

Snakeroot
(Eryngium cuneifolium)

5-Year Review:
Summary and Evaluation



Photos: Archbold Biological Station

June 2021

U.S. Fish and Wildlife Service
South Atlantic-Gulf Region
Florida Ecological Services Field Office
Vero Beach, Florida

5-YEAR REVIEW

Snakeroot (*Eryngium cuneifolium*)

I. GENERAL INFORMATION

A. Methodology used to complete the review: In conducting this 5-year review, we relied on the best available information pertaining to historical and contemporary distributions, life histories, genetics, habitats, and threats of this species. This review includes information from the previous 5-year review (Service 2010) that is still applicable to the species, with updated or new information incorporated, as appropriate. We announced initiation of this review and requested information in a published *Federal Register* notice with a 60-day comment period in 2019 (84 FR 28850). We used a variety of information resources, including monitoring reports, surveys, and other scientific and management information, augmented by conversations and comments from biologists familiar with the species. Specific sources included the final rule listing this plant under the Endangered Species Act of 1973, as amended (ESA) (52 FR 2227), the recovery plan (Service 1999) and its amendment (Service 2019), the last 5-year review (Service 2010), peer reviewed scientific publications, and unpublished field observations by Federal, State, and other experienced biologists. The Florida Ecological Services Field Office (FESFO) Vero Beach contracted with Archbold Biological Station's (ABS) plant ecologist to update this review, which the lead recovery biologist for snakeroot in FESFO Vero Beach finalized. Literature and documents used for this review are on file at the FESFO. All recommendations resulting from this review are a result of thoroughly reviewing the best available scientific information on snakeroot. The Service did not seek additional peer review for this update.

B. Reviewers

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C. Background

1. FR Notice citation announcing initiation of this review: June 20, 2019. 84 FR 28850

2. Listing history

Original Listing

FR notice: 52 FR 2227

Date listed: January 21, 1987

Entity listed: Species

Classification: Endangered

3. Associated rulemakings: There are no associated rulemakings for this species.

4. Review History: Each year the U.S. Fish and Wildlife Service (Service) reviews and updates listed species information to benefit the required Recovery Report to Congress. Through 2013, we performed a yearly recovery data call. The last review conducted in 2010 showed this species as uncertain with no change recommended to the species' status due to the probability of continued populations losses at unprotected sites and the lack of adequate fire management (Service 2010).

Recovery Plan: 1999

Recovery Plan revision: 2019

Previous 5-year review: 1991 and 2010

5. Species' Recovery Priority Number at start of review: 2. A recovery priority number of "2" indicates that this is a species with a high degree of threat and high recovery potential.

6. Recovery Plan or Outline

Name of plan: South Florida Multi-Species Recovery Plan (MSRP)

Date issued: May 18, 1999

Date of amendment to the original 1999 MSRP Snakeroot recovery criteria: September 24, 2019 (Service 2019)

Dates of previous revisions: June 20, 1996 (Recovery Plan for Nineteen Central Florida Scrub and High Pineland Plants) (revised plan) and January 29, 1990 (Recovery plan for Eleven Florida Scrub Plant Species) (original plan)

II. REVIEW ANALYSIS

A. Application of the 1996 Distinct Population Segment (DPS) policy

1. Is the species under review listed as a DPS? No. The ESA defines species as including any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate wildlife. This definition limits listing DPS to only vertebrate species of fish and wildlife. Because the species under review is a plant, the DPS policy is not applicable. The application of the DPS policy to the species listing is not addressed further in this review.

B. Recovery Criteria

1. Does the species have a final, approved recovery plan containing objective, measurable criteria? Yes.

2. Adequacy of recovery criteria.

a. Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat? Yes.

b. Are all of the 5 listing factors that are relevant to the species addressed

in the recovery criteria (and is there no new information to consider regarding existing or new threats)? Yes.

3. List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information.

The recovery criteria as presented in the 2019 amendment to the 1999 recovery plan are broken down into three parts ([1-3] in bold below) for clarity purposes (Service 2019). These criteria address factors A) the present or threatened destruction, modification, or curtailment of its habitat or range; D) inadequacy of existing regulatory mechanisms; and E) other natural or manmade factors affecting its survival. Factors B (overutilization for commercial, recreational, scientific, or educational purposes) and C (disease or predation) are not relevant to this species.

Snakeroot will be considered for delisting when:

- 1. at least 20 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes;**
- 2. populations in rosemary scrub habitats are distributed across the known range of the species; and**
- 3. populations are protected and managed via a conservation mechanisms to a degree that enough suitable habitat is present for the species to remain viable for the foreseeable future.**

These criteria have not been met. There are fewer than 20 populations, trends are unknown for most populations, and conservation mechanisms to promote viability have not been carefully studied.

C. Updated Information and Current Species Status

1. Biology and Habitat

Information on the biology and habitat of snakeroot has been summarized in the MSRP (Service 1999) and in the prior 5-year status review (Service 2010). Relevant biology and habitat information since 2010 are summarized and updated in this review.

- a. Abundance, population trends (e.g., increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate), or demographic trends:**

Abundance

The most recent Florida Natural Areas Inventory (FNAI) database was summarized for this document (FNAI 2020, summarized in Table 1). FNAI reports 13 Element Occurrence Records (EORs), all in Highlands County (Table

1). This number is reduced from 19 EORs reported in the previous 5-year review (Service 2010), due to changes in FNAI definitions. Since 2010, FNAI has increased the area used to define an EOR.

Population Sizes

Population sizes of snakeroot tend to vary widely with time since fire occurrence (Menges and Quintana-Ascencio 2004). Most EORs do not have regular population size estimates, although some have been reported previously (Service 2010). Population sizes reported by FNAI ranged from 10 to 10,000+ individual plants, but some EORs do not have population sizes indicated (FNAI 2020, Table 1). At ABS, the number of plants in study populations between 2014 and 2019 has ranged from 1,300 to 2,700 individuals, with several hundred additional plants outside of study areas (Menges, unpublished data). At Royce Ranch, plants in plots have varied from about 300 to 500 during the past few years, but there are probably thousands of additional plants at the site (Menges, unpublished data).

Fire Ecology

Fire is a key ecological factor in the ecology of snakeroot, with most aspects of its demography favored in the decade or two following fire (Menges and Kimmich 1996, Menges and Quintana-Ascencio 2004, Service 2010). Like some other Florida scrub endemic plants, snakeroot abundance is highest during a short period following fire (in the case of snakeroot, 6 to 9 years after fire; Slapcinsky et al. 2010). Snakeroot germination is enhanced by exposure to smoke (King and Menges 2018). Snakeroot is sensitive to shrub cover and is dependent on the gaps created between rosemary shrubs immediately after fires (Menges and Hawkes 1998, Menges et al. 2019). Very frequent or infrequent fire can result in population declines for this species (Service 2010). Modeling results identify the range of fire return intervals that are suitable for this species. Specifically, fire frequencies of less than four years led to declining populations due to depletion of the soil seed bank, fires between 4 to 15 years supported increasing populations, and fires occurring between 15 and 30 years could be sustainable for this species if the decay of suitable environments is relatively slow (Hindle et al. 2018). Because rosemary scrub will rarely be burned more frequently than every 15 years, a fire return interval of 15 to 30 years is recommended for snakeroot (Menges et al. 2019).

Demographic Features

A large body of research conducted by ABS has characterized snakeroot as a short-lived, seed-banking perennial with vital rates (survival, growth, flowering, and seedling recruitment) highest in recently burned areas, open areas, and in larger gaps (Menges and Quintana-Ascencio 2004, Service 2010). These data, collected since 1988, have been archived and used as the basis of large-scale, multi-species

Table 1. Summary of Florida Natural Areas Inventory data for snakeroot populations from Highlands County, Florida. Abbreviations: ABS=Archbold Biological Station; LWRWEA=Lake Wales Ridge Wildlife and Environmental Area.

EOR ID	EOR#	Last Observation	Habitat	Population Size*	Management Unit	Size (acres)
13498	1	1987-06-04	Open, sandy areas surrounding a small dense sand pine scrub area.	>100	None	5.64
5971	2	2012-10-03	Scrub.	unknown	Fisheating Creek/Smoak Groves Conservation Easement	755.79
11676	3	2012-10-16	Rosemary scrub, oak scrub, mesic flatwoods	variable, hundreds	ABS, McJunkin LWRWEA	3.00
547	6	2017-02-20	Oak and rosemary scrub	thousands, over 10,000	Gould Road LWRWEA	105.96
8884	7	1983-04-17	Disturbed sand pine scrub with oak/hickory and rosemary understory. Roadsides.	“common”	None	2.82
24699	10	2012-10-24	Rosemary scrub	hundreds	Holmes Avenue LWRWEA	71.01
22859	13	2015-11-18	White sand scrub with cleared areas	widespread, locally abundant	Royce Ranch LWRWEA	86.63
19954	14	1987-04-05	Rosemary scrub	unknown	None	908.45
23747	15	2012-10-23	Open sand pine scrub have Eryngium	abundant	Royce Ranch LWRWEA	8.75
11193	19	2012-10-19	Sand pine scrub	10-100	Lake Placid Scrub LWRWEA	0.82
5834	21	1999 -- 2000	Rosemary scrub	unknown	ABS	12.92
30516	22	1999 -- 2000	Rosemary scrub	unknown	ABS	0.03
36265	23	2014-11-07	Scrub	16-24	Lake June-in-Winter Scrub State Park**	0.51

*Populations vary widely in size, and FNAI estimates are often lower than peak population sizes. Populations in the thousands have occurred at ABS, McJunkin, Gould Road, and Royce Ranch (Menges, personal observation).

**Population has not been found in several subsequent searches.

modeling projects (Morris et al. 2006, 2008, Menges 2008, Ellis et al. 2012, Crone et al. 2013). Hindle et al. (2018) demonstrated how fire drives demographic responses in snakeroot (see Fire Ecology section above). Detailed sampling of soil seed banks in Florida rosemary scrub at ABS, across a time-since-fire ranging from 3 to greater than 24 years, affirmed that snakeroot had a soil seed bank (Navarra et al. 2011). Seed densities were highest in recently burned areas. Seed germination was increased by exposure to smoke but not heat (King and Menges 2018). Snakeroot recruited significantly more seedlings in degraded, than intact, scrub (Stephens et al. 2012). Seed germination was higher in bare sand than in litter only or under shrubs. In another study, snakeroot seed germination and seedling biomass was enhanced by exposure to microbes, relative to a microbe-reduced control (David et al. 2020).

At the landscape scale, snakeroot distributions among rosemary scrub patches suggests metapopulation dynamics with periodic extinctions and colonizations and a tendency to occur relatively often on larger and less isolated habitat patches (Miller et al. 2012).

Demographic Trends

General trends of snakeroot with time-since-fire are well known, as detailed above and in Service (2010). Populations peak in abundance in the first decade after fire, with local disappearances aboveground noted after roughly 30 years without fire.

b. Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding):

Snakeroot has very low genetic variation, although comparable with other narrowly endemic plants, and has low levels of differentiation among populations (Service 2010). Patterns of genetic variation were unrelated to populations size and landscape variables (Menges et al. 2010).

c. Taxonomic classification or changes in nomenclature:

None. The Integrated Taxonomic Information System (2021) was checked while conducting this review. The taxon *Eryngium cuneifolium* Small is accepted and current.

d. Spatial distribution, trends in spatial distribution (e.g., increasingly fragmented, increased numbers of corridors), or historic range (e.g., corrections to the historical range, change in distribution of the species' within its historic range):

FNAI data indicates 13 EORs, of which 10 are in managed areas (Table 1). These include ABS, a state park, a conservation easement, and several units of the Florida Fish and Wildlife Conservation Commission Lake Wales Ridge Wildlife Environmental Area (LWRWEA). Snakeroot is known from eight units of the LWRWEA (not all represented in the FNAI database): Clements, Gould Road, Highland Park Estates, Holmes Avenue, Lake Placid Scrub, McJunkin, Orange Blossom, and Royce Ranch (Menges et al. 2019).

e. Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):

Snakeroot is narrowly specialized for Florida rosemary scrub on xeric white sands (summarized in Service 2010) and is considered an indicator species for Florida rosemary scrub (Menges et al. 2019). Within these habitats, it is a specialist for open gaps among the matrix of shrubs. While diversity, species occurrence, and the local extinction and colonization of many species is driven by fire and gap size, research (Menges et al. 2017) has not analyzed this relationship specifically for snakeroot. Many of the sites with known snakeroot populations are managed to try and control invasive species and maintain healthy scrub habitats using prescribed fire; however, lack of fire management continues to be a problem, especially for unprotected sites.

2. Five-Factor Analysis

a. Present or threatened destruction, modification or curtailment of its habitat or range:

Snakeroot is one of the most vulnerable of Florida scrub endemic plants on the Lake Wales Ridge (LWR) (Turner et al. 2006). Threats to the species including habitat loss and fire suppression were detailed in the previous 5-year review (Service 2010) and are discussed below.

Continued conversion of Florida scrub and sandhill to agriculture, housing, and other development activity is undoubtedly affecting the number, size, and distribution of snakeroot populations. An analysis of land conversion on the LWR suggests that about 85 percent of upland habitats were lost to development and habitat modification by about 1990 (Weekley et al. 2008). By the early part of this century, about 87 percent of upland habitat was gone (Turner et al. 2006). Habitat losses were greatest on yellow sands and in the northern part of the LWR (Weekley et al. 2008). About 11 percent of the LWR is currently protected in conservation lands (Weekley et al. 2008). The loss of so much habitat suggests that many snakeroot populations may have become extirpated.

Habitat destruction from development continues to occur and development pressure remains high. Increasing pressure from population growth is likely to result in further loss of these habitats going forward. If trends continue, Carr and

Zwick (2016) estimate 34 percent of land in Florida will be developed by 2070, up from 19 percent in 2010. At the same time, conservation lands will increase less than 1 percent (from 9,269,000 ac in 2010 to 9,525,000 ac by 2070). Overall, loss of habitat to development, primarily on private lands, will likely continue in Central Florida, eliminating populations and reducing the area of suitable habitat for snakeroot. Therefore, habitat on protected lands are critical for the recovery of snakeroot.

As discussed above, fire is necessary to maintain the habitats that support snakeroot. Fire suppression started on a regional scale on the LWR about 80 years ago. Due to the extent of residential and agricultural development on the LWR, fire has all but disappeared from the region as a widespread, natural phenomenon.

In protected areas, prescribed fire is needed to manage scrub habitats and restore suitable conditions for snakeroot. Prescribed fire has not been implemented at numerous sites since they were acquired for conservation (The Nature Conservancy 2010). Because there is little chance of prescribed fire being implemented to maintain habitats on private land, imperiled species on unprotected sites will almost certainly disappear over time (Turner et al. 2006).

Land managers also use mechanical treatments such as mowing, roller-chopping, and logging to manage scrub habitats and prevent the loss of habitat by invasive species such as natal grass (*Melinis repens*), which is a potential threat to snakeroot (David et al. 2020). The long-term effects on scrub vegetation dynamics, and the response of species to these novel disturbances are not well-understood (Menges and Gordon 2010). Mechanical treatments cause soil compaction, soil disturbance, and may increase invasion by non-native plant species. Menges and Gordon (2010) recommend that mechanical treatments be used only when prescribed fire is precluded because of a site's proximity to the urban interface, or perhaps in the initial phases of restoring severely overgrown sites to a natural fire condition (i.e. as a complimentary treatment to accelerate the restoration process rather than a surrogate for fire).

b. Overutilization for commercial, recreational, scientific, or educational purposes:

Overutilization for commercial, recreational, scientific, or educational purposes was not identified as a potential threat in the original listing package. Since listing, no evidence of overutilization has been observed.

c. Disease or predation:

The threat of disease or predation to snakeroot has not been thoroughly studied but is thought to be low. There is no new information available regarding these threats since the previous 5-year review (Service 2010).

d. Inadequacy of existing regulatory mechanisms:

The ESA protect plants only when they occur on federally-owned lands or when a federal nexus is involved. Florida’s “Preservation of Native Flora of Florida” law (Rule Chapter 5B-40 of the Florida Administrative Code under authority from the Florida Statutes, Chapters 581.185, 581.186, and 581.187) protect plants only when they occur on state-owned lands. This law allows for collection of plants on state-owned lands by permit only and only for scientific and educational purposes.

Snakeroot is listed as endangered by the State of Florida on the Regulated Plant Index (Florida Department of Agriculture and Consumer Services Rule [FDACS] 5B-40). This law regulates the taking, transport, and sale of listed plants. However, property owners are not prohibited under this law from destroying populations of listed plants nor are they required to manage habitats to maintain populations.

Existing Federal (ESA) and state regulations (FDACS Rule 5B-40) prohibit the removal or destruction of listed plant species on public lands. However, they afford no protection to listed plants on private lands. In addition, state regulations are less stringent than federal regulations on land management practices that may adversely affect populations of listed plants. In conclusion, no existing regulatory measures are in place that reduce or remove the threat of loss of populations or removal/destruction of plants on private property.

e. Other natural or manmade factors affecting its continued existence:

The threats of limited dispersal capacity, drought (especially after fire), and off-road vehicles were discussed in the previous five-year review (Service 2010). There is no new information regarding these threats. The newly identified threats of isolated populations and climate change are discussed below.

Isolated Populations Within a Limited Geographic Range

Snakeroot occurs within a relatively limited geographic range consisting of a single Central Florida county. The limited geographic range in combination with the loss of habitat has resulted in a highly fragmented landscape where the remaining scrub areas that provide habitat for snakeroot have become increasingly isolated from each other, thereby making resiliency, redundancy, and representation more challenging to achieve. Given the limited geographic range of the species, a single catastrophic event could greatly reduce redundancy. In addition, the fragmented landscape may prevent ‘rescue’ or ‘repopulation’ from surrounding nearby populations.

Climate Change

There is currently no evidence of negative impacts to snakeroot from climate change factors. However, this could change in the future, as Florida is vulnerable to changes in precipitation and temperatures expected due to climate change. While the strong influence of ocean currents make projecting regional climate in Florida difficult (Kirtman et al. 2017), estimates project that Florida's average annual temperatures will increase approximately 1.5 to 5.5°F (0.8 to 3.1°C) by 2050 and from 2.3 to 11.5°F (1.1 to 6.4°C) by 2100 depending on the greenhouse gas emission rates and the region in Florida (Runkle et al. 2017). In addition, it is predicted that for Central Florida summer precipitation (wet season) will decrease up to 5 percent by 2050 (Runkle et al. 2017). Higher temperatures and changes in precipitation patterns could alter relative humidity levels and evapotranspiration rates, leading to the potential for more frequent and intense droughts and wildfire events. Scrub and sandhill species, in general, can tolerate drought conditions, but it is unclear how this anticipated future threat will fully affect species like snakeroot or the ability to implement prescribed fire (Kupfer et al. 2020).

In addition to changes in precipitation and temperatures patterns, there are also anticipated changes to the severity of tropical storms and hurricanes. Sweet et al. (2017) predicted a 20 percent increase in both rainfall rates and wind speeds near the center of storms due, in part, to higher sea surface temperatures.

Sea-level rise is another anticipated consequence of climate change in Florida. The Central Florida ridges will be spared from the direct impacts of sea level rise that are anticipated for coastal and low elevation areas. However, as sea level rises in coastal regions, development is likely to move inland, further increasing the threat of development in the higher elevation areas, such as the LWR (Volk et al. 2017).

D. Synthesis

In summary, none of the three delisting criteria for snakeroot have been met. There are fewer than 20 extant populations and trends are unknown for most populations. Snakeroot is currently known from 13 EORs, 10 of which are protected and managed for scrub habitats. Conservation mechanisms to provide suitable habitat for population viability are likely in place for a few populations, although this has not been studied at most sites.

The historic range of snakeroot has become increasingly fragmented due to development and alteration of the landscape. Populations are limited to Highlands County where they occur discontinuously since suitable habitat has a patchy distribution and is increasingly fragmented by development. The protected rosemary scrub fragments where the species occurs are surrounded by residential neighborhoods, citrus groves, and other anthropogenic habitats. Habitat loss (nearly 90 percent) and modification continues to be a threat to snakeroot, and increasing human population growth is expected to result in further habitat loss in the future.

Lack of adequate fire management continues to be a threat to snakeroot populations because the species thrives in the open conditions created and maintained by fire. While fire return intervals of 15 to 30 years will provide conditions for snakeroot populations to persist, the species peaks at 4 to 7 years post-burn. Regeneration occurs from a persistent soil seed bank and seed dispersed from surviving plants in unburned patches. Managers now apply prescribed fire and mechanical treatment to maintain rosemary scrub habitat in most of the protected conservation areas where snakeroot occurs; however at unprotected sites there is little chance of prescribed fire implementation, and fire suppression continues to be a threat at all the unprotected sites.

Anticipated climate change factors such as alteration to temperature and precipitation patterns and sea-level rise will only exacerbate threats to the species. Due to the probability of continued population losses at unprotected sites and the lack of adequate fire management at some existing protected sites, snakeroot continues to meet the definition of endangered under the ESA.

III. RESULTS

A. Recommended Classification:

 X No change is needed

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

- Introduce plants to suitable, managed habitats to increase the number of such populations to 20.
- Continue demographic monitoring and expand to additional occurrences, especially those that are protected. Menges et al. (2019) suggest level 3 demographic monitoring as the highest priority.
- Advocate and support the application of prescribed fire on managed areas to maintain rosemary scrub habitat for snakeroot.
- Ensure representation of snakeroot at the National Center for Genetic Resources Preservation in Fort Collins, Colorado.
- Service recovery leads should maintain open lines of communication with State land managers and provide updates as appropriate to ensure proper management of occurrences.
- Continue to improve the capacity for planting snakeroot as part of restoration efforts.
- Acquire land with existing populations from willing sellers and restore scrub habitat on these sites, including the implementation of prescribed fire.
- Utilize outreach and assistance programs to encourage private landowners to protect and manage scrub habitat on private lands.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of Snakeroot (*Eryngium cuneifolium*)

Current Classification: Endangered.

Recommendation resulting from the 5-Year Review:

- Downlist to Threatened**
- Uplist to Endangered**
- Delist**
- No change needed**

Review Conducted By: Emily Bauer, Florida Ecological Services Field Office, Vero Beach.

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve _____ Date _____

* Since 2014, Southeast Region Field Supervisors have been delegated authority to approve 5-year reviews that do not recommend a status change.