

Appendix C-2

Status of the Species - Plants

SPECIES ACCOUNT: *Helianthus verticillatus* (Whorled Sunflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 8/1/2014; Southeast Region (R4) (USFWS, 2015)

Physical Description

A tall, perennial, herbaceous sunflower 1-2 meters in height with flower heads about 1 cm wide (Matthews et al. 2002). Flowers from August into October (NatureServe, 2015).

Taxonomy

The U.S. Fish and Wildlife Service (Call 2009) accepts this taxon as a species in considering it a candidate for federal listing; Matthews et al. (2002) and Flora of North America Editorial Committee (2006) also treat it as a species. Two supporting studies are cited by the USFWS: (1) morphological studies and root-tip chromosome counts which showed it to be a distinct, fertile diploid (Matthews et al. 2002); and (2) comparative genetic studies with its putative parents (*H. grosserratus* and *H. angustifolius*), which showed that it does not exhibit a mixture of parental alleles at nuclear loci and does not share chloroplast DNA haplotype with either of its putative parents (Ellis et al. 2006). In contrast, the Kartesz checklists (1994 and 1999) treat this taxon as a hybrid between *Helianthus angustifolius* and *H. grosseserratus*, following earlier treatments written when it was known from only the type specimen (NatureServe, 2015).

Historical Range

The species is known from Cherokee County, Alabama; Floyd County, Georgia; and McNairy and Madison Counties, Tennessee (USFWS, 2013).

Current Range

This species occurs in remnant prairie habitats found in uplands and swales of headwater streams in the Coosa River watershed in Georgia and Alabama and in the East Fork Forked Deer and Tuscumbia Rivers' watersheds in Tennessee (USFWS, 2014).

Critical Habitat Designated

Yes; 8/26/2014.

Legal Description

On August 26, 2014, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Helianthus verticillatus* (Whorled Sunflower) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes four critical habitat units (CHUs), in Indiana, Alabama, Georgia and Tennessee (79 FR 50990-51039).

Critical Habitat Designation

The critical habitat designation for *Helianthus verticillatus* includes four CHUs in Cherokee County, Alabama; Floyd County, Georgia; and Madison and McNairy Counties, Tennessee. This species critical habitat encompasses approximately 1,542.3 acres (ac) (624.2 hectares (ha)) (79 FR 50990-51039).

Unit 1: Mud Creek: Unit 1 consists of 210.6 ha (520.4 ac) of privately owned lands in Cherokee County, Alabama, located approximately 11.6 km (7.2 mi) southeast of the city limits of Cedar

Bluff. The unit begins approximately 0.06 km (0.04 mi) north of the junction of CR-164 and CR-29 and extends in a northerly direction to encompass much of the drainage area of an unnamed tributary to Mud Creek and to the northeast to encompass much of the drainage area of a second unnamed tributary to Mud Creek. The easternmost boundary of this unit is adjacent to CR-101, from approximately 1.0 km (0.6 mi) to 1.4 km (0.9 mi) north of its junction with CR-164. Silt loam and silty clay loam soils are present throughout the unit, spanning broad uplands, and terraces and flood plains of headwater streams in the Coosa River watershed (PCE 1). The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats of soil disturbance due to silvicultural site preparation or timber harvest; indiscriminate herbicide use or mowing for silvicultural purposes or road right-of-way maintenance; conversion of remnant prairie habitat to agricultural or industrial forestry uses; and excessive shading or competition from native woody species or invasive, nonnative plants.

Unit 2: Coosa Valley Prairie: Unit 2 consists of 366.9 ha (906.5 ac) of privately owned lands in Floyd County, Georgia, located approximately 4.5 km (2.8 mi) northwest of the city limits of Cave Spring. This unit corresponds to the boundary of The Nature Conservancy's conservation easement on lands formerly owned by The Campbell Group and now owned by Plum Creek, a site commonly referred to as the Coosa Valley Prairie. The northern boundary of this unit follows Jefferson Road for approximately 1.4 km (0.9 mi) in a southeasterly direction, beginning approximately 1.7 km (1.0 mi) east of the Alabama-Georgia State line. From the eastern extent on Jefferson Road, the unit boundary follows an unnamed dirt road south for a distance of approximately 1.5 km (0.9 mi), where the boundary turns to the west and south before turning back to the north and again to the west, reaching the Alabama-Georgia State line. Here, the unit follows the State line in a northwest direction for approximately 0.8 km (0.5 mi) before turning east and following an unnamed dirt road in a northeasterly direction for approximately 2.7 km (1.7 mi) and reuniting with the northern boundary on Jefferson Road. Silt loam and silty clay loam soils are present throughout the unit, spanning broad uplands, depressions, and terraces and flood plains of headwater streams in the Coosa River watershed (PCE 1). Prairie openings and woodlands with low levels of canopy cover (PCE 2) are present throughout much of the unit. While Ellis and McCauley (2009, pp. 1837-1838) found very few viable achenes and low germination rates at this site, whorled sunflower has responded favorably to habitat management efforts by increasing in numbers, and there likely are now a sufficient number of compatible mates for production of viable achenes (PCE 3) at this site. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats of soil disturbance due to silvicultural site preparation or timber harvest; indiscriminate herbicide use or mowing for silvicultural purposes or road right-of-way maintenance; conversion of remnant prairie habitat to agricultural or industrial forestry uses, and excessive shading or competition from native woody species or invasive, nonnative plants.

Unit 3: Prairie Branch: Unit 3 consists of 6.0 ha (14.9 ac) of privately owned land in McNairy County, Tennessee, and is located approximately 0.6 km (0.5 mi) south of the easternmost city limit of Ramer. This unit is located along Prairie Branch, a tributary to Muddy Creek, beginning approximately 0.42 km (0.26 mi) upstream of the point where it passes under Mt. Vernon Road and extending downstream for approximately 2.0 km (1.2 mi). Within this reach, the critical habitat unit forms a buffer extending 15 m (50 ft) upslope from the tops of the banks on both sides of Prairie Branch. Sandy loam soils (PCE 1) are present throughout the unit, as are small patches of vegetation containing whorled sunflower and other wet prairie species (PCE 2). The

features essential to the conservation of the species in this unit may require special management considerations or protection to address threats of soil disturbance due to agricultural practices; indiscriminate herbicide use or mowing for road or railroad right-of-way maintenance; conversion of remnant prairie habitat to agricultural uses; and competition from invasive, nonnative plants.

Unit 4: Pinson: Unit 4 consists of 40.7 ha (100.5 ac) of privately owned land in Madison County, Tennessee, and is located approximately 4.1 km (2.5 mi) northwest of the city limits of Henderson, Tennessee. Beginning approximately 0.7 km southeast of the junction of U.S.–45 and Bear Creek Road, this unit extends approximately 0.08 km (0.05 mi) northeast of U.S.–45, crossing a railroad track, and then turns in a southeasterly direction, paralleling the track for a distance of approximately 0.5 km (0.3 mi). From this corner, the unit boundary turns southwest for a distance of approximately 0.79 km (0.49 mi), and then turns to the northwest for a distance of approximately 0.65 km (0.4 mi). From this corner, the unit boundary turns to the northeast for a distance of approximately 0.63 km (0.39 mi). Silt loam soils (PCE 1) are present throughout the unit, small patches of vegetation containing whorled sunflower and wet prairie species (PCE 2) are present, and a sufficient number of compatible mates are present for the production of a limited number of viable achenes (PCE 3) (Ellis and McCauley 2009, p. 1838). The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats of soil disturbance due to agricultural practices; indiscriminate herbicide use or mowing road or railroad right-of-way maintenance; conversion of remnant prairie habitat to agricultural uses; and excessive shading or competition from native woody species or invasive, nonnative plants. Much of the land within this unit has been converted to agricultural uses, but is included because of the potential for decreasing fragmentation among the subpopulations that are present in this unit by restoring suitable vegetation within previously converted lands.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Helianthus verticillatus* critical habitat consists of three components (79 FR 50990-51039):

- (i) Silt loam, silty clay loam, or fine sandy loam soils on land forms including broad uplands, depressions, stream terraces, and floodplains within the headwaters of the Coosa River in Alabama and Georgia and the East Fork Forked Deer and Tuscumbia rivers in Tennessee.
- (ii) Sites in which forest canopy is absent, or where woody vegetation is present at sufficiently low densities to provide full or partial sunlight to whorled sunflower plants for most of the day, and which support vegetation characteristic of moist prairie communities. Invasive, nonnative plants must be absent or present in sufficiently low numbers to not inhibit growth or reproduction of whorled sunflower.
- (iii) Occupied sites in which a sufficient number of compatible mates are present for outcrossing and production of viable achenes to occur.

Special Management Considerations or Protections

The features essential to the conservation of whorled sunflower may require special management considerations or protection to reduce the following threats: (1) Soil disturbance

due to silvicultural site preparation, timber harvest, or cultivation of row crops; (2) indiscriminate herbicide use or mowing; (3) conversion of remnant prairie habitat to agricultural or industrial forestry uses; and (4) excessive shading or competition from native woody species or invasive, nonnative plants. Management activities that could ameliorate these threats include, but are not limited to: (1) Avoiding areas located in close proximity to whorled sunflower sites when planning for establishing new sites for agriculture or pulpwood and timber production; (2) ensuring that herbicide use or mowing does not occur in whorled sunflower sites during the species' growing season; (3) locating suitable habitat, determining presence or absence of whorled sunflower, and protecting or restoring as many sites or complexes of sites as possible; (4) managing, including prescribed burning, mowing, and bushhogging, to reduce canopy cover, minimize competition from native and invasive, nonnative plants, and maintain characteristic moist prairie vegetation; (5) reaching out to all landowners, including private, State, and Federal landowners, to raise awareness of the plant and its habitat; and (6) providing technical or financial assistance to landowners to help in the design and implementation of management actions that protect the plant and its habitat.

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Vegetative (NatureServe, 2015); sexual (inferred from USFWS, 2014)

Breeding Season

Adult: August - October (USFWS, 2013)

Reproduction Narrative

Adult: The low number of populations in the wild may be due to poor in situ seed germination (Matthews et al. 2002). However, seed germination is high in the laboratory and the species can reproduce rapidly from rhizomes, forming a dense colony (Call 2009) (NatureServe, 2015). This species is self-incompatible (USFWS, 2014). It produces flowers from August into October (Matthews et al. 2002, pp. 17–20; Ellis and McCauley 2008, p. 1837) (USFWS, 2013).

Habitat Type

Adult: Terrestrial, wetland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Wet prairie, calcareous barrens, riparian (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Full to partial sunlight (USFWS, 2014)

Geographic or Habitat Restraints or Barriers

Adult: Succession (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 2013)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Habitat Narrative

Adult: A narrow habitat specialist occurring in remnant wet prairie areas and calcareous barrens, in moist, prairie-like openings in woodlands and along adjacent creeks. Soils are sandy clays which are alkaline, high in organic matter, and seasonally wet. Some associated plant species, including *Schizachyrium scoparium*, *Sorghastrum nutans*, *Andropogon gerardii*, and *Panicum virgatum*, suggest a strong prairie affinity. Other associates include *Carex cherokeensis*, *Sporobolus heterolepis*, *Physostegia virginiana*, *Silphium terebinthinaceum*, *Pycnanthemum virginianum*, *Symphytotrichum novae-angliae*, *Hypericum sphaerocarpum*, *H. angustifolius*, *Helenium autumnale*, and *Marshallia mohrii*. Most remaining wet prairies are remnants along rights-of-way where succession is artificially impeded (Call 2009) (NatureServe, 2015). The soil types are silt loams, silty clay loams, and fine sandy loams at the sites where whorled sunflower occurs. These soils share the characteristics of being strongly to extremely acidic and having low to moderate natural fertility and low to medium organic matter content (USDA 1997, pp. 73–76; USDA 1978a, pp. 24–54; USDA 1978b, p. 20; USDA 1978c, p. 44). Full or partial sunlight for most of the day is an essential feature for this species (USFWS, 2014). Initial efforts to estimate population sizes of whorled sunflower relied on counting individual stems (Allison 2002, pp. 3–8; Schotz 2001, pp. 8–10); however, due to the species' clonal growth habit, stem counts overestimate the true number of genetically distinct individuals (genets) (USFWS, 2013).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Not available

Population Information and Trends**Population Trends:**

Unknown (NatureServe, 2015)

Species Trends:

Unknown (NatureServe, 2015)

Resiliency:

Low to moderate (inferred from USFWS, 2014; see current range/distribution)

Representation:

High (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from USFWS, 2014)

Number of Populations:

4 (USFWS, 2014)

Population Size:

250 - 10,000 individuals (NatureServe, 2015)

Population Narrative:

The low number of populations in the wild may be due to poor in situ seed germination (Matthews et al. 2002). However, seed germination is high in the laboratory and the species can reproduce rapidly from rhizomes, forming a dense colony (Call 2009). *H. verticillatus* has a high level of genetic diversity at the population and species level despite its rarity, which may indicate that it was more widespread in the past and perhaps became rare relatively recently (Ellis et al. 2006). Most sites recently discovered. Rarity is due to habitat loss. Its wet prairie habitat was more extensive before European settlement, fire suppression, and conversion to farmland; much of this habitat has been degraded or destroyed due to agricultural, silvicultural, and residential development (Matthews et al. 2002, Call 2009). The Georgia site has hundreds to thousands of stems (Norquist 2005, Call 2009); the number of genetic individuals is believed to be much lower than this, but is not known for certain (Call 2009). One site in Tennessee has about 70 plants (genetic individuals) with 500-1000 stems, the other site, discovered in 2006, has 36 clumps (genetic individuals) with approximately 400 stems (A. Bishop, pers. comm., 2007). One Alabama site contains an estimated 100 genetic individuals, and the second Alabama site contains an estimated 175-200 stems (representing a lower, but unknown, number of genetic individuals) (Call 2009). Five population groups are currently known extant, two in Alabama, one (with three sub-populations) in Georgia, and two in Tennessee (Norquist 2005; A. Bishop, pers. comm., 2007); in addition, there is the historical type collection from Tennessee in 1892, which has not been relocated despite searches. The estimated population size is 250 - 10,000 individuals. Population trends are unknown (NatureServe, 2015). There are four whorled sunflower populations known to be extant (USFWS, 2013).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: The threats to whorled sunflower from habitat destruction and modification are occurring throughout the entire range of the species. These threats include mechanical or chemical vegetation management associated with industrial forestry practices, maintenance of transportation and utility rights-of-way, agricultural practices, and shading and competition. While a conservation easement and suitable habitat management alleviate threats from industrial forestry that otherwise would adversely affect the Georgia population, one of the Alabama whorled sunflower subpopulations currently is threatened by industrial forestry practices. The population-level impacts from these activities are expected to continue into the future (USFWS, 2013).

Stressor: Small, isolated populations (USFWS, 2013)

Exposure:

Response:

Consequence:

Narrative: The whorled sunflower is vulnerable to localized extinction because of its extremely restricted distribution and small population sizes at most known locations, which reduces the resilience of these populations to recover from acute demographic effects of threats to its

habitat. the highly fragmented distribution of populations within Tennessee, combined with their disjunct location with respect to those in Georgia and Alabama, presumably precludes gene flow among them and leaves little chance of natural recolonization of these populations in the event of localized extinctions. Small population size could be affecting reproductive fitness of the whorled sunflower. The findings of Ellis and McCauley (2008, entire) suggest that the Madison County, Tennessee, population is reproductively less fit than the Alabama population. Ellis and McCauley (2008, p. 1840) offered two possible explanations for reduced reproductive fitness of the Tennessee population, including limited mate availability due to limited diversity of self-incompatibility alleles, or more extensive inbreeding. Both could be contributing to reduced seed production and viability rates (USFWS, 2013).

Recovery

Reclassification Criteria:

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

Delisting Criteria:

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

Recovery Actions:

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

Conservation Measures and Best Management Practices:

- Avoiding areas located in close proximity to whorled sunflower sites when planning for establishing new sites for agriculture or pulpwood and timber production (USFWS, 2014).
- Ensuring that herbicide use or mowing does not occur in whorled sunflower sites during the species' growing season (USFWS, 2014).
- Locating suitable habitat, determining presence or absence of whorled sunflower, and protecting or restoring as many sites or complexes of sites as possible (USFWS, 2014).
- Managing, including prescribed burning, mowing, and bush hogging, to reduce canopy cover, minimize competition from native and invasive, nonnative plants, and maintain characteristic moist prairie vegetation (USFWS, 2014).
- Reaching out to all landowners, including private, State, and Federal landowners, to raise awareness of the plant and its habitat (USFWS, 2014).
- Providing technical or financial assistance to landowners to help in the design and implementation of management actions that protect the plant and its habitat (USFWS, 2014).

References

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

NatureServe. 2015. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia.

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

USFWS 2014. Endangered and Threatened Wildlife and Plants

Designation of Critical Habitat for *Physaria globosa* (Short's bladderpod), *Helianthus verticillatus* (whorled sunflower), and *Leavenworthia crassa* (fleshy-fruit gladeceess)

Final Rule. 79 Federal Register 165. August 26, 2014. Pages 50989 - 51039

USFWS 2013. Endangered and Threatened Wildlife and Plants

Endangered Status for *Physaria globosa* (Short's bladderpod), *Helianthus verticillatus* (whorled sunflower), and *Leavenworthia crassa* (fleshy-fruit gladeceess). 78 Federal Register 149. August 2, 2013. Pages 47109 - 47134.

U.S. Fish and Wildlife Service. 2014. Endangered and Threatened Wildlife and Plants

Designation of Critical Habitat for *Physaria globosa* (Short's bladderpod), *Helianthus verticillatus* (whorled sunflower), and *Leavenworthia crassa* (fleshy-fruit gladeceess). 79 FR 50990-51039 (August 26, 2014).

USFWS 2014a. Endangered and Threatened Wildlife and Plants

USFWS. 2013. Endangered and Threatened Wildlife and Plants

Final Rule. 79 Federal Register 165. August 26, 2014. Pages 50989 - 51039.

SPECIES ACCOUNT: *Schwalbea americana* (American chaffseed)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/29/1992; Southeast Region (Region 4)

Physical Description

Schwalbea is an erect herb with unbranched stems or stems branched only at the base, growing to a height of 3.0 to 6.0 dm (12 to 24 in). The plant is densely albeit minutely hairy throughout, including the flowers. The leaves are alternate, lance-shaped to elliptic, stalkless, 2.5 to 5.0 cm (0.8 to 2 in) long, and entire; the upper leaves are reduced to narrow bracts. The large, purplish-yellow, tubular flowers, 3.0 to 3.5 cm long (1.2 to 1.4 in) are borne singly on short stalks in the axils of the uppermost, reduced leaves (bracts) and form a many flowered, spike-like raceme. The showy flowers have a high degree of bilateral symmetry elaborated for pollination by bees (Pennell 1935). The fruit is a narrow capsule approximately 10 to 12 mm (0.4 to 0.5 in) long, with a septical dehiscence. The numerous seeds are pale greenish brown or yellowish-tan, narrowly linear, somewhat flattened or compressed, slightly curved, and enclosed in a loose-fitting, sac-like structure that provides the basis for the common name, chaffseed (Musselman and Mann 1978). Flowering occurs from April to June in the southern part of the species' range, and from June to mid-July in the northern part of its range. Fruits mature from early summer in the South to October in the North (Johnson 1988). (USFWS, 1995)

Taxonomy

Pennell (1935) recognized a northern and southern species of Schwalbea, *Schwalbea americana* L. and *Schwalbea australis* Pennell, respectively. He distinguished *Schwalbea americana* by mostly recurved hairs and leaves up to 1.0 cm (0.4 in) wide or less, and *Schwalbea australis* by a pubescence of mostly upcurved hairs and leaves up to 1.5 cm (0.6 in) wide. *Schwalbea americana* was known from Massachusetts southward to Virginia, and *Schwalbea australis* was known from North Carolina to Kentucky and southward to Florida and Louisiana. Fernald (1937) found characters of the leaves and calyx lobes to vary over the total range so that recognition of two species was unwarranted. Following an examination of herbarium material, Musselman and Mann (1977) concurred that there was little taxonomic merit in recognizing more than a single species. Therefore, the U.S. Fish and Wildlife Service accepts the more recent treatments of Fernald (1937) and Musselman and Mann (1977), which recognize *Schwalbea americana* and *Schwalbea australis* as one species, *Schwalbea americana*. In this plan, *Schwalbea americana* will be henceforth referred to as the monotypic genus *Schwalbea*. (USFWS, 1995)

Historical Range

Historically known from Massachusetts and New York south along the East Coast to Florida and west along the Gulf Coast states to Texas. (NatureServe, 2015)

Current Range

Currently found in the following states: Massachusetts, New Jersey, North Carolina, South Carolina, Georgia, Alabama, Florida, and Louisiana. (USFWS, 2019a)

Critical Habitat Designated

No;

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Asexual and sexual (outcrossing) (NatureServe, 2015)

Dependency on Other Individuals or Species

Adult: Schwalbea produces showy, insect-pollinated flowers with a high degree of zygomorphy elaborated for pollination by bees (Pennell 1935). (USFWS, 1995)

Breeding Season

Adult: April to June (USFWS, 1995)

Other Reproductive Information

Adult: The germination rates of collected Schwalbea seeds are high. Kirkman (1993) reported that the germination rate of seeds placed in petri dishes, with and without cold stratification, was approximately 90 percent. (USFWS, 1995)

Reproduction Narrative

Adult: This species produces showy, insect-pollinated flowers; the high degree of zygomorphy elaborated for pollination by bees (Pennell 1935). Reproduction primarily occurs via outcrossing (sexual) but can also reproduce asexually. Flowers bloom between April and June. (USFWS, 1995; NatureServe, 2015)

Habitat Type

Adult: Palustrine and terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Bog/fen, forest/woodland, savanna, woodland - mixed (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Sunny open areas (NatureServe, 2015)

Environmental Specificity

Adult: Sunny areas (NatureServe, 2015)

Dependency on Other Individuals or Species for Habitat

Adult: The root parasitic behavior of Schwalbea has been known since 1856 (Musselman and Mann 1977). Schwalbea is considered the rarest root parasitic plant in the South, and, like most parasitic Scrophulariaceae, it is not host-specific. (USFWS, 1995)

Habitat Narrative

Adult: Characteristically, Schwalbea occurs in sandy (sandy peat, sandy loam), acidic, seasonally moist to dry soils. The species is generally found in habitats described as pine flatwoods, fire-maintained savannas, ecotonal areas between peaty wetlands and xeric sandy soils, and other open grass-sedge systems (Kral 1983). Schwalbea appears to be shade intolerant and, therefore, occurs in areas maintained in an open to partially open condition. In Georgia, Schwalbea occurs in

ecotonal areas between freshwater wetlands and upland pine forests. In North Carolina, the species occurs in moist to dryish pine flatwoods, longleaf pine/wiregrass savannas, and on longleaf pine/oak sandhills composed of Upper Cretaceous deep, white sands, at the western edge of the coastal plain. In South Carolina, the predominant habitat is described as fire-maintained (or mowed, as under power lines), dry, well-drained, longleaf pine flatwoods. The soil is generally a sandy loam. In New Jersey, *Schwalbea* occurs in open areas that have been maintained by mowing within a pitch pine community. The site is next to a roadcut through a cedar swamp. (USFWS, 1995)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: The structure of the *Schwalbea* seed, somewhat flattened or compressed, slightly curved, and enclosed in a loose-fitting sac-like structure, suggests wind dispersal; however, no information is available to support this hypothesis. Information is lacking on both the mechanism and distance of seed dispersal. (USFWS, 1995)

Population Information and Trends

Population Trends:

Long-term trends indicate population declines from 50 to 90%, whereas short-term trends suggest declines of 10 to 30% (NatureServe, 2015)

Species Trends:

Declining (NatureServe, 2015)

Number of Populations:

43 (USFWS, 2019a)

Population Size:

2500 - 10,000 individuals (NatureServe, 2015)

Adaptability:

Moderate (NatureServe, 2015)

Population Narrative:

When *Schwalbea* was listed as an endangered species in 1992, 19 extant occurrences were known from the following States: New Jersey (1), North Carolina (1), South Carolina (11), Georgia (4), Florida (1), and Mississippi (1). At the completion of the recovery plan in 1995, extensive searches for this species that occurred in the Southeast, namely North and South Carolina, increased the number of extant occurrences to 72: New Jersey Pleasantville, New Jersey (1), North Carolina (18), South Carolina (42), Georgia (10), and Florida (1). The last comprehensive review of this species status occurred in 2008. At that time, 53 occurrences were extant (30% of sites extant) in 2008: New Jersey (2), North Carolina (11), South Carolina (33), Georgia (4), Alabama (1), Florida (1), and Louisiana (1). It is important to note that in the 1995 recovery plan and 2008 5-year review, the terms population and occurrence were used interchangeably. Since some *Schwalbea* populations have multiple element occurrences or sites per population, the number of populations across the species range was over-reported in some

cases. In order to standardize population numbers across state boundaries, NatureServe's (2018) population delimitation guidelines were used for all extant populations across Schwalbeas' range in this five-year review. Historic and unknown occurrences were not delimited. Currently, there are 43 extant populations across the species range: Massachusetts (1), New Jersey (2), North Carolina (6), South Carolina (18), Georgia (9), Alabama (2), Florida (3), and Louisiana (2). (USFWS, 2019a)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2019a)

Exposure:

Response:

Consequence:

Narrative: Habitat destruction and adverse modification of suitable habitat for Schwalbea continue to be major threats for this species. Development along the coast continues to threaten Schwalbea by (1) direct loss of habitat and (2) indirect threats due to urbanization resulting in fire suppression from either local air pollution regulations or safety concerns. Fire suppression continues to threaten this species on both private and public lands. Conversion of longleaf flatwoods and savannas to commercial pine plantations and agriculture fields continue to threaten this species. Although new Schwalbea populations are being discovered, the number of extant populations declined by approximately 25% since the last 2008-five year review. (USFWS, 2019a)

Stressor: Herbivory (USFWS, 2019a)

Exposure:

Response:

Consequence:

Narrative: Herbivory continues to serve as a minor threat to the species, herbivores include the striped leaf beetle (*Kuschelina* sp.), Chrysomelid leaf beetle sp., and Buckeye caterpillar (*Junonia coenia*) larvae (M. Jenkins, Florida Department of Agriculture and Consumer Resources, pers. comm. 2017; Bob Dellinger, U.S. Forest Service, pers. comm. 2017). The Lethcoe, FMNF population suffered from herbivory when fresh new growth sprouted following a prescribed fire. (USFWS, 2019a)

Stressor: Small population size (USFWS, 2019a)

Exposure:

Response:

Consequence:

Narrative: Small population size was noted as a threat in the last 2008 five-year review and remains a threat today. Populations that appear stable throughout time contain at least 100 individuals. Currently, 20 populations contain 100 or more individuals. Small populations are highly vulnerable to extirpation, especially in the absence of prescribed fire. Small populations may be less resilient to environmental changes related to climate change. (USFWS, 2019a)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2019a)

Exposure:

Response:

Consequence:

Narrative: Because the Act only grants protection to plants when a Federal nexus is involved (e.g., federal permit required, federally funded projects), existing regulatory mechanisms are inadequate to protect Schwalbea. Schwalbea receives protection from state rare plant protection laws in Massachusetts, New Jersey, North Carolina, South Carolina, Georgia, and Florida. (USFWS, 2019a)

Stressor: Drought (USFWS, 2019a)

Exposure:

Response:

Consequence:

Narrative: Since Schwalbea is mostly (can occur outside of ecotone areas in longleaf flatwoods) an ecotone species occurring in transitional areas between uplands and freshwater wetlands, an increase in drought frequency and decrease in precipitation events could threaten smaller, less resilient populations. (USFWS, 2019a)

Recovery

Reclassification Criteria:

1. Long-term protection is achieved for 50 geographically distinct, self-sustaining populations. The population sites must be protected from development and other anthropogenic threats that may interfere with the species' survival. Protection of populations on private lands will be evidenced through landowner agreements or conservation easements. Protection of Schwalbea on public lands will be secured through agreements that ensure the long-range protection, management, and monitoring of Schwalbea. Protected sites will be distributed to include, at a minimum, all of the States currently supporting Schwalbea, with at least four populations in the northern portion of the species' range. Site protection agreements will cover the immediate occurrence site and, where possible, enough contiguous unoccupied habitat to allow for dispersal and natural colonization and expansion of the species. (USFWS, 1995)
2. Management agreements or plans are developed for the 50 protected occurrence sites with the primary objective of ensuring that an ecosystem capable of supporting viable populations of Schwalbea will be permanently maintained. In the case of private ownership, these management agreements could be part of the conservation easement or landowner agreement. (USFWS, 1995)
3. Viable populations of Schwalbea are established at four sites in the northern portion of the species' range (Massachusetts to Virginia), preferably with genetic material from the only remaining northern population in New Jersey. (USFWS, 1995)
4. Biennial monitoring shows that the 50 protected populations are viable as well as stable or increasing over a 10-year period. Demographic population data will be required to meet this condition. (USFWS, 1995)
5. Life history and ecological requirements are understood sufficiently to reliably predict the effectiveness of protection, management, and monitoring. (USFWS, 1995)

Delisting Criteria:

1. Protection via a conservation mechanism is achieved for 50 geographically distinct, self-sustaining populations (Addresses listing factors A, D, and E). (USFWS, 2019b)
2. Protected populations will be distributed to include all of the states currently supporting Schwalbea, and at least four populations in the northern portion of the species range (Massachusetts to Virginia) (Addresses listing factors A, D, and E). (USFWS, 2019b)
3. The land management plans or agreements for the 50 protected Schwalbea populations must include management objectives that abate threats to Schwalbea such as fire suppression, hog damage, and/or silviculture practices (Addresses listing factors A, D, and E). (USFWS, 2019b)

Recovery Actions:

- Protect extant populations and manage habitat. Identify ownership of all known populations. Establish contact with landowners and negotiate landowner agreements or conservation easements. Ensure that activities and management on public lands are consistent with the protection and management of Schwalbea. Use existing regulatory mechanisms to protect Schwalbea. Conduct additional surveys. (USFWS, 1995)
- Expand the extent of Schwalbea in the northern portion of the current range. The New Jersey occurrence of Schwalbea, which is critical to maintaining the northern range of the species, will receive continued protection. In addition, populations should be established in New Jersey, Delaware, Maryland, New York, Connecticut, and Massachusetts to guard against the extirpation of the species from the northern portion of its range. Data are not currently available that indicate the genetic significance of the remaining northern population; however, Pennell (1935) considered the northern and southern populations of Schwalbea to be distinct species, with the southern species occurring as far north as Virginia (Reveal and Broome 1981). Genetic analyses (Recovery Task 6 below) may further support the significance of maintaining viable populations from the northern gene pool. (USFWS, 1995)
- Investigate best management techniques. Continue experiments to determine the effects of fire. Conduct experiments to determine the effects of other disturbances. (USFWS, 1995)
- Investigate the species' biology. Conduct research to obtain more comprehensive information on life history and population demography. Determine minimum viable population size. (USFWS, 1995)
- Investigate genetic variability. Genetic analyses should be conducted to determine inter and intra-genetic variability of populations. Differences in the genetic composition of populations may influence site protection and reintroduction priorities. Ongoing genetic analyses may be sufficient to determine if significant variability exists. (USFWS, 1995)
- Monitor populations. Meeting the recovery objectives is contingent upon the stabilization of viable populations over time. Consistent monitoring will provide population data necessary to determine if the recovery objectives are being met. (USFWS, 1995)
- Review recovery progress and revise recovery plan as necessary. The overall success of the recovery program should be periodically assessed, and recommendations regarding appropriate changes in recovery objectives or tasks as suggested by research, studies, or monitoring should be implemented. (USFWS, 1995)

Conservation Measures and Best Management Practices:

- Research and determine if in situ recruitment and reintroduction can occur under different levels of soil disturbance and watering regimes. (USFWS, 2019a)
- Continually search for new populations in areas managed for quail and/or red-cockaded woodpeckers or any areas with a 1-2 year fire return interval within the species' historic range. (USFWS, 2019a)
- Survey unknown and historic populations and if present negotiate landowner agreements or conservation easements. (USFWS, 2019a)
- Develop an easy and repeatable Schwalbea survey form and methodology for range-wide use in order to track/monitor recovery populations annually. (USFWS, 2019a)
- Research the germination ecology of Schwalbea in regards to moisture and light requirements and seedling recruitment / host attachment to understand Schwalbea's regeneration strategy. (USFWS, 2019a)
- Research fire seasonality effects, especially early April and late July/August fires, in conjunction with rainfall patterns/climatic fluctuations. (USFWS, 2019a)
- Continue population reintroductions within the historic range and introductions into protected areas with 1-3 year fire return intervals. (USFWS, 2019a)
- Expand the extent of Schwalbea in the northern portion of the current range. (USFWS, 2019a)

References

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USFWS. 2010. American Chaffseed (*Schwalbea americana*) 5-Year Review: Summary and Evaluation. New Jersey Field Office Pleasantville, New Jersey

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SPECIES ACCOUNT: *Hibiscus dasycalyx* (Neches River rose-mallow)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/11/2013; Southwest Region (R2)

Physical Description

The rose-mallow is a nonwoody perennial in the Malvaceae (mallow) family that grows 1.9-7.5 feet (ft.) (0.6-2.3 meters (m)) tall. Leaves are alternate, simple, generally t-shaped, and deeply three-lobed with petioles 1.1-1.8 inches (in) (3-5 centimeters (cm)) long. The species generally produces a single creamy white (rarely pink) flower at the base of the leaf stalk along the uppermost branches or stems. Plants are single to multi-stemmed. Each branch or stem can have numerous leaves, with the total number of flowers per plant numbering in the hundreds. Flowering is rain dependent, spanning a few weeks in June and July. Seeds are set in August (T. Philipps, pers. comm. 2016a). Large, numerous stamens are monadelphous, forming a tube that is united with the base of the petals. Potential pollinators may include, but are not limited to: the American bumble bee (*Bombus pensylvanicus*), Hibiscus bee (*Ptilothrix bombiformis*), moths, and the scentless plant bug (*Niesthrea louisianica*) (Klips 1995, Warnock 1995, Warriner 2011). (USFWS, 2018)

Taxonomy

In the Malvaceae (mallow) family (USFWS, 2013)

Historical Range

The natural range is within Trinity, Houston, Harrison, and Cherokee Counties, Texas (USFWS, 2013a)

Current Range

Known from Trinity, Houston, Harrison, Cherokee, and Nacogdoches Counties in east Texas, in the Neches, Sabine, and Angelina River basins and the Mud and Tantanog Creek basins (USFWS, 2013a).

Critical Habitat Designated

Yes; 10/11/2013.

Legal Description

On September 11, 2013, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective October 11, 2013) for *Hibiscus dasycalyx* (Neches River rose-mallow) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes eleven critical habitat units (CHUs), in Cherokee, Harrison, Houston, Nacogdoches, and Trinity Counties, Texas (78 FR 56072-56120).

Critical Habitat Designation

The critical habitat designation for *Hibiscus dasycalyx* includes eleven CHUs in Cherokee, Harrison, Houston, Nacogdoches, and Trinity Counties, Texas. This species critical habitat encompasses approximately 166.5 acres (ac) (67 hectares (ha)). Brief descriptions are provided below; maps depicting these areas are included in the Final Rule (USFWS, 2013).

Unit 1: SH 94 ROW: Unit 1 consists of 3.4 ac (1.4 ha) on both the 94 ROW and on private land in Trinity County.

Unit 2: Harrison County: Unit 2 is found at a location between 0.2–0.4 mi (0.3–0.6 km) north of Farm to Market Road 2625 in Harrison County.

Unit 3: Lovelady: Unit 3 in Houston County, found northwest of Farm to Market 230, extends 0.3 mi (0.5 km) north and contains 6.3 ac (2.5 ha) of private land.

Unit 4: SH 204 ROW: Unit 4 in Cherokee County contains 8.7 ac (3.5 ha) of occupied habitat along SH 204 ROW and within the Mud Creek basin.

Unit 5: Davy Crockett NF, Compartment 55: Unit 5 is the only unit that contains a natural population of the Neches River rose-mallow on Federal lands within the Davy Crockett NF.

Unit 6: Davy Crockett NF, Compartment 11: Unit 6 includes 7.3 ac (3.0 ha) of occupied habitat on Compartment 11 on Federal land in the Davy Crockett NF within Houston County.

Unit 7: Davy Crockett NF, Compartment 20: Unit 7 includes 3.4 ac (1.4 ha) of Federal land in Compartment 20 of the Davy Crockett NF, Houston County.

Unit 8: Davy Crockett NF, Compartment 16: Unit 8 encompasses 32.8 ac (13.3 ha) of occupied Federal habitat in the Davy Crockett NF, Houston County.

Unit 9: Champion: The Champion site, Trinity County, is located on private land approximately 0.7 mi (1.1 km) south-southeast of the Houston County line, about 0.8 mi (1.2 km) north of the confluence of White Rock Creek and Cedar Creek (TXNDD 2012a, p. 55).

Unit 10: Mill Creek Gardens: Unit 10 is an introduced site at Mill Creek Gardens, Nacogdoches County. Stephen F. Austin State University Mass Arboretum purchased the land and created the gardens in 1995 as part of a conservation agreement.

Unit 11: Camp Olympia: Unit 11 is located on private property in Trinity County. The unit contains 0.2 ac (0.1 ha) of palustrine wetland habitat north of Lake Livingston.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Hibiscus dasycalyx* critical habitat consists of two components (78 FR 56072-56120):

- (i) Hydric alluvial soils and the potential for flowing water when found in depressional sloughs, oxbows, terraces, side channels, or sand bars; and
- (ii) Native woody or associated herbaceous vegetation, largely with an open canopy providing partial to full sun exposure with few to no nonnative species.

Special Management Considerations or Protections

Threats to those features that define the primary constituent elements for the Neches River rose-mallow include: (1) Alteration of naturalized flow regimes through projects that require channelization; (2) water diversions or hydrologic change to streams and rivers; (3) encroachment from native woody riparian species and nonnative species; (4) detrimental roadside management practices including inappropriate frequency and timing of mowing during the species' blooming period; (5) herbivory and, (6) trampling from hog and cattle; and (7) drought. Special management considerations or protection are required within critical habitat areas to address these threats. Special management activities that could ameliorate these threats include, but are not limited to: • Construction of cattle exclusion fencing to remedy herbivory at Lovelady to maintain plant survival and suitable habitat; • Restoration of the cattle stock pond back to a natural flatwoods pond at Lovelady to restore the sites hydrology; • Coordination with TXDOT to establish and continue effective management along ROWs for control of native woody species and nonnatives (including, but not limited to mowing, brush-hogging, or other hand-clearing techniques) and completion of these techniques only during the appropriate life stages of the Neches River rose-mallow to maintain open habitat; • Coordination with the Angelina and Neches River Authority and consultation with the U.S. Army Corps of Engineers on the proposed construction of Lake Columbia Reservoir in Cherokee County to maintain hydrology at the downstream Neches River rose-mallow site; • Consultation between the Service and the U.S. Army Corps of Engineers for any filling or draining of Federal jurisdictional wetlands to ensure maintenance of hydrology; and • Clearing or burning on the Davy Crockett NF for control of Chinese tallow and to maintain an adequate level of openness in habitat. (USFWS, 2013)

Life History**Food/Nutrient Resources****Reproductive Strategy**

Adult: Insect (USFWS, 2013a)

Lifespan

Adult: Unknown (USFWS, 2013a)

Breeding Season

Adult: Flowering occurs between June and August, sometimes into late October (USFWS, 2013a)

Key Resources Needed for Breeding

Adult: Insects for pollination (USFWS, 2013a)

Reproduction Narrative

Adult: This perennial species dies back to the ground every year and resprouts from the base; however, the plant still maintains aboveground stems. Longevity of the species is unknown, but it may be long-lived. Cross-pollination occurs within populations, and the species has high reproductive potential (fecundity). Flowering occurs between June and August, sometimes into late October; the blooming period may only last 1 day. The species produced an average of 50 fruits per plant, but seed viability and survivorship are not known. Potential pollinators of the Neches River rose-mallow may include, but are not limited to, the common bumblebee (*Bombus*

pensylvanicus), Hibiscus bee (*Ptilothrix bombiformis*), moths, and the scentless plant bug *Niesthrea louisianica* (USFWS, 2013a).

Habitat Type

Adult: Wetlands (USFWS, 2013a)

Habitat Vegetation or Surface Water Classification

Adult: Seasonally or regularly inundated sloughs, oxbows, terraces, sand bars, and bottomlands (USFWS, 2013a)

Environmental Specificity

Adult: Narrow. Specialist or community with key requirements common (NatureServe, 2015)

Habitat Narrative

Adult: The Neches River rose-mallow is endemic to relatively open habitat of the Pineywoods (or Timber belt) of east Texas, within Cherokee, Houston, Harrison, and Trinity Counties, and has been introduced into Nacogdoches and Houston Counties. It is known from seasonally or regularly inundated sloughs, oxbows, terraces, sand bars, and bottomlands, with hydric alluvial soils (loamy to clayey). An open canopy is typical, but plants also grow in partial sun. Sites are both perennial and intermittent wetlands with water levels between sites varying due to their proximity to water, amount of rainfall, and floodwaters. Intermittent wetlands are inundated during the winter months but become dry during the summer months (USFWS, 2013a).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Neches River rose-mallow seeds are likely to be dispersed by flowing water. Research has not been done to identify methods of seed dispersal upstream; however, avian species may facilitate this process (USFWS, 2013a).

Population Information and Trends**Number of Populations:**

11 (8 natural; 3 introduced) (USFWS, 2018)

Population Size:

Approximately 2200 - 2500 individuals (NatureServe, 2015)

Minimum Viable Population Size:

At least 10 viable populations of the rose-mallow, each containing an average of about 1,400 individuals (USFWS, 2018)

Population Narrative:

When the species was listed in 2013, 11 populations were determined to be occupied by the rose-mallow. Of those 11 populations, 3 sites have not been verified in over 20 years and 3 included introductions on the Davy Crockett National Forest. In addition to these natural populations, the Service is also aware of 8 reintroductions, introductions, or display gardens, some of which were coordinated through the Service. (USFWS, 2018)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013a)

Exposure:

Response:

Consequence:

Narrative: A primary threat to the Neches River rose- mallow is the ongoing encroachment of nonnative and native woody species into its generally open, intermittent or perennial wetlands. Altered hydrology (including beaver dams) can have huge impacts on habitat since this species is water-dependent. Right-of-way populations are vulnerable to bridge and road expansion, new road construction, and upgrade projects, which could impact the sites' hydrology, soil stability, wetland and riparian vegetation, and water quality. Conversion of wetlands to silvicultural uses and associated herbicide use to remove unwanted vegetation is a threat. Habitat damage from trampling by feral hogs and cattle is also a threat, as is drought periods possible related to climate change (USFWS, 2013a).

Stressor: Predation (USFWS, 2013a)

Exposure:

Response:

Consequence:

Narrative: Mammalian herbivory has affected the majority of sites; however, grazing pressures are largely attributed to the lack of other available food resources during periods of drought. Neches River rose-mallow recovers quickly from herbivory incidents and can produce secondary growth, minimizing the overall negative effects of mammalian herbivory. This type of herbivory is not considered to be a threat to the species. Insect herbivory was also observed on several of the sites and was not rangewide, but, with anticipated climate change shifts in temperature and the likelihood that insect populations will increase, the Services conclude that insect predation is a minor stressor that will likely continue into the future, but it is not a threat to the species (USFWS, 2013a).

Recovery**Reclassification Criteria:**

Not applicable.

Delisting Criteria:

A Recovery Plan has not been developed.

Recovery Actions:

- A Recovery Plan has not been developed. The following present the summary statement of recovery needs presented in the 2018 Recovery Outline. (USFWS, 2018)
- - Survey sites that have not been visited in over 20-30 years and determine if they contain the physical and biological features of habitat. - Engage landowners to conduct conservation and stewardship on their property. - Using current niche models to identify other areas of potential habitat for rose-mallow and plan to conduct surveys at those sites. Niche models can also be used in future scenarios where climate change might alter the species current range (i.e. range expansion). - Consider introductions and reintroductions that would further

the representation and resiliency of the rose-mallow across its range, but that are also in-line with the species' propagation and reintroduction plan. - Communicate with partners, academics, nurseries, and plant communities about proper introduction procedures and encourage collaboration with the Service. - Continue to monitor existing populations for threats. - Conduct key biological studies to better understand the species reproductive needs (i.e. longevity, seed dispersal, age structure). This information can inform the recovery targets and needs in a recovery plan. - Develop a species Recovery Plan in FY2020. (USFWS, 2018)

Conservation Measures and Best Management Practices:

- Not available.

References

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SPECIES ACCOUNT: *Sarracenia rubra ssp. alabamensis* (Alabama canebrake pitcher-plant)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015) 3/10/1989

Physical Description

An insectivorous perennial herb with light green, red-veined leaves that form erect, vase-like structures, 1-5 dm tall (in late summer, these are enlarged and turn yellow-green). Flowers are 5-merous, with maroon petals that are constricted medially, to 2.5 cm in width and 3.6 cm in length; pendent, borne singly on an erect, leafless scape to 60 cm in height. Flowering season: late April to early June (NatureServe, 2015).

Taxonomy

There is taxonomic uncertainty within the genus *Sarracenia* as a whole but the Services and others recognize the taxon as a subspecies within the "rubra complex" (i.e., *Sarracenia rubra ssp. alabamensis*) (USFWS, 2018).

Historical Range

The Alabama canebrake pitcher plant is a carnivorous plant that is endemic to central Alabama, with all known populations, extant and extirpated, found in the Fall Line Hills ecoregion (USFWS, 2019). Species historically occurred in Autauga, Chilton, and Elmore Counties, Alabama. In Autauga County one population has since been extirpated (Byrd 2016) and the remaining five now represent three populations, with two populations continuing as distinct populations and three of the former populations now representing three sub-populations comprising one population. No extant populations are known to occur in Elmore County (USFWS, 2018).

Current Range

There are currently seven natural, extant populations of Alabama canebrake pitcher plant known (Autauga County – 3; Chilton County – 4) (USFWS, 2018). All are found in the Fall Line Hills ecoregion (see Griffith et al. 2001 for ecoregion description). Furthermore, within this ecoregion, most of the species' populations are known from the Upper Alabama subbasin (8-digit hydrologic unit code: 03150201) while the remaining populations are known from the Lower Coosa subbasin (03150107) (USFWS, 2019).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Food/Nutrient Narrative

Adult: This is a carnivorous plant, although it is unclear what benefit it receives from its carnivory (USFWS, 1992). Studies found that Alabama canebrake pitcher plants captured

comparatively more flying insects than crawling insects, likely due to the species' relatively tall stature (USFWS, 2018).

Reproductive Strategy

Adult: Vegetatively

Lifespan

Adult: Perennial herb, 60+ years (USFWS, 2012)

Dependency on Other Individuals or Species

Adult: Likely pollinators for this species are small bumblees (USFWS, 2018).

Reproduction Narrative

Adult: Seedling recruitment was reported to be absent from the majority of populations (Brewer and Chesser 2009), further inhibiting recovery efforts, as well as long-term viability and evolutionary potential. Because the species can reproduce vegetatively, seedling recruitment may not be paramount at sites experiencing light to moderate levels of fire exclusion; however, vegetative reproduction may not compensate for mortality or the lack of sexual reproduction at some sites (Brewer and Chesser 2009) (USFWS, 2012). Likely pollinators are small bumblebees (*Bombus* spp.) which have a flight distance of 1 mile; at distances greater than 1 mile, pollen flow (and consequent gene flow) is restricted by the inability of pollinators to traverse this distance (USFWS, 2018).

Habitat Type

Adult: Hillside seepage bogs and in bottomland or streamside vegetation (USFWS, 2012)

Environmental Specificity

Adult: Narrow. Specialist or community with key requirements common. (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: *Sarracenia rubra* ssp. *alabamensis* inhabits two distinct habitat types that share similar floristic composition. The majority of sites are characterized as hillside seepage bogs, permanently saturated areas that attain their greatest development where an impervious layer of clay lies in close proximity to the ground surface. Precipitation, once reaching this clay zone, becomes restricted and is gradually propelled along a sloping gradient until surfacing further downslope. The other habitat type occurs in association with bottomland or streamside vegetation. Unlike the foregoing habitat, moisture conditions are generally maintained with greater connection to topography and precipitation amounts (USFWS, 2012). All extant populations of *S. rubra* ssp. *alabamensis* occur in close association with the following combination of arborescent and herbaceous species (which therefore serve as the best indicators of suitable habitat): *Osmunda cinnamomea* (cinnamon fern), *Rhynchospora chalarocephala* (loosehead beak sedge), *Dichanthelium scoparium* (velvet panicgrass), *Xyris*

torta (twisted yellow-eyed grass), *Eriocaulon decangulare* (tenangle pipewort), *Arundinaria gigantea* (giant cane), *Cleistes bifaria* (small spreading pogonia), *Calopogon tuberosus* (tuberous grass pink), *Platanthera ciliaris* (yellow-fringed orchid), *Viola primulifolia* (white violet), *Rhexia nashii* (maid Marian), *Eryngium integrifolium* (blue coyotethistle), *Asclepias rubra* (red milkweed), *Magnolia virginiana* (sweetbay magnolia), *Solidago rugosa* (wrinkle-leaf goldenrod), *Eupatorium fistulosum* (joe pye weed), *Fuirena squarrosa* (hairy umbrella-sedge), and *Sphagnum* spp. Bottomland and streamside populations generally contain a greater proportion of woody species and *A. gigantea* (U.S. Fish and Wildlife Service 1992, Garrett 2004, Schotz 2006) (USFWS, 2012). It is most vigorous in open bogs and declines when the habitat becomes overgrown with woody vegetation (NatureServe, 2015).

Dispersal/Migration

Dispersal

Adult: Seed dispersal is poorly understood but studies with similar pitcher plants indicate seed dispersal distances from parent plants at typically a few inches and water or birds may facilitate dispersal over longer distances, but this remains unstudied for Alabama canebrake pitcher plant (USFWS, 2018).

Dispersal/Migration Narrative

Adult: Brewer and Chesser (2009) at the University of Mississippi recently completed a study correlating seedling recruitment and population dynamics in relation to site differences. They found that seedling recruitment was greater on sites with higher soil moisture content as opposed to drier sites. This correlation held true even when comparing unmanaged wet sites to managed dry sites (USFWS, 2012).

Population Information and Trends

Population Trends:

Stable (USFWS, 2018)

Species Trends:

Stable (USFWS, 2018)

Resiliency:

Low (inferred from NatureServe, 2015)

Representation:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

7 (USFWS, 2018)

Population Size:

3-200 individuals (USFWS, 2018)

Population Narrative:

Given proper habitat conditions, this species has demonstrated high fecundity - able to grow quickly and reproduce. According to anecdotal information furnished by wildflower enthusiasts, some sites historically contained thousands of plants. Was likely stable when fires were allowed to burn freely and naturally across the landscape, covering thousands of acres. Only recently, within the past 60 years, has public sentiment changed in opposition to free-ranging fires, due to the impact such fires have on timber production, agriculture, and development. Consequently, a broad range of fire maintained species, including *Sarracenia rubra* ssp. *alabamensis*, have become critically imperiled (NatureServe, 2015). Short-term trends indicate that species has remained stable, despite the recent loss of one small population and apparent local population declines at some sites which are likely offset by population increases at the largest sites. Currently, there are seven natural, extant populations of this species (3 in Autauga County and 4 in Chilton County) where a population is considered distinct if separated by at least 1 mile from nearest known neighbors; no new populations have been discovered since 2012. Currently, individual subpopulations range in size from 3 or 4 plants to well over 200 and all populations are privately owned. Only 3 populations are comprised of 100 or more individuals, while 2 populations have fewer than 10 individuals (Byrd 2016, 2017, Yawn 2018). Several attempts to augment and establish populations are known but information on sites is limited and their contribution to recovery is uncertain. Conservation efforts in cooperation with various entities has occurred and 3 populations are permanently protected and managed by TNC but three populations have been extirpated since the species was listed (USFWS, 2018).

Threats and Stressors

Stressor: Woody succession (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The inability to regularly burn some sites has reduced habitat suitability by allowing continued encroachment of woody species that increase shade for this shade-intolerant species (USFWS, 2012).

Stressor: Fire suppression (USFWS, 2012)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: All populations occur in fire-maintained habitat, requiring an active prescribed burning regimen to sustain species viability and site integrity. As with all pitcher-plants, *S. rubra* ssp. *alabamensis* is intolerant of shade, quickly becoming depauperate and unable to reproduce with the encroachment of woody vegetation. Therefore, site integrity and viability of all populations are inherently linked to regular prescribed burning. Efforts by U.S. Fish and Wildlife Service, ALNHP, TNC, and Atlanta Botanical Gardens to adequately maintain specific populations have been hampered by difficulties in obtaining permission to apply prescribed fires at some of the known populations and unfavorable burning condition (USFWS, 2012).

Stressor: Gravel mining (USFWS, 2012)

Exposure:

Response:**Consequence:** loss of habitat**Narrative:** Gravel mining in close proximity to another population has adversely altered the hydrology of the site, further hampering recovery efforts (Byrd 2011, Tassin in litt. 2011b) (USFWS, 2012). However, the cooperation and interest in conserving this site by the landowner has allowed land management activities to reduce the impacts of gravel mining induced hydrologic alterations (Byrd 2016, 2017, ANHP 2018, Yawn 2018) (USFWS, 2018).**Stressor:** Drainage of wetlands/bogs (USFWS, 2012)**Exposure:****Response:****Consequence:** loss of habitat**Narrative:** Alabama canebrake pitcher plant populations continue to be threatened by development and incompatible land use, such as drainage for agriculture and livestock grazing (USFWS, 2012).**Stressor:** Habitat modification (USFWS, 2018).**Exposure:****Response:****Consequence:****Narrative:** The species continues to be threatened by development, agricultural activities, gravel mining, and livestock management (Schotz 2006, Byrd 2016, 2017, ANHP 2018, Yawn 2018), which can exacerbate threats posed by inadequate habitat management (e.g., fire exclusion) and encroachment of competing vegetation (including non-native invasive species)(USFWS, 2018).**Stressor:** Hydrologic alterations (USFWS, 2018)**Exposure:****Response:****Consequence:****Narrative:** Two populations have historically been subjected to hydrological alterations as a result of beaver (*Castor canadensis*) activities, one of which was nearly extirpated by flooding. Beaver trapping has occurred at one of these populations to reduce their impact (USFWS, 2018).**Stressor:** Inadequate habitat management (USFWS, 2018)**Exposure:****Response:****Consequence:****Narrative:** Inadequate habitat management threatens the long-term viability of some populations. All populations occur in habitat requiring periodic fire to maintain site ecological integrity and population viability. The lack of prescribed fire or periodic mowing and hand clearing of competing vegetation at some sites allows for unchecked growth of woody species and other fast-growing herbaceous species that can increase shade and competition for resources. Alabama canebrake pitcher plant is intolerant of shade, with individual plants and, ultimately, populations, quickly becoming depauperate and unable to reproduce following woody species encroachment and consequent increased shade. Prescribed fires and other vegetation clearing activities help to maintain Alabama canebrake pitcher plant's necessary open, sunny habitat. In addition, over the years, ANHP, TNC, and ABG have occasionally had difficulties obtaining landowner permission to apply prescribed fires at some sites, thus hampering

necessary efforts to adequately maintain these sites (Byrd 2016, ANHP 2018). One small population was recently lost, possibly due to incompatible road right-of-way maintenance, such as herbicide application (Byrd 2016). Habitat management is needed to promote seedling recruitment. Alabama canebrake pitcher plant continues to be extremely vulnerable due to the small number of populations and small population size at many of these sites (USFWS, 2018).

Recovery

Reclassification Criteria:

1. At least 10 geographically distinct populations of sufficient size within the Fall Line Hills ecoregion in Alabama exhibit stable or increasing population trends, as evidenced by natural recruitment and multiple generations over an appropriate time span. Populations are considered to be geographically distinct when they are separated by at least 1 mile (1.6 kilometer) from their nearest neighbors. (Addresses Factors A, B, E) (USFWS, 2019).
2. These 10 populations are protected by a conservation mechanism that addresses the conservation needs of the Alabama canebrake pitcher plant. (Addresses Factors A, D) (USFWS, 2019).
3. Protected populations are managed to promote open canopies, integrity of native plant communities, and Alabama canebrake pitcher plant growth. (Addresses Factors A, E) (USFWS, 2019).

Delisting Criteria:

In addition to meeting downlisting criteria, the Alabama canebrake pitcher plant will be considered for delisting when the following criteria are met:

4. At least 10 additional geographically distinct populations of sufficient size (as described in Criterion 1) within the Fall Line Hills ecoregion in Alabama exhibit stable or increasing population trends, as evidenced by natural recruitment and multiple generations over an appropriate time span. (Addresses Factors A, B, D, E) (USFWS, 2019).
5. The Upper Alabama and Lower Coosa sub-basins within Fall Line Hills ecoregion each support at least three (3) viable populations protected by a conservation mechanism. (Addresses Factors A, E) (USFWS, 2019).

Recovery Actions:

- A. Continue use of prescribed fires at protected sites and encourage owners of unprotected sites to conduct prescribed fires as frequently as possible (USFWS, 2012).
- B. Continue to track population trends and evaluate management needs as a means to gather baseline data and implement long-term monitoring efforts (USFWS, 2012).
- C. Continue surveys in vicinity of known populations and revisit all known historical sites regularly (USFWS, 2012).
- D. Work to secure protection, either through conservation easements or acquisition, of privately-owned populations (USFWS, 2012).
- E. Renew contact with state and county highway departments to ensure proper protective measures are implemented for those areas where plants occur on roadside rights-of-way (USFWS, 2012).

- F. Continue to preserve genetic material from all populations to the extent possible through long-term seed storage and propagation efforts at the Atlanta Botanical Gardens, Georgia (USFWS, 2012). Efforts have expanded to include Auburn University's Donald E. David Arboretum (USFWS, 2018).
- G. Implement all other tasks identified in the recovery plan, as appropriate (USFWS, 2012).
- H. Update the recovery plan, as appropriate (USFWS, 2012).

Conservation Measures and Best Management Practices:

- Continue use of prescribed fires at protected sites and encourage owners of unprotected sites to conduct prescribed fires as frequently as possible (USFWS, 2012).
- Continue to track population trends and evaluate management needs as a means to gather baseline data and implement long-term monitoring efforts (USFWS, 2012).
- Continue surveys in vicinity of known populations and revisit all known historical sites regularly (USFWS, 2012).
- Work to secure protection, either through conservation easements or acquisition, of privately-owned populations (USFWS, 2012).
- Renew contact with state and county highway departments to ensure proper protective measures are implemented for those areas where plants occur on roadside rights-of-way. 10 (USFWS, 2012).
- Continue to preserve genetic material from all populations to the extent possible through long-term seed storage and propagation efforts at the Atlanta Botanical Gardens, Georgia (USFWS, 2012).
- Implement all other tasks identified in the recovery plan, as appropriate (USFWS, 2012).
- Update the recovery plan, as appropriate (USFWS, 2012).

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SPECIES ACCOUNT: *Pinguicula ionantha* (Godfrey's butterwort)

Species Taxonomic and Listing Information

Listing Status: Threatened; 8/11/1993; Southeast Region (R4)

Physical Description

Pinguicula ionantha has a rosette of fleshy, oblong, bright green leaves that are rounded at their tips, with only the edges rolled upward. The rosette is about 15 cm (6 in) across. The upper surfaces of the leaves are covered with short glandular hairs that capture insects. The flowers are on leafless stalks (scapes) about 10-15 cm (4-6 in) tall. When a flower is fully open, its corolla is about 2 cm (almost 1 in) across. The five corolla lobes are pale violet to white. The throat of the corolla and the corolla tube are deeper violet with dark violet veins. The corolla has a spur 4-5 mm (0.2 in) long that is yellow to olive (Godfrey and Stripling 1961, Godfrey and Wooten 1981). (USFWS, 1994)

Taxonomy

Pinguicula ionantha Godfrey (Godfrey's butterwort or violet-flowered butterwort) is a member of the bladderwort family (Lentibulariaceae), a small family of carnivorous plants closely related to the snapdragon family (Scrophulariaceae) (USFWS, 1994).

Historical Range

See current range/distribution.

Current Range

Endemic to the central panhandle region of Florida with reported occurrences in Bay, Calhoun, Franklin, Gulf, Liberty, and Wakulla counties (USFWS, 2018).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Food/Nutrient Narrative

Adult: *Pinguicula* L., the second most diverse genus of the carnivorous Lentibulariaceae is monophyletic and composed of about 85 to 100 species native to Europe, North America, Asia, South and Central America, and southern Mexico (Cieslax et al. 2005, Degtjareva et al. 2006). Members of this genus use sticky, glandular leaves to trap and digest insects (USFWS, 2009). It is unclear what benefit the plant derives from this carnivory.

Breeding Season

Adult: The flowers rise from late February to April according to temperatures (USFWS, 2009).

Reproduction Narrative

Adult: *Pinguicula ionantha* has a rosette of fleshy, bright green-yellow leaves of up to 15 cm across that can be characterized by upward rolled leaf edges. The plants stay in rosette form all

year. The flowers rise from late February to April according to temperatures. The flowers, borne on stalks of about 10 to 15 cm in height, are about two centimeters across and possess five pale violet to white petals all of same shape corolla. The throat of the corolla and the corolla tube are deeper violet with dark violet veins. A yellow to olive spur 4 to 5 mm long is present on the corolla and the palate is yellow with a purple base and covered with yellow hairs (Godfrey and Stripling 1961, Godfrey and Wooten 1981) (USFWS, 2009). SEXUAL; ABIOTIC; Wind; (NatureServe, 2015)

Habitat Type

Adult: Bos/long leaf pine savannas (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits open, acidic soils of seepage bogs on gentle slopes, deep quagmire bogs, ditches, and depressions in grassy pine flatwoods and grassy savannas, often occurring in shallow standing water. "Pinguicula ionantha occurs in herb bog habitats embedded in longleaf pine savannas. Specifically, it is found between a lower elevation habitat dominated by pond cypress (*Taxodium ascendens*) overstory and a slightly higher elevation pine flatwoods dominated by an overstory of longleaf pine (*Pinus palustris*) (USFWS 2009) (NatureServe, 2015). High ecological integrity of the community and site fidelity and low tolerance ranges are inferred based on the species specific habitat needs.

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: No information found.

Population Information and Trends**Population Trends:**

Unknown (USFWS, 2018)

Species Trends:

Unknown (USFWS, 2018)

Population Growth Rate:

It is estimated that between 85 and 98% of herb bog/savanna habitats have been lost (Folkerts 1982 cited by Kesler et al. 2008). Decline of >70% (NatureServe, 2015)

Number of Populations:

92 sites (USFWS, 2018)

Population Size:

2500 - 100,000 individuals (NatureServe, 2015)

Additional Population-level Information:

Previously, 83 historical sites were documented between 1956 and 2009 (FNAI 2008). Based on information provided by FNAI (2017) and FWCC (2018) and recent surveys, the number of sites has increased to 92; technically representing 66 EOs. About 10,558 plants were present at 21 of the 23 EOs revisited in 2015 (Molano-Flores et al. 2014). A total of 52 sites were visited in 2006, 2008, and 2009 surveys: 33 sites were revisited by Kesler and Trusty (2008) during April 2006, and 19 sites were visited by Negrón-Ortiz during 2008 and 2009 surveys. Plants were present at 24 (46%) of these sites. Searches did not locate plants at 22 (42%) of the previously recorded sites. Additionally, high water or a dense woody midstory prevented access to six previously recorded sites in Gulf and Franklin counties (Kesler and Trusty 2008, Negrón-Ortiz, 2008 surveys). This species appears to be increasing in number of populations on public lands. However, overall trends in both abundance of individuals within each population and the total number of populations through the species range remain unknown. (USFWS, 2018)

Population Narrative:

Current survey information indicates an increase in the number of populations. Survey information shows 22 (33%) of the 66 EOs appear to be extirpated due to development and/or habitat modification. However, since surveys were conducted irregularly and based on either presence/absence and/or qualitative visual estimate (Jenkins et al. 2007); with most sites visited only once; and the actual counts of plants rarely provided, a comprehensive population survey is needed in order to better assess the current status of this species. Studies have demonstrated variation among the number of plants necessary for a population to survive risks of extinction (Given 1994, Matthies et al. 2004, Menges 1990). Matthies et al. (2004) study of 379 populations of eight threatened plant species in northern Germany demonstrated that very small populations face a considerable risk of extinction, while the risk for populations with more than 1000 individuals was very small. Because most of the *P. ionantha* populations have less than 1000 individuals, any impact to existing populations (specifically sites outside the ANF) could cause extirpation of these populations. Furthermore, the relatively low level of genetic diversity associated with this species is a concern as it may impair fitness and evolutionary adaptability in a changing environment (Zaya et. al 2016). (USFWS, 2018)

Threats and Stressors

Stressor: Logging and Pulpwood Production (USFWS, 2018)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Privately owned forests managed (clearcutting, mechanical site preparation, and bedding) for commercial timber production, is a primary threat to *P. ionantha* habitat. An active paper mill located in Panama City (Bay County) receives timber from thousands of acres of pine plantation. The commercial timber industry in North Florida became well established in the 1850's (FNAI 2005). It started in Franklin County in the 1870's and continued to be a prominent industry until the mid-1990's (Howell and Hartsell 1995). The Timberland Company had close to a

million acres in timber production in the eastern region of the Panhandle and they plan to continue to commercially harvest and replant off-site pine species. The Company also owned a paper mill in Port St. Joe until it was sold and shut down in 1999. In 2013, the Timberland Company sold more than 380,000 acres of its land to AgReserves, Inc.. The land sold included timberlands in Bay, Calhoun, Franklin, Gadsden, Gulf, Jefferson, Leon, Liberty and Wakulla counties. Within Gulf County, AgReserves, Inc. has repurposed timberlands into pasture lands for cattle (A. North, FDEP, 2/6/2018, pers. comm.). (USFWS, 2018)

Stressor: Coastal real estate and road development (USFWS, 2018)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Urban development continues to threaten Godfrey's butterwort. The Timberland Company is one of the largest private landowners in Florida, and one of the largest real estate operating companies in the Southeast. The Company develops both residential and commercial properties along roadways and near or within business districts in the region. More than a third of Florida's land is projected to be developed by 2070 along with a grow of about 33.7 million residents—almost 15 million more people than in 2010 (University of Florida GeoPlan Center 2017). Many *P. ionantha* locations are found along U.S. and state roads. Construction activity may directly kill individual plants or convert habitat to unsuitable habitat; widening may convert native habitat to managed road side; and culvert modification may change drainage patterns, which may change seasonal hydrology. Evidence suggests past road improvements have resulted in localized extirpation of Godfrey's butterwort in ANF (Kesler and Trusty 2008). Therefore, because they contribute to habitat loss, road widening and new roads continue to pose a threat to the species. (USFWS, 2018)

Stressor: Fire suppression (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Suppression of fire during the growing season continues to threaten the pineland and savanna's flora, as fire is an important factor in the maintenance of flatwoods (Abrahamson and Hartnett 1990). Fire influences community structure and composition (Abrahamson and Hartnett 1990), and with insufficient frequency in longleaf pine communities, a woody midstory quickly develops (Glitzenstein et al. 1995), negatively affecting the understory diversity. Several studies have shown that frequent, low intensity prescribed fire regimes are important for maintenance of flatwoods diversity (Hiers et al. 2007). Therefore, frequent prescribed burnings, i.e., < 3 yr interval, are needed to maintain optimal habitat for *P. ionantha* populations (Kesler et al. 2008). At present, the Apalachicola National Forest utilizes a 3- to 5-yr interval burn rotation (2-4 yr burn rotation at the burn units with *P. ionantha*, J. Drake, USFS, 02/21/2018, pers. comm.); Box-R WMA and SJBSBP utilize 2- to 3-yr interval; and Lathrop Bayou applies prescribed fire on a 2- to 7-yr interval. Thus, fire suppression continues to threaten to *P. ionantha* habitat and population numbers. Lack of fire, and subsequent growth of shrubs (particularly encroachment of *Cyrilla racemiflora* L., commonly known as swamp titi) and saplings in the understory, in addition to shading by planted pines, inhibits this species emergence (Negrón-Ortiz, 2008, pers. observ.; FNAI 2008, Kesler et al. 2008). Declining fire frequency reduces *P. ionantha* abundance in areas where it was previously observed in large quantities (FNAI 2008). Emergence of this species is prolific within one year of the fire event (Kesler and Trusty 2008). (USFWS, 2018)

Stressor: Over collection (USFWS, 2018)

Exposure:

Response:

Consequence: Loss of individuals

Narrative: This factor is a threat, but the magnitude has been reduced. Butterworts are widely cultivated, grown and sold by plant enthusiasts and nurseries. *Pinguicula ionantha* was overcollected in the 1970s (58 FR 37440). Many thousands of plants propagated by tissue culture were sold without permits, but the plant is no longer commercially available in large quantities (D'Amato, California carnivores). In order to implement conservation measures and regulations, the Service granted a permit (TE061005-1) to the International Carnivorous Plant Society (ICPS) in 2003, which allows the society to sell seeds of endangered and threatened carnivorous plants only within the USA. Some restrictions apply to this permit (see <http://www.carnivorousplants.org/conservation/policies>); in addition, an annual report is required stipulating their selling activities. Collecting guidelines for live plants and seeds were developed by the ICPS: 1) they do not recommend collecting live plants unless it is for scientific purposes such as herbaria, the species has never been introduced to cultivation, or because a variant (a taxon exhibiting slight differences in form); 2) they will not accept field collected seed of listed plants, only seeds from cultivated plants will be accepted if they are donated in accordance with all relevant laws. The Nurseries Stock Restrictions manual summarizes the entry status of regulated plant material capable of or intended for propagation (USDA 2010). (USFWS, 2018)

Stressor: Hurricanes (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Saltwater inundation from storm surges caused by hurricanes represents a threat. Kesler and Trusty (2008) monitored one population in Franklin County, which was flooded during Hurricane Francis in 2004. In 2005, they observed that the plant number declined from about 100 to two individuals. (USFWS, 2018)

Stressor: Sea Level Rise (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Sea level rise (SLR) as a result of climate change is a growing concern for much of Florida's coastline and the endemic species that occur there because about 10% of Florida is less than 1 meter above current sea level. Being endemic to Florida, Godfrey's butterwort is threatened by climate change. Using the NOAA Sea Level Rise and Coastal Flooding Impacts Viewer (<https://coast.noaa.gov/slr/>), the projections indicated potential impacts to six known *P. ionantha* EOs (Bay Co.: 1 EO; Franklin Co.: 5 EOs) by intrusion of saltwater beginning at one foot SLR. (USFWS, 2018)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2018)

Exposure:

Response:

Consequence:

Narrative: Section 7(b)(4) and 7(b)(2) of the Endangered Species Act (Act) generally do not apply to listed plant species. However, limited protection of listed plants from take is provided to the extent that the Act prohibits the removal and reduction to possession of Federally listed threatened and endangered plants or the malicious damage of such plants on areas under Federal jurisdiction, or the destruction of endangered plants on non-Federal areas in violation of State law or regulations or in the course of any violation of a State criminal trespass law. Seeds of both threatened and endangered species found on Federal land are regulated under the Act. However, the seeds of threatened species are not regulated if they come from cultivated plants (7 CFR 319.37.2, USDA 2008). Since *P. ionantha* is a threatened species, growers can obtain and sell seeds from other growers. Several populations of *P. ionantha* occur on private timberland and ROWs. While the Act requires Federal agencies to carry out programs for the conservation of endangered and threatened species, no such programs are stipulated for private landowners. The Act does not provide for protection of plants on private lands as long as the activity is permissible under state/local laws. The State requires permission of private landowners for collecting of State-listed plants from their property. *Pinguicula ionantha* is protected under Florida State Law, chapter 581.185: Preservation of native flora of Florida, which includes preventions of take, transport, and the sale of the plants listed under the State Law. The rule Chap. 5B-40, Florida Administrative Code, contains the "Regulated Plant Index" (5B-40.0055) and lists endangered, threatened, and commercially exploited plant species for Florida; defines the categories; lists instances where permits may be issued; and describes penalties for violations (Coile and Garland 2003). Bay County Comprehensive plan, under chapter 6, provides restrictions, constraints and requirements to protect and preserve designated habitat conservation areas for rare, threatened, or endangered species, and wetlands (<http://baycountyfl.gov/276/Planning-Zoning>). Calhoun, Gulf, Franklin, and Liberty Counties do not have such regulations. Highway ROW maintenance activities are not always reviewed for threatened and endangered species impact. However, if there is an activity (e.g., construction, mowing, or maintenance projects) affecting protected species, then the Service can recommend consultation to the FDOT under section 7 of the Act. The FDOT routinely consults with the Service on all major road construction activities. (USFWS, 2018)

Recovery

Reclassification Criteria:

Not relevant. (USFWS, 1994)

Delisting Criteria:

1. When 15 populations are adequately protected and managed throughout its historic range. Existing public land (mainly the Apalachicola National Forest) does not suffice for recovery). (USFWS, 1994)

Recovery Actions:

- Manage ROW Continue fostering conservation practices for utility and highway Right-of-Ways with the Forest Service, FDOT, and USFWS; a ROW Best Management Practices plan should be developed and implemented. (USFWS, 2018)
- Develop a stand-alone plan for managing listed plants at the Apalachicola National Forest and THSF, and integrate it to their Management Plan. (USFWS, 2018)
- Conduct a long-term study using 15 populations distributed throughout the species' historical range for 10 years to determine whether the observed declines in abundance

reflect acceptable stochasticity or if they are indicative of dangerously declining populations. This study could use the sites from Kesler and Trusty (2008) study, and will address the delisting criterion. (USFWS, 2018)

- Since habitat loss and degradation are leading causes of endangerment for *P. ionantha*, designating habitat that is critical for survival and recovery is recommended. (USFWS, 2018)
- Complete a comprehensive census (e.g., the total number of individuals, number of flowering vs. non-flowering plants, and whether seedling recruitment is occurring) throughout the present distribution including all the historical locations to determine the species' status. (USFWS, 2018)
- Conduct surveys/inventories on potentially new sites. This action can include the use of aerials and species distribution modeling methods to initially determine potential sites, with subsequent field inventory of the site using a consistent, statistically valid, repeatable inventory method. If new populations are discovered, protection should be sought, and identify sites for reintroductions such as areas that will not be affected by SLR and future development (USFWS, 2018)
- Establish (or continue) frequent growing-season fire regimes (i.e., 2-3 yr interval) on selected areas such as Apalachicola National Forest, SJBSBP, THSF, and Tyndall AFB to maintain optimal conditions of *P. ionantha* populations. Re-visit sites shortly after a burn event, and mark and count individual plants. Populations tend to be more evident after a fire event. (USFWS, 2018)
- Garden propagation and reintroduction. An ex-situ plant collection should be actively pursued and implemented with a botanical garden. (USFWS, 2018)
- Investigate if there is a soil seed bank persistence of *P. ionantha* seeds throughout the species geographic range. (USFWS, 2018)
- Conduct population biology studies at Apalachicola National Forest. Compare the demographic performance of *P. ionantha* in pinelands and road habitats. Survey for seedling recruitment and survival of tagged individuals (plant height and reproduction) for a period of 3-5 years in or near roadside populations of SR 65 and pinelands. (USFWS, 2018)
- The recovery plan should be updated to define objective measurable criteria and better address the five listing factors.(USFWS, 2018)

Conservation Measures and Best Management Practices:

- 1. Manage ROW
- 2. Since habitat loss and degradation are leading causes of endangerment for *P. ionantha*, designating habitat that is critical for survival and recovery is recommended (USFWS, 2009).
- 3. Evaluate the current species status (USFWS, 2009).
- 4. Conduct surveys/inventories on potentially new sites. This action can include the use of species distribution modeling methods to initially determine potential sites, with subsequent validation or inspection of the sites (USFWS, 2009).
- 5. Establish frequent growing-season fire regimes (i.e. 2-3 yr interval) on selected areas such as Tate's Hell State Forest, St. Joseph State Buffer Preserve, and ANF to maintain optimal conditions of *P. ionantha* populations. Re-visit sites shortly after burn event and mark individual plants. Populations tend to be more evident after a fire event (USFWS, 2009).
- 6. Garden propagation and reintroduction. An ex-situ plant collection should be actively pursued and implemented with a botanical garden. Studies on the viability of dry-stored seeds, the timing of the germination, and whether a persistent seed bank is present should be addressed (USFWS, 2009).
- 7. Conduct population studies at ANF (USFWS, 2009).

- 8. Conduct systematic studies to examine the current taxonomic classification (USFWS, 2009).
- 9. Conduct pollination studies (USFWS, 2009).
- 10. The recovery plan should be updated to define objective measurable criteria and better address the five listing factors (USFWS, 2009).

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SPECIES ACCOUNT: *Lindera melissifolia* (Pondberry)

Species Taxonomic and Listing Information

Listing Status: Endangered; 7/31/1996; Southeast Region (R4) (USFWS, 2015)

Physical Description

A deciduous, aromatic shrub. 0.5 to 2 meters tall. Plants are stoloniferous and generally grow in clones of numerous, usually unbranched, stems. The species is dioecious. and the flowers of both sexes are small and pale yellow. Pistillate flowers are less conspicuous than staminate flowers. Fruits are about 1 centimeter long at maturity and are bright red (USFWS, 1993).

Taxonomy

In the order Laurales, family Lauraceae (Laurel family) (NatureServe, 2015).

Historical Range

Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, Missouri, North Carolina, and South Carolina (USFWS, 2014).

Current Range

Alabama, Arkansas, Georgia, Mississippi, Missouri, North Carolina, and South Carolina (USFWS, 2014).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect (EPA, 2016)

Breeding Season

Adult: February-March (flowering); March - fall (fruiting) (EPA, 2016)

Key Resources Needed for Breeding

Adult: Possibly seasonal floods (USFWS, 2014)

Reproduction Narrative

Adult: Species is insect-pollinated; flowering occurs from February to March, with fruiting from March to the fall (EPA, 2016). Seeds are tolerant of prolonged flooding and may not be able to form a seed bank without seasonal floods. The seeds do not germinate while submerged, but readily germinate once they are no longer submerged (USFWS, 2014).

Habitat Type

Adult: Seasonally flooded wetlands (USFWS, 2014)

Habitat Vegetation or Surface Water Classification

Adult: Carolina bays, limestone or limesink ponds, sand ponds, and lowland sand prairie depressions (USFWS, 2014); on the bottoms and edges of shallow seasonal ponds in old dune fields, along the margins of ponds and depressions in pinelands, around the edges of sinkholes in coastal areas with karst topography, and along the borders of Sphagnum bogs (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Needs closed canopy and standing water during some part of the year (NatureServe, 2015)

Environmental Specificity

Adult: Narrow (NatureServe, 2015)

Habitat Narrative

Adult: Pondberry is found within seasonally flooded wetlands that broadly include riverine bottomland hardwood forests and geographically isolated wetlands in the Atlantic and Gulf Coastal Plains and Mississippi Alluvial Valley of the southeastern United States. Four primary types of geographically isolated wetlands are known to support pondberry populations and include Carolina bays, limestone or limesink ponds, sand ponds, and lowland sand prairie depressions (USFWS, 2014). Can apparently occupy a variety of habitats as long as hydrological requirements are met. Occurs in seasonally flooded wetlands such as floodplain/bottomland hardwood forests and forested swales, on the bottoms and edges of shallow seasonal ponds in old dune fields, along the margins of ponds and depressions in pinelands, around the edges of sinkholes in coastal areas with karst topography, and along the borders of Sphagnum bogs. Usually in shade, but tolerates full sun. Needs closed canopy and standing water during some part of the year (NatureServe, 2015).

Dispersal/Migration**Dispersal**

Adult: Low (inferred from NatureServe, 2015)

Dependency on Other Individuals or Species for Dispersal

Adult: *Catharus guttatus* (hermit thrush) (USFWS, 2014)

Dispersal/Migration Narrative

Adult: Dispersal mechanisms of pondberry remain poorly understood. Pondberry's bright red fruits suggest that animals (including black bears) may play an important role in the dispersal of the species. While numerous animals have been associated with pondberry plants, only the hermit thrush (*Catharus guttatus*) has been confirmed as a dispersal agent of pondberry (USFWS, 2014).

Population Information and Trends**Population Trends:**

Decline of 30 - 70% (NatureServe, 2015a)

Species Trends:

Stable to declining (USFWS, 2014)

Resiliency:

High (inferred from USFWS, 2014)

Redundancy:

High (inferred from USFWS, 2014)

Number of Populations:

61 (USFWS, 2014)

Population Size:

10,000 - 1,000,000 individuals (NatureServe, 2015b)

Population Narrative:

Since listing, new colonies and populations have been discovered in Alabama, Arkansas, Georgia, Mississippi, Missouri, North Carolina, and South Carolina. However, while new colonies/populations have been discovered in each of these states, with the exception of Alabama, populations have also been extirpated from these states during this time (USFWS, 2014). Flower and fruit production can be highly variable. This species appears to require some sort of pollinator (bagged flowers do not set fruit), but does not appear limited by pollinator supply (supplemental pollination does not improve fruit set) (Devall et al. 2001). Even when flower production is high, fruit production may be limited because female clones are absent from many stands, and many sites are isolated. Furthermore, even when fruit production is significant, seedlings are rarely observed (Devall et al. 2001). In combination, these observations suggest a very low rate of sexual reproduction in the wild. Moreover, natural dispersal appears limited (at least in current times), as many populations occur in small habitat patches surrounded by an unsuitable matrix (e.g. agricultural fields), limiting colony establishment opportunities. In the past, seeds could have been disseminated by floodwater, but floodwaters are controlled throughout the species' range today. Devall et al. (2001) believe it unlikely that new colonies will be established without human intervention. This species has probably always been [relatively] rare (Devall et al. 2001). Nevertheless, occurrences of the habitat types in which it is known to thrive have been greatly reduced in number and quality in recent and historic times (USFWS 1985). When this species was proposed for Federal listing in 1985, the US Fish and Wildlife Service noted that "almost all populations known in 1985 had declined since their discovery, some severely." Rangewide, 17 occurrences are thought to be extirpated. A decline of 30-70% is reported. Census figures for many extant populations are lacking. At least 12 extant sites scattered throughout the range report several hundred to several thousand stems (ramets); one Arkansas site has "tens, if not hundreds of thousands of stems; dominant shrub on 100+ acres." Consistent with this information, the Missouri Natural Heritage Program notes that the species "can occur by the tens of thousands at the best [rangewide] sites." Nevertheless, although some of these populations appear quite large, many of the plants may be clones rather than different genetic individuals. Also, many of the other sites appear to have only small populations; McCue (2002) reports that "the number of stems at any given site varies from a few to several hundred" and Devall et al. (2001) indicate that "many of the existing colonies are small, and occupy only a portion of the apparently suitable habitat." Approximately 99 extant occurrences are currently mapped, of which 2-3 are reintroductions (2 in Missouri and

possibly 1 in Arkansas). An additional 17 occurrences are likely extirpated. However, the true number of extant populations may be less than 99, as some currently-mapped occurrences are in close proximity. For example, 19 EOs in Mississippi derive from one USFS inventory of the Delta National Forest, and 18 EOs in Arkansas derive from one status survey in Jackson and Lawrence counties. If more data on these occurrences were available, perhaps they could be delineated as a smaller number of populations (NatureServe, 2015a).

Threats and Stressors

Stressor: Small population sizes and inbreeding depression (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Inbreeding depression or the low number of genetically different individuals (genets) in most or all eastern populations may reduce pondberry's ability to cope with environmental stochasticity, disease, and ultimately threaten the existence of these populations (USFWS, 2014).

Stressor: Climate change (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Climate change has the potential to affect distribution and abundance of plants by influencing seasonal weather patterns, frequency and timing of severe weather events, and myriad plant physiological responses (Hawkins et al. 2008). The specific impacts of climate change to pondberry populations are poorly understood; however, a variety of impacts are possible (USFWS, 2014).

Stressor: Habitat destruction, fragmentation, altered hydrology, and encroaching vegetation (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Geographically isolated wetlands that once sustained pondberry have been cleared for agriculture or timber operations. Similarly, agricultural and silvicultural activities adjacent to some pondberry sites have deleteriously affected these sites by altering hydrological regimes. Other sites have been extirpated by or are threatened by hogs or domestic cattle. Encroaching vegetation can reduce the suitability of some sites for pondberry (USFWS, 2014)

Stressor: Disease (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: All populations are susceptible to the lethal laurel wilt disease, which has spread rapidly since its discovery in 2003 and is likely to continue spreading (USFWS, 2014).

Stressor: Domestic animal and wildlife disturbance (USFWS, 2014)

Exposure:

Response:

Consequence:

Narrative: Trampling by domestic cattle (Service 1993; NatureServe 2012) and hog disturbance (Service 2007; Gustafson 2011; NatureServe 2012; Pittman 2012, in litt.) pose an apparently small risk to pondberry range-wide, but may pose a severe, highly localized threat to some colonies and populations (e.g., Service 1993). (USFWS, 2014)

Recovery**Reclassification Criteria:**

The protection of 15 self-sustaining populations (USFWS, 1993)

Delisting Criteria:

The permanent protection of 25 self-sustaining populations (USFWS, 1993).

Recovery Actions:

- Search for new populations and protect and monitor existing populations (USFWS, 1993).
- Study the species and its habitat (USFWS, 1993).
- Determine the management requirements of the species and implement actions essential for recovery and protection (USFWS, 1993).
- Place selected material into cultivation and place seeds from all populations into seed banks (USFWS, 1993).
- Conduct a public education program (USFWS, 1993).

Conservation Measures and Best Management Practices:

- Further study and characterize potential threats posed by laurel wilt disease. Identify methods and management practices to limit this disease's potential to negatively impact pondberry and its associated habitats (USFWS, 2014).
- Work with federal and state entities, non-governmental organizations, and private individuals to permanently protect and manage existing habitats and populations, including the development and implementation of management plans, as needed (USFWS, 2014).
- Form recovery team to update the recovery plan, which will incorporate and address recent advances in our knowledge and understanding of pondberry genetics, physiology, ecology, threats, and management needs (USFWS, 2014).
- Define what characterizes a "self-sustaining" pondberry population (USFWS, 2014).
- Update existing and develop new monitoring and habitat management methods (USFWS, 2014).
- Continue and expand conservation genetics work to include all populations and determine effective population sizes (USFWS, 2014).
- Characterize genetic diversity and representation of current ex situ safeguarded collections. Expand ex situ preservation of genetic stock to represent all populations with increased emphasis placed on preserving and safeguarding individual genets within and across populations (USFWS, 2014).
- Study the feasibility of and necessary methodology to augment genetically depauperate and sexually limited populations (USFWS, 2014).
- Develop guidelines to efficiently establish plants and seedlings in natural habitats (USFWS, 2014).
- Further study the effects of various types of disturbance (e.g., fire, prolonged flooding, overstory disturbance, etc.) on pondberry survivorship and reproduction (USFWS, 2014).

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SPECIES ACCOUNT: *Sarracenia oreophila* (Green pitcher-plant)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015) 10/21/1979

Physical Description

A perennial, carnivorous herb arising from rhizomes. The leaves consist of two types: tubular or pitcher-shaped leaves, appearing in the spring, that grow 2-7.5 dm tall, which, in late summer begin to wither and are replaced by flat, prostrate leaves that persist until the following spring. Flowers 5-parted, with yellow petals 4-5.5 cm long; pendent, borne singly on an erect, leafless scape to 7 dm tall. Flowering Season: early May to early June (NatureServe, 2015).

Taxonomy

Distinct species, one of only three species of *Sarracenia* with a geographical distribution outside the coastal plain (NatureServe, 2015).

Historical Range

Historically, the distribution of *Sarracenia oreophila* spanned five different geographical provinces: The Cumberland Plateau, Blue Ridge, Piedmont, Ridge and Valley, and East Gulf Coastal Plain (U.S. Fish and Wildlife Service 1985) (NatureServe, 2015).

Current Range

Restricted to areas of the Cumberland Plateau and the Ridge and Valley province in these four regions: Coosa Valley, Lake Chatuge, Lookout Mountain, and Sand Mountain (USFWS 2013). Extent of occurrence was calculated during the 2015 conservation status review to be approximately 9,000 sq. km. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Food/Nutrient Narrative

Adult: Carnivory is the most striking interaction between members of the genus *Sarracenia* and other species, though the precise benefit to pitcher plants from this highly specialized adaption is not understood. Christensen (1976) found that when insects were fed to *Sarracenia flava*, there was no consequent increase in Ca, Mg, or K in the plants' leaf tissue. However, nitrogen and phosphorus did increase, indicating that carnivory may be useful in soils low in these elements. Folkerts (1982) suggests that carnivory may be used to obtain micronutrients, such as molybdenum, which are present at very low levels in a low pH environment. Folkerts (1982) also proposes that carnivory may be important at times of nutrient stress since nutrient levels in bogs decrease over the course of the growing season. Another possibility is that the breakdown of prey detritus from decaying pitchers may help fertilize the soil around the plants (Christensen 1976) (USFWS, 2013).

Breeding Season

Adult: The flowers of the green pitcher plant mature in late April at lower elevations, and mature in May at higher elevations (Troup 1982) (NatureServe, 2015).

Reproduction Narrative

Adult: *Sarracenia oreophila* reproduces both sexually and asexually, though in some situations, reproduction may be limited to asexual means, resulting in large spreading clones (Troup and McDaniel 1980). Humphrey (1987) estimates that green pitcher plants do not become sexually mature until they are 6-7 years old. The flowers of the green pitcher plant mature in late April at lower elevations, and mature in May at higher elevations (Troup 1982). Cross pollination is needed for seed to set (Troup and McDaniel 1980). Insects associated with *S. oreophila* flowers which may act as pollinators include flies (*Sarcophaga* spp.), honeybees (*Apis* spp.) and bumblebees (*Bombus* spp.) (Troup and McDaniel 1980). Fruits mature in early autumn, but seed may not be released right away (Troup and McDaniel 1980). Seeds are apparently water dispersed (Troup and McDaniel 1980) (NatureServe, 2015).

Habitat Type

Adult: Streambanks/Bogs/Flatwoods (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Sandy and highly acidic soils (NatureServe, 2015)

Environmental Specificity

Adult: Narrow. Specialist or community with key requirements common. (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Historically, the distribution of *Sarracenia oreophila* spanned five different geographical provinces: The Cumberland Plateau, Blue Ridge, Piedmont, Ridge and Valley, and East Gulf Coastal Plain (U.S. Fish and Wildlife Service 1985). The present distribution of *S. oreophila* is restricted to the Cumberland Plateau, Blue Ridge, and Ridge and Valley provinces (U.S. Fish and Wildlife Service 1985), with known, extant populations in northeastern Alabama (Jackson, Marshall, DeKalb, Cherokee and Etowah Counties), northeastern Georgia (Towns county) and adjacent North Carolina (Clay County) (Humphrey 1987). Three distinct habitat types have been described for *S. oreophila*. They are sandstone streambanks, with 13 extant colonies in the Cumberland Plateau; mixed oak or pine flatwoods, with 5 extant colonies in the Cumberland Plateau; and seepage bogs, with 5 extant colonies in the Cumberland, 2 colonies in the Blue Ridge, and 2 colonies in the Ridge and Valley provinces (U.S. Fish and Wildlife Service 1985). The soils in all of these habitats are sandy and highly acidic. Woodland and bog soils are sandy clays and loams with an upper layer of organic material, while the streambank soils are composed almost purely of sand (U.S. Fish and Wildlife Service 1985) (NatureServe, 2015). High ecological integrity of the community and site fidelity along with low tolerance ranges are inferred based on the specific habitat needs of this species.

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Seed dispersal is poorly understood for this species. However, a study of a related, wide-spread pitcher plant species, *Sarracenia purpurea*, indicates that seed dispersal distance from parent plants is typically only a few inches (Ellison and Parker 2002). These authors further suggest that water may facilitate dispersal over longer distances for *Sarracenia* species. Indeed, flooding events are thought to be responsible for the establishment of some green pitcher plant colonies (G. Folkerts 1992). For example, flooding may have transported seeds from upland bog colonies to suitable streambanks within the Little River watershed (Emanuel 1998) (USFWS, 2013).

Population Information and Trends**Population Trends:**

Decreasing (NatureServe, 2015)

Resiliency:

Given proper habitat conditions, this species has demonstrated high fecundity - able to grow quickly and reproduce. (NatureServe, 2015)

Population Growth Rate:

Likely stable as fires were allowed to burn freely and naturally across the landscape, covering thousands of acres. Only recently, within the past 60 years, has public sentiment changed in opposition to free-ranging fires, due to impacts such fires have on timber production, agriculture, and development. Consequently, a broad range of fire maintained species, including *S. oreophila*, have become critically imperiled (NatureServe, 2015).

Number of Populations:

21 - 80 (NatureServe, 2015)

Population Size:

1000 - 2500 individuals (NatureServe, 2015)

Adaptability:

Given proper habitat conditions, this species has demonstrated high fecundity - able to grow quickly and reproduce. (NatureServe, 2015)

Threats and Stressors

Stressor: Development (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat/Loss of populations

Narrative: Development of land for agriculture and housing is a threat to this species (USFWS, 2013).

Stressor: Fire suppression (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Fire is an integral part of maintaining green pitcher plant bog habitats (Service 1994; Boyer and Carter 2011; NatureServe 2013). In the absence of regular fires, competing plant species encroach on green pitcher plant habitats and out-compete the pitcher plants for resources (e.g., nutrients and light) (Troup and McDaniel 1980; Jennings and Rohr 2011). Encroachment of competing vegetation can lead to the eventual elimination of green pitcher plants (44 FR 54922). Furthermore, excessive fuel accumulation may occur at sites where fire has been excluded or occurs rarely, thus increasing the risk of re-introduced fires having potentially detrimental effects to green pitcher plants (Hermann 2014, in litt.). Alternatively, burning too frequently (e.g., multiple annual fires) or regularly burning during unfavorable seasons (e.g., winter) may reduce habitat suitability for green pitcher plants (Service 1994). Similarly, frequent application of early growing season burns may eliminate seedling recruitment (Determann 2013c, in litt.) (USFWS, 2013).

Stressor: Over-collection (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of individual plants/loss of populations

Narrative: Over-collection was cited as a reason for listing the green pitcher plant in 1979 (44 FR 54922) and was considered a serious threat when the current recovery plan was revised 15 years later (Service 1994). Recent reviews of threats to carnivorous species note that over-collection of wild plants and plant parts remain a persistent threat to *Sarracenia* species (McPherson 2007; Jennings and Rohr 2011). More recently, over-collection pressure from plant poachers may have declined as evidence (e.g., holes in the ground) of removal of whole green pitcher plants is limited, but not absent (Emanuel 2002; ALNHP 2012; Byrd 2013a; Determann 2013b, in litt.; Hermann 2013, in litt.; Hodges 2013c, in litt.; Shew 2013c, in litt.). Collection pressure may have been somewhat ameliorated by limited, legal interstate sale of commercially grown green pitcher plants from 16 U.S. Fish and Wildlife Service issued Section 10 permitted growers and sellers. However, Hermann (2013, in litt.) proposed that poaching of individual green pitcher plants may not be readily apparent as evidence of poaching could be easily obscured. Alternatively, Hodges (2013b, in litt.) suggested that poaching of plants may have shifted to unauthorized seed collection. Byrd (2013a) stated that several green pitcher plant populations are easily accessible and, thus, are vulnerable to illegal collection by poachers. Indeed, Byrd (2013a) noted that plants from at least one of these populations were recently poached (USFWS, 2013).

Stressor: Inadequacy of regulatory mechanisms (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of individual plants/loss of populations

Narrative: Green pitcher plant receives some legal protection in Georgia and North Carolina; however, these laws do not protect against habitat destruction. Collection of green pitcher plants on public lands without a permit is prohibited in Georgia under the Georgia Wildflower Preservation Act of 1973. No such provisions are afforded to plants found on privately-owned lands in the State. North Carolina General Statute 106-202.12- 202.19, also known as the Plant Protection and Conservation Act, authorizes the State to establish a list of protected plants and

regulate the collection, sale, and transport of plants on this list. Green pitcher plant is included on the North Carolina's list of protected plants. The species does not receive any specific legal protections from State laws or regulations in Alabama USFWS, 2013).

Stressor: Genetics (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of genetic variability

Narrative: As summarized by Godt and Hamrick (1996), small population sizes have been associated with low genetic diversity and reduced fitness in a variety of plant species. Within populations of *S. oreophila*, genetic diversity is relatively low and related to population size and geographic isolation. Specifically, small and isolated populations exhibit less genetic diversity than larger, less isolated populations (Godt and Hamrick 1996). Effects of small population size and low genetic diversity on *S. oreophila*'s fitness have yet to be assessed. However, together, low genetic diversity, small population sizes, and isolation of some populations may limit *S. oreophila*'s ability to respond and adapt to stochastic environmental events and future climate change (USFWS, 2013).

Stressor: Climate change (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The precise magnitude and impacts of climate change on the southeastern United States are uncertain, but models have projected that climate change in the region may include increased temperatures of 2 to 4°C (3.6 to 7.2°F) accompanied by reduced average annual precipitation by the end of the century (Joyce et al. 2011). Climate change has the potential to affect distribution and abundance of plants by influencing seasonal weather patterns, frequency and timing of severe weather events, and myriad plant physiological responses (Hawkins et al. 2008). The specific impacts of climate change on green pitcher plant populations are poorly understood; however, a variety of impacts are possible. For example, climate change may threaten green pitcher plant populations if the habitats that the species relies on become drier as a result of higher temperatures and reduced rain (Devall and Parresol 1998; Wilcox 2012). Indeed, Wilcox (2012) notes that pitcher plant declines at a TNC preserve in North Carolina were associated with two droughts and lower water tables during the early 2000s. However, Davenport (2007) suggests that climate change's effects might be somewhat ameliorated for this species if drier climates increase the frequency of fires that maintain green pitcher plant habitats. In addition, climate change may disrupt plant-pollinator interactions via phenological shifts in flowering and/or pollinator activity (Memmott et al. 2007; Hawkins et al. 2008), which may thereby reduce sexual reproduction of green pitcher plants. Any disruption in pollinator efficacy may further threaten isolated green pitcher plant populations that are already pollinator limited (*sensu* D. Folkerts 1999). While disease is not currently known to threaten green pitcher plants, climate change has the potential to promote the spread of infectious diseases among plants, particularly if arthropod vectors become more widespread and abundant (Anderson et al. 2004; Garrett et al. 2006; Hawkins et al. 2008). Given the variety and complexity of the potential effects of climate change on plant species and communities (*cf.* Hawkins et al. 2008; Walther 2010), more research is needed to assess its potential long-term impacts on green pitcher plant populations and habitats (USFWS, 2013).

Stressor: Livestock disturbance (USFWS, 2013)

Exposure:

Response:

Consequence: Degradation of habitat

Narrative: Trampling and soil disturbance from cattle have destroyed or degraded several green pitcher plant habitats and populations (Service 1994; Gunn 1994, in litt., 1996, in litt.; Emanuel 2002; NCNHP 2012) (USFWS, 2013).

Stressor: Logging (USFWS, 2013)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Logging/forestry activity is listed as a threat to this species (USFWS, 2013).

Recovery

Conservation Measures and Best Management Practices:

- Work with federal and state entities, non-governmental organizations, and private individuals to permanently protect and manage existing habitats and populations, including the development and implementation of management plans, as needed (USFWS, 2013).
- • Continue use of prescribed fires at protected sites and encourage owners of unprotected sites to conduct prescribed fires as frequently as possible (USFWS, 2013).
- Study and evaluate efficacy of a variety of prescribed fire regimes (USFWS, 2013).
- Study and evaluate efficacy of alternative management strategies to prescribed fire, such as hand clearing, mowing, and limited herbicide application (USFWS, 2013).
- Update population inventories, create detailed maps of all populations and their habitats to assist with population management, and attempt to relocate populations (USFWS, 2013).
- Characterize genetic diversity and representation of current ex situ safeguarded collections. Expand ex situ preservation of genetic stock, including long-term cryopreservation of seeds as well as live collections, to represent all populations with increased emphasis placed on preserving and safeguarding individual genets within and across populations (USFWS, 2013).
- Continue and expand conservation genetics work to include all populations and determine effective population sizes (USFWS, 2013).

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

Species Taxonomic and Listing Information

Commonly-used Acronym: SJV

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

Physical Description

A robust annual legume that typically attains a height of 1.0-2.0 m in a single growing season, although it may grow as tall as 2.4 m. The stems are single, sometimes branching near the top, with stiff or bristly hairs. The leaves are even-pinnate, 2.0-12.0 cm long, with entire, gland-dotted leaflets. Each leaf consists of 30-56 leaflets. Leaflets are 0.8-2.5 cm long and 0.2-0.4 cm wide. The leaves fold slightly when touched. Pedicels are 3.0-8.0 mm long, bearing toothed bractlets about 4.0 mm long and 2.0-3.0 mm wide immediately below the flowers. The yellow, irregular, legume-type flowers are 1.0-1.5 cm across, streaked with red, and grow in racemes 2.0-6.0 cm long. The flowers have uniformly shaped anthers. The fruit is a loment with 4-10 one-seeded segments, the lowest 5.0-7.0 mm wide, turning dark brown when ripe. Fruits are 3.0-7.0 cm long, on a stipe 10.0-25.0 mm in length, and shallowly scalloped along one side (USFWS, 1995).

Taxonomy

In the pea family, Fabaceae (USFWS, 1995)

Historical Range

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

Current Range

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

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect (EPA, 2016)

Breeding Season

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

Key Resources Needed for Breeding

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

Reproduction Narrative

Adult: Germination begins late May - early June. Plants begin flowering in July, continuing through September; fruits are produced simultaneously from July to late October. Limited pollinator observations of the small bumblebees have been made on the plants. Establishment of seedlings may be restricted by deposition of flotsam on the river bank and dense stands of perennial species such as *Peltandra virginica* and *Pontederia cordata*. However, most of the *Aeschynomene* zone is composed of annual species which die back, presumably leaving many available germination sites. Plants have been known from a site in NJ for at least 9 years, so as long as conditions remain the same, the species seems to maintain itself adequately (NatureServe, 2015). Some self-pollination is possible (EPA, 2016).

Habitat Type

Adult: Wetland (EPA, 2016)

Habitat Vegetation or Surface Water Classification

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

Habitat Narrative

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

Dispersal/Migration**Motility/Mobility**

Adult: Abiotic (EPA, 2016)

Dispersal/Migration Narrative

Adult: Abiotic dispersal, possibly floating on water (EPA, 2016). Fruits disseminate as individual articles and have been observed to float; length of floatability is unknown. Plants consistently reappear (observed in NJ & MD) in the same place indicating limited dispersal, or at least some seed remaining in place as a seed bank (NatureServe, 2015).

Population Information and Trends**Population Trends:**

Decline of 50-70% (NatureServe, 2015)

Species Trends:

Decline of 10-30% (NatureServe, 2015)

Resiliency:

Medium (inferred from NatureServe, 2015)

Representation:

Medium (inferred from NatureServe, 2015)

Redundancy:

Medium (inferred from NatureServe, 2015)

Number of Populations:

Approximately 20 (NatureServe, 2015)

Population Size:

Approximately 7000 individuals (NatureServe, 2015)

Adaptability:

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

Population Narrative:

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

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 1995)

Exposure:

Response:

Consequence:

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

Stressor: Natural disturbances (USFWS, 1995)

Exposure:

Response:

Consequence:

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

Recovery

Reclassification Criteria:

Not available.

Delisting Criteria:

1. The sensitive joint-vetch and the ecosystems upon which it depends are adequately protected within the following six watersheds: Manokin Creek in Maryland; Manumuskin River in New Jersey; and Rappahannock, Pamunkey, Mattaponi, and Chickahominy Rivers in Virginia (USFWS, 1995).
2. Annual monitoring over a 10-year period shows that the populations in these six river systems are stable or expanding (USFWS, 1995).
3. Life history and ecological requirements of the species are understood sufficiently to allow for effective protection, monitoring, and, as needed, management (USFWS, 1995).

Recovery Actions:

- Maintain the integrity of the tidal wetland systems upon which the sensitive joint-vetch depends (USFWS, 1995)
- Protect extant sensitive joint-vetch populations and sites (USFWS, 1995).
- Survey for additional populations (USFWS, 1995).
- Establish monitoring priorities, develop reliable monitoring techniques, and monitor populations accordingly (USFWS, 1995).
- Determine the ecological and distributional characteristics and requirements of the sensitive joint-vetch (USFWS, 1995).
- Develop an informational brochure on the importance of the sensitive joint-vetch and the tidal wetlands upon which it depends (USFWS, 1995).

Conservation Measures and Best Management Practices:

- More consistent monitoring of all of the Virginia occurrences is needed to confirm the population trends in the portion of its range that has the greatest number of extant occurrences/subpopulations. This monitoring can also serve to detect current threats and identify areas where management actions such as *Phragmites* control may be needed in Virginia (USFWS, 2013).

- A review of the monitoring methodologies being used across the range of this species should be conducted with the purpose of increasing standardization. Monitoring protocols likely vary across the species range. Although long-standing monitoring programs may not want to abandon established methodology for fear of making their year-to-year data less comparable, a review could highlight where changes might be made and lead to increased standardization and therefore more comparable data rangewide (USFWS, 2013).
- Conduct genetic research to ensure that seeds representing the genetic diversity of SJV are in the collection of the National Center for Genetic Resources Preservation (Formerly National Seed Storage Laboratory) in Fort Collins, Colorado (USFWS, 2013).
- Investigations should continue into the effects of invasive plants such as *Murdannia keisak* and the introduced insect species, tobacco budworm (*Heliothis virescens*) and corn earworm (*Helicoverpa zea*) on SJV (USFWS, 2013).
- The role of muskrats in creating and maintaining SJV habitat needs to be investigated (USFWS, 2013).
- Consideration should be given to what role proactive measures such as habitat management, seed additions, and introductions in upstream habitat should play in a long term management strategy for SJV in light of dwindling populations in parts of its range, the serious threat from sea level rise, and questions about the ability of this species to migrate to upstream habitat. Recent publications mention the use of vegetation management and seed additions for the conservation and management of SJV or recommend directing research efforts to introducing the species into new upstream sites. Guidelines should be developed in case more aggressive management strategies are warranted (USFWS, 2013).
- Surveys should be conducted in potential habitat throughout the range of the species (USFWS, 2013).
- Revise the recovery plan to update information and to consider the incorporation of the James River Basin in the Recovery Criteria (USFWS, 2013).

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SPECIES ACCOUNT: *Campanula robinsiae* (Brooksville bellflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 8/28/1989; Southeast Region (R4)

Physical Description

Campanula robinsiae is an annual herb, with stems 1-15 cm (0.5-6 in.) tall, very slender, simple or branched, faintly winged or 4-angled. The stems are glabrous except for a few trichomes in the angles (Morn 1987). The plant may be submerged for part of its life, which may affect its growth. Some stems root at the nodes (Morn 1987). The leaves are alternate, the blades varying in size and shape on different parts of the plant and from plant to plant (Morn 1987). Open flowers are solitary, 3-10 mm long, bell-shaped, "deep purple" (Morn 1987). Steven Leonard (under contract to The Nature Conservancy; report at Florida Natural Areas Inventory) discovered in 1983 that the plant has cleistogamous (closed, self-pollinating) flowers, which are quite small. This is the only North American *Campanula* with cleistogamous flowers (Morn 1987). The fruit is a subglobose capsule about 2 mm in diameter (Wunderlin et al. 1980a). The seeds are about 1 mm long, the smallest of any North American member of the genus (Shetler and Morn 1986; description adapted from Wunderlin et al. [1980a] and other sources as noted). Leonard observed only cleistogamous flowers on February 8 and 11, 1983, and did not see a chasmogamous flower until February 23 (letters from Leonard to Morn in Morn 1987). Flowering specimens have also been collected March 11, 1983; April 13, 1983; and April 26, 1958. Seed production proceeds while flowering continues. *Campanula robinsiae* may be confused with *Campanula floridana*, but the latter species has very different seeds and leaves that are "much firmer than those of *C. robinsiae*" (Morn 1987). (USFWS, 1993)

Taxonomy

Small (1926) formally published the species, but later (Small 1933) transferred the species to his new genus *Rotantha*, along with *Campanula floridana*, based on the shared character of their rotate corollas' (Small 1933). Later workers (Shetler 1963, Wunderlin et al. 1980a) determined that these two species are not closely related, so *Rotantha* is an artificial genus; the two species are retained in *Campanula* (USFWS, 1993).

Historical Range

All historically known sites of *C. robinsiae* occurred within approximately 2-3 square miles centered on Chinsegut Hill, which is located 5 miles north of Brooksville, in Hernando County, Florida. (USFWS, 2019)

Current Range

Hernando and Hillsborough Counties, Florida. (USFWS, 2019)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from EPA, 2016); asexual (EPA, 2016)

Dependency on Other Individuals or Species

Adult: Insect and bird pollinators (EPA, 2016)

Breeding Season

Adult: March - April (EPA, 2016)

Key Resources Needed for Breeding

Adult: Insect and bird pollinators (EPA, 2016); rainfall (USFWS, 2010)

Reproduction Narrative

Adult: Flowering specimens have been collected March-April. Capable of self-pollination. Insects and birds are also potential pollinators. Seeds germinate in winter or spring. Seed production occurs while flowering continues (EPA, 2016). It was determined that water levels from rainfall rather than time of year may be a critical factor controlling germination (Williams 1998) (USFWS, 2010).

Habitat Type

Adult: Palustrine, terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Herbaceous wetland, forest (NatureServe, 2015)

Environmental Specificity

Adult: Moderate (inferred from NatureServe, 2015)

Habitat Narrative

Adult: *Campanula robinsiae* was originally found in a seepage area on the north facing slope of Chinsegut Hill surrounded by pasture used for animal husbandry. It has since been found within an oak/palm hydric hammock along the edge of an elongated maidencane (*Panicum hemitomom*) marsh at Burns Prairie (Laundry 1996). Typically this species is found along the margins of ponds and marshes with fluctuating water levels and moist seepage areas, both surrounded by pastures. *C. robinsiae* is associated with other wetland plants, such as mosquito fern (*Azolla carolinaiana*), hair sedge (*Bulbostylis* spp.), coinwort (*Centella asiatica*), button snakeroot (*Eryngium* spp.), pennywort (*Hydrocotyle* spp.), rush (*Juncus* spp.), pimpernel (*Anagallis minima*), pearlwort (*Sagina decumbens*), and maidencane (*Panicum hemitomom*). (USFWS, 2019)

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Fruit dispersal potential occurs via abiotic factors and birds and mammals (EPA, 2016).

Population Information and Trends**Population Trends:**

Not available

Species Trends:

Stable (USFWS, 2019)

Number of Populations:

6 (USFWS, 2019)

Population Size:

~8600 individuals (USFWS, 2019)

Population Narrative:

Although there are six extant populations (Burns Prairie, Croom- Bell Heaven, Croom- Power Line Road, and Hillsborough River State Park #1, #2, and #4) (Fig. 1), all on public land along wet prairies, pond margins, or seepage areas. There is one more population than when the last 5-Year Review was conducted in 2010. Three populations have been discovered and two are now considered historic due to habitat degradation and development. Populations are determined based on whether there was a hydrological connection and are considered extant if plants were found within the past 6 years. Most populations have been monitored yearly by Bok Tower Botanical Garden (BTG) since 2001. The species is only found in Hernando and Hillsborough Counties. The oldest remaining population in Hernando County is Burns Prairie, which was discovered in 1983. Most of the Burns Prairie population occurs on land owned by Florida Agricultural and Mechanical University (FAMU) and the southern extent is owned by the Florida Fish and Wildlife Conservation Commission (FWC). Less than 3 miles from Burns Prairie are two other populations that have not had plants in several years due to habitat degradation (Chinsegut Hill) and development (Young). In 2015, several plants were found in the Croom Tract of Withlacoochee State Park (WSF) in Hernando County along a power line road (Croom- Power Line Road). A year later, another population was found along a pond margin a tenth of a mile away (Croom- Bell Heaven) (Peterson, BTG pers. comm. 2018b). These populations are located approximately 5 miles southeast of the other Hernando County sites. Approximately 40 miles south of all other known sites are four populations within Hillsborough River State Park (HRSP #1-4). The HRSP populations were found starting in 2006 along pond margins and wetlands within HRSP, all within approximately 0.4 miles of each other. Surveyors have not found plants in one of the populations since 2009. These populations are much lower in elevation than the Hernando County sites. From 2016- 2018 three populations consistently had more than three hundred plants: Burns Prairie, Croom-Bell Heaven, and HRSP #2. Minimal to no habitat management is taking place for any of the populations. Without regular management, it is possible that the species will disappear from these sites. (USFWS, 2019)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2019)

Exposure:

Response:

Consequence:

Narrative: This species is threatened by habitat destruction and degradation on its six extant sites due to the lack of habitat management and development of the land surrounding protected sites. Previously, conversion of existing sites to residential and agriculture was determined to be

the primary threat and resulted in the need to list the species (USFWS 1994). Since all six known extant populations now occur on public land, the threat of conversion of known sites to residential land use has been significantly reduced. The lack of habitat management has resulted in the disappearance of the Chinsegut Hill and Young populations and may be affecting other populations, such as the introduction and Burns Prairie. At Chinsegut Hill and the Young site, *C. robinsiae* was likely outcompeted by dense vegetation due to lack of disturbance, which was previously created by mowing or trampling by cattle. In addition, at Chinsegut Hill, the death of an oak tree that provided shade to *C. robinsiae* likely affected moisture levels (Service 2010). It is important to consider overstory composition when managing habitat. The introduction at the Blackwater Creek Preserve failed due to lack of habitat management that would have allowed cattle to graze the site. In 2012, Burns Prairie lost its grazing cattle and the only management that has taken place is that overgrown competing vegetation was removed in 2015 (Peterson, BTG pers. comm. 2019a). It is possible that this population will disappear if grazing or other habitat management is not continued. More research is needed to determine which methods are effective at managing habitat. Development of the land surrounding protected lands may alter hydrology by increasing runoff to *C. robinsiae* sites. This runoff may also contain fertilizers and herbicides that may affect growth and germination of the plants. *C. robinsiae* occurs in the Central Region of Florida, which is projected to experience the greatest population growth in the state in the near future. By 2070, the percentage of developed land is expected to double from 25% in 2010 to almost 50% (Carr and Zwick 2016). Due to modeling efforts (Lewis 2010, 2011), unknown populations and suitable habitat for introductions likely exist on private land and may be at risk to development. It is likely that agricultural lands will be converted to residential land uses in the near future (Carr and Zwick 2016). This conversion may negatively affect *C. robinsiae* habitat because cattle may benefit the species by providing the disturbance necessary to reduce competition from other plants. (USFWS, 2019)

Recovery

Reclassification Criteria:

Not developed

Delisting Criteria:

Not developed - Plausible criteria for recovery might include securing at least 10 viable and self-sustaining populations of Brooksville bellflower in pond margin habitats, consisting of approximately 10,000 individuals during prolific years (USFWS, 1993).

Recovery Actions:

- Develop management and protection criteria for populations on current managed areas (includes collection of biological/systematic data and control of exotic plants) (USFWS, 1993).
- Acquire additional habitat, or protect habitat through conservation easements and/or regulation. Sufficient information is available to proceed immediately (USFWS, 1993).
- Conduct additional surveys for new populations of the species (USFWS, 1993).
- Augment existing cultivated populations, including establishment of a germ plasm bank (USFWS, 1993).
- Develop plans for possible (re)introduction of plants into suitable habitats (includes 10-year monitoring of existing and/or reintroduced populations) (USFWS, 1993).

- Enforce protective legislation (USFWS, 1993).

Conservation Measures and Best Management Practices:

- Revise the current recovery plan to include updated objective and measurable recovery criteria for reclassifying this species to threatened status and delisting that are related to reducing the threats identified in the recovery plan, as well as updated information on the species distribution and biology (USFWS, 2010).
- Support further research on: a. Effects of cattle grazing on this species. b. Life history needs. c. Microhabitat requirements of this species. d. Effect of severe changes in temperatures (freezing) on germination. e. Drought and fluctuating water levels and their effect on germination. f. Transplant experiments, long-term seed viability trials, and optimizing germination protocols (USFWS, 2010).
- Continue working with public land managers to increase management efforts to benefit *C. robinsiae*. No management plans have been developed for this species but are necessary. Minimal management has been taking place at some sites. Once disturbance has been removed from some sites, populations have disappeared. Burns Prairie especially needs additional management because competing vegetation has taken over since grazing cattle were removed from the site. (USFWS, 2019)
- Continue conducting surveys at known sites of occurrence and expand surveys to other suitable areas in Hillsborough and Hernando Counties. This information is necessary to determine where plants currently exist and to prioritize recovery actions such as reintroductions at suitable sites. BTG has continued conducting surveys at known sites of occurrence. This work has been made possible through annual grants from the State of Florida, Department of Agriculture and Consumer Services, Division of Plant Industry, which funds the basic operations of BTG's Rare Plant Conservation Program. Surveys have been expanded to other sites determined by a GIS model to have suitable habitat. However, due to either flood or drought conditions during the survey periods, no plants were found. One introduction took place in 2013, but no plants were found the following year due to overgrowth of competing vegetation. No plants have been found at the introduction site since. Habitat management is necessary to control competing vegetation. (USFWS, 2019)

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SPECIES ACCOUNT: *Oxypolis canbyi* (Canby's dropwort)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015) 2/25/1986

Physical Description

A perennial herb with strong, fleshy rhizomes. Plants have slender stems, often more than 1 m tall. Leaves are thin and quill-like. Herbage smells slightly of dill. From mid-August to October the plants bear compound clusters of small white flowers (sometimes tinged with red) (NatureServe, 2015).

Taxonomy

Molecular and morphological studies have shown evidence that the genus *Oxypolis* as currently circumscribed, including compound-leaved and rachis-leaved species, is not monophyletic: the rachis-leaved species of *Oxypolis* (which include *O. canbyi*) are transferred to their own genus, *Tiedemannia* (Feist and Downie 2008 and Feist et al. 2012) (NatureServe, 2015).

Historical Range

See Current

Current Range

Native to the coastal plain, from southwestern Georgia through South Carolina to southeastern North Carolina (mostly in the middle and inner Coastal Plain), and from eastern MD to (historically) Delaware (Weakley 2008). (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Existing populations of *Oxypolis canbyi* are maintained mainly through asexual reproduction. This species is strongly clonal, reproducing vegetatively by means of stoloniferous rhizomes. Stems also become decumbent and root at the nodes, especially in drier sites where there is little or no water to support the stems. The flowers can be either unisexual or bisexual. Bisexual flowers may facilitate some self-pollination; however, the flowers are protandrous, which is indicative of some degree of outcrossing.; Existing populations of *O. canbyi* are maintained mainly through asexual reproduction. This species is strongly "clonalizing," reproducing vegetatively by means of stoloniferous rhizomes. Stems also become decumbent and root at the nodes, especially in drier sites where there is little or no water to support the stems. Perfect (bisexual) flowers are produced which may result in some self-pollination; however, the flowers are protandrous which may ensure some degree of outcrossing. The potential for outcrossing may be higher in those umbels which produce inner male flowers and outer female flowers. Outcrossing results in increased recombination and heterozygosity, thereby ensuring increased evolutionary potential. Sexual reproduction theoretically should act

as a sort of evolutionary buffer enabling the species to survive environmental changes. This may not be the case in *O. canbyi* due to a possible high selfing rate and/or the isolation of small populations. Predation by the caterpillar of the black swallowtail butterfly (*Papilio polyxenes asterius*) may be a factor in reducing the sexual reproductive potential of *O. canbyi*. This caterpillar chews through the stems just below the inflorescence (NatureServe, 2015).

Habitat Type

Adult: Coastal Plains (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from NatureServe, 2015)

Site Fidelity

Adult: Moderate (inferred from NatureServe, 2015)

Habitat Narrative

Adult: *O. canbyi* has been found in a variety of Coastal Plain habitats prone to long periods of inundation, including pond cypress ponds, grass-sedge dominated Carolina bays, wet pine savannahs, shallow pineland ponds and cypress-pine swamps or sloughs. The largest and most vigorous populations reported occur in open bays or ponds which are flooded throughout most of the year and which have little or no canopy cover. Many sites are on a sandy loam or loam soil which is underlain by a clay layer. Based on county soil surveys, known soil types which support populations of *O. canbyi* include Rembert loam, Portsmouth loam, McColl loam, Grady loam, Coxville fine sandy loam, and Rains sandy loam. These soil types are similar in that they have a medium to high organic content, high water table, and are deep, poorly drained, and acidic. Historically, fire was a key element maintaining the open nature of the habitat at many *O. canbyi* sites. The following species are frequently found associated with *O. canbyi*: *Ilex myrtifolia*, *Nyssa biflora*, *Taxodium ascendens*, *Pinus serotina*, *Stillingia aquatica*, *Rhynchospora tracyi*, *R. inundata*, *Manisuris rugosa*, *Rhexia aristosa*, *Polygala cymosa*, *Pluchea rosea*, *Lobelia boykinii* and *Hypericum denticulatum* (NatureServe, 2015). Moderate ecological integrity of the community, tolerance ranges and site fidelity are inferred based on the variety of habitat in which the species can be found.

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: The vectors of seed dispersal are not well understood, but at least some seed dispersal is by wind (USFWS, 1990).

Population Information and Trends**Population Trends:**

Decreasing (NatureServe, 2015)

Resiliency:

Moderate (inferred from NatureServe, 2015)

Representation:

Moderate (inferred from NatureServe, 2015)

Redundancy:

Moderate (inferred from NatureServe, 2015)

Number of Populations:

21 - 80 (NatureServe, 2015)

Population Size:

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

Population Narrative:

Specific habitat requirements; vulnerable to succession if hydrology and/or fire regime changes. Habitat for this species has declined significantly from historical levels. For example, in South Carolina over 90% of Carolina Bays over 1.2 ha in size are believed to have been ditched or destroyed (Glitzenstein no date). The few known extirpated populations are presumed or known to have been destroyed by habitat loss or modification (USFWS no date); for example, at least one Georgia occurrence was destroyed by urbanization, and another was likely destroyed by agricultural development. In Georgia, at least three occurrences have "thousands" of plants, and at least four more have several hundred to a thousand; others are smaller (25-250) or of unknown size. In South Carolina, one occurrence is described as "extremely large", three others as "very large", and one additional as "fairly large"; remaining occurrences are described as "good size", "fair size", or "small", or are of unknown size. The Maryland occurrence fluctuated between 14 and 82 plants over nine years of detailed monitoring. The North Carolina occurrence has had very few plants (e.g., 2 individuals) observed in recent years, although it was larger in the past. Approximately 40 occurrences are believed extant, mostly in South Carolina and Georgia (North Carolina and Maryland have 1 occurrence each). An additional 16 occurrences are ranked "failed to find," "historical," or "unknown." (NatureServe, 2015). NatureServe (2015) also notes that the short-term trend is a decline of 10-50%. Moderate redundancy, resiliency and representation are inferred based on the number of populations and individuals as well as the relatively wide geographical region that populations of this species occur.

Threats and Stressors

Stressor: Wetland draining (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The most significant threat to Canby' dropwort is the direct loss or alteration of its rare wetland habitat. Ditching and draining of wetland areas, primarily for agriculture and silviculture, have reduced the frequency, depth and duration of surface water, lowered the groundwater table, and changed the vegetative composition in many areas of the mid-Atlantic coastal plain where the species historically occurred. Reducing surface water, changing soil moisture levels and lowering of the water table enables other plants to become established, modifies vegetative succession, and makes sites less conducive overall to the plant's growth and reproduction (Murdock and Rayner 1990). As a result, many sites have been invaded by shrubs

and some sites have been planted in pine. Other sites have been dredged thus breaking the clay hardpan and draining the wetland (Murdock and Rayner 1990, Gaddy 2006) (USFWS, 2015).

Stressor: Fire suppression (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: On sites that are not actively disturbed by logging, ditching or dredging, habitat management is often needed to prevent encroachment of shrubs or trees that increase evapotranspiration, lower the water table and shade out Canby's dropwort. Periodic fires probably limited this encroachment under natural conditions but many sites are no longer surrounded by pine forest subject to regular fires and few sites are managed with prescribed burning. An example is the Big Cypress Meadow which is owned by The Nature Conservancy and is the only site in North Carolina. Young trees, shrubs and maidencane have invaded much of the meadow and the number of Canby's dropwort has declined from as many as 10,000 plants in 1986 to only a few plants in recent years and none in 2006 (Gaddy 2006) (USFWS, 2015).

Stressor: Predation (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of plants

Narrative: Black swallowtail butterfly, grasshoppers, rabbits and rodents have all been known to damage/eat these plants (USFWS, 2015).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2015)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: There is currently little regulatory protection of Canby's dropwort habitat. The U.S. Army Corps of Engineers (Corps) generally does not regulate dredge and fill activities in isolated wetlands because of a 2001 U.S. Supreme Court opinion. The 2001 opinion was issued in the Solid Waste Agency of Northern Cook County (SWANCC) v. the U.S. Army Corps of Engineers et al. and ruled in favor of SWANCC. The Corps' requirement for a Clean Water Act Section 404 permit to fill isolated wetlands to construct a landfill was overturned. The Corps had asserted jurisdiction on the isolated intrastate waters based solely on use by migratory birds (Findlaw 2007). Since that ruling isolated wetlands are generally not considered jurisdictional by the Corps. Therefore, there is no Federal nexus and consultation under section 7 of the Endangered Species Act is not required. Because Canby's dropwort grows only in isolated wetlands, there is currently no Federal regulatory control of actions that would affect its habitat. In South Carolina and Georgia, where almost all Canby's dropwort populations occur, there are no State laws that protect the isolated wetlands that provide Canby's dropwort habitat. Maryland and North Carolina, with one Canby's dropwort population each, do regulate isolated wetlands and therefore offer some protection to the habitat (Maryland Department of the Environment 2010, North Carolina Department of Environment and Natural Resources 2010). The Endangered Species Act prohibits the taking of endangered plants from Federal lands without a permit and regulates trade of listed plants. In addition, the Endangered Species Act prohibits the malicious damage or destruction of plants on Federal lands; and, their removal, cutting, digging, damaging, or destroying in knowing violation of any state law or regulation, including criminal trespass law.

The State of Maryland prohibits taking of the species from private property without the landowner's permission and from State property without a permit and regulates trade in the species (Code of Maryland regulations 08.03.08). The State of North Carolina prohibits taking of the plant without a permit and the landowner's permission and regulates trade (North Carolina General Statute 19-B, 202.12-202.19). The State of Georgia prohibits digging, removal, or sale of State listed plants from public lands without the approval of the State management authority, and regulates sale or transport of State listed plants from private property (Georgia Wildflower Preservation Act of 1973). The State of South Carolina does not have any regulations that protect endangered plants on private land. However, regulations prohibit the unauthorized taking of plants from South Carolina Heritage Preserves and State Parks (South Carolina Code of Laws: Sections 50-11-2200, 50-11-2210, and 51-3-140) (USFWS, 2015).

Recovery

Delisting Criteria:

Canby's dropwort (*Oxypolis canbyi*) will be considered for delisting when there are at least 19 self-sustaining populations in existence that are protected to such a degree that the species no longer qualifies for protection under the Endangered Species Act (see criteria below). A self-sustaining population is a reproducing population that is large enough to maintain sufficient genetic variation to enable it to survive and respond to natural habitat changes. The number of individuals necessary and the quantity and quality of habitat needed to meet this criterion will be determined as one of the recovery tasks. The populations should be distributed throughout the species' historic range. This recovery objective is considered an interim goal because of the lack of data on biology and management requirements of the species. As new information is acquired, the estimate of self-sustaining populations required for the species' survival may be readjusted. The recovery objective for *O. canbyi* will be reassessed at least annually in light of any new information that becomes available (USFWS, 1990).

Conservation Measures and Best Management Practices:

- Conduct surveys and habitat assessments at all surveyed sites by Gaddy (2006) that are not routinely monitored to determine the species presence and to assess habitat quality (USFWS, 2015).
- Protect known Canby's dropwort populations on private lands with conservation easements or Wetland Reserve Program easements (USFWS, 2015).
- Assess moribund and extirpated sites as well as other isolated wetlands for suitable habitat and resource availability (USFWS, 2015).
- Improve our understanding of the relationship between precipitation (and other parameters) and Canby's dropwort population viability (USFWS, 2015).
- Determine objective, quantitative criteria for self-sustaining populations (USFWS, 2015).
- For populations confined within roadside or powerline right-of-ways, promote management actions that shift Canby's dropwort populations away from right-of-ways and towards the interior of adjacent wetlands (USFWS, 2015).
- Conduct demographic studies that further examine genetic variability, population structures, reproduction, and indeterminate growth factors (USFWS, 2015).

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SPECIES ACCOUNT: *Thalictrum cooleyi* (Cooley's meadowrue)

Species Taxonomic and Listing Information

Listing Status: Endangered; 02/07/1989; Southeast Region (R4) (USFWS, 2017)

Physical Description

A small, rhizomatous, perennial herb with erect to lax stems, up to 1 m tall. Loose clusters of flowers are borne in June. The unisexual flowers lack petals, but the sepals are white, pale yellow, or pale green with lavender filaments. The leaves are narrow and lance-shaped. The fruits are single-seeded and winged. Phenology: Flowers appear mid to late June and fruit mature in August or September (NatureServe, 2015).

Taxonomy

Thalictrum cooleyi is distinguished from other such members of the genus, *Thalictrum revolutum* in particular, by the combination of leaflet narrowness (4 to 26 times as long as wide), lack of lobing in the majority of the leaflets, and absence of hairs, glands, or papillae on lower leaflet surfaces, petioles, peduncles, and achenes (Park 1992) (USFWS, 1994).

Historical Range

Three historic North Carolina populations--Brunswick, Columbus, and Pender Counties--are assumed extirpated, because recent surveys showed habitat destruction at the sites and no plants were found (North Carolina Natural Heritage Program 1992). Cooley's meadowrue has been reported from New Hanover County, North Carolina (Radford et al. 1968), but without documentation (USFWS, 1994).

Current Range

All of the known *Thalictrum cooleyi* populations occur in the Coastal Plain Province in NC, GA, and FL (USFWS, 2009).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual, wind- and insect-pollinated (NatureServe, 2015)

Breeding Season

Adult: Flowering in June (Radford et al, 1968) (NatureServe, 2015)

Reproduction Narrative

Adult: Flowering in June (Radford et al, 1968). The winged, single-seeded fruits mature in August and September (Lowe et al. 1990), but the seed life is presumably short. A dioecious species, *Thalictrum cooleyi* has separate male and female flowers that are wind- and insect-pollinated (NatureServe, 2015).

Habitat Type

Adult: Pine Savanna (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Wetlands/intermittent fire (NatureServe, 2015; USFWS, 1994); soil pH 5.8-6.6 (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (Inferred from NatureServe, 2015 and USFWS, 1994)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (Inferred from NatureServe, 2015 and USFWS, 1994)

Site Fidelity

Adult: High (NatureServe, 2015)

Habitat Narrative

Adult: Sunny, moist places such as open, savanna-like forest edges and clearings, wet savannas over calcareous clays, and ecotones between wet savannas and non-riverine swamp forests. Soils are basic, sandy loams. Also on roadsides and power line rights-of-way in former savannas. It grows on circumneutral soils in wet pine savannas, grass-sedge bogs, and savanna-like areas, often at the border of intermittent drainages or swamp forests. Boggy savannah-like borders of low woodlands, roadside ditches, and power line rights-of-way. Usually associates with some type of disturbance, e.g., clearings, the edges of frequently burned savannas, power line right-of ways which are maintained either by fire or mowing, and roadside edges. Typically on Grifton soil. This plant is found on fine sandy loams that are at least seasonally (winter) moist or saturated and are only slightly acidic (pH 5.8-6.6). Sufficient moisture is critical to plant vigor and reproductive effort. This plant occupies a narrow hydrological niche, where soil is moist to saturated but water does not stand above the soil surface. This species occurs in moist to wet bogs and savannas and savanna-like openings on circumneutral soils and is dependent upon some form of disturbance to maintain the open quality of its habitat. Currently, artificial disturbances, such as power line and road right-of-way maintenance, and plowed firebreaks, are maintaining some of the openings historically provided by naturally occurring periodic fires (Murdock 1989). This species grows in circumneutral soil in moist to wet savannas and savanna-like areas kept open by frequent fire or other disturbance. "This borderline type of habitat would have been disturbed historically by naturally occurring savanna fires moving through at 1- to 5-year intervals, clearing litter from the soil surface and causing the cyclical advance and retreat of woody growth. A typical population of Cooley's meadowrue has robust reproductive plants among shrubs and in adjacent open savanna and repressed individuals in nearby dense shade" (Boyer 1994) (NatureServe, 2015; USFWS, 1994). Low tolerance range and clumped spatial arrangement are inferred based on the specific habitat needs of this species and the relatively low number of populations (NatureServe, 2015; USFWS, 1994).

Dispersal/Migration

Motility/Mobility

Adult: Low (USFWS, 1994)

Dispersal/Migration Narrative

Adult: Possibly propagate by breaking off and dispersal of vegetative parts in aquatic habitat (USFWS, 1994).

Population Information and Trends**Population Trends:**

Decreasing (NatureServe, 2015)

Species Trends:

Stable (USFWS, 2009)

Resiliency:

Moderate (inferred from USFWS, 2009)

Representation:

Low (inferred from NatureServe, 2015)

Redundancy:

Moderate (inferred from USFWS, 2009)

Number of Populations:

12 (USFWS, 2009)

Population Size:

1 - 1000 total individuals (NatureServe, 2015)

Population Narrative:

Thalictrum cooleyi is intrinsically vulnerable in several ways. It is rhizomatous, so the number of ramets is far greater than the number of genets. It is dioecious, so the populations where only one sex persists are particularly vulnerable. It produces few seeds and apparently does not have a seed dispersal mechanism (USFWS 1989). (NatureServe, 2015) The total number of individuals is estimated at between 1 and 1000 and the number of populations between 6 and 20. In addition, the short-term population trend indicates a decline of 10-30% (NatureServe, 2015). Low representation, resiliency and redundancy are inferred based on species specific habitat needs, low number of populations and fragmentation of suitable habitat (NatureServe, 2015). In the 2008 Recovery Data Call, the status of *Thalictrum cooleyi* was listed as stable. Between 2005 and 2007, NCNHP staff or other knowledgeable botanists have visited 12 of 25 North Carolina subpopulations (representing 10 populations) of *Thalictrum cooleyi*. As of 2008, there were 9 extant populations in NC; 2 in GA; and 1 in FL (USFWS, 2009).

Threats and Stressors

Stressor: Agriculture (USFWS, 1994)

Exposure:**Response:****Consequence:** Loss of habitat**Narrative:** USFWS (1994) notes that land clearing for agriculture is a threat to this species.**Stressor:** Succession (USFWS, 1994)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:** USFWS (1994) notes that succession (due to lack of disturbance/fire) is a threat to this species.**Stressor:** Forestry (USFWS, 1994)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:** USFWS (1994) notes that forestry/logging is a threat to this species.**Stressor:** Mining and Development**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:** USFWS (1994) notes that mining and development are threats to this species.**Stressor:** Draining (USFWS, 1994)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:** USFWS (1994) notes that draining (for development/road construction) is a threat to this species.**Stressor:** Road construction (USFWS, 1994)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:** USFWS (1994) notes that highway construction is a threat to this species.**Stressor:** Inadequacy of regulatory mechanisms (USFWS, 2009)**Exposure:****Response:****Consequence:****Narrative:** There are no known populations on federal lands (USFWS, 2009).***Recovery*****Reclassification Criteria:**

Not available

Delisting Criteria:

Cooley's meadowrue (*Thalictrum cooleyi*) will be considered for delisting when there are at least 16 self-sustaining, geographically distinct populations in existence that are protected to such a degree that the species no longer qualifies for protection under the Endangered Species Act (see criteria below). A self-sustaining population is a reproducing population that is large enough to maintain sufficient genetic variation to enable it to survive and respond to natural habitat changes. The number of individuals necessary and the quantity and quality of habitat needed to meet this criterion will be determined as one of the recovery tasks (USFWS, 1994).

Recovery Actions:

- Protect existing populations and essential habitat. Develop interim research and management plans in conjunction with landowners and managers. Search for additional populations and potential habitat. Rank populations for focus of protection efforts. Evaluate habitat protection alternatives (USFWS, 1994).
- Determine and implement management necessary for long-term reproduction, establishment, maintenance, and vigor. Determine population size, stage-class distribution and sex ratios for all populations. Study abiotic and biotic features of the species' habitat. Conduct long-term demographic studies. Determine the effects of past and ongoing habitat disturbance. Define criteria for self-sustaining populations and develop appropriate habitat management guidelines based upon the data obtained from Tasks 2.2 through 2.4. Implement appropriate management techniques as they are developed from previous tasks. Develop techniques and reestablish populations in suitable habitat within the species' historic range (USFWS, 1994).
- Maintain and expand cultivated sources for the species and provide for long-term maintenance of selected populations in cultivation (USFWS, 1994).

Conservation Measures and Best Management Practices:

- Revisit known populations that have not been visited in the past three years; monitor the habitat condition of each site including threats; discuss conservation options with landowners where appropriate; update Natural Heritage Program files with this information (USFWS, 2009).
- Search for additional populations (USFWS, 2009).
- Prioritize known sites for protection (USFWS, 2009).
- Protect additional populations (USFWS, 2009).
- Develop management plans for all protected populations (USFWS, 2009).
- Develop monitoring protocols, initiate long term population monitoring and determine the criteria for sustaining populations (USFWS, 2009).
- Conduct research on general biology of the species including life history and reproductive biology (breeding systems, seed production and seedling survivorship) (USFWS, 2009).
- Compare, genetically, the populations of questionable taxonomy in Georgia with those known from North Carolina and Florida (USFWS, 2009).
- Work with North Carolina Botanical Garden to conserve seeds and develop propagation protocols (USFWS, 2009).

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SPECIES ACCOUNT: *Boltonia decurrens* (Decurrent false aster)

Species Taxonomic and Listing Information

Listing Status: Threatened; 11/14/1988; Great Lakes-Big Rivers Region (R3) (USFWS, 2016)

Physical Description

A robust, short-lived perennial herb, up to 2 m tall, that produces numerous flower heads with white or pale violet ray flowers surrounding a yellow central disk (NatureServe, 2015).

Taxonomy

Formerly classified as *Boltonia asteroides* var. *decurrens* or *B. latisquama* var. *decurrens*; now recognized as a distinct species (*B. decurrens*) by Flora of North America (2006) and Kartesz (1994), the U.S. Fish and Wildlife Service, and the Illinois and Missouri Heritage Programs (NatureServe, 2015).

Historical Range

Historical collection records reveal that *Boltonia decurrens* once occurred in almost contiguous populations along a 400 km stretch between LaSalle, Illinois and St. Louis, Missouri within the Illinois and Mississippi River floodplain. A disjunct population, reported in 1976, but not found since, is known from Cape Girardeau, MO, about 195 km down the Mississippi River from St. Louis (Schwegman and Nyboer, 1985) (NatureServe, 2015).

Current Range

The species is currently limited to disjunct populations from Woodford County, Illinois to Madison County, Illinois. In some years, ephemeral populations occur in St. Charles County, Missouri, in the area of confluence of the Mississippi and Illinois Rivers (NatureServe, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

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

Lifespan

Adult: 1 - 2+ years (USFWS, 2012)

Breeding Season

Adult: August - October (NatureServe, 2015)

Key Resources Needed for Breeding

Adult: Unshaded soil surface (NatureServe, 2015)

Reproduction Narrative

Adult: Vegetative reproduction occurs through shoots formed from a basal rosette (Smith and Keevin 1998). The species is primarily outcrossing, but some selfing occurs (Smith, 1995). Seed production is prolific with an average of ca. 50,000 seeds produced per plant (Smith & Keevin 1998; Smith, 1990). Seedling survival in the field is < 1%. However, under optimal conditions, the average plant produces 40,000 seedlings but the rate of seedling survival is low (Smith & Keevin 1998). *Boltonia decurrens* blooms from August through October throughout its range (Schwegman and Nyboer, 1985). Germination and seedling establishment do not occur where the soil surface is shaded, such as in places where natural succession has been uninterrupted for a period of 3 - 5 years. Seed germination is also inhibited by silt deposition (NatureServe, 2015). It is considered a perennial plant but also exhibits annual and biennial lifecycles (USFWS, 2012).

Habitat Type

Adult: Riparian, wetland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

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

Dependencies on Specific Environmental Elements

Adult: Disturbance regime, preferably flooding (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Successional vegetation (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 1990)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from NatureServe, 2015)

Habitat Narrative

Adult: It colonizes periodically disturbed riverine moist soil habitats (Smith et al. 2005). In general, sites where the species is successful in reproducing sexually and maintaining a self-sustaining population are characterized by moist, sandy soil and regular disturbance, preferably periodic flooding, which maintains open areas with high light levels. Analysis of 19th-century habitat data taken from herbarium sheets indicates that natural habitat was the shores of lakes and the banks of streams, including the Illinois River. In these habitats, regular flooding prevented succession, allowing sunlight to reach the seedlings. *Boltonia decurrens* is still found in these occasional natural habitats, but it is now primarily restricted to disturbed lowland areas, where it appears to be dependent on human activities (mowing, cultivation) for survival. Although prolonged flooding by extremely turbid water can damage a population (US Fish and Wildlife Service, 1990), the species is extraordinarily flood tolerant (Stoecker, Smith and Melton, 1995) and is known to survive several months of complete inundation by relatively clear groundwater (Smith, 1990). The palustrine habitat is characterized as forested wetland and herbaceous wetland (NatureServe, 2015). As many as 11 plants have been observed to grow

from a single stem of the previous year, giving a 2-year-old wild population a definite clumped appearance (USFWS, 1990).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Achenes float and are often dispersed by flowing water (Baskin and Baskin 2002). (NatureServe, 2015).

Population Information and Trends

Population Trends:

Unknown, periodic expansion and contraction (USFWS, 2012)

Species Trends:

10 - 30% decline (NatureServe, 2015)

Resiliency:

Low (inferred from NatureServe, 2015; see current range/distribution)

Representation:

High (inferred from NatureServe, 2015)

Redundancy:

High (inferred from USFWS, 2012)

Number of Populations:

43 (USFWS, 2012)

Population Size:

1000 - 10,000 individuals (NatureServe, 2015)

Population Narrative:

Like the numbers of populations, numbers of individuals of *B. decurrens* also fluctuate greatly from year to year. Larger stands sometimes have several thousand plants in good years, occasionally exceeding 10,000. Because of the vulnerability of this species to changes in flooding regime, population number is expected to continue to fluctuate in upcoming years. The short term population trend has been relatively stable to a < 30% decline. Preliminary isozyme data developed by Thomas Ranker (University of Colorado, Boulder) from seeds collected from three populations in Illinois in 1994 indicate that there is a high level of genetic diversity (Smith, 1995). This rare species is much more variable, by all the measures examined, than most rare or geographically-restricted plant species, and is even slightly more variable than the average plant species (NatureServe, 2015). Approximately 43 populations have been discovered and monitored intermittently from 1984 to present. Due to the intermittent nature of the available data, long-term trends are not readily apparent but appear to include a periodical expansion and contraction of populations (USFWS, 2012).

Threats and Stressors

Stressor: Habitat degradation (NatureServe, 2015 and USFWS, 1990)

Exposure:

Response:

Consequence:

Narrative: *Boltonia decurrens* is threatened primarily by anthropogenic disturbance of natural habitat. Principal threats include flood-control measures; agricultural use of marginal river-bottom land; increased siltation of floodwater, which decreases light availability and prevents germination and seedling establishment; herbicide use for weed control; and marina construction (NatureServe, 2015). *Boltonia decurrens* populations may also be vulnerable to destruction by discing and herbicide use in low-lying marginal lands for crop weed control. Nearly all stands are in habitats kept open by occasional cropping (USFWS, 1990).

Stressor: Hybridization (USFWS, 2012)

Exposure:

Response:

Consequence:

Narrative: Preliminary allozyme research has been conducted on the potential hybridization of *B. decurrens* and a related species in the genus, *B. asteroides*. Hybridization could pose a threat to the species through decreased fertility, genetic swamping, and ecological competition from hybrid individuals (DeWoody 2011). DeWoody et.al. (2011) tested for hybridization in sympatric populations using allozyme genetic marker data. The results revealed a very low rate of hybridization and introgression, indicating that cross-pollination and hybridization may not pose an immediate threat to the species. However, higher resolution genetic testing has yet to be performed, and therefore the level of threat posed by hybridization is currently indeterminable (USFWS, 2012).

Stressor: Prolonged flooding (USFWS, 1990)

Exposure:

Response:

Consequence:

Narrative: Prolonged flooding during the growing season appears to be a limiting factor. A flood in 1981 inundated most of the unvegetated flood plain of the Illinois River with turbid flood water for an extended period during the summer. Shrubs such as *Cephalanthus occidentalis* were killed by the prolonged total inundation in some areas, and herbs were buried under heavy deposits of silt. Despite intensive searches, no *B. decurrens* was found for 2 subsequent seasons along the Illinois River. Such conditions severely limit natural reproduction and survival by *B. decurrens* (USFWS, 1990).

Recovery

Reclassification Criteria:

Not available

Delisting Criteria:

1. A basic research program to determine the requirements of a naturally reproducing population must be completed (USFWS, 2012).

2. Twelve geographically distinct self-sustaining natural or established populations of the species must be protected through purchase in fee, easement, or by cooperative management agreements (USFWS, 2012).

3. Populations must be monitored for a period of five years to determine if they are self-sustaining. Self-sustaining is defined for recovery purposes as a population which is found to be stable or expanding during the five-year monitoring period (USFWS, 2013).

Recovery Actions:

- Survey suitable habitat for additional populations (USFWS, 1990).
- Protect existing and established populations (USFWS, 1990).
- Establish new populations (USFWS, 1990).
- Conduct research on the biology of the species (USFWS, 1990).
- Monitor natural and established populations (USFWS, 1990).
- Develop and maintain public support (brochure/display) (USFWS, 1990).

Conservation Measures and Best Management Practices:

- Continue to monitor known *B. decurrens* sites and search for new populations annually, collecting GPS location and census data. Include survey efforts for *B. decurrens* in suitable habitat at the confluence of the Illinois River and Mississippi River to determine the extent of the species' southern range (USFWS, 2012).
- Finalize the draft cooperative management agreement between the ILDNR and the Service (USFWS, 2012).
- Establish a consensus among the workgroup regarding the core sub-populations that are important for the survival of the species during times of adverse hydrologic conditions. Also, normal, expected patterns of expansion and contraction of populations over time should be identified to facilitate the definition of population stability in the context of recovery (USFWS, 2012).
- Based on the results of the genetic primer research by Drs. Romano, explore genetic relationships between sub-populations and refine the metapopulation model for the species. Specifically, dispersal patterns and important source populations could be identified through microsatellite research in combination with spatial analysis (USFWS, 2012).
- Explore the phenomenon of hybridization between *B. decurrens* and *B. asteroides* using microsatellite genetic markers. Research should include a confirmation of hybridization between the two species and an analysis of the extent of hybridization in the population (USFWS, 2012).

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SPECIES ACCOUNT: *Marshallia mohrii* (Mohr's Barbara's buttons)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/7/1988; Southeast Region (R4)

Physical Description

Erect perennial herb, 3 to 7 decimeters (1 to 2.3 feet) tall. The leaves are alternate, 8 to 20 centimeters (cm) (3.2 to 7.8 inches) long, firm-textured, three-nerved, and lanceolate-ovate in shape. Leaves are often clustered near the base and gradually reduce in size upwards. The flowers are typically produced in several heads in a branched arrangement. The heads are approximately 2.5 cm (1 inch) broad and consist of disk flowers (tubular in shape) which are pale pink or white in color. The fruit is an achene (USFWS, 1991).

Taxonomy

In the sunflower family (Asteraceae) (USFWS, 1991). The taxon is currently recognized as valid by the Integrated Taxonomic Information System (ITIS) (ITIS 2015), as well as national and regional floras (e.g., Flora of North America [Watson 2006] and Flora of the Southern and Mid-Atlantic States [Weakley 2015]). While the taxonomic status of this species is not affected, some authors use the alternate common name Coosa Barbara's-buttons (e.g., Noss 2012, Spaulding 2013, Weakley 2015) rather than Mohr's Barbara's buttons used by the Service and others (e.g., Chafin 2007, ITIS 2015, NatureServe 2015). (USFWS, 2016)

Historical Range

Historical records exist for Walker County, Georgia, and Walker and Cullman Counties, Alabama, in addition to the current range (USFWS, 1991).

Current Range

Currently known from Bibb, Cherokee, and Etowah Counties, Alabama, and Floyd County, Georgia (USFWS, 1991)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Abiotic, Insect (EPA, 2016)

Breeding Season

Adult: Flowering in mid-June; fruiting in July to August (EPA, 2016)

Key Resources Needed for Breeding

Adult: Insects for pollination (EPA, 2016)

Reproduction Narrative

Adult: Reproduction is abiotic and by insect. Flowering occurs in mid-June, with fruiting in July to August. As a means of avoiding self-pollination, flowers on a given plant produce pollen before that plant's stigmas become receptive (EPA, 2016)

Habitat Type

Adult: Wetland, Terrestrial (NatureServe, 2015b)

Habitat Vegetation or Surface Water Classification

Adult: Barrens, forest edges, meadows, grasslands (NatureServe, 2015b)

Dependencies on Specific Environmental Elements

Adult: sandy clays, which are alkaline, high in organic matter, and seasonally wet (USFWS, 1991)

Environmental Specificity

Adult: Narrow (NatureServe, 2015b)

Habitat Narrative

Adult: The habitat is moist prairie-like openings in woodlands, along shale-bedded streams, and meadows. The soils are sandy clays, which are alkaline, high in organic matter, and seasonally wet. Most currently known populations occur on soils of the Conasauga-Firestone Association. Plants occur in full sun or partial shade in a grass-sedge community (USFWS, 1991; NatureServe, 2015).

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: Seeds are probably dispersed by birds and other small mammals (EPA, 2016).

Population Information and Trends**Population Trends:**

Not available.

Number of Populations:

19 extant, 9 historical/extirpated (USFWS, 2016)

Population Size:

Up to 6,740 individuals estimated (USFWS, 2016)

Population Narrative:

Schotz (2014) estimated the total range-wide population to be up to 6,740 individuals. Additional recent survey data from some of these sites and other sites not visited by Schotz in Alabama (e.g., AANG 2015, TVA 2015) suggests that this estimate is low; however, 2015 surveys by Malcolm Hodges (pers. comm. 2015) did not relocate plants at three small sites in Georgia where Schotz had previously found them. Together, this recent survey data suggests that the range-wide Mohr's Barbara's buttons population size may approach 10,000 plants (Schotz 2014, AANG 2015, M. Hodges pers. comm. 2015, TVA 2015). Individual sites may range from fewer than 20 plants to well over 1,000 (Schotz 2014, AANG 2015, TVA 2015); although, most (27

[79%]) of the 34 extant sites surveyed by Schotz support 200 or fewer plants. Furthermore, two-thirds of the plants encountered during Schotz's surveys were found at only seven sites. Additionally, Schotz noted that at a given site, plants may be clustered in areas of approximately 50 square feet or can be scattered across several acres, which is similar to observations made by others (i.e., AANG 2015, TVA 2015). (USFWS, 2016)

Threats and Stressors

Stressor: Destruction and Degradation of Habitat (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Clearing, conversion, and agricultural activities remain persistent threats to various Mohr's Barbara's buttons' occurrences (Schotz 2014). Nearly one-third (11 of 34) of extant sites Schotz (2014) surveyed have been converted to pine plantations and/or had been impacted by recent timber harvests. In addition, logging is thought to have extirpated Etowah County, Alabama's only known population (Schotz 2014, D. Spaulding pers. comm. 2015), while conversion to row crop agricultural field has likely extirpated one population in Cherokee County, Alabama (Schotz 2014). Suitable habitat for Mohr's Barbara's buttons remains vulnerable to loss. As described above, most Coosa Valley prairies are thought to have been lost since the early 1800s with the only known remnants of this habitat currently located in Floyd County, Georgia (Duncan 2013). Similarly, Bibb County, Alabama's Ketona dolomite glades are unique and exceedingly rare habitats and are vulnerable to damage by recreational uses and adjacent logging activities. Schotz (2014) noted damage to two glades by recreational traffic (e.g., ATV use) and logging damage or vulnerability of two others. Construction of a borrow pit is thought to have reduced available habitat for one site in Floyd County, Georgia (Schotz 2014). Furthermore, development and associated habitat destruction are projected to continue for decades to come throughout the southeastern United States (Stein et al. 2010), which could further encroach upon and limit habitat suitable for Mohr's Barbara's buttons. (USFWS, 2016)

Stressor: Inadequate/Incompatible Habitat Management (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: An important threat to Mohr's Barbara's buttons' continued survival is incompatible and inadequate land management. While the species is apparently able to survive certain types of forestry practices (e.g., limited timber harvesting that opens up the canopy), its apparent inability to tolerate heavy shading likely increases its susceptibility to practices that promote vegetation succession and encroachment of invasive species (e.g., fire suppression). Fire may be an important mechanism for maintaining the open character of some of Mohr's Barbara's buttons habitats. Inadequate fire regimes threaten some occurrences by allowing competing vegetation—particularly hardwoods—to grow unchecked, thereby encroaching upon available habitat for Mohr's Barbara's buttons and reducing availability of resources (e.g., light) that the species requires to survive and thrive (Patrick et al. 1995, Schotz 2014). Fire exclusion was noted as a primary threat to 24% of sites surveyed by Schotz (2014), whereas succession was considered a threat to 29%. Highway and utility rights-of-way are currently home to various Mohr's Barbara's buttons sites. The known extent of three extant populations are restricted to a TVA utility right-of-way (in Jefferson County, Alabama), whereas portions of at least six other

populations occur in either utility or road rights-of-way (Allison 1993, Schotz 2014, M. Hodges pers. comm. 2015). As such, these sites are heavily dependent upon compatible management regimes to maintain healthy populations (e.g., Schotz 2014, AANG 2015, TVA 2015). Mohr's Barbara's buttons is particularly vulnerable to herbicides and incompatible mowing regimes within its habitats; however, appropriate mowing regimes may also serve as valuable conservation tools in these areas (Schotz 2014). Schotz (2014) noted that nearly one-third of all sites surveyed were vulnerable to incompatible management regimes within rights-of-way throughout the species' range. Furthermore, at least one site along a road right-of-way in Cherokee County, Alabama is thought to have been extirpated by incompatible management (Schotz 2014). Additional emphasis on reintroducing fire or fire surrogates (e.g., mowing) is needed to promote healthy populations and maintain open conditions that this species requires. (USFWS, 2016)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Mohr's Barbara's buttons is a State threatened plant in Georgia (Patrick et al. 1995) and, therefore, receives State protection from non-permitted collection and sale; however, State law does not provide protection against habitat destruction in Georgia. Collection of this species on public lands without a permit is prohibited in Georgia under the Georgia Wildflower Preservation Act of 1973, O.C.G.A. 12-6-170. No such provisions are afforded to plants found on privately owned lands in the State. The species does not receive any specific legal protections from State laws or regulations in Alabama. (USFWS, 2016)

Stressor: Invasive Species (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: During the most recent range-wide survey, Schotz (2014) noted that invasive species are a potential threat to some Mohr's Barbara's buttons populations. Indeed, Schotz (2014) observed encroachment of exotic invasive plants species at 14 Mohr's Barbara's buttons sites. These species—predominantly Chinese privet (*Ligustrum sinense*)—left unchecked have the potential to degrade habitat quality and out-compete Mohr's Barbara's buttons for resources (e.g., moisture, nutrients, light, and recruitment sites). Currently, threats posed from invasive plants at most sites appears to be minimal (Schotz 2014); however, habitat management (e.g., fire, mechanical or hand thinning, etc.) may be required to control invasive species where they threaten Mohr's Barbara's buttons. (USFWS, 2016)

Stressor: Small Population Size (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: Most extant populations of Mohr's Barbara's buttons are comprised of a number of small, fragmented occurrences. While population sizes (i.e., number of plants obtained from counts or estimates) are not available for all sites/populations of Mohr's Barbara's buttons, the most recent range-wide status assessment by Schotz (2014) found that most sites had small local population sizes and that most of the range-wide population was contained in only a few sites

with comparatively large local populations. Indeed, Schotz found that 53% (18 of 34) of extant sites had local populations of ≤ 100 individuals and 79% (27 of 34) of these sites had ≤ 200 individuals. Together, sites with ≤ 200 individuals accounted for about one-third of the total population evaluated by Schotz. By contrast, only three sites evaluated were found to have 500 or more plants, which accounted for nearly half of the entire population evaluated range-wide. Small population sizes increase the vulnerability of individual sites to environmental and anthropogenic perturbations and chance events. In addition, small population sizes increase the risks posed by inbreeding and genetic drift, which may limit the species' adaptive capacity and ability to cope with future stressors (Ellstrand and Elam 1993). (USFWS, 2016)

Stressor: Climate Change (USFWS, 2016)

Exposure:

Response:

Consequence:

Narrative: The precise magnitude and impacts of climate change on the southeastern United States are uncertain, but models have projected that climate change in the region may include increased temperatures of 2 to 4°C (3.6 to 7.2°F) accompanied by reduced average annual precipitation by the end of the century (Joyce et al. 2011). Specific impacts of climate change on populations of Mohr's Barbara's buttons are poorly understood; however, a variety of impacts are possible. Climate change has the potential to affect distribution and abundance of plants by influencing seasonal weather patterns, frequency and timing of severe weather events, and myriad plant physiological responses (Hawkins et al. 2008). Davenport (2007) suggested that Mohr's Barbara's buttons may be negatively impacted by climate change within Alabama as available habitat becomes constricted. In addition, climate change may disrupt plant-pollinator interactions via phenological shifts in flowering and/or pollinator activity (Memmott et al. 2007, Hawkins et al. 2008), which may thereby reduce sexual reproduction of Mohr's Barbara's buttons. While disease is not currently known to threaten Mohr's Barbara's buttons, climate change has the potential to promote the spread of infectious diseases among plants, particularly if arthropod vectors become more widespread and abundant (Anderson et al. 2004, Garrett et al. 2006, Hawkins et al. 2008). Given the variety and complexity of climate change's potential effects (cf. Hawkins et al. 2008, Walther 2010), more research is needed to assess its potential long-term impacts on Mohr's Barbara's buttons populations and habitats. (USFWS, 2016)

Recovery

Reclassification Criteria:

Not applicable.

Delisting Criteria:

1. There are 15 viable populations and all are protected from present and foreseeable human-related and natural threats (USFWS, 1991)
2. At least three populations each should be located within the two physiographic regions represented by its historic range (Cumberland Plateau, Ridge and Valley) (USFWS, 1991).
3. At least three of the 15 populations should be located within Alabama and three in Georgia. Viability of populations will be assessed through monitoring for a period not less than 15 years (USFWS, 1991).

Recovery Actions:

- Protect existing populations from any present or foreseeable threats, and search for additional populations (USFWS, 1991)
- Determine population size. Conduct demographic studies and gather life history information (USFWS, 1991).
- Determine habitat characteristics. An understanding of this species ecology is an important component to determining what factors limit its distribution (USFWS, 1991).
- Determine parameters of a viable population. The long-term survival of the species will be ensured only if a sufficient number of viable populations are protected. (USFWS, 1991).
- Determine and implement appropriate management. Management of habitat, as well as protection, appears to be essential for ensuring that vigorous populations are maintained (USFWS, 1991).
- Conduct monitoring studies. A general monitoring program should be devised and implemented on sites in order to track population trends and evaluate the effectiveness of recovery efforts (USFWS, 1991).
- Preserve genetic material. Protection of the gene pool should be accomplished through seed bank storage and by maintaining material in cultivation (USFWS, 1991).
- Recommendations for Future Actions from 2016 5-Year Review: •Work with federal and state entities, non-governmental organizations, and private individuals to permanently protect and manage existing habitats and populations, including the development and implementation of management plans, as needed. •Conduct studies to determine the number and distribution of populations required to maintain the species' genetic diversity. •Investigate metapopulation structure and dynamics of the species. •Conduct studies into the species' life history, biology, and ecology. •Investigate efficacy of habitat management techniques (e.g., fire). Update and improve monitoring and habitat management methods. •Update the species' recovery plan to reflect current knowledge (e.g., distribution, habitats) and needs (e.g., data/knowledge deficiencies, management). (USFWS, 2016)

Conservation Measures and Best Management Practices:

- Personnel of the Alabama Highway Department (Department) are aware of the plants on or near the ROWs they maintain and of the importance of protecting them. An informal agreement exists between the U.S. Fish and Wildlife Service (Service) and the Department for protection of the plants on their ROWs (USFWS, 1991).
- One population on private land in Cherokee County is protected through a long-term Cooperative Agreement (USFWS, 1991).

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SPECIES ACCOUNT: *Helianthus paradoxus* (Pecos (=puzzle, =paradox) sunflower)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/20/1999; Southwest Region (R2) (USFWS, 2016)

Physical Description

An annual herb with stems 1-2 m tall. Flower heads have yellow rays and are 3-5 cm across (NatureServe, 2015).

Taxonomy

Puzzle sunflower is a species of hybrid origin (Rieseberg et al. 1990; Rieseberg 1991). The parental species are the common sunflower and the prairie sunflower, *H. petiolaris*. These two species occupy different habitats from puzzle sunflower (NatureServe, 2015).

Historical Range

Historically there were six other locations within Pecos and Reeves Counties; however all except one of these sites have not been relocated due to imprecise locality data and the lack of access to private land. The relocated site was heavily invaded by salt cedar and had little water left. No puzzle sunflowers were found, although the entire site was not searched (NatureServe, 2015).

Current Range

At present puzzle sunflower occurs in two general areas in Pecos and Reeves Counties in west Texas and four general areas in New Mexico (NatureServe, 2015). Pecos sunflower populations occur at alkaline wetlands in the arid regions of west Texas, lower Pecos River of eastern New Mexico, and the Rio Grande and Rio San Jose of west-central New Mexico (USFWS, 2015).

Critical Habitat Designated

Yes; 4/1/2008.

Legal Description

On April 1, 2008, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Helianthus paradoxus* (Pecos (=puzzle, =paradox) sunflower) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes five critical habitat units (CHUs), in New Mexico and Texas (73 FR 17762-17807).

Critical Habitat Designation

The critical habitat designation for *Helianthus paradoxus* includes five CHUs (ten sub-units) in Chaves, Cibola, and Guadalupe counties, New Mexico, and in Pecos County, Texas. This species critical habitat encompasses approximately 1,305 acres (ac) (528 hectares (ha)) (73 FR 17762-17807).

Unit 1: West-Central New Mexico: Subunit 1a is located at Rancho del Padre Spring Cienega. This subunit is 26 ac (10 ha) in Cibola County, New Mexico. The subunit consists of an area of Rancho del Padre Spring Cienega from the spring on the south side of I-40 then northeast approximately 0.5 mi (0.8 km) to the Rio San Jose. This population consists of large patches of several thousand

plants on areas owned by two private landowners (23 ac (9 ha)) and the Pueblo of Acoma (3 ac (1 ha)). This site was known to be occupied at the time of listing and has been visited or observed from a public right-of-way by species experts during four or more seasons. These experts have found the site occupied by *H. paradoxus* on every visit (Sivinski 2007a, p. 3). This unit is currently occupied, contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by water withdrawal, wetland filling and development, and livestock grazing during *H. paradoxus*'s growing and flowering season. Therefore, special management or protections may be required to minimize these threats. At this time, we are not aware of any management plans that address *H. paradoxus* in this area. Subunit 1b is located at Grants Salt Flat Wetland. This subunit is 63 ac (25 ha) of private land in Cibola County, New Mexico. The subunit consists of an area of wet alkaline playa (i.e., a seasonal, shallow desert lake) between railroad tracks and I-40 and west of Hwy 122 (Road from Interstate to downtown Grants). Playas are nearly level areas at the bottom of undrained desert basins that are sometimes covered in water. This population consists of large patches of several thousand plants mostly on private property. This site was occupied at the time of listing and has been visited or observed from a public right-of-way by species experts during four or more seasons. These experts have found the site occupied by *Helianthus paradoxus* on every visit (Sivinski 2007). This unit is currently occupied, contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by wetland filling and development, encroachment by nonnative vegetation, and livestock management not compatible with *H. paradoxus* physiology. Therefore, special management or protections may be required to minimize these threats. At this time, we are not aware of any management plans that address *H. paradoxus* in this area. Subunit 1c is located at the Pueblo of Laguna. This subunit's acreage is undefined in Valencia County, New Mexico. The subunit consists of an area along the Rio San Jose, South Garcia, New Mexico. At this site, *Helianthus paradoxus* plants are located in patches at springs along the Rio San Jose. Each patch consists of several hundred to several thousand plants, and a few scattered plants grow along the river (Sivinski 1995, p. 4). The entire site belongs to the Pueblo of Laguna. This site was occupied at the time of listing, is currently occupied, contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by water withdrawal, encroachment by nonnative vegetation, and livestock grazing during *H. paradoxus*' growing and flowering season. The Pueblo has developed a management plan for *H. paradoxus*. On the basis of this plan and our partnership with the Pueblo of Laguna, we are excluding this area from the final critical habitat designation pursuant to section 4(b)(2) of the Act (see "Application of Section 4(b)(2) of the Act" section below for additional information).

Unit 2: La Joya Wildlife Management Area: Unit 2 is located in the La Joya Wildlife Management Area. This unit is 854 ac (346 ha) in Socorro County, New Mexico. This population is located about 7 mi (11 km) south of Bernardo within Socorro County near the confluence of the Rio Grande and the Rio Puerco. The La Joya population is bounded to the west by I-25 and to the east by the Unit 7 Drain. The north boundary is adjacent to River Mile 126 of the Rio Grande and the south boundary is adjacent to River Mile 123. One of the largest populations of *Helianthus paradoxus* occurs adjacent to the Rio Grande at La Joya. This Rio Grande population consists of 100,000 to 1,000,000 plants and occurs on the La Joya Wildlife Management Area (Service 2005, p. 4). It is within the La Joya Unit of the Ladd S. Gordon Waterfowl Complex. This property is owned by the New Mexico State Game Commission. It is managed by the NMDGF for migratory waterfowl habitat, which is compatible with preservation of wetlands for *H. paradoxus*. We believe this area was not occupied at the time of listing. It was discovered in 2004. This site has been found to be occupied every year since then and represents one of the largest populations of *Helianthus paradoxus* in the range of the species (Hirsch 2006, p. 1). This unit is currently

occupied by a stable population (Blue Earth Ecological Consultants, Inc. 2007c, p. 3), contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by encroachment of nonnative vegetation. We have determined this site to be essential to the conservation of the species because it is currently occupied by a stable, very large population of *Helianthus paradoxus*, and is sufficiently distant (over 40 mi (64 km)) from other populations to serve as an additional locality that contributes to the conservation of genetic variation. This population may prevent extirpation of the species resulting from encroachment of nonnative species, degradation of habitat, or a catastrophic event because it is the sole representative located in an area distinct from any other population in the range of the species. As such, it may contain genetic variation not found anywhere else in the range of the species. Because the water source for this population is stable, this population can be expected to persist in very large numbers every year. As described below, we are excluding Unit 2, the La Joya Wildlife Management Area, from the critical habitat designation for *Helianthus paradoxus* (see “Exclusions Under Section 4(b)(2)” section).

Unit 3: Santa Rosa: Subunit 3a is located at Blue Hole Cienega/Blue Hole Fish Hatchery Ponds. This subunit is 134 ac (54 ha) in Guadalupe County, New Mexico. The Blue Hole Fish Hatchery Ponds population of *Helianthus paradoxus* is part of the same population as and nearly contiguous with the Blue Hole Cienega in Santa Rosa, New Mexico. The Blue Hole Fish Hatchery Ponds population is immediately north of Blue Hole Road and the Blue Hole Cienega is immediately south. This subunit was occupied at the time of listing and has been visited by species experts during four or more seasons. These experts found the subunit to be occupied by *Helianthus paradoxus* on every visit (Sivinski 2007a, p. 2). This subunit is currently occupied (Blue Earth Ecological Consultants, Inc. 2006, p.1), contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by encroachment of nonnative vegetation, wetland filling, and park maintenance activities. Therefore, special management or protections may be required to minimize these threats. At this time, we are not aware of any management plans that address *H. paradoxus* in this area. The part of this population at Blue Hole Cienega consists of 100,000 to 1,000,000 plants and is the largest population of *Helianthus paradoxus* in the upper Pecos River basin. A nontraditional section 6 grant was awarded to the State of New Mexico in 2004 for acquisition of the Blue Hole Cienega, which was finalized in July 2005. At this site, shallow ground water seeps to the surface to create cienega communities. This subunit is currently occupied, contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by encroachment by nonnative vegetation. Therefore, special management or protections may be required to minimize these threats. At this time, we are not aware of any management plans that address *H. paradoxus* in this area. The part of this population at the Blue Hole Fish Hatchery Ponds is owned and administered by the City of Santa Rosa and consists of approximately 1,000 plants. This site is maintained as a recreational area. City of Santa Rosa park maintenance staff have voluntarily stopped mowing and cutting *Helianthus paradoxus* during the months of August and September. An information kiosk on endangered wetland plants is being planned for the bike/foot path along the creek at Blue Hole Park. This subunit was confirmed to be occupied in 2006 (Blue Earth Ecological Consultants, Inc. 2006, p. 4), contains all of the PCEs, and is threatened by encroachment from nonnative vegetation, wetland filling, and park maintenance activities. Therefore, special management or protections may be required to minimize these threats. At this time, we are not aware of any management plans that address *Helianthus paradoxus* in this area. Subunit 3b is located at Westside Spring. This subunit is 6 ac (3 ha) of private land in Santa Rosa, Guadalupe County, New Mexico. The subunit consists of an area along an unnamed spring on the west side of the Pecos River, located to the west of River

Road and 1 mi (1.6 km) east of Highway 54. We believe this area was not occupied at the time of listing. It was discovered in 2005, and contained thousands of plants. This site was found to be occupied again in 2006 by a species expert observing from a public right-of-way (Sivinski 2007). This subunit is currently occupied by a stable population, contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by water withdrawal, wetland filling and development, and encroachment of nonnative vegetation. Therefore, special management or protections may be required to minimize these threats. At this time, we are not aware of any management plans that address *Helianthus paradoxus* in this area. We have determined this site to be essential to the conservation of the species because it is currently occupied by a stable, large population of *Helianthus paradoxus*, and is one of only two stable, large populations in Unit 3. This subunit is sufficiently distant (over 40 mi (64 km)) from other populations to serve as an additional locality that contributes to the conservation of genetic variation. This population may prevent extirpation of the species resulting from encroachment of nonnative species, degradation of habitat, or a catastrophic event that could occur to the other subunit in Unit 3. It may also contain genetic variation specific to this Unit. Because the water source for this population is stable and not anticipated to be subject to any known future water withdrawals, this population can be expected to persist in large numbers every year.

Unit 4: Roswell/Dexter: Subunit 4a includes 576 ac (233 ha) of Bitter Lake National Wildlife Refuge and City of Roswell land located in Chaves County, New Mexico. This subunit is located approximately 5 mi (8 km) northeast of the city of Roswell. One of the largest *Helianthus paradoxus* populations occurs on the Bitter Lake National Wildlife Refuge in New Mexico on Federal lands managed by the Service. Several hundred thousand to a few million plants occur nearly continuously along the shores and small islands of all the artificial lakes in the southern unit of the refuge. Also, a few small patches of plants occur on the west side of Bitter Lake Playa and adjacent springs on the Lost River. This area was occupied at the time of listing and has been visited by species experts during four or more seasons. These experts found the site occupied by *Helianthus paradoxus* on every visit (Ulibarri 2006a, p. 1; Sivinski 2007a, p. 2; Blue Earth Ecological Consultants, Inc. 2007a, p. 3). This area is currently occupied, contains all of the PCEs essential to the conservation of the species, and is threatened by water withdrawal and encroachment of nonnative vegetation. Additional threats occurring on the City of Roswell lands include wetland filling and development, and incompatible livestock management. Therefore, special management or protections may be required to minimize these threats. Subunit 4b includes 96 ac (39 ha) of land within the Bitter Lake National Wildlife Refuge Farm (Refuge Farm). This subunit is located in Chaves County, New Mexico, approximately 5 mi (8 km) east of Roswell on the west side of the Pecos River. Subunit 4b consists of a few large patches with several thousand plants on alkaline seeps behind the dikes on the western edge of the Refuge Farm south of Highway 380. This land is owned and managed by the Service as a grain farm and feeding area for migratory birds. The eastern portion of the Refuge Farm is a marshy spring-seep area that contains a large population of *Helianthus paradoxus*. The wet soils in this population are not cultivated. This area was known to be occupied at the time of listing and has been visited by species experts during four or more seasons. The experts found the site occupied by *Helianthus paradoxus* on every visit (Ulibarri 2006b, p. 1; Sivinski 2007a, p. 2; Blue Earth Ecological Consultants, Inc. 2007a, p. 3). This subunit is currently occupied and contains all of the PCEs in the appropriate spatial arrangement and quantity essential to the conservation of the species. Subunit 4c is located at the Oasis Dairy. This subunit is 104 ac (42 ha) of private land in Chaves County, New Mexico. The subunit is located on the east side of Roswell, west side of Pecos River Valley, approximately 4 mi (7 km) southeast of the Hwy 380 bridge, and beside an

unnamed spring approximately 0.6 mi (1 km) west of the Pecos River and 6 mi (9 km) south of Highway 380. This site contains a very large, dense patch of several thousand *Helianthus paradoxus* in a low alkaline sink area approximately 0.5 mi (0.8 km) west of the Pecos River on private land. It also contains a large patch with many thousands of *H. paradoxus* in a low area below a spring, also on private land. This site was occupied at the time of listing and has been visited by species experts during at least three seasons. These experts found the site occupied by *H. paradoxus* on every visit (Sivinski 2007a, p. 3). This subunit is currently occupied, contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by livestock grazing during *H. paradoxus*' growing and flowering season, water withdrawal, and wetland filling and development. Therefore, special management or protections may be required to minimize these threats. At this time, we are not aware of any management plans that address *H. paradoxus* in this area.

Subunit 4d is located at Lea Lake at Bottomless Lakes State Park. This subunit is 20 ac (8 ha) in Chaves County, New Mexico. It includes the wet margins of Lea Lake. This site contains a few thousand plants on the riparian margins of Lea Lake. This land belongs to the State of New Mexico and is managed by the New Mexico Parks and Recreation Division. The lands adjacent to Lea Lake are used as a picnic area and campground for the State Park. This site was occupied at the time of listing and has been visited by species experts during four or more seasons. These experts found the site occupied by *Helianthus paradoxus* on every visit (Sivinski 2007a, p. 3). This subunit is currently occupied (Sivinski 2007a, p. 3; Blue Earth Ecological Consultants, Inc. 2007a, p. 3), contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by encroachment of nonnative vegetation, and recreational and park maintenance activities. Therefore, special management or protections may be required to minimize these threats. At this time, we are not aware of any management plans that address *H. paradoxus* in this area.

Cienega. This subunit is 41 ac (17 ha) of private land in Chaves County, New Mexico. The subunit is located in a small valley west of the Pecos River, east of the Hagerman Irrigation Canal, and 3 mi (5 km) north of Dexter. This site consists of several thousand plants on private land along a wide, boggy drainage bottom. This site was known to be occupied at the time of listing based upon observations from a public right-of-way by species experts during at least three seasons (Sivinski 2007a, p. 2). This subunit is currently occupied, contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by water withdrawal, wetland filling and development, and livestock grazing during *Helianthus paradoxus*' growing and flowering season. Therefore, special management or protections may be required to minimize these threats. At this time, we are not aware of any management plans that address *H. paradoxus* in this area.

Unit 5: West Texas Unit 5 includes 240 ac (97 ha) of private land located on Diamond Y Spring in Pecos County, Texas. The unit is located approximately 12 mi (20 km) north-northwest of Fort Stockton, Texas. Unit 5 consists of several hundred thousand to one million plants found on The Nature Conservancy's Diamond Y Spring Preserve and a contiguous parcel of private land. This site was occupied at the time of listing and has been visited by species experts during four or more seasons. These experts found the site occupied by *Helianthus paradoxus* on every visit (Poole 2006, p. 2). This unit is currently occupied (Blue Earth Ecological Consultants, Inc. 2007b, p. 3) and contains all of the PCEs essential to the conservation of the species. The land within The Nature Conservancy's Diamond Y Spring Preserve was purchased to protect Diamond Y Spring Preserve and other rare or endangered aquatic species in the Diamond Y Spring system. This habitat is managed for the conservation of such species (Service 2005, p. 12). Diamond Y Spring Preserve has recently expanded from 1,500 ac (607 ha) to 4,000 ac (1,618 ha). However, *Helianthus paradoxus* on the Preserve is threatened by water withdrawal occurring outside the

Preserve. On the adjacent private land, *H. paradoxus* is also threatened by water withdrawal, wetland filling and development, and livestock grazing during the growing and flowering season. As a result, special management or protections may be required to minimize these threats. At this time, we are not aware of any completed management plans that address *H. paradoxus* in this area.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Helianthus paradoxus* critical habitat consists of two components (73 FR 17762-17807):

- (i) Silty clay or fine sand soils that contain high organic content, are saline or alkaline, are permanently saturated within the root zone (top 50 cm (19.7 in) of the soil profile), and have salinity levels ranging from 10 to 40 parts per thousand; and
- (ii) A low proportion (less than 10 percent) of woody shrub or canopy cover directly around the plant.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the areas occupied by the species at the time of listing contain the physical and biological features essential to the conservation of the species, and whether these features may require special management consideration or protections. As stated in the final listing rule (64 FR 56582), threats to *Helianthus paradoxus* and its physical and biological features include drying of wetlands from groundwater depletion, alteration of wetlands (e.g., wetland fills, draining, impoundment, and development), competition from nonnative plant species, overgrazing by livestock during *H. paradoxus*' flowering season, impacts from recreational activities, mowing, and highway maintenance. The loss or alteration of wetland habitat continues to be the main threat to *Helianthus paradoxus*. The scattered distribution of cienegas makes them aquatic islands of unique habitat in an arid-land matrix (Hendrickson and Minckley 1984, p. 169). There is evidence these habitats have been historically, and are presently being, reduced or eliminated by aquifer depletion, and severely impacted by agricultural activities and encroachment by exotic plants (Poole 1992, pp. 1–2; Sivinski 1995, p. 11). The lowering of water tables through aquifer withdrawals for irrigation and municipal use, diversion of water from wetlands for agriculture and recreational uses, and wetland filling for conversion to dry land uses destroy or degrade desert wetlands. In Grants, New Mexico, *Helianthus paradoxus* has been observed in close proximity to building sites that may have contained suitable wetland habitat prior to filling (Service 2005, p. 8). A cienega containing *H. paradoxus* near Dexter, New Mexico, was dried when a wellhead was placed on the spring and the water diverted for other uses (Service 2005, p. 8). Springs that have fed *H. paradoxus* habitats have been converted to swimming pools and fishing ponds in the towns of Roswell and Santa Rosa, New Mexico (Service 2005, p. 8). Groundwater withdrawals for agriculture in Pecos and Reeves counties in Texas have had an especially severe impact on desert springs (Service 2005, p. 8). Of the 61 historical desert springs in these two counties, only 13 were still flowing in 1980 (Brune 1981 in Poole 1992, p. 5). Beginning around 1946, groundwater levels fell as much as 400 feet (ft) (120 meters (m)) in Pecos County and 500 ft (150 m) in Reeves County. Groundwater pumping has lessened in more recent years due to the higher cost of removing water from deeper aquifers, but rising water tables and resumption of spring flows are not expected (Poole 1992, p. 5). We are not aware of any protections afforded by Texas water

law for the remaining springs that support *H. paradoxus* populations on The Nature Conservancy properties, which limits options for addressing this threat. Livestock will eat *Helianthus paradoxus* when other green forage is scarce, and when the buds are developing and abundant (Service 1999, p. 56587). Cattle and horses tend to pull off the flower heads, which can reduce seed production (Bush and Van Auken 1997, p. 416). However, well-managed grazing during non-flowering months may have a beneficial effect on *H. paradoxus* populations by decreasing the density and biomass of potentially competing plant species in these habitats. This sunflower germinates earlier than most associated plants and grows vigorously on wet, bare, highly insolated soils (Service 2005, p. 9). Actions that remove shading grass cover, such as grazing, appear to enhance growth and reproduction of sunflower plants that are later protected from grazing while they are reproductively maturing. Therefore, properly managed livestock grazing can be compatible with *H. paradoxus* conservation. Livestock grazing operations that are not managed to protect *H. paradoxus* occur in populations in the Grants and Roswell areas of New Mexico (Service 2005, p. 9). Although water contamination is a significant threat for the Roswell springsnail, Koster's springsnail, Noel's amphipod, and the Pecos assiminea found on Bitter Lake National Wildlife Refuge (70 FR 46304), we have no information on whether contamination of water would affect *Helianthus paradoxus*. We did not find that reduced water quality was a threat to the species when it was listed in 1999 (64 FR 56582). Moreover, we are not aware of any research or information that documents the species' response to elevated nutrients or contaminants. For these reasons, we do not believe that water contamination is a significant threat to *H. paradoxus* at this time. We have determined that each area included in this designation meets the definition of critical habitat for the reasons described in our unit descriptions below.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination (inferred from NatureServe, 2015)

Lifespan

Adult: 1 year (inferred from USFWS, 2015)

Breeding Season

Adult: August - October (USFWS, 2015)

Key Resources Needed for Breeding

Adult: Possibly ground disturbance (inferred from NatureServe, 2015); pollinators unknown - likely various insects (USFWS, 2005)

Reproduction Narrative

Adult: No specific research has been conducted on the reproduction of this species. The reproductive biology is likely to be very similar to that of the common sunflower, *H. annuus*. Cattle disturbance of the surrounding vegetation may supply puzzle sunflower with light gaps for germination and growth, and lessen competition (Bush and Van Auken 1997). Numerous experiments have been conducted both in and ex situ on competition between puzzle sunflower and its associates (Van Auken and Bush 1993, 1994, 1995). With competitors removed, puzzle

sunflower exhibited greater basal stem diameter, more flower heads, and greater flower head, leaf, and stem dry mass (Bush and Van Auken 1997). Annual species of sunflowers hybridize in cultivation, but have reduced pollen viability and seed fertility (Heiser 1965, 1969). Hybrids of puzzle and common sunflower have been observed at Diamond Y Preserve in west Texas and in the Santa Rosa area of New Mexico (NatureServe, 2015). The Pecos sunflower is an annual plant that must re-establish each population by seeds produced during preceding years. It is annual plant that germinates in the spring, and flowers and makes seed from late August through October (USFWS, 2015). Pollination vectors for the Pecos sunflower have not been studied. However, most radiate-headed plants in the aster family are generalists in attracting a variety of insect pollinators (USFWS, 2005).

Habitat Type

Adult: Wetland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Cienega (NatureServe, 2015), wet meadow, spring seeps (USFWS, 2015)

Dependencies on Specific Environmental Elements

Adult: Disturbance regime, 10 - 40 ppt soil salinity, < 10% canopy cover (USFWS, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 3,280 - 6,561 ft. elevation (USFWS, 2015)

Spatial Arrangements of the Population

Adult: Patches of dozens to thousands (USFWS, 2005)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 2015)

Habitat Narrative

Adult: *Helianthus paradoxus* is the only sunflower in the Southwest United States that requires permanent wetlands for its survival. Puzzle sunflowers grow in saline soils that are permanently saturated. Areas that maintain these conditions are commonly called cienegas (desert wetlands) associated with springs. However, the required conditions may also be found at stream margins and at the margins of impoundments. Where plants are associated with the latter the impoundments have replaced the natural cienegas. Van Auken and Bush (1995) tested puzzle sunflower to determine if it was mycorrhizal. The greenhouse experiments, done with non-native soil, indicated that puzzle sunflower was an obligate mycorrhizal species (NatureServe, 2015). This species is associated with spring seeps and desert cienegas, or wet meadows, which are very rare in the dry regions of New Mexico and Texas. The cienega climax community has been described as mid-elevation, 3280.84 to 6561.68 feet (ft.). Disturbance regimes, such as fire or tillage, which eliminate vegetation thatch and expose bare ground surface tend to increase Pecos sunflower cover and productivity (Van Auken and Bush 2004; New Mexico Forestry Division 2008). Based on knowledge of the life history, biology, and ecology of the Pecos sunflower and the habitat requirements for sustaining the essential life history functions of the

species, the PBFs for Pecos sunflower are the desert wetland or riparian habitat components that provide: (1) Silty clay or fine sand soils that contain high organic content, are saline or alkaline, are permanently saturated within the root zone in the top 19.69 inches (in) (50 centimeters (cm)) of the soil profile, and have salinity levels ranging from 10 to 40 parts per thousand; and (2) low proportion (less than 10 percent) of woody shrub or canopy cover directly around the plant (U.S. Fish and Wildlife Service 2008b). The Pecos sunflower is intolerant of habitats that are too wet at the surface and prefers soils that are relatively dry at the surface and wet in the lower root zone (Bush 2006) (USFWS, 2015). Populations tend to grow in crowded patches of dozens or even thousands of individuals (USFWS, 2005).

Dispersal/Migration

Dispersal

Adult: Low (USFWS, 2015)

Dispersal/Migration Narrative

Adult: Limited seed mobility restricts the ability of the Pecos sunflower to disperse to other suitable habitats or away from habitat that becomes unsuitable (USFWS, 2015).

Population Information and Trends

Population Trends:

Unknown (NatureServe, 2015)

Resiliency:

Low (inferred from USFWS, 2015)

Redundancy:

Low (inferred from USFWS, 2005)

Number of Populations:

7 (USFWS, 2005)

Population Size:

< 100 to > 200,000 per site, fluctuates yearly (USFWS, 2015)

Adaptability:

Low (inferred from USFWS, 2015)

Population Narrative:

At some occurrences it is locally abundant - maybe > 3000 individuals in total - but some New Mexico occurrences are small and nonviable. At present there are six general areas where the species occurs: four in New Mexico and two in Texas. There are between 1 and 11 sites at each of these six general locations for a total of 25 sites. Ten of the 11 Pecos River sites occur within a 22 mile (36 km) stretch of the Pecos River Valley. All eight observations in the Santa Rosa area occur within a four square-mile area. The two sites in Grants are near the San Jose River and separated from the Laguna population by approximately 44 miles (73 km). The two Diamond Y sites are within three miles of each other. The Diamond Y and East Sandia Springs Preserves are

within 50 miles (80 km) of each other. The Texas sites are approximately 150 miles (241 km) south of the most southerly New Mexico site. The overall trend for the species is unclear as the historical distribution, with few exceptions, is unknown (NatureServe, 2015). The Pecos sunflower has a small, localized range, such that either a natural (e.g., drought) or anthropogenic (e.g., water withdrawal) perturbation can eliminate many or all of the existing populations. The number of sunflowers per site varies from less than 100 to several hundred thousand. Because Pecos sunflower is an annual, the number of plants per site can fluctuate greatly from year to year with changes in precipitation and depth to ground water. The Pecos sunflower has a small, localized range, such that either a natural (e.g., drought) or anthropogenic (e.g., water withdrawal) perturbation can eliminate many or all of the existing populations (USFWS, 2015). Pecos sunflower occurs in seven populations; two occur in west Texas and five are located in New Mexico (USFWS, 2005).

Threats and Stressors

Stressor: Reduction of water in springs (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Loss or alteration of spring habitat continues to be the main threat to Pecos sunflower. Lowering water tables from aquifer withdrawals for irrigation and municipal use has degraded many desert spring habitats. The primary threat to the Pecos sunflower in west Texas is the potential failure of spring flow due to excessive groundwater pumping or drought or both, which would result in total habitat loss for the species. There is evidence that spring habitats have been historically reduced or eliminated by aquifer depletion on the Bitter Lake NWR (Jones and Balleau 1996). In addition, recent drought years may have impacted the size of Pecos sunflower populations on La Joya WMA (Hirsch 2012). Here, the total number of acres occupied by Pecos sunflower fell from 261 ac (105.622 ha) in 2010, to 224 ac (90.65 ha) in 2011, to 200 ac (80.94 ha) in 2012, as the drought in New Mexico intensified (USFWS, 2015).

Stressor: Nonnative plants (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Exotic plants have potential to seriously impact the native plant community composition and ecological integrity of arid land springs and cienegas. Exotic trees, especially salt cedar and Russian olive can almost completely convert a treeless cienega to a dense woodland with little understory vegetation. Aggressive, rhizomatous non-native grasses and forbs compete with, and replace, native cienega plants, especially in areas of soil disturbance. Herbaceous exotics that are currently degrading some arid land springs and cienegas include Persoon (Johnsongrass) (*Sorghum halepense*), Hudson meadow fescue and perennial pepperweed (USFWS, 2015).

Stressor: Water contamination (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Water contamination, particularly from oil and gas operations, could be a potential threat for Pecos sunflower, but the effects on this species have not been studied. In order to assess the potential for contamination, a study was completed in September 1999 to delineate the area that serves as sources of water for the springs on Bitter Lake NWR (Balleau Groundwater, Inc. 1999). This study reported that the sources of water that will reach Bitter Lake NWR's springs include a broad area beginning west of Roswell near Eightmile Draw, extending to the northeast to Salt Creek, and southeast to Bitter Lake NWR. This area represents possible pathways from which contaminants may enter the groundwater that feeds the springs on the Refuge. This broad area is located within a portion of the Roswell Basin and contains a mosaic of Federal, State, City, and private lands with multiple land uses, including expanding urban development. There are 378 natural gas and oil wells in the 12-township area encompassing the source-water capture zone for the Middle Tract of Bitter Lake NWR that are potential sources of contamination (Go-Tech 2010). The Diamond Y Springs Complex is within an active oil and gas extraction field. At this time, there are still many active wells and pipelines located within approximately 330 ft. (100 m) of the surface waters at the springs. In addition, a natural gas refinery is located within 0.5 mi (0.8 km) upstream of Diamond Y Spring (USFWS, 2015).

Stressor: Climate change (USFWS, 2015)

Exposure:

Response:

Consequence:

Narrative: Increased air temperatures lead to higher evaporation rates, which may reduce the amount of runoff, groundwater recharge, and consequently spring discharge. Increased temperatures across the Southwest may also increase the extent of area influenced by drought (Lenart 2003), decreasing groundwater recharge regionally, and thereby reducing spring discharge. Prolonged drought leading to diminishment or drying of springs would have a negative impact on Pecos sunflower. Springs would not have to dry out completely to have an adverse effect. In addition, as water becomes increasingly scarce, conflict over its use becomes more intense. The proportion of human and livestock consumption of water would be expected to increase during drought. Any of these factors, alone or in combination, could lead to either the reduction or extirpation of Pecos sunflower populations. Therefore, climate change is a significant threat to the Pecos sunflower into the foreseeable future (USFWS, 2015).

Recovery

Reclassification Criteria:

Not available

Delisting Criteria:

1. Identify and establish at least one core conservation area for Pecos sunflower in each of the four distinct recovery regions that would collectively, if protected, ensure the long-term survival of the species. Each core habitat must occur on wetlands that are not threatened by depletion of the contributing aquifer and have demonstrated a self-perpetuating stand of Pecos sunflowers of greater than 5,000 individuals for a minimum of 7 out of 10 years. In addition to the core conservation area, each region should have at minimum one isolated stand of protected Pecos sunflowers with greater than 1,600 individuals for at least 7 out of 10 years to protect against catastrophic loss of the regional population (USFWS, 2015).

2. Assure long-term protection of designated core conservation areas and designated isolated stands in perpetuity through the implementation of appropriate management plans, conservation easements, or land acquisitions (USFWS, 2015).

Recovery Actions:

- Identify and establish core conservation areas and isolated stands (USFWS, 2005).
- Identify and address information gaps, compatible uses, and management actions regarding Pecos sunflower distribution, biology and aquifer stability (USFWS, 2005).
- Protect core conservation areas and isolated stands through landowner education, implementation of management plans, conservation easements, and land acquisition (USFWS, 2005).
- Monitor Pecos sunflower conservation areas and management actions as needed to satisfy delisting criteria (USFWS, 2005).

Conservation Measures and Best Management Practices:

- Habitat protection through land acquisition or conservation agreements with landowners is the most important remaining recovery task. The development of management plans for the different agencies, as outlined in the recovery plan, should continue to be pursued. Government programs that acquire cienegas or assist landowners with their management are greatly needed (USFWS, 2015).
- Non-native tree species and thatch should continue to be removed in occupied and potential Pecos sunflower habitats. Pecos sunflowers should be re-seeded in suitable areas with willing land owners or managers within the range of the species to expand occupied habitats. The Pecos sunflower would also make an excellent focal species for public education and awareness of the importance of wetlands and the recovery of listed species. These opportunities should be explored and implemented where appropriate (USFWS, 2015).
- The recovery criteria in the Pecos Sunflower Recovery Plan (U.S. Fish and Wildlife Service 2005) should be collectively re-evaluated to determine if they constitute the most effective strategy for conservation and recovery of the species. Of most significance, the actual size of existing core populations is between 50 and 100 times, or even higher multiples in some years of, the minimum number required in the recovery plan. The current recovery criteria may not have considered this much higher number of plants extant throughout the range of the species (USFWS, 2015).
- Survey efforts in occupied and potential habitats should be increased and improved, and surveys should employ an agreed-upon standardized protocol. Surveys should cover the entire range of the species and be repeated at least every 3 years. Existing populations should be monitored to document population trends in response to habitat restoration and maintenance (USFWS, 2015).

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SPECIES ACCOUNT: *Lysimachia asperulaefolia* (Rough-leaved loosestrife)

Species Taxonomic and Listing Information

Listing Status: Endangered; 7/13/1987; Southeast Region (R4)

Physical Description

A perennial rhizomatous herb, with erect stems 30 to 60 centimeters (cm) tall. Leaves are sessile in whorls of 3 to 4, are broadest at the base (0.8 to 2 cm wide), and have three prominent veins. The upper surface is deep yellow-green or blue-green and lustrous; the leaf margins are entire and slightly revolute (Figure 1). The yellow bisexual flowers are borne in a loose, cylindrical, terminal raceme, 3 to 10 cm long. The corolla is 1.5 cm across. There are usually five petals that have ragged margins near the apex and that have dots or streaks. The anthers are yellow-orange, and the style tapers to the simple stigma. The fruit is a capsule. Stipitate glands are usually present on most parts of the plant. Flowering is from late May to early June. Seeds are formed by August, but capsules do not dehisce until October. Although the plants are dormant in the winter, they are easy to find in the fall because of the distinctive leaf pattern and the reddish color of the leaves. (USFWS, 1995)

Taxonomy

Lysimachia asperulaefolia was described by Jean Louis Marie Poiret in 1814. Since listing as endangered in 1987, there have been no changes to the nomenclature of the species, however some references now spell the specific epithet as “*asperulifolia*” an orthographic variant of “*asperulaefolia*.” In addition, in the listing documents and the Recovery Plan, the common name is referred to as Rough-leaved Loosestrife; however, some references use the common name Rough-leaf Loosestrife. Ironically, the leaves are actually smooth in texture. The genus *Lysimachia* is now considered to be part of the Myrsinaceae family and not the Primulaceae family (Weakley 2012). (USFWS, 2014)

Historical Range

Southern coastal plain and sandhills of North Carolina and the sandhills of South Carolina. (USFWS, 1995)

Current Range

Southern coastal plain and sandhills of North Carolina and the sandhills of South Carolina. Twelve counties in North Carolina; one county in South Carolina. (USFWS, 2014)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: Flowering is from late May to early June (USFWS, 1995).

Reproduction Narrative

Adult: The first spring shoots of *L. asperulaefolia* appear in late March or early April. Flowering begins in late May and extends through mid to late June. *L. asperulaefolia* is an obligate out-crossing species, pollinated by solitary bees: most of the pollinators are in the genus *Dialictus*. Pollinators were found to be scarce and inefficient, perhaps contributing to low natural fruit and seed set. Fruit and seed set were much higher when flowers were artificially pollinated (Frantz 1984). Another possible explanation for low fruit and seed set is that populations are highly clonal, with several shoots arising from one rhizome. Since self-fertilization does not occur, pollinator activity among ramets would not result in seed set. Fruits are visible within 3 weeks of fertilization, but capsules do not dehisce until October. An average of 3.2 capsules are produced by flowering stems, with an average of less than two seeds per capsule. In one germination trial, 85 percent of the seeds germinated (Frantz 1984). While fruit and seed set are low, this is not unusual for a perennial species that apparently has a life strategy based largely on rhizomatous growth and therefore does not depend upon sexual reproduction and seedlings for short-term survival (USFWS, 1995). Flowering is from late May to early June. Seeds are formed by August, but capsules do not dehisce until October (USFWS, 1995).

Spatial Arrangements of the Population

Adult: Clumped (inferred from NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Rough-leaf loosestrife occurs most often in ecotones between longleaf pine uplands and pond pine pocosins in moist, sandy or peaty soils with low vegetation that allows for abundant sunlight to the herb layer (USFWS 1993). Fire is primarily responsible for maintaining low vegetation in these ecotones which have been documented to occur between the following habitat types: longleaf pine savanna and pocosin; longleaf pine flatwood and pocosin; longleaf pine savanna and mixed herb; longleaf pine-pond pine and evergreen shrub; longleaf pine/wiregrass savanna and Carolina bay pocosin; Streamhead Pocosin and Pine/Scrub Oak Sandhill; and Sandhill Seep and Pine/Scrub Oak Sandhill (NCNHP 1993). This species often spreads from the ecotone into the open edges of the bordering habitats, for example into longleaf pine savannas and low shrub communities of Carolina bays. Other habitats and community types in which it has been found include: Low Pocosin, High Pocosin, Wet Pine Flatwoods, Pine Savanna, Streamhead Pocosin, and Sandhill Seep (Schafale and Weakley 1990), as well as creek flood basins, pond and lake margins, boggy seeps and meadows, boggy pools in shrub pocosins, and disturbed areas such as roadside depressions, powerline rights-of-way, firebreaks, and trails. In the NC Sandhills, *Lysimachia asperulifolia* prefers to be in lower parts of the ecotone, well within the shrub zone, even when such ecotones are well-burned. On Fort Bragg, a sizeable occurrence was found in a shrub ecotone/pocosin that had burned within four

months of its discovery; most shrubs there had been 2 meters or more tall prior to burning. Low Pocosins occur in areas with deep peat overlaying wet sands and in Carolina bays. They are nutrient-poor, seasonally saturated, and dominated by a dense shrub layer, kept small by low nutrients and severe fires. *L. asperulifolia* occupies openings in the dense shrub layer (USFWS 1993). Rough-leaf loosestrife is also found in the ecotones between Wet Pine Flatwoods or Pine Savannas and High Pocosins where the water table is near the surface during winter and early spring. If burned, these ecotones remain open with characteristic grasses, herbs, and low shrubs (USFWS 1993) (NatureServe, 2015). Clumped spatial arrangement of the population, high ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of this species.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: No information available.

Population Information and Trends

Population Trends:

See narrative.

Number of Populations:

148 in NC and 1 in SC (USFWS, 2014)

Population Narrative:

Since 2000, land managers have monitored sub-populations at 62 different sites within nine population centers. Kristopher Voss, a Duke University graduate student, conducted a preliminary PVA using Bayesian State-Space Models on the monitoring data collected from 2000 to 2012. Based on his analysis, it appears that two populations are increasing, two populations are stable, five populations are estimated as declining and the trends at one population are undeterminable with the current amount of monitoring data available. (USFWS, 2014)

Threats and Stressors

Stressor: Development (USFWS, 2014)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Residential and commercial development are listed as threats to this species (USFWS, 2014).

Stressor: Road construction (USFWS, 2014)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Road construction is listed as a threat to this species (USFWS, 2014).

Stressor: Silviculture (USFWS, 2014)

Exposure:**Response:****Consequence:** Loss of habitat**Narrative:** Silviculture (pine plantations) are listed as a threat to this species (USFWS, 2014).**Stressor:** Wetland draining/filling (USFWS, 2014)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:** Wetland draining and/or filling are listed as threats to this species (USFWS, 2014).**Stressor:** Herbicide use (USFWS, 2014)**Exposure:****Response:****Consequence:** Loss of individuals**Narrative:** Herbicide use, especially on road shoulders and powerline rights of way has potential to quickly cause negative impacts to this rhizomatous perennial (USFWS, 2014).**Stressor:** Herbivory (USFWS, 2014)**Exposure:****Response:****Consequence:** Loss of individuals**Narrative:** Herbivory (likely by deer) is listed as a threat to this species (USFWS, 2014).**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2014)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:** At the time of federal listing, this species was also listed as state endangered by the State of North Carolina under the Plant Protection and Conservation Act of 1979 (North Carolina Code Article 19B, § 106-202.12; NC Act). The NC Act provides limited protection from unauthorized collection and trade of plants listed under that statute. However, the statute does not protect the species or its habitat from destruction in conjunction with development projects or otherwise legal activities (Robinson and Finnegan 2014). The NC Act authorizes the NC Plant Conservation Program to establish nature preserves for protected species and their habitat, but that agency has not yet created any nature preserves for this species (USFWS, 2014).**Stressor:** Fire suppression (USFWS, 2014)**Exposure:****Response:****Consequence:** Loss of habitat**Narrative:** Fire suppression was also identified as a serious threat. The lack of fire in the habitat where this species occurs allows woody species to grow and compete for sunlight, eventually shading out this low growing species. The exclusion of fire also affects nutrient cycling and insect populations (USFWS, 2014).**Stressor:** Small population size (USFWS, 2014)**Exposure:**

Response:**Consequence:** Loss of populations**Narrative:** Populations that are small in size and number of individual plants are vulnerable to stochastic events (USFWS, 2014).***Recovery*****Reclassification Criteria:**

1. Management plans have been prepared and are being implemented for all publicly owned population centers and those owned by The Nature Conservancy (USFWS, 1995)
2. Populations at these centers have been monitored for at least 5 years and are determined to be stable. (USFWS, 1995)

Delisting Criteria:

1. When the reclassification criteria are met and a binding management agreement for each population center is in place (USFWS, 1998)

Recovery Actions:

- 1. Protect significant sites and adjacent habitat. - Map all sites and mark sites in the field (except where there is ready public access and where signs would increase the threat of collecting): include in the marked area the adjacent habitat and buffer. - Map and search appropriate habitat for new sites within each population center. - Prepare a management plan for each population center. (USFWS, 1995)
- 2. Conduct research to more fully understand habitat conditions, fire frequency effects, seedling recruitment, genetic diversity among and within sites and population centers, population dynamics, and reestablishment techniques. (USFWS, 1995)
- 3. Enforce laws protecting the species and its habitat. Provisions of the Endangered Species Act of 1973, as amended, will be enforced. North Carolina regulations prohibit taking a protected species from private property without the landowner's written permission and a State permit. However, at this time the collection of *L. asperulaefolia* plants ~ not the major threat to the species' continued survival. In meeting their responsibilities under the Endangered Species Act, the military services involved have developed guidance directing certain actions with respect to listed species occurring on their bases. Implementation of these policies and directives should continue. (USFWS, 1995)
- 4. Reintroduce the species into historic habitat. In cooperation with the North Carolina Botanical Garden and the Center for Plant Conservation, plants should be propagated and a program of reintroduction should be initiated. Historic sites, such as the proposed Minnesott Ridge-Prescott Ridge Natural Area in Pamlico County, would be ideal sites for this program. Plants introduced into such an area should derive from the same population center, when possible, or from a nearby population source, unless genetic analyses indicate that inbreeding is a problem within populations. The genetic analysis will assist in determining appropriate reintroduction source material. (USFWS, 1995)
- 5. Negotiate binding management agreements. In order to ensure the survival of this species and proceed with delisting, permanent binding management agreements should be negotiated between the Service and landowners. The North Carolina Plant Conservation Program or North Carolina Natural Heritage Program should assist the Service in monitoring these agreements. (USFWS, 1995)

- 6. Conduct public information and education activities. News releases concerning the status and significance of the species and recovery efforts should be prepared and distributed to newspapers on the coastal plain and in the sandhills area. Cooperation with military bases should be sought: this would be a positive public relations opportunity for them. State agencies managing lands where *L. asperulaefolia* occurs should prepare/distribute brochures and offer educational hikes to sites where this would be appropriate. (USFWS, 1995)
- 7. Annually review the recovery efforts. The Service, North Carolina Plant Conservation Program, North Carolina Natural Heritage Program, and South Carolina Heritage Trust should meet annually with the managers of *L. asperulaefolia* sites to assess progress toward the recovery goals, review new information, assign any new sites to a new or existing population center, evaluate and coordinate programs planned for the coming year, and, if necessary, redirect monitoring or management actions. (USFWS, 1995)

Conservation Measures and Best Management Practices:

- Revisit known populations that have not been visited in the past three years, especially those populations that have been ranked as F (Failed to Find) or H (Historic) in the NCNHP database; monitor the condition of the habitat at each site including threats; discuss conservation options with landowners where appropriate; report the results of these site visits to the appropriate Heritage Program (USFWS, 2014).
- Search for additional populations in appropriate habitat (USFWS, 2014).
- Prioritize known sites for protection and identify recovery populations (USFWS, 2014).
- Protect additional populations (USFWS, 2014).
- Identify those populations that would contribute the most toward recovery (self-sustaining, protected, etc.) as recovery populations (USFWS, 2014).
- Determine which sites have management plans and how they are being implemented (USFWS, 2014).
- Develop and implement management plans for all remaining protected populations (USFWS, 2014).
- Determine the management techniques for sustaining populations, such as fire frequency and seasonality (USFWS, 2014).
- Update monitoring protocols and remind land managers about their commitment to monitoring this species on their property, continue to analyze monitoring data using PVA or other accepted methods (USFWS, 2014).
- Complete a population genetic analysis as suggested by Edwards (2007) (USFWS, 2014).
- Organize a meeting of land managers, researchers and other interested parties to discuss the long-term recovery of this species (USFWS, 2014).
- Work with NC Botanical Garden to conserve germplasm and further develop propagation and transplantation protocols (USFWS, 2014).

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SPECIES ACCOUNT: *Helenium virginicum* (Virginia sneezeweed)

Species Taxonomic and Listing Information

Listing Status: Threatened; 11/03/1998; Northeast Region (R5) (USFWS, 2015)

Physical Description

A perennial herb, 7-11 dm tall. Some Missouri plants reach 17 dm in height (Tim Smith, Missouri Dept. of Conservation, pers. comm. 2006). Basal leaves form a rosette and may be broad in the middle tapering toward the ends, but otherwise may appear oblong. Stem leaves are lanceolate and become progressively smaller from the base to the tip of the stem. Stems are winged, wings being continuous with the base of the stem leaves. Flower ray petals are yellow and wedge shaped with three lobes at the ends. Central disk is nearly ball-shaped. Clusters of golden-yellow flower heads bloom from July to September (NatureServe, 2015).

Taxonomy

A member of the Asteraceae (Aster family) (USFWS, 2000). Knox et al. (1995) determined that *H. virginicum* is distinct from *H. autumnale* morphologically and ecologically. Genetic work by Simurda and Knox (2000) supported treating *H. virginicum* and a Pomona, Missouri, *Helenium* sp. as a monophyletic group. Additional genetic work with a larger number of *Helenium* populations over a broader geographic range strengthened this conclusion and determined a narrow-leaved *Helenium autumnale* population from the Bruce Peninsula in Ontario, Canada, to be a sister group to the *virginicum* group (Simurda et al. 2005) (NatureServe, 2015).

Historical Range

It was first found in Augusta County, Virginia, in 1935 (Blake 1936) and the known range was expanded to Rockingham County by C. E. Stevens in 1967 (Roe 1977) (USFWS, 2000).

Current Range

As of 2000, 23 populations have been documented in Augusta county and 7 in Rockingham County. Recent studies from a sinkhole pond in southern Missouri suggest that it may represent a disjunct population, but further studies are needed to resolve this (USFWS, 2000).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual: vegetative; sexual: cross-pollination (USFWS, 2000)

Lifespan

Adult: 5 years (USFWS, 2000)

Breeding Season

Adult: July - October (NatureServe, 2015)

Key Resources Needed for Breeding

Adult: Insect pollinators, abundant soil moisture, seed bank (NatureServe, 2015)

Reproduction Narrative

Adult: Flowers from early July to October, with peak flowering occurring in late July to early August at most sites. The pollination biology has not been studied in detail; however, cursory observations conducted at Kennedy Mountain Meadow suggest that the primary insect pollinators are bees, wasps (Hymenoptera: Apidae, Halictidae, Sphecidae), butterflies (Lepidoptera: Hesperidae and Lycaenidae, among others), and hoverflies (Diptera: Syrphidae) (C. Williams, pers. obs.). During favorable years at Kennedy Mountain Meadow, approximately one quarter of the population may flower (Knox and Williams 1988). Flowering appears to correlate with water availability during late spring and early summer, a critical period for bolting and flower formation (Knox et al. 1987). Seasonal water fluctuation, particularly inundation, is probably a key factor affecting recruitment and maintenance of populations (J. Knox, unpubl.). For example, extensive periods of inundation during the growing season may greatly limit recruitment and result in high levels of mortality in established plants. Reestablishment of inundation-depleted populations may be facilitated by a soil seed bank; viable seeds can persist in the soil for at least two years (J. Knox, pers. obs.). Thus *H. virginicum* appears to be a "boom-bust" species in which recruitment is keyed by water fluctuations: population peaks occur in years of abundant soil moisture and troughs in years of excessive and persistent inundation. In addition, seasonal water fluctuations may also modulate populations of co-occurring plants that compete with *H. virginicum* for space and resources. (NatureServe, 2015). In a nine year demographic field study at one population, plants were found to live up to five years and flower two to three times (Knox 1997). Individual plants identified in the field are nearly always genets (Knox 1997). Research by Messmore and Knox (1997) determined that plants from at least one site have a self-incompatible breeding system (USFWS, 2000).

Habitat Type

Adult: Wetland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Ephemeral pond, wet meadow (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Seasonal inundation (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Shade (USFWS, 2000)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: In Virginia, *Helenium virginicum* is a wetland plant restricted to shallow, seasonally inundated ponds (which are in or near sinkholes) in Augusta and Rockingham Counties, Virginia (Blake 1936; Roe 1977; Harvill et al. 1986). The pond basins in which this species occurs are usually flooded from January to July. The substrate at most *H. virginicum* sites consists of poorly

drained, acidic, low fertility Purdy silt loams (USDA 1979) underlain by gray clays and dolomitic bedrock (Werner 1966; Rader 1967). The level of disturbance present at the sinkhole ponds includes relatively undisturbed ponds surrounded by forest, more meadow-like habitats around farm ponds actively used by cattle, a backyard seasonal wetland maintained in an open state by the landowner, a seasonally wet mowed lawn, and a seasonal wetland degraded by severe cattle trampling and an ongoing attempt to fill the site. In Missouri it is found on sinkhole pond margins and wet meadows in the Ozark Highlands (Rimer and McCue 2005). The plant has been found to prefer open growing conditions and is found in a variety of sites in addition to the less disturbed sinkholes and wet meadows including rural airports, roadside ditches, and cattle ranches (R. Rimer and J. Summers, pers. comm. 2005). It appears to be less confined to discrete wetlands in Missouri and can occur in a temporarily wet portion of a hayfield or in roadside ditches (Tim Smith pers. comm.) (NatureServe, 2015). Data from one site indicate that *H. virginicum* is shade intolerant (USFWS, 2000).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Unknown (NatureServe, 2015)

Resiliency:

Low to moderate (inferred from USFWS, 2000; see current range/distribution)

Redundancy:

High (inferred from USFWS, 2000)

Number of Populations:

26 - 30 (USFWS, 2000)

Population Size:

10,000 - 100,000 individuals (NatureServe, 2015); 1 - 500,000 per occurrence (USFWS, 2000)

Population Narrative:

Species exhibits high tolerance to mechanical disturbance. Surprisingly, it appears to benefit from grazing. The stems and leaves of this species are extremely bitter in taste and apparently unpalatable, thus selective grazing by cattle may eliminate competing plants (John Knox, pers. obs.). Moreover, the largest (100,000 - 1,000,000 plants) and densest *H. virginicum* population (> 400 plants/m²) grows at a site that is mowed yearly. The estimated population size in Virginia is 2500-10,000; in Missouri over 10,000. Widely fluctuating population numbers have been taken into consideration: a population of 10,000 one year may be reduced to a handful in years of drought or prolonged inundation. The long term population trend is unknown (NatureServe, 2015). As of 2000, 30 populations have been documented, four of which have not been seen since the late 1970's and may be locally extirpated. Population sizes documented among the different occurrences range from one individual to 500,000 (USFWS, 2000).

Threats and Stressors

Stressor: Habitat destruction and modification (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: In Virginia the long-term viability of existing populations is primarily threatened by human-induced disruptions of hydrologic regimes, particularly by encroaching agriculture, residential land development, and logging (Van Alstine 1991; J. Knox, C. Williams pers. obs.). In addition, a private site and adjacent sites on the George Washington National Forest are sporadically impacted by off road vehicles (e.g., during summer 1991 on the private land; J. Knox, C. Williams, pers. obs.). The following paragraphs are taken, with modifications, from U.S. Fish and Wildlife Service (2000): The most serious threat to *H. virginicum* appears to be habitat loss, most often arising from changes in the natural hydrological regime of the sinkhole pond habitat. Four of the sites, three of which are grazed by cattle, have had a portion of the wetland deepened to create a permanent pond; prior to being excavated, much of this section once undoubtedly supported *H. virginicum* and so loss of some habitat has occurred. Input from groundwater sources may be decreased by withdrawals for wells for adjacent developments such as subdivisions. Overland surface water flow may be altered by activities such as timber harvesting or road building in upslope areas. A variety of site-specific threats to *H. virginicum* from habitat loss have appeared over the last ten years. The Virginia Department of Transportation (VDOT) has proposed to widen to four lanes Route 340, a currently two lane north-south corridor on the east side of the Shenandoah Valley. A portion of one site in Augusta County is immediately east of Route 340. Another *H. virginicum* population is near the site of silos built in the early 1990's that are used to store septic waste. Mowing occurs in at least 3 of the Virginia sites. Repeated mowing before seed is set and the seed bank is replenished, may lead to local extinction as vegetative plants die out and the seed bank ultimately becomes depleted. As the soils of the *H. virginicum* sites have been found to be nutrient-limiting (Knox 1997), long-term nutrient enrichment from cattle could ultimately create more favorable habitat for other plant species (NatureServe, 2015).

Stressor: Nonnative species (NatureServe, 2015)

Exposure:

Response:

Consequence:

Narrative: Exotic organisms may pose threats to *H. virginicum* populations in the near future. Purple loosestrife, *L. salicaria*, is slowly spreading through Virginia and may eventually invade some *H. virginicum* sites, especially following disturbances to hydrologic regime and/or substrate. The gypsy moth, *L. dispar*, is currently defoliating large areas of the George Washington National Forest and adjacent lands but it is unclear whether the gypsy moth will negatively impact *H. virginicum* populations. For example, as *H. virginicum* is shade-intolerant, defoliation of trees and shrubs that grow on the periphery of sinkholes may increase light availability and allow *H. virginicum* to expand into areas from which it was formerly excluded (NatureServe, 2015).

Stressor: Stochastic events (USFWS, 2000)

Exposure:

Response:**Consequence:**

Narrative: Extremes in the fluctuating hydroperiod of the ponds could, when preceded by a low investment in the seed bank, result in local extirpations of populations. The self-incompatible breeding system may eventually lead to local extinction at sites with low population numbers (Messmore and Knox 1997) (USFWS, 2000).

Recovery**Reclassification Criteria:**

Not available

Delisting Criteria:

1. Twenty self-sustaining populations and their habitats have received permanent protection across the species' Virginia range (USFWS, 2000).
2. Monitoring over a 15-year period indicates that populations in the 20 sites are viable (USFWS, 2000).
3. Life history and ecological requirements are understood sufficiently to allow for effective protection, monitoring, and, as needed, management (USFWS, 2000).
4. Seeds representing the range of genetic diversity in *H. virginicum* are placed in long-term storage to provide a source of genetic material in the event of extinction (USFWS, 2000).
5. If determined to be *H. virginicum*, the Missouri population and its habitat are permanently protected and seeds placed in long-term storage (USFWS, 2000).

Recovery Actions:

- Protect the extant populations and their habitat (USFWS, 2000).
- Monitor extant populations (USFWS, 2000).
- Definitively identify the range and distribution of the species (USFWS, 2000).
- Continue investigations into the life history and ecology of *Helenium virginicum* (USFWS, 2000).
- Maintain seed sources for the species (USFWS, 2000).
- Develop informational materials to create more awareness of *H. virginicum* and its status (USFWS, 2000).

Conservation Measures and Best Management Practices:

- *H. virginicum* has been listed as endangered by the Commonwealth of Virginia since 1989 under the Endangered Plant and Insect Species Act. This law protects listed plant and insect species from take in the form of collection or translocation, except by the landowner (USFWS, 2000).
- Site-specific conservation planning, funded by the U.S. Fish and Wildlife Service and the Virginia Department of Agriculture and Consumer Services, was conducted by the Virginia Department of Conservation and Recreation's Division of Natural Heritage at five privately-owned sites (Erdle 1996, Erdle 1997) (USFWS, 2000).

- If the Missouri *Helenium* sp. is confirmed to be *H. virginicum*, sinkhole pond habitat in Missouri, intervening states, and other areas of Virginia will need to be targeted for surveys to determine the distribution of this species (USFWS, 2000).
- A fact sheet on *H. virginicum* was developed by the Virginia Department of Conservation and Recreation's Division of Natural Heritage in 1995 (USFWS, 2000).
- Six of the sites that have been documented to support populations of *H. virginicum* are on land managed by the U.S. Forest Service (USFWS, 2000).
- A number of studies are underway or planned for the near future by J.S. Knox and associates at Washington and Lee University (USFWS, 2000).

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SPECIES ACCOUNT: *Lesquerella perforata* (Spring Creek bladderpod)

Species Taxonomic and Listing Information

Listing Status: Endangered; 12/23/1996; Southeast Region (R4) (USFWS, 2015)

Physical Description

A herbaceous annual, stems several to many, outer ones usually decumbent (a plant that has its base lying on the ground and a stem that grows upward) at base, inner ones erect, simple or branched, 10 to 15 cm tall, stems and leaves are covered with fine or coarse hairs. Leaves at the base (rosette) have a petiole (leafstalk) and are lyrate (several lobes, which increase in size toward one large terminal lobe) lobed with pointed teeth on the margins. The stem leaves are sessile (stalkless and attached directly at the base), auriculate (ear shaped), oblong to obovate (egg shaped), with few to many teeth on the margins. The cross-shaped flowers are arranged in a raceme (stalked flowers arranged singly along an elongated unbranched axis), have white to pale lavender petals with a yellow base, and are 7 to 9 mm long. The fruits, or pods, are broadly obovoid (egg shaped) to pear-shaped, very inflated, 4 to 7 mm long, and divided into two halves. The outer surface of the pod is papery with very sparse hairs and the inside is densely hairy. The septum (the internal partition between the two halves) is perforated or nearly absent with only a small portion attached to the fruit wall. There are up to 10 round seeds in a pod measuring 1.5 to 2.5 mm long, strongly flattened and surrounded by a thin margin (USFWS, 2006)..

Taxonomy

Lesquerella is a genus of the Brassicaceae, the mustard family, named for the seventeenth century Swiss and American botanist Leo Lesquereux. There are approximately 75 taxa of *Lesquerella* with the majority occurring in the western states; only a few taxa are found in the Interior Low Plateau of Tennessee, Alabama, and Kentucky (Al-Shehbaz 1987). Only one species, *Lesquerella lescurii* (Nashville mustard), had been described in the eastern states prior to the 1950's work of Dr. Reed C. Rollins, a Harvard University expert on the Brassicaceae. From 1952 to 1955, Rollins described three new species of *Lesquerella* endemic to the Central Basin of Tennessee, *L. densipila* (Duck River bladderpod), *L. stonensis* (Stones River bladderpod), and *L. perforata* (Spring Creek bladderpod) (USFWS, 2006).

Historical Range

See current range/distribution.

Current Range

Known only from Wilson County, Tennessee (USFWS, 2006).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: Flowering usually occurs in March and April. The fruit splits open upon maturity in late April and early May, and the enclosed seeds are dispersed and lie dormant until autumn. The plant dies back soon after the fruits mature (USFWS, 2006).

Reproduction Narrative

Adult: Lesquerella perforata is an annual that germinates between September and early October, overwinters as a small rosette of leaves, and fully develops and flowers the following spring. Full sunlight is required for optimum growth. Flowering usually occurs in March and April. The fruit splits open upon maturity in late April and early May, and the enclosed seeds are dispersed and lie dormant until autumn. The plant dies back soon after the fruits mature. Germination can only occur when the correct temperature coincides with adequate moisture (Pearson 1967). Upon germination, the cycle starts over again. The seeds of L. stonensis can remain viable in the seed bank for at least 6 years, and perhaps those of L. perforata can do the same (Rollins 1955, Kral 1983, Baskin & Baskin 1990, Fitch 2004) (USFWS, 2006).

Habitat Type

Adult: Limestone outcrops (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: This species is found mainly where sites have been disturbed by flooding or by cultivation, and tends to occur in areas of full sun on well-drained soils, as well as (rarely) on limestone rock outcrops. Most historic and current occurrences are on flood plains, where periodic flooding removes encroaching grasses and woody plants. Also occurs in places where other types of disturbances "substitute," such as on annually cultivated bottom land fields (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of this species and the low number of known populations.

Dispersal/Migration**Dispersal/Migration Narrative**

Adult: No information found.

Population Information and Trends**Resiliency:**

Low (inferred from NatureServe, 2015)

Representation:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

Fluctuates widely from year to year (USFWS, 2006)

Population Narrative:

Known from four populations consisting of 13 extant sites in Wilson County, Tennessee. Three additional sites no longer support the species. (U.S. Fish and Wildlife Service 1996) (NatureServe, 2015). Low resiliency, representation and redundancy are inferred by the low number of known populations and the specific habitat requirements of this species.

Threats and Stressors

Stressor: Cropland conversion to pasture (USFWS, 2006)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: The conversion of cropland to pastures that contain grasses (e.g.) fescue poses a threat because of competition and lack of annual disturbance (USFWS, 2006).

Stressor: Urbanization/Development (USFWS, 2011)

Exposure:

Response:

Consequence: Loss of habitat

Narrative: Those sites on private lands in the City of Lebanon, primarily in Barton's Creek drainage, remain at high risk of loss to urbanization (USFWS, 2011). This includes placing fill material on this species habitat and road building.

Recovery

Reclassification Criteria:

Spring Creek bladderpod will be considered for reclassification to threatened status when there are 15 protected occurrences, five of which are located within the floodplain of each of three creeks (Spring Creek, Barton's Creek, and Cedar Creek). These occurrences, located on either public or private land, must be protected by a permanent conservation easement with a management agreement. Each occurrence must consist of an average of 500 plants over a five-year period, with no less than 100 plants in any given year (USFWS, 2011).

Delisting Criteria:

Spring Creek bladderpod will be considered for delisting when there are 25 protected occurrences, with at minimum five occurrences located within the floodplain of each of the three creeks (Spring Creek, Barton's Creek, and Cedar Creek). Each occurrence located on either

public or private land must be protected by a permanent conservation easement with a management agreement. Each occurrence must consist of an average of 500 plants over a ten-year period, with no less than 100 plants in any given year (USFWS, 2011).

Recovery Actions:

- We have not met the criteria for reclassifying Spring Creek bladderpod to threatened. No occurrences are protected by conservation easement; though three are protected by non-binding cooperative management agreements. Spring Creek bladderpod abundance fluctuates considerably over time (Table 1). While 500 or more plants have been observed at most of the occurrences at some point in time, fewer than 100 have also been observed at most occurrences at some point in time (USFWS, 2011).

Conservation Measures and Best Management Practices:

- Continued efforts to implement recovery actions identified in the species' recovery plan, improve monitoring techniques, and refine guidance for managing Spring Creek bladderpod are necessary. Specific emphasis should be placed on determining whether additional occurrences exist in the Cedar Creek drainage, and efforts should be redoubled to work with private and municipal landowners to ensure long-term protection of known occurrences through conservation easements (USFWS, 2011).

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