occurrence sizes fluctuate dramatically from year to year (Service 2005, p. II-107). Due to a lack of well-established and repeated monitoring of all Solano grass occurrences, it is difficult to determine overall population trends. Beginning December 2015 through September 2019, Olcott Lake underwent a re-seeding event, wherein seeds collected from 250 plants at the Davis Air Force Communication Facility and Yolo Grasslands Regional Park were distributed across four separate areas within Olcott Lake (Witham 2019, p. 8). Solano grass has been found at this location ever since, indicating the reseeding was successful. Since the 2009 5-year review, the number of individual Solano grass plants at Olcott Lake has been 40 (2016), 14 (2017), 117 (2018), 480 (2019), 205 (2022), and 421 (2023) (C. Witham, private consultant, in litt. 2023; J. Westbrook, Solano Land Trust, pers. comm. 2024). (USFWS, 2024)

Population Narrative:

Individual numbers vary greatly from year to year based on precipitation. The latest rare grass surveys at the Yolo Regional Grasslands/Davis Communications Site were conducted in 2008, when approximately 5600 individual plants were counted within six relatively discrete basins onsite (J. Gerlach, Environmental Science Associates, in litt. 2008). In 2007, a year with little precipitation, monitors documented only 45 individual Solano grass plants that germinated but were not expected to produce seed (J. Gerlach, Environmental Science Associates, in litt. 2007). Several thousand individual plants were seen at this site in 2000, and transect counts in 2003 provided a population count of at least 1,400 plants. The distribution of the plants within pools has been found to change annually (ESA 2008; J. Gerlach, in litt. 2007). Because the number of germinated plants varies substantially each year depending on inter-annual climatic conditions, to date monitors have not been able to determine a trend for the occurrence (J. Gerlach in litt. 2008) (USFWS, 2009). Low resiliency, representation and redundancy are inferred based on the limited number of populations and the specific habitat needs of this species.

Threats and Stressors

Stressor: Agriculture (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Agricultural development is listed as a threat to this species (USFWS, 2009)

Stressor: Housing developments (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The original listing noted that the building of housing developments was a threat to this species (USFWS, 2009).

Stressor: Non-native plants (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat/Extirpation of populations
Narrative: The known occurrences of the Solano grass are currently threatened by destruction or modification of habitat due primarily to invasion of vernal pools by non-native plants and to altered hydrology. Development in the region may reduce the options for re-introducing the species to suitable habitat (USFWS, 2009).

Stressor: Altered hydrology (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat/Extirpation of populations
Narrative: The hydrology at Olcott Lake has likely been altered by bisection of the lake by an elevated gravel road, and by construction of a small drainage ditch. Altered hydrology has been suggested as one potential factor in the extirpation of Solano grass from the site (CNDDB 2009). Management activities at protected sites have the potential to modify habitat for this species. Volunteers began planting oak trees (Quercus spp.) at the Yolo County site about 15 years ago. Some trees were planted close to vernal pools; however, the plantings have been stopped. Managers do not consider the trees to be an issue for the Solano grass because the soils where the grass occurs are not conducive to growing oaks, so oaks seldom survived in that habitat. In addition, a prescribed burn and subsequent wildfires at the property have killed some of the oaks so that the oaks are not proximate to Solano grass occurrences (S. Lines and C. Alford, pers. comm. 2007) (USFWS, 2009).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: In summary, without protection under the Endangered Species Act, regulatory mechanisms to protect the Solano grass would be inadequate. State regulations also do not protect habitat for the species. Changes in implementation of the Clean Water Act may result in greater losses of vernal pool habitat on private lands as fewer permits are required under section 404. Other Federal 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, 2009).

Stressor: Fragmentation (USFWS, 2009)
Exposure:
Response:
Consequence: Lack of generic variability
Narrative: The continuing fragmentation of Solano grass habitat range-wide may increase the isolation of the few known occurrences of this species. In contrast with some other vernal pool plant species, Solano grass seeds are not likely to be dispersed by waterfowl, as seeds of the Orcuttieae tribe do not become viable until mid to late summer when vernal pool areas are dry and waterfowl are unlikely to be present (J. Gerlach, in litt. 2007) (USFWS, 2009).

Stressor: Inbreeding Depression, Genetic Drift, and Stochastic Extinction (USFWS, 2009)
Exposure:
Response:
Consequence: Lack of generic variability
Narrative: The Service does not have any additional information on inbreeding depression or genetic drift within Solano grass populations. The few populations are considered to be isolated from each other, and continue to be threatened by the risk of stochastic extinction due to unforeseen natural and man-caused catastrophic events (e.g., droughts, fires, and accidental destruction of suitable habitat by grading, etc.), that may eliminate one or more occurrences

(Goodman 1987; Gilpin and Soulé 1986). In addition, pollination success may be hampered by the small size of extant populations (Davis et al. 2006) (USFWS, 2009).

Stressor: Contaminants (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat/loss of individuals
Narrative: The introduction of pesticides and other contaminants into vernal pool waters may threaten occurrences of the Solano grass. Glyphosate herbicides are being used to control invasive plant species at sites where the Solano grass is present (C. Alford, in litt. 2007); however, the Service has determined that at these sites the herbicides are being applied in a manner that precludes threats to the plant's persistence. Under Service-approved measures, broadcast application of herbicides and pesticides is restricted to areas that are a minimum of 250 feet from the outside edge of any vernal pool or swale habitat that may support federally listed species. Within the habitats of federally protected species, including the Solano grass, application of herbicides and pesticides is limited to hand application (such as painting/wick methods) that is completed only during the dry season when there is no standing water in the application areas (Service 2007) (USFWS, 2009).

Stressor: Drought and Climate Change (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Drought is likely to decrease or terminate reproductive output as pools fail to flood, or dry up before reproduction is complete. In a Mediterranean climate such as that of California, the annual season of precipitation (November to March) is relatively predictable, although the amount of precipitation can vary substantially from year to year (Graham 2003). For population maintenance, vernal pools must last longer, on average, than the time needed for a species to reach maturity and produce viable seeds, and relatively small changes in the timing or amount of precipitation can affect population dynamics (Graham 2003). Climate change has the potential to adversely affect the Solano grass through changes in vernal pool inundation patterns and temperature regimes. Vernal pools in California's Central Valley are particularly sensitive to slight increases in evaporation or reductions in rainfall due to their shallowness and seasonality (Field et al. 1999). Climate change is expected to lead to increased variability in precipitation (McLaughlin et al. 2002), and to increased loss of soil moisture due to evaporation and transpiration of water from plants (Field et al. 1999), which may exacerbate effects due to drought. Although the specific effects of climate change on the Solano grass are unknown, the effect of warming temperatures on winter storm events and pool conditions have the potential to adversely affect this species. Germination of the Solano grass is known to vary dramatically with inter-annual variation in climatic conditions (Holland 1987). Such interannual population fluctuations may be amplified by changes in precipitation and lead to rapid extinctions of individual populations (McLaughlin et al. 2002) (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 Solano grass is poorly understood. Grasses within the Orcuttieae tribe are thought to primarily be wind pollinated; however, some insect pollination may occur, including by native bees (Halictidae spp.), which have been observed gathering pollen from other species in the Orcuttieae tribe including Sacramento Orcutt grass (Orcuttia viscida) and hairy Orcutt grass (Orcuttia pilosa; Griggs 1974, as cited in Stone et al. 1988, p. 16). The Agency's final biological evaluations determined that all three pesticides are highly toxic to invertebrate pollinators including bees, have the potential to result in bee brood and colony reductions, and if affected bee colonies decline near Solano grass, 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)

Stressor: Climate change (USFWS, 2024)
Exposure:
Response:
Consequence:
Narrative: California's Fourth Climate Change Assessment was published in 2018 (Thorne et al. 2018, entire) and has included subsequent regional reports on the different regions of California, including two regions overlapping the core range of Solano grass that are expected to experience significant impacts from climate change. The average annual maximum temperature in the North Coast region where the species occurs is projected to increase 5–9° F through the end of the 21st century with interior regions experiencing the greatest degree of warming (Grantham 2019, p. 6). Wetlands (including vernal pools) are expected to be more sensitive to climate change because precipitation is often their main water source (Winter 2000, p. 307), so alterations to precipitation regimes are likely to disproportionally affect these ecosystems. Pyke (2004, pp. 3–4) reported that climate change and reduced frequency of suitable habitat might represent the greatest threat to vernal pool species. Modeling of vernal pool hydrology and plant community composition in northern California show that snow-fed vernal pools will have shorter inundation times with little change in maximum depth under projections of altered climate change conditions (Montrone et al. 2019, p. 1010). The vernal pools where Solano grass occur are rainfed, not snow-fed; however, climate change is likely to have a similar impact to inundation regime. Vernal pool specialists are highly sensitive to inundation time, so shortened inundation time due to climate change is expected to cause declines in the number of vernal pool specialist species. Variation in annual weather exacerbated by climate change also contributes to changes in vernal pool plant abundance and community composition, often allowing invasion by nonnative exotic species (Javornik and Collinge 2016, p. 66). Specifically, vernal pool obligate plant species, such as the Solano grass, may experience an increased risk from environmental and ecological changes from climate change (USFWS, 2024)

Recovery

Reclassification Criteria:
Recovery Priority Number: 2

Delisting Criteria:
The Recovery Plan discusses a variety of participation programs to achieve the goal of recovery of the listed species in the plan. An essential component of this collaborative approach is the formation of a single recovery implementation team overseeing the formation and function of multiple working groups formed at the vernal pool region level. The Service is currently in the preliminary stages of organizing both a recovery implementation team and multiple working groups. Service employees have met with various stakeholders to determine interest of stakeholders to be involved in working groups and/or the recovery implementation team. This criterion has not yet been met (USFWS, 2009).

Recovery Actions:
- 1. Recovery: Re-introduce Solano grass to Olcott Lake at the Jepson Prairie Preserve. Introduce the plant to other suitable vernal pools in a buffer around Jepson Prairie, potentially including East Wilcox Ranch and the Tule Ranch area in the Yolo Bypass Wildlife Area. Pursue placing the unprotected Solano Grass occurrence on private land under a conservation easement. Work with the Rancho Santa Ana herbarium to preserve the accessioned Solano grass seeds for potential use in restoration efforts (USFWS, 2009).
- 2. Research: Fund continuing research for the Solano grass that assesses the pollination ecology for the species, barriers to pollination, determines long-term trends in population growth, and experimentally measures probabilities of local extinction and recolonization (USFWS, 2009).
- 3. Monitoring: Develop and implement a standardized formal monitoring program that collects data in sufficient detail to evaluate species status and examine changes in population dynamics and community composition (USFWS, 2009).
- 4. Habitat Management. Develop management indicators for identifying potential problems and assessing ecosystem health as it pertains to the Solano grass. Establish requirements for appropriate management of vernal pool landscapes. Establish improved guidelines, monitoring protocols, and success criteria for appropriate management of this species (USFWS, 2009).
- 1A. 95% of suitable vernal pool habitat for the species within each of the two prioritized core areas (Davis Communication Annex and Jepson Prairie) is protected. 1B. 100% of the 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. 1C. Reintroductions must be carried out and meet success criteria established in the recovery plan. 1D. Additional occurrences identified through future site assessments, GIS and other analyses, and status surveys that are determined essential to recovery goals are permanently protected. 1E. Habitat protection results in protection of hydrology essential to vernal pool ecosystem function, and monitoring indicated 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, a multi-year drought, and a minimum of 5 years of post-drought monitoring. (USFWS, 2024)
- 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. 2B. Mechanisms are in place to provide for management in perpetuity

and long-term monitoring. 2C. Monitoring indicates that ecosystem function has been maintained in the areas protected 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. Seeds have been collected from all populations and are stored at two seed banking facilities. (USFWS, 2024)

- 3A. 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 minimum of 5 years of postdrought 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 assessment and habitat management planning also must be ameliorated or eliminated (USFWS, 2024)
- 4A. Research actions necessary for recovery and conservation of Solano grass have been identified. Additionally, 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. 4B. Research on genetic structure has been completed and results incorporated into habitat protection plans to ensure that within and among population genetic variation is protected. 4C. Research necessary to determine appropriate parameters to measure population viability for Solano grass have been completed. (USFWS, 2024)
- 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 and incentive programs that develop partnerships contributing to achieving recovery criteria. (USFWS, 2024)

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 Solano grass. The recommendations put forth in the Recovery Plan (Service 2005, pp. ix–xii) and the previous 5-year review (Service 2009, p. 23) are still relevant and are expanded upon in this section. Additional recommendations have been identified based on communication with species experts, a literature search, and review of existing records. 1. Develop and implement standardized population trend survey protocols to complete population status surveys. Annual population monitoring of all known extant locations. Incomplete and infrequent monitoring of this species makes population status and trends difficult to assess. An effort should be made to conduct regular status surveys for Solano grass (and other listed vernal pool plants, like Witham's 2013 survey) to make assessment of population trends possible. Without a better understanding of the population dynamics of the species, we do not know the extent to which protected lands provide self-sustaining populations of this species within each vernal pool region. Furthermore, monitoring of annual trends needs to assess short- and long-term fluctuations of individual localities which would assist in anticipating demographic changes in response to climate change over time. 2. Conduct coordinated research on the impact certain threats and their management have on the Solano grass: 1. Assess the long-term effects from urbanization and agricultural-related alterations to vernal pool sub-watersheds on the hydrology of vernal pools.

Efforts should lead to determinations of appropriate hydrology (or upland) buffers. Stone et al. (1988, pp. 4–5) also recommended research focused on assessing the range of inundation conditions necessary to maintain Solano grass. 2. Identify and understand the anticipated risks from climate change, specifically the effects of drought on the long-term viability of Solano grass. 3. Determine if and how pesticides may threaten Solano grass population viability. Evaluate if fungicides inhibit germination of Solano grass, as is the case for other species in the Orcuttieae tribe (Keeley 1988, p. 1088). Additional research is warranted on how pesticides impact sensitive vernal pool plants in conjunction with other stressors. Specifically, identify whether there is a need for agricultural buffer zones and to evaluate the overall tolerances of vernal pools to pesticides (Johnson 2006, p. 5). 3. Conduct a Species Status Assessment: The Yolo Habitat Conservation Plan is in the process of protecting the Yolo Grasslands Regional Park and Davis Air Force Communication Facility sites in perpetuity (A. Stewart, Senior Fish and Wildlife Biologist, in litt. 2024). Once in place all occurrences will be permanently protected in perpetuity. For the next 5-year status review of the species, the Service should conduct a Species Status Assessment (SSA). If the species is found to continue to exist within its historical range and all or most occurrences are protected in perpetuity, the SSA will help assess the species status and whether downlisting is appropriate. 4. Initiate a collaborative seed banking program with botanical gardens to collect and preserve Solano grass seeds from across its range. Seed banking actions should ensure adequate collection from each occurrence to preserve the genetic diversity. No seeds have been collected for a seed bank since 2001. 5. Design and implement transplantation and population augmentation experiments. Augmenting existing occurrences may benefit them by increasing plant individuals and genetic diversity. Developing success criteria based off existing literatures and the results of future population augmentations will help guide effective conservation efforts. 6. Develop regional and/or state-level working groups for vernal pool species. Initiating regional working groups will develop the partnerships needed to oversee regional recovery efforts for vernal pool species, including Solano grass. (USFWS, 2024)

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SPECIES ACCOUNT: *Xyris tennesseensis* (Tennessee yellow-eyed grass)

Species Taxonomic and Listing Information

Listing Status: Endangered; 07/26/1991; Southeast Region (R4) (USFWS, 2017)

Physical Description

A perennial herb with basal, mostly erect linear leaves, 1-4.5 dm long, and branched flowering stems, mostly 3-7 dm tall, arising from a bulbous base. The inflorescence consists of brown, cone-like spikes, which occur singly at the tips of the flowering stalks and contain small, pale yellow flowers, which open in late morning and close by mid-afternoon (only 1 or 2 flowers are evident at any 1 time). Flowering occurs from August through September. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

The known current and historic distribution of Xyris tennesseensis is restricted to the states of Alabama, Georgia, and Tennessee almost exclusively within the Interior Plateau and Ridge and Valley ecoregions (USFWS, 2014).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Food/Nutrient Narrative

Adult: No information available.

Reproductive Strategy

Adult: Sexual (inferred from USFWS, 2014)

Lifespan

Adult: perennial (NatureServe, 2015)

Breeding Season

Adult: Flowering occurs from August through September (NatureServe, 2015).

Key Resources Needed for Breeding

Adult: Open moist sites (USFWS, 2014)

Reproduction Narrative

Adult: Flowers are yellow, bisexual, opening in the late morning. closing by mid-afternoon [only 1 or 2 flowers evident at any one time]; with obovate petal blades 4.5 mm long by 3 mm broad, long-clawed petal bases, and rounded- lacerate apices, borne in a compact, broadly ovoid, terminal, cone- or head-like spike, each flower subtended by one of a series of spirally-arranged, tough, woody scales (or bracts) which hide the buds and fruits; the bracts are suborbicular, tan or brown with a greenish dorsal area. Fruit an obovoid or broadly elliptical capsule. Seeds ellipsoid, mealy-surfaced, with 18-20 fine longitudinal lines, these sometimes interconnected, about 0.6 mm in length. Flowering occurs from August through September (NatureServe, 2015). Current research on X. tennesseensis indicates that flower production and (perhaps) seedling recruitment are most extensive in locations that are relatively sunny and lack an overstory of shrub or tree canopies. The species does best in relatively open moist sites (USFWS, 2014).

Habitat Type

Egg: Although Xyris species are usually found on acidic soils, X. tennesseensis is restricted to basic or circumneutral soils that thinly cover calcareous substrates with year-round seepage or mineral-rich water flow. This species is found in open or thin canopy woods in gravelly seep-slopes or gravelly bars and banks of small streams, springs and ditches (Kral 1990). (NatureServe, 2015)

Larvae: Although Xyris species are usually found on acidic soils, X. tennesseensis is restricted to basic or circumneutral soils that thinly cover calcareous substrates with year-round seepage or mineral-rich water flow. This species is found in open or thin canopy woods in gravelly seep-slopes or gravelly bars and banks of small streams, springs and ditches (Kral 1990). (NatureServe, 2015)

Juvenile: Although Xyris species are usually found on acidic soils, X. tennesseensis is restricted to basic or circumneutral soils that thinly cover calcareous substrates with year-round seepage or mineral-rich water flow. This species is found in open or thin canopy woods in gravelly seep-slopes or gravelly bars and banks of small streams, springs and ditches (Kral 1990). (NatureServe, 2015)

Adult: Wetland (USFWS, 2014)

Habitat Vegetation or Surface Water Classification

Egg: Although Xyris species are usually found on acidic soils, X. tennesseensis is restricted to basic or circumneutral soils that thinly cover calcareous substrates with year-round seepage or mineral-rich water flow. This species is found in open or thin canopy woods in gravelly seep-slopes or gravelly bars and banks of small streams, springs and ditches (Kral 1990). (NatureServe, 2015)

Larvae: Although Xyris species are usually found on acidic soils, X. tennesseensis is restricted to basic or circumneutral soils that thinly cover calcareous substrates with year-round seepage or mineral-rich water flow. This species is found in open or thin canopy woods in gravelly seep-slopes or gravelly bars and banks of small streams, springs and ditches (Kral 1990). (NatureServe, 2015)

Juvenile: Although Xyris species are usually found on acidic soils, X. tennesseensis is restricted to basic or circumneutral soils that thinly cover calcareous substrates with year-round seepage or mineral-rich water flow. This species is found in open or thin canopy woods in gravelly seep-slopes or gravelly bars and banks of small streams, springs and ditches (Kral 1990). (NatureServe, 2015)

Adult: Streams/springs (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Egg: Although Xyris species are usually found on acidic soils, X. tennesseensis is restricted to basic or circumneutral soils that thinly cover calcareous substrates with year-round seepage or mineral-rich water flow. This species is found in open or thin canopy woods in gravelly seep-slopes or gravelly bars and banks of small streams, springs and ditches (Kral 1990). (NatureServe, 2015)

Larvae: Although Xyris species are usually found on acidic soils, X. tennesseensis is restricted to basic or circumneutral soils that thinly cover calcareous substrates with year-round seepage or mineral-rich water flow. This species is found in open or thin canopy woods in gravelly seep-slopes or gravelly bars and banks of small streams, springs and ditches (Kral 1990). (NatureServe, 2015)

Juvenile: Although Xyris species are usually found on acidic soils, X. tennesseensis is restricted to basic or circumneutral soils that thinly cover calcareous substrates with year-round seepage or mineral-rich water flow. This species is found in open or thin canopy woods in gravelly seep-slopes or gravelly bars and banks of small streams, springs and ditches (Kral 1990). (NatureServe, 2015)

Adult: Disturbance (USFWS, 2014)

Geographic or Habitat Restraints or Barriers

Adult: Successive habitats (USFWS, 2014)

Spatial Arrangements of the Population

Adult: Clumped (inferred from NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (USFWS, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Egg: Although Xyris species are usually found on acidic soils, X. tennesseensis is restricted to basic or circumneutral soils that thinly cover calcareous substrates with year-round seepage or mineral-rich water flow. This species is found in open or thin canopy woods in gravelly seep-slopes or gravelly bars and banks of small streams, springs and ditches (Kral 1990). (NatureServe, 2015)

Larvae: Although Xyris species are usually found on acidic soils, X. tennesseensis is restricted to basic or circumneutral soils that thinly cover calcareous substrates with year-round seepage or mineral-rich water flow. This species is found in open or thin canopy woods in gravelly seep-slopes or gravelly bars and banks of small streams, springs and ditches (Kral 1990). (NatureServe, 2015)

Juvenile: Although Xyris species are usually found on acidic soils, X. tennesseensis is restricted to basic or circumneutral soils that thinly cover calcareous substrates with year-round seepage or mineral-rich water flow. This species is found in open or thin canopy woods in gravelly seep-slopes or gravelly bars and banks of small streams, springs and ditches (Kral 1990). (NatureServe, 2015)

Adult: Although Xyris species are usually found on acidic soils, X. tennesseensis is restricted to basic or circumneutral soils that thinly cover calcareous substrates with year-round seepage or mineral-rich water flow. This species is found in open or thin canopy woods in gravelly seep-slopes or gravelly bars and banks of small streams, springs and ditches (Kral 1990) (NatureServe, 2015). Clumped spatial arrangement, high ecological integrity and site fidelity and low tolerance ranges are inferred based on specific habitat needs of this species and the small number of known populations. It is obligate wetland plant that prefers relatively high pH seeps and streambanks. It has been shown to be a poor competitor and quickly succumbs to ecological succession without periodic disturbanc (USFWS, 2014).

Dispersal/Migration

Population Information and Trends

Population Trends:

Decline of 50-70% (NatureServe, 2015)

Species Trends:

Stable (USFWS, 2014)

Population Growth Rate:

At least four sites have been extirpated in the past. Decline of 50-70% (NatureServe, 2015)

Number of Populations:

23 (USFWS, 2014)

Population Narrative:

At least four sites have been extirpated in the past. Decline of 50-70%. There are between 6 and 20 known populations (NatureServe, 2015). Low resiliency, representation and redundancy are inferred based on low number of populations and specific habitat needs of this species (NatureServe, 2015). A more thorough survey completed in 2010 after two years of adequate rainfall indicates plants are still extant in original locations and in former abundances. Currently, a total of 23 populations are known to be extant including three in Bibb County, four in Calhoun County, and one each in Shelby and Franklin Counties, Alabama; four in Bartow County, one in Floyd County, and one in Whitfield County, Georgia; and seven in Lewis County, Tennessee (USFWS, 2014).

Threats and Stressors

Stressor: Habitat destruction (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: This species continues to be threatened by habitat destruction including stream impoundment, habitat conversion for agriculture and residential development, and poor management practices of the few wild populations (Johnson et al 2012) (USFWS, 2014).

Stressor: Competition (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Competition from woody plant encroachment including overcrowding and overshading are factors affecting the specialized habitat requirements of this species. Also, because this species relies on well-lit moist soils to become established, it is vulnerable to diversions of seep or ground water. A decline in number of three populations in Georgia and Alabama was attributed to alteration of disturbance regimes, competition with other plants at each site and recent devastating droughts (Boyd and Moffett 2010) (USFWS, 2014).

Stressor: Inadequacy of regulatory mechanisms (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: There are no State laws in Alabama protecting the Tennessee yellow-eyed grass and its habitat. State protections are in place for the species in Tennessee and Georgia but do not provide for the protection against habitat destruction. Tennessee legislation prohibits taking of the plant without the permission of the landowner and regulates commercial sale and export. In Georgia, listed plants or those proposed for listing are protected by the Wildflower Preservation Act of 1973. This legislation prohibits taking of plants from public lands without a permit and regulates the sale and transport of plants within the State. Neither of these statutes provides protection against habitat destruction, which is the principal threat (USFWS, 2014).

Recovery

Reclassification Criteria:
Not available

Recovery Priority Number: 8

Delisting Criteria:
Xyris tennesseensis will be considered for delisting when there are 15 adequately protected and managed, self-sustaining populations of the species distributed throughout the historical range and maintained for 10 years. A population will be considered adequately protected when it is legally protected and actively managed. A population will be considered “self-sustaining” if monitoring data support the conclusion that it is reproducing successfully and maintaining stable numbers or increasing (USFWS, 1994).

Recovery Actions:

- Protect and manage populations (USFWS, 1994).
- Search for new populations (USFWS, 1994).
- Investigate potential management techniques (USFWS, 1994).
- Conduct research on species' ecological requirements and life history (USFWS, 1994).
- Maintain plants and seed ex situ (USFWS, 1994).
- Provide public education (USFWS, 1994).
- Initiate periodic monitoring on sites with robust occurrences of the species (USFWS, 2014).
- Attempt to locate additional populations (USFWS, 2014).
- Work to obtain protection for sites on privately owned- lands (USFWS, 2014)
- Actively manage on occupied sites to include woody plant competition control at staggered intervals (USFWS, 2014).
- Explore well-guided safeguarding opportunities for the species on protected public lands (USFWS, 2014).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS Initiate annual monitoring on sites with robust occurrences of the species to assess population trends, specifically in relation to habitat degradation. Initiate monitoring on sites with less robust occurrences and prioritize efforts to manage sites, due to the higher risk of extirpation. Conduct surveys to locate additional populations on seep-slopes, in springy meadows, and on the banks of small streams. Work to obtain protection for sites on privately-owned lands. Actively manage occupied sites to include woody plant competition control at staggered intervals. Investigate and identify potential sites for well-guided safeguarding opportunities for the species on protected public lands. Conduct more genetic research to determine if out-planting is advised or if there are specific sites that have weighted conservation priority. (USFWS, 2021)

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SPECIES ACCOUNT: *Zizania texana* (Texas wild-rice)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/27/1978; Southwest Region (Region 2) (USFWS, 2016)

Physical Description

An aquatic, monoecious, perennial grass. The plant is generally 1-2 m (3.3-6.6 ft.) long (up to 4 m or 13 ft.) and usually immersed and prostrate in the swiftflowing water ofthe San Marcos River. In slow water the inflorescence, as well as the upper culms and leaves, becomes emergent. The culms are long decumbent, stoloniferous, and root only at the lower nodes.The leaves are linear, elongate, green, 12-110cm (4.7-43.3 in.) long, and 5-25 mm (0.2 - 1.0 in.) wide. The inflorescence is a narrow panicle, 16-3 1 cm (6.3 - 12.2 in.) long, and 1-10 cm (0.4 - 3.9 in.) wide. Flowering occurs primarily in the spring and fall although it may occur throughout the year in warm weather. The spreadingstaminate branches occur belowthe appressed pistillate branches. Spikelets consist of a single naked floret and lack glumes. The staminate spikelets are 6-11 mm (0.24 - 0.43 in.) long, 1.2-2 mm (.05 - .08 in.) wide, with white stamens, and hang downwhenmature. The pisrillate spikelers are 8-12mm (0.32-0.4 in.) long, 1.2-1.8 mm (0.05 - .07 in.) wide, erect, and awnripped. The awns are scabrous with scattered prickle hairs, and 10-35mm (0.39- 1.38 in.) long. The seeds (as obtained from cultivation) are cylindrical, 4.3-7.6mm (0.17-0.30 in.) long, 1-1.5 mm (0.04 -0.06 inch) wide, 1/2 to 3/4 as long as the lemma and palea, and black, browwn, or greenish (USFWS, 1995).

Taxonomy

First collected by G.C. Neally inAugust 1892 and was originally identifled as Z aquatica (U.S. National Herbarium sheet 979361). The next collection was by Ena A. Allen on July 10, 1921 (U.S. National Herbarium sheet 1611456). This sheet was labelled as Z. texana, apparently by A.S. Hitchcock, some time after its collection. WA. Silveus, an attorney and amateur botanist from San Antonio, first recognized Texas wild-rice as a distinct species. The plant was formally described and named as Z. texana by Hitchcock (1933) (USFWS, 1995).

Historical Range

When first described in 1933, Texas wild-rice was abundant in the San Marcos River, including Spring Lake and its irrigation waterways (USFWS, 1995).

Current Range

Texas wild-rice is endemic to the upper San Marcos River. The current distribution is from the Spring Lake to approximately 4.3 km (2.7 mi) downstream. The designated critical habitat extends to the confluence with the Blanco River (ca. 8.1 river-km [5 river-mi]). Low water velocity, water depth, turbidity, sediment, and shading may limit the establishment of Texas wild-rice in the lower San Marcos River (Poole et al. 2022, p. 7). However, depth may be limiting primarily due to effects of water clarity, since Texas wild-rice has been planted successfully in depths greater than 2 m (Crawford-Reynolds 2018, p. 10). Over 80 percent of the Texas wild-rice population is located from the Spring Lake dam to the Rio Vista railroad bridge, and less than 5 percent occurs downstream of I-35 (USFWS, 2024a)

Critical Habitat Designated

Yes; 7/14/1980.

Legal Description

On July 14, 1980, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Zizania texana (Texas wild-rice) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in Texas (45 FR 47355-47364).

Critical Habitat Designation

The critical habitat designation for Zizania texana includes one CHU in Hays County, Texas (45 FR 47355-47364).

Texas, Hays County: Spring Lake and its outflow, the San Marcos River, downstream to its confluence with the Blanco River.

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 Zizania texana critical habitat are not listed (45 FR 47355-47364).

Special Management Considerations or Protections

The most significant factors presently affecting the continued existence of the Texas wild rice are its extreme vulnerability due to limited range, its apparent inability to reproduce sexually in its native habitat, and the possibility of hybridization. Any action which would significantly alter the flow or water quality of the San Marcos River could adversely modify the Critical Habitat, since the species is adapted to conditions of clear water, uniform annual flow rate and constant year-round temperature (Beaty, 1975). Zizania Texana does not survive in stagnant water (Beaty, pers. comm., 1980). In addition, any actions which would physically alter the Spring Lake-San Marcos River site, such as dredging, bulldozing, or bottom plowing: or physically disturb the Texas wild rice, such as harrowing, cutting, or intensive collecting, would adversely modify Critical Habitat. These disturbances have been identified as contributors to the decline of the existing Texas wild rice population.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual and asexual (USFWS, 1996)

Breeding Season

Adult: Spring and fall but may occur year-round (USFWS, 1996)

Reproduction Narrative

Adult: Texas wild-rice produces new plants either via seeds or stolons. When reproducing sexually the long rigid decumbant culm (which can reach lengths of 3.6 - 4 m (12 feet) or more) bends upward at its nodes, emerges above the current, and produces a 3.2 to 4.7 cm (8 to 12 inch) flowering panicle (Beaty 1975). Flowering occurs primarily in the spring and fall, although it may occur throughout the year in warm weather. Asexual reproduction occurs where shoots arise at the ends of stolons. While asexual reproduction has been noted and some plants have produced culms for inflorescences, plants have not successfully been producing (or setting) seed in the San Marcos River (J. Poole, Texas Parks and Wildlife and P. Power, Southwest Texas State University, pets. comm.). Emery and Guy (1979) studied reproduction in Texas wild-rice and reported the species is predominantly out-breeding and wind-pollinated. In a study by Terrell et al. (1978), one individual plant produced about 80 seeds. (USFWS, 1996)

Habitat Type

Adult: Riverine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: spring/spring brook (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Constant year-round temperature between 21 and 25 degrees Celsius (NatureServe, 2015)

Environmental Specificity

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

Tolerance Ranges/Thresholds

Adult: Low (USFWS, 1996)

Habitat Narrative

Adult: Texas wild-rice forms large stands at depths from 0.23-1 m (0.76-3.3 ft) and requires clear, relatively cool, thermally constant (about 22.2°C [72°F]) flowing water (Poole and Bowles 1999, entire). Springflow and San Marcos River discharge are critically important for growth and survival of Texas wild-rice (Saunders et al. 2001, pp. 28, 30). Texas wild-rice relies on carbon dioxide as its carbon source for photosynthesis rather than the more commonly available bicarbonate used by most other aquatic plants (Rose and Power 2001, pp. 59-65). Edwards Aquifer water contains relatively high levels of carbonic acid, formed by the combination of carbon dioxide and water through karstification of carbonate rocks and microbial processes (BIO-WEST, Inc. 2004a, p. 10; Birdwell and Engel 2009, p. 147; Gray and Engel 2013, p. 335). Carbon dioxide in the water is readily available near spring openings and in relatively fastmoving waters that transport the dissolved gas downstream. Low springflows can be carbonlimiting for carbon dioxide-using obligates including Texas wild-rice. Texas wild-rice occurs primarily on gravel and sand substrates overlaying Crawford black silt and clay (USFWS, 2024a).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Emery and Guy (1979) studied reproduction in Texas wild-rice and reported the species is predominantly out-breeding and wind-pollinated. (USFWS, 1996)

Population Information and Trends

Population Trends:

Long-term trends suggest a decline of >90% (NatureServe, 2015)

Number of Populations:

1 (NatureServe, 2015)

Population Size:

<500 individuals (NatureServe, 2015)

Population Narrative:

Long-term population trends suggest a decline of >90%. Persists vegetatively but rarely produces seed under current conditions. Less than 500 individuals. Known only from the one site in the headwaters of the San Marcos River at San Marcos, Texas. (NatureServe, 2015)

Threats and Stressors

Stressor: Limited distribution, and lack of reproduction, and hybridization (USFWS, 1980)
Exposure:
Response:
Consequence:
Narrative: One of the most significant factors presently affecting the continued existence of the Texas wild rice is extreme vulnerability due to limited range, its apparent inability to reproduce sexually in its native habitat, and the possiblity of hybridization (USFWS, 1980).

Stressor: Herbivory (USFWS, 1996)
Exposure:
Response:
Consequence:
Narrative: Herbivory has been noted incidentally by several workers. Nutria (Myocaster coypus), an introduced mammal native to South America, have been observed eating plants of Texas wild-rice, and waterfowl have been observed feeding on the plants (USFWS, 1996).

Stressor: Recreation (USFWS, 1996)
Exposure:
Response:
Consequence:
Narrative: The Comal and San Marcos areas are very popular recreation sites that provide a variety of recreational opportunities including swimming, tubing, canoeing, fishing, snorkeling, scuba diving, and glass-bottomed boat tours. These activities and their associated support facilities may directly or indirectly impact the ecosystems and their species. Texas wild-rice plants may be physically damaged by water activity, or its inflorescences may be prevented from emerging so that the plants cannot successfully produce seed (USFWS, 1996).

Stressor: Reduction in water quanity and water quality (USFWS, 1996)
Exposure:
Response:
Consequence:
Narrative: A primary threat to all this species and its ecosystem is loss of springflows. Springflows at San Marcos and Comal Springs are tied inseparably to water usage from the entire Edwards Aquifer, and use of groundwater in that region decreases flow of water from the springs. light,

turbidity, and sedimentation. Chemical properties, physical properties, and temperature are important considerations. Threats to water quality occur as a result of human activities in the recharge zone and in the local watersheds. Permitted, nonpermitted, and accidental discharges into waterways are a possible threat. Surface runoff, particularly in urban areas, may impact the springs, lakes, and river systems. stormwater runoff may include such things as pesticides and herbicides, fertilizers, soil eroded from construction activities, silt, suspended solids, garbage, hydrocarbon and inorganic/metal compounds from vehicles and machinery, household solvents and paints, and other urban runoff from point and non-point pollution sources. Land-based oil and chemical spills in central Texas can affect surface and/or groundwater. The potential exists for catastrophic accidental spills from railroad tank cars, tractor trailers, or other motor vehicles crossing the San Marcos River on railroad bridges, the interstate highway, or other road crossings (USFWS, 1996).

Stressor: Nonnative species (USFWS, 1996)
Exposure:
Response:
Consequence:
Narrative: Certain nonnarive species (that is. those introduced to an area outside their normal range of distribution; including species native to areas outside the continent often termed exotic species) pose a significant threat. Threats occur due to competition over habitat or diet and/or by modifying habitat, such as affected by nonnarive elephant ears (Colocasia esculenta) and giant ramshorn snails (Marisa cornuarietis). Decreased flow may exacerbate the problem posed by nonnative species (USFWS, 1996).

Stressor: Habitat destruction or modification (USFWS, 1996)
Exposure:
Response:
Consequence:
Narrative: Human modifications (such as bank stabilization, dams, landlandowner maintenance activities in waterways and on adjacent tractsofland) have significantly altered natural configurations and drainage in the San Marcos and Comal systems. These alterations, in turn, have changed the historical magnitude and occurrence of episodic events such as flooding. Indirect impacts from surrounding development and urbanization have also changed these systems (USFWS, 1996).

Stressor: Management of aquatic vegetation (USFWS, 1996)
Exposure:
Response:
Consequence:
Narrative: It has been noted that cutting of aquatic vegetation in Spring Lake and other areas threatens Texas wild-rice because floating mats of cut vegetation released into the river shade and entangle Texas wild-rice plants and knock over inflorescences (USFWS, 1996)

Recovery

Reclassification Criteria:
Because ofthe limited distribution of this species the potential for full recovery and delisting is low. The Texas wild-rice will be considered for downlisting, from endangered to threatened,

when the following conditions have been achieved:

2. Captive, reproducing populations are being maintained in such a way that genetic integrity of the species is secured and there is suitable stock for reintroductions or supplementations should a catastrophe eliminate or drastically reduce numbers in their native ecosystem, and reintroduction techniques that are likely to be successful have been developed. (USFWS, 1996)

3. All measures identified in this plan to remove or minimize local threats have been successfully implemented (e.g. impacts from nonnative species, recreation, habitat alteration, and local water quality problems) (USFWS, 1996).

4. Healthy, self-sustaining, and reproductive populations are established throughout the historic range, and these populations are being maintained. Evaluation criteria specified in the Recovery Plan are calculated to achieve an average cover of 75% ofthe potential wild-rice habitat believed to be present in each segment. This percent cover is typical ofthat found in healthy vigorous stands of rice monitored over the last several years. Flowering, fruiting with production of viable seed, and seed germination in stands, with establishment of vigorous juvenile plants should be documented to occur in at least 5 percent of the stands each year for a 5-year period (USFWS, 1996).

Recovery Priority Number: 2C

Delisting Criteria:
Mean daily discharge in the San Marcos River as measured by the U.S. Geological Survey (USGS) San Marcos streamflow gage (USGS 08170500) equals or exceeds 55 cubic feet per second (cfs), 95 percent of the time, for 30 years. (USFWS, 2019)

A minimum instantaneous flow of 45 cfs is maintained in the San Marcos River as measured by the San Marcos streamflow gage (USGS 08170500) even in a drought of record. (USFWS, 2019)

Water quality is suitable and supportive by meeting these two requirements: 1)Turbidity, total dissolved solids (TDS) , and pH of the San Marcos River are consistently within established 25 to 75 percentile range of the earliest published San Marcos River water quality data (USGS data for upper San Marcos River, various stations) over a period of 5 continuous years. In general, suitable lake and river turbidity values (historic reference conditions) are in the low range for nephelometric turbidity units (NTU less than 1.0). Suitable total dissolved solids and pH values are comparable to those reported by Slattery and Fahlquist (1997) and earlier. The assessment of water quality to determine if these criteria are met will be based on the standard protocols and procedures of the USGS's National Field Manual (NFM) for the Collection of Water- Quality Data (USGS 2018). The selection of at least four sampling sites should be representative of the San Marcos River upstream from Cumming's Dam and water quality measurements from all sites must fall within the respective ranges for levels of turbidity, TDS and pH. The frequency of collection of water quality samples shall be a minimum of once per month and water-quality data shall be collected monthly for at least 5 years. (USFWS, 2019)

Water quality is suitable and supportive by meeting these two requirements: 2) The environmental concentrations of known phytotoxic compounds as surveyed annually in the San Marcos River in Zizania texana Segments G through M (see Figure 1) (including dissolved copper, dissolved zinc, and listed U.S. Environmental Protection Agency [EPA] and Texas Department of Agriculture regulated herbicides) are consistently below known adverse effects levels each year for 30 consecutive years. (USFWS, 2019)

Healthy, self-sustaining, and reproductive populations are established and maintained throughout the historic range. This criterion will be evaluated based on the presence of Zizania texana with more than minimum areal coverage and distribution provided in accompanying table of areal extent objectives (Table 1). Healthy for Zizania texana means free from disease, free from adverse biological interactions (e.g., free from detrimental levels of epiphytic algae), and free from limiting physical conditions (e.g., inadequate levels of photosynthetically active radiation as investigated by Crawford-Reynolds (2018)). To meet this criterion, the areal coverage by Zizania texana for each Upper San Marcos River segment must exceed delisting targets for that segment annually for 30 consecutive years. A population of Zizania texana in Segment X is not considered necessary for recovery as: (1) this habitat did not exist until Capes Dam and its mill race were constructed, (2) it has never had any significant stands of Zizania texana likely due unsuitable substrates, and (3) the mill race is subject to drying if or when Capes Dam is breached. (USFWS, 2019)

A minimum of two captive, reproducing Zizania texana stocks are maintained in separate geographic locations. (USFWS, 2019)

Recovery Actions:

- Assure sufficient water levels in the Edwards aquifer and flows in Comal and San Marcos Springs to maintain habitat for all life stages of the five listed species and integrity of the ecosystem upon which they depend. (USFWS, 1996)
- Protect water quality. (USFWS, 1996)
- Establish and maintain populations for all five listed species in their historic habitats. (USFWS, 1996)
- Conduct biological studies necessary for successful monitoring, management, and restoration. (USFWS, 1996)
- Encourage partnerships with landowners and agencies to develop and implement conservation strategies. (USFWS, 1996)
- Develop and implement a regional Aquifer Management Plan. (USFWS, 1996)
- Develop and implement local management and restoration plans to address multiple threats. (USFWS, 1996)
- Promote public information and education. (USFWS, 1996)
- Conservation measures are not available.
- 1. Recovery Action 1: Ensure Adequate Water Quantity and Quality within the Southern Edwards Aquifer and Management Units. Priority 1. • Recovery Activity 1-1: Gather information necessary to determine water quantity needed at each Management Unit. Information needs to be gathered and evaluated to ensure adequate water quantity to the Management Units at levels that protect the species and their habitat. This will involve monitoring of aquifer levels and spring flow under normal and drought conditions, modeling the impact of drought, groundwater pumping, and climate change on aquifer levels and spring flows, and incorporating any new information into water quantity requirements for each species at each Management Unit. Implement measures to provide adequate water quantity. Continuous flow monitoring should be implemented at Fern Bank Springs as part

of this activity. • Recovery Activity 1-2: Implement measures to provide adequate water quantity. To protect habitat, a comprehensive water management plan or equivalent would protect water quantity. This should include a regional aquifer management plan and the protection of aquifer recharge features. Long-term commitments need to be in place to ensure that these protections will continue in perpetuity. The plan must also identify how regional water needs will be met while considering these water limitations during severe droughts that could occur as a result of climate change. Considering comprehensive water planning should help ensure that the aquifer is not depleted due to lack of alternative water sources. • Recovery Activity 1-3: Evaluate the effectiveness of measures to provide adequate water quantity. Long-term water quantity monitoring should evaluate how well the implemented measures are protecting water quantity, especially during droughts. This monitoring campaign will include using the aquifer level, springflow, and groundwater pumping data collected by local groundwater conservation districts, Texas Water Development Board, U.S. Geological Service, and other entities. These data will be placed into a management framework that identifies critical aquifer levels and associated on-the-ground habitat conditions. This information should also be used to update the Contingency Plan for springflow triggers to salvage species for the refugia if needed. Projected frequency of droughts and groundwater levels used in models should be validated with data collected during future drought conditions. • Recovery Activity 1-4: Model effects of projected future land use changes on water quality and aquifer recharge, and whether additional land protection is needed. Increasing development and associated impervious cover in the contributing, recharge, and artesian zones of the Edwards Aquifer threatens water quality, may affect recharge, and increases the risk of catastrophic spills. Modeling these effects is necessary to consider for preventing water quality degradation and whether land preservation in the contributing and recharge zones is needed. • Recovery Activity 1-5: Develop and implement effective measures to avoid chronic water quality degradation and maintain aquifer recharge. Measures to avoid or limit chronic water quality degradation should be developed, implemented, and when needed, modified to ensure their effectiveness. These measures could involve land acquisition, conservation easements, best management practices, impervious cover regulations, buffer zones, outreach programs, and numerous other tools. Evaluate the effectiveness of these measures. • Recovery Activity 1-6: Develop and implement effective measures to avoid chronic water quality degradation, contaminant spills, and maintain aquifer recharge. Measures to avoid or limit spills and chronic water quality degradation should be developed, implemented, and when needed, modified to ensure their effectiveness. These measures could involve land acquisition, conservation easements, best management practices, impervious cover regulations, buffer zones, outreach programs, and numerous other tools. Plans should also be developed to reduce the risk of spill and reduce the impacts of spills through containment to avoid contaminants entering groundwater. These measures should also evaluate the effectiveness of these measures. • Recovery Activity 1.7: Monitor the physical and chemical constituents (sediment, nutrients, ions, and contaminants) present during baseflow and stormflow conditions at the springs. Information should be collected on the physical and chemical constituents of greatest concern during baseflow and stormflow conditions. This research should also be designed to evaluate the effectiveness and modify, if necessary, the measures that avoid or minimize water quality degradation. • Recovery Activity 1-8: Consult with environmental agencies on effects of wastewater discharges. Use interagency consultation to evaluate the combined effects of permitted wastewater discharges and future permitted discharges in the recharge and contributing zone on water quality in the

Management Units. Implement conservation measures as part of the consultations to protect water quality (USFWS, 2024)

- 2. Recovery Action 2. Protect and Restore Habitat in Waters and on Lands Within and Adjacent to the Management Units. Priority 1. • Recovery Activity 2-1: Control non-native species. Control or eliminate non-native species spread that outcompete native flora and fauna, contribute to scouring flood severity, and reduce the adaptive capacity and resiliency of listed species' populations within the Management Units. Additionally, proactive measures to reduce conditions preferred by non-native species should be a long-term priority. Regulations to prevent the spread or introduction of non-native species should be enforced through TPWD and the Service. Private landowners should be educated on illegal activity reporting and prevention of introducing non-native species that may adversely affect the habitats within the Management Units. • Recovery Activity 2-2: Reduce human disturbance in habitat. Reduce unintentional disturbance from recreation using measures such as designated access points and prohibiting access in sensitive areas. Intentional disturbance (e.g., from vegetation removal and littering) could be reduced from education, availability of alternatives that would prevent the disturbance, and from legal enforcement. • Recovery Activity 2-3: Develop and implement habitat management plans. Management plans should include descriptions of on-the-ground projects and activities necessary to improve or maintain adequate high-quality habitat in which the species' populations can be resilient. This may include erosion control strategies and reducing mechanical disturbances in coordination with local jurisdictions, resource management agencies, and private landowners. Land development effects should be minimized using best management practices. Sediment removal projects, in coordination of resource management agencies and industries, should minimize disturbance to the habitat where possible, to enhance areas of diminished habitat value. The habitat can be evaluated to determine if it has degraded to the point where specific habitat restoration projects would be beneficial to improve habitat. Adjacent riparian zones should be included in the habitat management plans to protect aquatic habitat. Additionally, the habitat management plans should include abatement strategies for existing threats and measures to identify undetected threats as new information becomes available. • Recovery Activity 2-4: Protect and restore habitat at Fern Bank and Hueco springs. Access to these springs is needed to evaluate habitat restoration needs. Easements or other conservation agreements could be used to protect these springs from human disturbance. • Recovery Activity 2-5: Evaluate the efficacy of recovery activities in protecting and restoring species habitat. Plans and activities should be reviewed and revised as needed based on outcomes from activities and new information. (USFWS, 2024)
- 3. Recovery Action 3: Establish and Implement a Captive Population Management Plan and Reintroduction Plan. Priority 1 for San Marcos salamander, Texas blind salamander, Texas wild-rice; Priority 2 for Comal Springs riffle beetle, Comal Springs dryopid beetle, Peck's cave amphipod, fountain darter. • Recovery Activity 3-1: Determine optimal conditions for captive breeding of each listed species. Ensure that each species has captive conditions that maximize life expectancy and reflect or exceed life expectancy of wild individuals. Ensure that under captive conditions, most individuals successfully reproduce and offspring from most broods survive until maturity and also reproduce. Until the optimal conditions have been determined for a species, large numbers of a species should not be kept in captivity because they will not be useful for the activities outlined in 3.3 or provide a safeguard against extinction. • Recovery Activity 3-2: Maintain captive breeding programs of each of the listed species. Captive breeding programs for each species will be maintained until threats to the species are ameliorated and delisting is achieved. The program is intended to

achieve the goals of the plan described in 3.3. However, captive breeding programs should be established even if the plan has not yet been created to safeguard against extinction.+ • Recovery Activity 3-3: Develop and implement a comprehensive strategy for the six endangered species. This includes developing and updating Captive Propagation, Contingency, and Reintroduction Plans to ensure their long-term survival. Regular reassessment and adjustments (e.g., annually) are essential. The Captive Propagation plans should be consistent with the USFWS “Policy Regarding Controlled Propagation of Species Listed Under the Endangered Species Act” (USFWS and NOAA 2000, entire). The plan should address four captive rearing situations: 1) captive rearing during non-crisis times in the event of a rapidly developing crisis when there is no time to collect wild animals, 2) collection and captive rearing of animals as a response to a rapidly developing crisis in which there is time to collect additional wild animals, 3) collection and captive rearing of animals in response to a slowly developing crisis, and 4) captive rearing of animals during non-crisis times without a developing crisis (i.e., standard operating procedures). The plans should balance the needs of the captive refugia with those of the wild populations through employing strategies that minimize the need for collecting wild individuals, while still fulfilling plan objectives. The Contingency Plans should establish the protocols needed to respond to crisis situations, including the emergency threat of water quantity (springs drying or limited flow), water quality (contaminant events such as oil spills), habitat fragmentation or isolation, or habitat loss. Contingency planning should be regularly updated, independent of the completion of genetic, breeding, and reintroduction studies. To mitigate the risk of extirpation before further collections can be made, the plans must address: maintaining and reproducing the species in captivity for multiple generations, maintain a sufficient captive population with genetic diversity representative of the wild for an extended period without the possibility of additional collections in case of extirpation from the wild, managing diseases and parasites in captivity, and incorporating strategies to avoid artificial selection that could reduce successful reintroductions. The Reintroduction Plans should adhere to standard guidelines for reintroduction plans (e.g., Association of Zoos & Aquariums). They should outline the process and circumstances under which the captive population(s) would be reintroduced into the wild, address research needed to improve reintroduction success (White et al. 2015, entire), consider the possibility of multiple reintroduction attempts, address contingency plans if reintroduction is unsuccessful, and include a post-release monitoring plan. The plan should be developed in coordination with agencies, permittees, and academic experts to ensure collection efforts maintain genetic diversity and population viability. An existing contingency plan exists (USFWS 1996) for managing salvage collections from the wild, though it requires substantial updates to align with current knowledge of the species. Additionally, a Participation Plan should be developed in coordination with the USFWS that outlines the level of commitment that partner facilities will implement this plan (i.e., long-term versus short-term holding facilities), personnel willing to collect and transport animals, research to be conducted, and level of information to be collected. The CPCP and Participation Plans. should regularly updated. (USFWS, 2024)

- 4. Recovery Action 4: Promote Edwards Aquifer Species Conservation and Recovery through outreach, education, and cooperation. Priority 3. • Recovery Activity 4-1: Provide outreach and education to local communities. Partners and management agencies will conduct outreach through events and engaging social media posts. Additionally, events and workshops hosted to the local community (e.g., tribes, local governments, citizens, and associations within the taxon’s range) should use strategies to seek out broad participation, including those that may not pursue conservation-focused events. Development and installation of interpretive signage should be considered to improve public awareness and appreciation for the ecosystems the seven species depend on and conservation of aquifer and aquatic habitats in general. • Recovery Activity 4-2: Promote cooperation and provide incentives and education for private landowners, land managers, and businesses. All habitat within management units in which land managers, landowners, and businesses are the primary caretaker should be incentivized and provided with education on the significance of their cooperation for the recovery of these species. Incentives are encouraged to engage landowners in activities that would improve or restore habitat. This can be achieved through obtaining conservation agreements (e.g., Safe Harbors or easements) whenever possible to protect natural attributes of the property from disturbance, participation or permission for the monitoring of populations, and adaptive management and timeline transparencies for agreements (e.g., Habitat Conservation Plans) with businesses. (USFWS, 2024)

- 5. Recovery Action 5: Establish and Implement Effective Disease and Parasite Protocols. Priority 2. • Recovery Activity 5-1: Investigate largemouth bass virus in fountain darters. Evaluate whether the virus affecting fountain darters is largemouth bass virus or a novel virus using genetic sequencing. Develop captive techniques to treat this virus and reduce mortality of infected individuals. • Recovery Activity 5-2: Control parasites in fountain darters and salamanders in captivity. Develop captive techniques to treat parasites, reduce mortality, and increase reproduction from infected individuals. • Recovery Activity 5-3: Monitor parasite prevalence at Management Units and assess whether it affects resiliency of wild populations. This action should also investigate the relationship between population trends and parasite prevalence and assess health of infected individuals to assess the extent that parasites are affecting individual fitness. • Recovery Activity 5-4: Control parasites at Management Units if needed. Based on monitoring results, techniques to reduce parasites in the wild may need to be implemented such that the parasites are not decreasing the resiliency of the population (USFWS, 2024)
- 6. Recovery Action 6. Monitor Progress Toward Criteria within the Management Units: Priority 3. • Recovery Activity 6-1: Create and implement monitoring plan to evaluate habitat quality and population resiliency of each species at each Management Unit. This should include mark/recapture or other population level analyses to provide population estimates when feasible, as well as the use of other techniques, such as abundance estimates and eDNA. Data should be statistically analyzed for trends in population and habitat quality over time. Population viability analysis should be performed at each Management Unit. Monitoring data should also be analyzed to evaluate the extent that climate change affects groundwater recharge, water temperature and water quality in species habitat. • Recovery Activity 6-2: Determine data needs for monitoring. Due to the subterranean nature of some of the listed species, it may not be possible to obtain adequate data to assess population size. Other estimates may be needed as surrogates in these cases. For subterranean species populations, presence/absence detection through eDNA sampling may provide suitable information in place of formal monitoring due to the inaccessibility of this habitat, access to private properties where species could occupy, and survey difficulties that result in repeatable detection accuracies. New monitoring techniques that provide better population estimates for subsurface species, and how springflows and groundwater levels affect subsurface habitat should be used if they become available. (USFWS, 2024)

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