Snakeroot
(Eryngium cuneifolium)

5-Year Review:
Summary and Evaluation

Photos: Archbold Biological Station

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

5-YEAR REVIEW
Snakeroot / *Eryngium cuneifolium*

I. GENERAL INFORMATION

A. Methodology used to complete the review: This review is based on monitoring reports, surveys, and other scientific information, augmented by conversations and comments from biologists familiar with the species. The review was conducted by a biologist in the South Florida Ecological Services Field Office. Literature and documents used for this review are on file at the South Florida Ecological Services Field Office. All recommendations resulting from this review are a result of thoroughly reviewing the best available scientific information on the snakeroot. Public notice of this review was given in the *Federal Register* on April 9, 2009, with a 60-day public comment period (74 FR 16230). No part of the review was contracted to an outside party. Comments received and suggestions from peer reviewers were evaluated and incorporated as appropriate (see Appendix A).

B. Reviewers

Lead Region: Southeast Region, Kelly Bibb, 404-679-7132

Lead Field Office: South Florida Ecological Services Field Office, Mark Salvato, 772-562-3909

C. Background

1. FR Notice citation announcing initiation of this review: April 9, 2009. 74 FR 16230

2. Species status: Uncertain (2009 Recovery Data Call): There are 19 occurrences of snakeroot, 8 of which are protected on seven managed areas, all in Highlands County, Florida **(**Florida Natural Areas Inventory [FNAI] 2009). Four occurrences on private, unprotected lands are presumed extirpated. Fire suppression and habitat loss continue to be threats to occurrences on private land, except those owned by Archbold Biological Station (ABS). Inadequate prescribed fire implementation remains a significant threat at some publically managed sites. Most scrub sites are not burned frequently enough to support viable populations and mechanical surrogates may not provide the same benefits as fire. Further loss of unprotected populations is likely as development continues on the Lake Wales Ridge. Unprotected habitat continues to be developed for agriculture, housing, and other uses. Range-wide data are not available to infer overall population trends for the past year. In addition, trends in threats have continued over the past year. Therefore, the overall species status is uncertain.

3. Recovery achieved: 1 (0-25 percent recovery objectives completed)

4. Listing history
Original Listing
FR notice: 52 FR 2227
Date listed: January 21, 1987
Entity listed: Species
Classification: Endangered

5. Associated rulemakings: None

6. Review History: 5-year review, November 6, 1991 (56 FR 56882). In this review, different species were simultaneously evaluated with no species-specific in-depth assessment of the five factors or threats as they pertained to the species' recovery. The notices summarily listed these species and stated that no changes in the designation of these species were warranted at that time. No changes were proposed for the status of snakeroot**.**
Final Recovery Plan: 1999
Recovery Data Call: 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, and 2009

7. Species' Recovery Priority Number at start of review (48 FR 43098): 2 (a species with a high degree of threat and high recovery potential).

8. Recovery Plan
Name of plan: South Florida Multi-Species Recovery Plan (MSRP)
Date issued: May 18, 1999
Dates of previous plans: Recovery Plan for nineteen central Florida scrub and high pineland plants June 20, 1996 (revised plan). Recovery plan for eleven Florida scrub plant species January 29, 1990 (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 Endangered Species Act (ESA) defines species as including any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or 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.

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? No.

The criterion of 20 to 90 percent probability of persistence over 100 years is too wide. It allows for a possible 80 percent chance of extinction at the lower end of the range of probability of persistence.

Population stability is not a useful concept in a species such as snakeroot where healthy populations fluctuate in response to periodic fire. A metapopulation model is better suited to analyze population trends for a species with metapopulation dynamics, such as snakeroot.

This species does not reproduce by vegetative means, so the term "vegetative reproduction" should not be used in the criteria.

The primary habitat of snakeroot is rosemary scrub, not xeric oak scrub. The habitat management criteria should be amended to reflect this fact.

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)? No.

The criteria do not address other natural or manmade factors affecting its continued existence, including, drought and its limited capacity for dispersal.

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.

Criteria for when reclassification to threatened status will be considered for snakeroot:

1. Enough demographic data are available to determine the appropriate numbers of self-sustaining populations required to ensure 20 to 90 percent probability of persistence for 100 years.

This criterion has not been met. Detailed demographic data have been collected from multiple populations at five sites (two on ABS and three on Lake Wales Ridge Wildlife and Environmental Area (LWRWEA) lands), since 1988 (Menges and Quintana-Ascencio 2004, E. Menges, ABS, pers. comm. 2010a). Dolan et al. (1999) sampled snakeroot at 16 locations across the species range for genetic analysis; however, many of these locations have not been visited since. A population viability analysis (PVA) was conducted using data collected at the ABS sites which indicated that nearly every aspect of snakeroot demography is negatively affected as time-

since-fire increases (Menges and Quintana-Ascencio 2004). However, the PVA did not attempt to address the question of the number of populations required by the stated probability of persistence criteria. Demographic data have been collected consistently from only five sites, so rangewide issues cannot be addressed. This criterion addresses factor A and E.

2. When these populations, within the historic range of snakeroot, are adequately protected from further habitat loss, degradation, and fragmentation.

This criterion has not been met. The number of populations required to satisfy this criterion has yet to be established. Eight of 19 snakeroot occurrences are protected on private or State-owned conservation lands (FNAI 2009). Eleven of 19 occurrences are located on unprotected, private land and their present status is unknown. Four occurrences are presumably extirpated based on an evaluation of 2008 aerial imagery. These occurrences are either already destroyed or could be destroyed at any time. Unprotected occurrences are susceptible to habitat loss and degradation and are unlikely to be managed with prescribed fire. More than half of all occurrences are not adequately protected from further habitat loss, degradation, and fire suppression. Populations are not protected across the historic range of snakeroot. No occurrences are protected in the northern part of its range near Sebring. A cluster of six extant occurrences are located on private lands at the extreme southern end of its range, none of which are targeted for acquisition. This criterion addresses factors A and D.

3. When these sites are managed to maintain the rosemary scrub that supports snakeroot.

This criterion has not been met. Thirteen of 19 occurrences are not managed to maintain the rosemary scrub habitat that supports snakeroot. Six of the eight protected occurrences on ABS and State properties are managed, primarily with prescribed fire, to maintain rosemary scrub. This criterion addresses factor A.

4. When monitoring programs demonstrate that these sites support populations of sufficient sizes, are distributed throughout the historic range, and are sexually or vegetatively reproducing at sufficient rates to maintain the population.

This criterion has not been met. Protected sites represent only a portion of the species' range. Protection is lacking for occurrences in both the north and south limits of snakeroot's historic range. Monitoring programs do not cover the species throughout its historic range. Existing research predicts that populations occurring at sites that have remained unburned for more than 12 years will not reproduce at sufficient rates to maintain these populations (Menges and Quintana-Ascencio 2004). The species does not reproduce vegetatively so that part of the criterion should be revised. This criterion addresses factor A and E.

C. Updated Information and Current Species Status

1. Biology and Habitat

Information on the biology and habitat of snakeroot is summarized in the South Florida Multi-Species Recovery Plan (MSRP) (Service 1999). Relevant biology and habitat information is summarized and updated in this review.

Snakeroot (*E. cuneifolium*), a member of the Apiaceae (carrot family), is a short-lived (less than 10 years) perennial herb with a very long taproot and flowering stems growing to 0.5 meters (m) in height. The species does not spread clonally. Greenish flowers occur for about a month in late summer to fall (August to October). Germination is in winter and spring. The species is endemic to the Lake Wales Ridge (LWR) and occurs only in Highlands County, Florida (Turner et al. 2006, FNAI 2009). Habitat for snakeroot is open sand gaps in white sand scrub, primarily Florida rosemary scrub 'balds', characterized by xeric conditions, relatively sparse vegetation, persistent gaps, and longer fire-return intervals than oak (*Quercus* spp.) and sand pine (*Pinus clausa*) dominated scrubs.

a. Abundance, population trends, demographic features, or demographic trends:

Abundance

FNAI maintains a database of Element Occurrence Records (EORs) for rare plants and animals of Florida. Each EOR identifies a place on the landscape where a rare plant or animal has been observed. FNAI has 19 EORs for snakeroot (FNAI 2009); all are in Highlands County. Eight of 19 occurrences of snakeroot are within seven protected areas - ABS (private ownership; EORs 3, 21 and 22) and State-owned LWRWEA lands at McJunkin Tract (EOR 3), Gould Road Scrub (EOR 6), Holmes Avenue Scrub (EOR 10), Lake Apthorpe (EORs 13 and 15), and Lake Placid Scrub (EOR 19). Eleven of 19 occurrences (EORs 1, 2, 4, 5, 7, 9, 12, 14, 16, 17, and 18) are located on unprotected, private land and their present status is unknown. Based on analysis of 2008 aerial images, it appears that two are likely destroyed or heavily disturbed, two have been destroyed by development and another seven may still be extant based on remaining habitat in the area where they were previously recorded.

The most northern snakeroot occurrences are in Sebring along State Road 17 (EORs 1 and 18). The site at Sebring Triangle East (EOR 1) has been commercially developed and snakeroot is probably extirpated at this location, however the species may be extant at Sebring Triangle Northeast (EOR 18) given the presence of white sands on and adjacent to the site. Placid View Road scrub (EOR 7) is a residential development and this occurrence has likely been extirpated. An extensive occurrence in north-east Lake Placid,

including much of the area known as Sylvan Shores (EOR 14) is lightly developed and remaining habitat may still support snakeroot, particularly based on its location central to two LWRWEA areas, Lake Apthorpe to the north and Holmes Avenue to the south, which both maintain substantial snakeroot populations. The site at EOR 12 includes a few single-family residences and a citrus grove. Although much of the location is undisturbed, it is severely overgrown and as a result, this occurrence may be extirpated. A cluster of occurrences (EORs 2, 4, 5, 9, 16 and 17) on private lands, five of which are under the same ownership, lie directly south of snakeroot populations at ABS and the Gould Road LWRWEA. Although none of these locations have been recently surveyed for snakeroot, examination of aerial photos indicates habitat appears favorable for extant populations at all but one site (EOR 5). The site at EOR 5 is overgrown suggesting that occurrence has probably been extirpated.

A snakeroot population was reported to occur at Lake June Scrub State Park on the west side of Lake June (Service 1996), but it was not relocated after several intensive searches (Schultz et al. 1999). Schultz et al. (1999) surveyed 26 properties on the LWR under consideration for purchase by the State of Florida and did not find any new localities for snakeroot.

Population Sizes

Recent estimates (within 5 years) of the number of plants at each locality are unavailable for most occurrences. Abundance estimates for three populations of snakeroot are as follows:

- ABS. In the latest sampling (Fall 2009), 263 plants were counted, down from the 398 plants recorded in 2008. However, additional plants occur outside of study sites, particularly in disturbed areas on ABS. A rough estimate of population size at ABS is about 500 plants (Menges, pers. comm. 2010b). During 2009, many locations on ABS were burned for the first time since 1986. As a result, snakeroot abundance is expected to increase at ABS within the next 5 years (Menges, pers. comm. 2010b). Few seedlings were recruited in 2009, less than previous years (E. Menges, pers. comm. 2010b).
- Lake Placid Scrub (2009 survey). No living plants were encountered (Menges, pers. comm. 2010b). However, there is probably a seedbank present, and snakeroot may rebound at this site in response to spring rains.
- Royce Ranch (2009). One hundred fifty-six plants were recorded within the designated study plot, however large numbers of additional plants were also observed throughout the property (Menges, pers. comm. 2010b).

Fire Ecology

Natural fires are a major ecological force in maintaining Florida rosemary scrub. In this habitat, nearly every aspect of snakeroot's demography is affected by time-since-fire (Menges and Kimmich 1996, Menges and Quintana-Ascencio 2004). The beneficial effects of fire are largely indirect, through removal of litter, competing vegetation, and ground lichens. Snakeroot is sensitive to shrub cover and is dependent on the gaps created between rosemary shrubs immediately after fires (Menges and Hawkes 1998). Hunter and Menges (2002) and Hewitt and Menges (2008) found that snakeroot germination is inhibited by the leaf litter and by allelopathic compounds produced by Florida rosemary. When fire burns through populations of snakeroot, most of the living plants are killed. However, the species is capable of forming persistent seed banks and post-fire recruitment occurs mostly from dormant seeds (Quintana-Ascencio and Menges 1997, Menges and Quintana-Ascencio 2004). Menges (2007) indicates the snakeroot seed bank can remain viable for at least 6 years.

Obligate-seeding scrub plants, with persistent seed banks, such as snakeroot, can be eliminated with too frequent fire, but decline with infrequent fires (Menges 2007). Historically, fires likely occurred in the rosemary scrub at 20 to 100 year intervals, but have been suppressed over the past 60 years in a large part of the LWR (Menges 1999, Menges and Quintana-Ascencio 2004). While fire return intervals of 15 to 20 years will provide conditions for snakeroot populations to persist, Menges and Weekley (1999) indicated that species peaks at 4 to 7 years post-burn. Populations decline to zero in patches of rosemary scrub left unburned for 25 to 35 years (Menges 2007). Menges (2007) suggests that variation in fire regimes in time and space is recommended which can allow species with disparate life histories to co-exist in rosemary scrub.

Demographic Features

Hawkes (2004) examined soil crust in rosemary scrubs in south-central Florida for effects on snakeroot seed germination. Snakeroot is a small-seed herb, making its germination susceptible to microclimate characteristics, such as soil moisture, which is influenced by soil crusts and shrub cover. Hawkes (2004) found that snakeroot had higher seed germination with increased rainfall and suggested that during drought conditions, the number of favorable microsites available is reduced to only the most optimal. For snakeroot, these are living crusts away from shrubs in recently burned areas. On average, germination and survival of only 0.2 percent of snakeroot seeds produced in a season would be required for population replacement (Hawkes 2004). Most germination in rosemary scrub occurs during the winter season and winter rains may be a cue for germination, while spring and summer rainfall directly affect seedling survival (Menges and Weekley 1999, Hawkes 2004). Seedling

numbers are highest during wet spring weather and in recently burned areas (ABS 2003). Dispersal is limited and appears to be primarily via gravity, with most seedlings found clustered around the previous season's flowering plants (Quintana-Ascencio and Menges 1996, Dolan et al. 1999).

Menges et al. (2006) conducted restoration of degraded sites to high quality Florida scrub at ABS. Seeds for numerous species, including snakeroot, were collected at ABS for introduction into restoration areas. During these restoration efforts, over twice as many seeds germinated in open microsites (96, 0.97 percent) as compared to within shrub microsites (45, 0.45 percent). Overall germination rates in this study were low (11 germinants from 900 seeds, 1.2 percent).

In a similar study, Quintana-Ascencio et al. (2008) planted seeds for numerous species, including snakeroot, in disturbed scrub undergoing restoration, as well as native scrub areas, to determine the effect of habitat type on germination and establishment. In single treatment trials, snakeroot initially showed minimal germination within the restoration areas (6.25 percent, based on 160 seeds planted). Overall germination for seeds planted in both disturbed and native habitats was lower at 2.08 percent (based 480 seeds). However, all seedlings in the study died before reaching maturity.

Demographic Trends

Menges and Quintana-Ascencio (2004) found high rates of snakeroot survival, growth and fecundity in the years following a fire, with population explosions within the first decade post-burn. Snakeroot survival, growth and reproduction require open habitats with limited and low shrub cover (Menges and Kimmich 1996). In long-unburned sites, population growth rates are negative, suggesting continued population decline (Menges 2007). Local extinctions of snakeroot, even in larger populations, are predicted at 30 years post-fire (Menges and Weekley 1999, Menges 2007). Individual plants are particularly sensitive to scrub cover and require large open-sand gaps between patches of rosemary (Menges and Kimmich 1996). Hawkes (2004) indicates that snakeroot is a gap and post-fire specialist with a distribution largely driven by its ability to germinate and survive in these conditions. The exacting habitat requirements for snakeroot mean that, despite large populations at several sites (possibly millions of individual plants in its small range, plus dormant seeds), its habitats must be managed aggressively to maintain the gaps that species needs.

Pollination

A diverse assemblage of insects visit snakeroot, though not necessarily for pollination; only bees and syrphid flies were observed to collect pollen (Evans et al. 2003). Seed set from insect pollinator visitation resulted in high

fecundity. Insect movements were largely among flowers on the same nearby plants (less than 5 m apart). Evans et al. (2003) indicated that self and cross treatments produced similar numbers of seeds, suggesting that inbreeding depression is not acting at this life history stage.

b. Genetics, genetic variation, or trends in genetic variation:

Dolan et al. (1999) investigated isozyme variation in rare perennial scrub plants endemic to the LWR. These studies indicated that while snakeroot has low genetic variation, it is comparable to other endemic plants with restricted geographic ranges. The species has intermediate values for most genetic parameters; the observed moderate levels of population differentiation may be maintained by fire-dependent demographic fluctuations with bottlenecks or even local extirpations in above ground populations in areas that have persisted without fire for 20 or more years (Dolan et al. 1999). Although snakeroot can be locally numerous, with some sites maintaining thousands of individuals, there are only 19 known populations and opportunities for long-distance seed dispersal are limited. Nevertheless, the remaining populations are not particularly distinct genetically (Dolan et al. 1999).

c. Taxonomic classification or changes in nomenclature:

None. The Integrated Taxonomic Information System (2010) was checked while conducting this review. The taxon *Eryngium cuneifolium* Small is accepted and current.

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

Snakeroot occurs on the LWR within a 30 kilometer (km) band that runs along a roughly north-south axis in southern Highlands County. At the northern extreme of the species range, one isolated population north of Sebring is 15 km disjunct from the nearest other population (Dolan et al. 1999). The historic distribution also included several sites in and around the town of Sebring (Wunderlin et al. 1981). Habitat fragmentation has likely played a large role in the current abundance and distribution of snakeroot. Most occur in discrete populations separated by large areas due to development and fire suppression (Quintana-Ascencio and Menges 1996).

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

Habitat Preference

Snakeroot is restricted to open areas of well-drained white sand in Florida rosemary scrub that is very xeric with persistent gaps and longer fire-return intervals than other types of scrub (Menges and Kimmich 1996, Menges and Hawkes 1998, Dolan et al. 1999, Menges et al. 2008b). Rosemary scrub is a phase of sand pine scrub that recovers relatively slowly after fire and retains open gaps for decades between burns (Menges 2007). Because of the persistent open gaps created between fires, a greater proportion of herbaceous species occur in rosemary scrub than in other denser types of Florida scrub (Hawkes and Menges 1996).

The characteristic dense canopy of oaks, pine, and hickory is periodically top-killed by fire. The natural fire return interval varies by the type of Florida scrub. Scrub vegetation tends to burn infrequently (every 10 to 60 years) and intensely (Myers 1985). Fire opens scrub canopies and consumes litter. Most perennials in the community resprout vigorously after fire, re-establishing the canopy. Others, including snakeroot, are killed by fire and must regenerate from a persistent seed bank (Quintana-Ascencio and Menges 2000). Because snakeroot is short-lived, seedling recruitment is important in maintaining populations between fires (Menges and Weekley 1999). Based on PVA modeling, Menges and Quintana-Ascencio (2004) recommended a fire return interval of 15 to 20 years in rosemary scrub to maximize persistence of snakeroot populations. Menges et al. (2008b) noted that as time-since-fire increases, herb cover, species richness, herb diversity, and gap size decreased significantly. Menges (2007) suggested burning rosemary scrub at 15 to 30-year intervals, as repeated longer fire return intervals would gradually reduce snakeroot population sizes and make each post-recovery more muted.

Habitat Loss

Post-Columbian settlement of south-central peninsular Florida, which has been escalating since the 1920s, has drastically altered the LWR. Most habitat loss occurred between 1920 and 1990. By the late 1980s, about 78 percent of upland habitat was lost to agriculture, ranching, commercial and residential development (Weekley et al. 2008). Despite the acquisition between 1985 and 2005 of over 45,500 acres of undeveloped land on the LWR, primarily through State programs such as Preservation 2000 and its successor Florida Forever, natural areas have continued to be destroyed during the past 2 decades (Weekley et al. 2008). Turner et al. (2006) estimated that 87 percent of upland habitat has been lost on the LWR by 2006, including over 46 percent of areas with white sand substrate (Weekley et al. 2008).

Land Acquisition

Land acquisition to date has placed nearly half (21,596 acres, or 48.9 percent) of the remaining 44,157 acres of xeric upland habitat on the LWR within protected areas (Turner et al. 2006). Successful acquisition of all targeted sites will place an additional 4,052 acres within protected areas, bringing the proportion of extant habitat that is protected to 58.1 percent. This would represent 7.5 percent of the xeric upland habitats that existed on the LWR prior to widespread human settlement (Turner et al. 2006). However, Turner et al. (2006) indicates that aside from pursuing additional inholdings where needed in the conservation lands discussed below, no other snakeroot populations are presently targeted for acquisition.

Royce Ranch, a 125-acre addition to Lake Apthorpe, was purchased by the State in 2003 and added to LWRWEA conservation lands (Florida Department of Environmental Protection [FDEP] 2008). The southern half of Royce Ranch has been cleared for pasture, but scrub vegetation persists, including a large and vigorous population of snakeroot on the low ridges of white sand (Schultz et al. 1999, FNAI 2009, E. Menges, pers. comm. 2010b). The larger ownerships within the Highland Park Estates have either been acquired or are being negotiated. Several lots important for management (including all those with known snakeroot occurrences) have been acquired as well (FDEP 2008).

FDEP (2008) indicates that approximately half of the approximately 1200-acre Holmes Avenue has been acquired for the LWRWEA, including two areas (Holmes Avenue Rosemary Bald and Holmes Avenue South End) in which Schultz et al. (1999) documented snakeroot occurrence, however, multiple ownerships remain. Holmes Avenue South End, in particular, has exposed white sand covering at least one-quarter of the tract, harboring numerous individuals of snakeroot (Schultz et al. 1999, Menges et al. 2008a).

The 419-acre Gould Road contains 200 acres of high quality scrub communities. The northeast corner of Gould Road was partially cleared, leaving huge areas of exposed white sand with only occasion clumps of rosemary shrubs and as a result snakeroot is abundant (Schultz et al. 1999). FDEP (2008) indicates that the major ownerships at Gould Road have been acquired as part of the LWRWEA and that discussions are ongoing with the owners of smaller inholdings.

The 1,860-acre McJunkin Tract, once part of ABS, is now part of the State-owned LWRWEA. FDEP (2008) indicates the entire tract has been acquired.

Management

Habitat for snakeroot is managed using prescribed fire, and efforts to control exotic species are underway at the protected sites. The Florida Fish and Wildlife Conservation Commission (FWC) manages habitat at six LWRWEA

locations that maintain snakeroot populations. ABS manages the habitat for snakeroot populations on ABS property.

2. Five-Factor Analysis

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

Current threats to the habitat of snakeroot include loss from development and modification due to long-term fire suppression. Eight of 19 occurrences are protected on private or State-owned conservation lands (FNAI 2009). Turner et al. (2006) indicates that aside from pursuing additional inholdings where needed in the existing eight protected occurrences, no other sites with snakeroot occurrences are presently targeted for acquisition.

The status of 11 snakeroot occurrences on unprotected, private land is unknown. They are either already destroyed or could be destroyed at any time. Private property owners are not prohibited under the ESA or State laws from destroying populations of listed plants nor are they required to manage habitats to maintain populations.

Public and private institutions have worked to protect the remaining undeveloped areas on the LWR. However, many species are likely to remain at great risk of extinction despite ongoing conservation efforts, primarily because even the most optimistic acquisition scenarios will protect only 7.5 percent of the original LWR habitats; most having already been destroyed. The protected fragments are surrounded by residential neighborhoods, citrus groves, and other anthropogenic habitats (Turner et al. 2006).

A recent analysis of Florida scrub conservation progress based on land acquisition included snakeroot among the 36 rare species of the LWR. Turner et al. (2006) calculated protection indices for each species and for three time periods (past, present, future) based on number of locations, extent of occurrence, and area of occupancy. The overall protection index of less than '1' identified snakeroot as 'critically endangered'. In addition, the analysis identified it as one of at least eight LWR species in which translocation and captive propagation may be necessary to ensure its survival due to inadequate representation on conservation lands (Turner et al. 2006).

Ward et al. (2003) developed a system for numerically ranking Florida's endangered flora to reflect the degree to which they are at risk. The system scores each species based on the number of occurrences, abundance, range, degree of protection, degree of threat, and special considerations such as reproductive issues. The scoring results in a rank from 1.5 to 19.0 (1.5 to 8.5 = 'endangered', 9 to 12 = 'threatened') for each species. Snakeroot was ranked 3.5 and 'endangered' (Ward et al. 2003).

Increasing pressure from population growth is likely to result in further loss of LWR habitats. Zwick and Carr (2006) analyzed existing land use and landscape patterns to identify the areas most likely to be developed to accommodate a growing human population and estimated relative losses to agriculture, open space, and conservation to other land uses. They predicted central Florida will experience "explosive" growth, with continuous urban development from Ocala to Sebring, the area encompassing the entire range of snakeroot. They estimated 2.7 million acres of native habitat and 630,000 acres of land currently under consideration for conservation purchase will be lost. Also of significance, they state that "more than 2 million acres within 1 mile of existing conservation lands will be converted to an urban use, complicating management and isolating some conservation holdings in a sea of urbanization" (Zwick and Carr 2006).

Fire suppression continues to be a threat to snakeroot populations because the species thrives in the open conditions (gaps between shrubs) created and maintained by fire (Menges 2007). Quintana-Ascencio and Menges (1996) investigated the metapopulation dynamics of patch specialist scrub herbs and concluded that long-term fire suppression decreases gap size and increases extinction probability for species restricted to open habitats.

Fire suppression started on a regional scale on the LWR about 70 years ago. Long-unburned oak scrub sites have dense shrub growth and litter accumulation. In these communities, gap specialists and shade-intolerant endemics, including snakeroot, tend to decline with time-since-fire (Menges 2007). Fire management in some managed areas is inadequate to maintain habitat quality for occurrences of snakeroot, as noted above for some LWRWEA sites. There is a backlog of long-unburned habitat within conservation areas on the LWR. For example, 16 of the 63 LWR conservation sites have not received any fire management since they were acquired. The TNC fire history database showed that in 2008 (the last year for which data analysis was completed) 123,484 acres are within the recommended fire return interval and 38,359 acres outside the recommended fire return interval (TNC 2010b). The fire management condition of most privately owned parcels is unknown. Fire management is highly unlikely on private properties unless they are designated conservation areas. Undeveloped private sites are likely to be overgrown due to fire suppression.

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. Managers now apply prescribed fire and mechanical treatments to maintain habitat suitability in the eight protected areas where snakeroot occurs. Because there is little chance of such measures taking place to maintain habitat suitability in unprotected fragments, imperiled species on unprotected sites will almost certainly disappear over time (Turner et al. 2006).

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:

Quintana-Ascencio et al. (2008) evaluated the role of vertebrate and invertebrate predators and dispersers on a variety of Florida scrub plant species seeds, including snakeroot, in both natural and disturbed scrub. These studies found that snakeroot seeds were most often removed by vertebrates in both natural and disturbed scrub treatments. The vertebrates were not identified by species, but could range from small mammals to ungulates. Invertebrates removed little or no seeds throughout these studies. A fungus has been documented to kill snakeroot (E. Menges, pers. comm. 2010b), however the extent to which disease may influence the species requires further study. We believe the overall threat level from disease or predation is low.

d. Inadequacy of existing regulatory mechanisms:

Snakeroot is listed as endangered by the State of Florida on the Regulated Plant Index (Florida Department of Agriculture and Consumer Services Rule 5B-40). This law regulates the taking, transport, and sale of listed plants. It does not prohibit private property owners from destroying populations of listed plants on their property nor require landowners to manage habitats to maintain populations. Existing Federal and State regulations prohibit the removal or destruction of listed plant species on public lands. However, such regulations afford no protection to listed plants on private lands. The ESA only protects populations from disturbances on Federal lands or when a 'Federal nexus' is involved for other lands, meaning any action that is authorized (e.g. permitted), funded or carried out by a Federal agency. In addition, State regulations are less stringent than Federal regulations toward land management practices that may adversely affect populations of listed plants on private land. Existing regulatory mechanisms are inadequate to protect snakeroot.

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

Limited Dispersal Capability

Snakeroot seed dispersal is limited to a few meters from the parent plant (Quintana-Ascencio and Menges 1996, Dolan et al. 1999). Scrub habitat consists of a mosaic of patches in which only some are suitable for population

expansion. In fragmented habitats, limited dispersal capability may have a negative effect on persistence because propagules are less likely to disperse to distant patches that are suitable for recruitment. Decreasing size and increased isolation of remaining areas of Florida scrub have potential negative effects on gap specialist species (Quintana-Ascencio and Menges 1996) such as snakeroot.

Drought

Drought exacerbates declines due to lack of fire and prevents strong post-fire recovery of snakeroot populations. Regeneration of populations from seed after fire is mediated in part by annual precipitation patterns. Unusually long periods without rainfall lead to increased seedling mortality. At ABS, a burn in 2009 was followed by a drought period that resulted in much lower seedling recruitment than encountered in 2007 and 2008. However, snakeroot is capable of forming persistent seed banks and recruitment after fire depends mostly on dormant seeds, which generally will not germinate until 1 year after sowing (Quintana-Ascencio and Menges 1997, Menges and Quintana-Ascencio 2004). Therefore, a rebound in snakeroot population numbers at ABS over the next few years is anticipated (E. Menges, pers. comm. 2010b).

Off-road vehicles (ORVs)

ORV impacts have been observed on natural areas on the LWR (Schultz et al. 1999) and throughout central Florida. Off-road vehicles crush, uproot and tear plants as they drive over them. Roads facilitate and intensify illegal collection of rare plants and serve as corridors for exotic plant invasion and illegal trash dumping. Schultz et al. (1999) considered ORV use a threat to sensitive areas maintaining snakeroot occurrences within both Lake Apthorpe and Holmes Avenue Scrub. Based on analysis of 2008 aerial images, extensive ORV activity appears evident at Sebring Triangle Northeast (EOR 18), an area with white sands on which snakeroot may still occur.

D. Synthesis

Snakeroot, a short-lived, perennial herb, is endemic to the LWR. The historic range of snakeroot is limited to Highlands County. Habitat for snakeroot is well-drained, white sand in Florida rosemary scrub that is very xeric with persistent gaps and longer fire-return intervals than other types of scrub (Menges and Kimmich 1996, Menges and Hawkes 1996, Dolan et al. 1999). Snakeroot is known from 19 occurrences. Eight of the 19 occurrences are protected at one private conservation site (ABS) and six on State-owned sites within the LWRWEA. Eleven of the 19 occurrences are located on private land and their present status is unknown. They are either already destroyed or could be destroyed at any time because private property owners are not prohibited from destroying populations of listed plants nor are they required to manage habitats to maintain populations.

Fire suppression continues to be a threat to snakeroot populations because the species thrives in the open conditions created and maintained by fire (Menges and Hawkes 1998). Menges and Quintana-Ascencio (2004) indicate that nearly every aspect of snakeroot demography is affected by time-since-fire. While fire return intervals of 15 to 20 years will provide conditions for snakeroot populations to persist, the species peaks at 4 to 7 years post-burn. Research indicates that the populations decline completely in patches of rosemary scrub left unburned for 25 to 35 years (Menges 2007). 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 the protected conservation areas where snakeroot occurs. Fire suppression continues to be a threat at all the unmanaged sites. There is little chance of prescribed fire implementation at unprotected areas (Turner et al. 2006).

Habitat loss and modification continues to be a threat to snakeroot. Populations occur discontinuously across the species range since suitable habitat has a patchy distribution and is increasingly fragmented by development. Turner et al. (2006) estimated that 87 percent of historic upland habitat has been lost on the LWR by 2006, mainly to agriculture, ranching, commercial and residential development (Weekley et al. 2008). The protected fragments are surrounded by residential neighborhoods, citrus groves, and other anthropogenic habitats (Turner et al. 2006). Increasing pressure from human population growth is expected to result in further loss of LWR habitats (Zwick and Carr 2006).

None of the recovery criteria for reclassification have been achieved to date. In particular, more than half (11 of 19) of occurrences currently have no protection because they are located on private land, and these sites are not managed to maintain rosemary scrub habitat in suitable condition for long-term persistence of the species. For these reasons, 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

- Determine the condition of the eleven unprotected occurrences on private land whose status is currently unknown.
- 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.
- Continue demographic monitoring and expand to additional occurrences, especially those that are protected.

- Advocate and support the application of prescribed fire on State lands to maintain rosemary scrub habitat for snakeroot.
- Evaluate and strengthen efforts to study germination requirements for snakeroot.
- Evaluate the influence of insect herbivory and pathogens, such as the unidentified fungus, on snakeroot ecology.
- Service recovery leads should maintain communication with State land managers and provide updates as appropriate to ensure proper management of occurrences.
- Continue to improve the capacity for use of snakeroot in restoration efforts.

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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

_X_ No change is needed

Review Conducted By Mark Salvato, Biologist

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve _____ Date 6/11/10

The lead Field Office must ensure that other offices within the range of the species have been provided adequate opportunity to review and comment prior to the review's completion. The lead field office should document this coordination in the agency record.

REGIONAL OFFICE APPROVAL:

The Regional Director or the Assistant Regional Director, if authority has been delegated to the Assistant Regional Director, must sign all 5-year reviews.

Acting
Lead Regional Director, Fish and Wildlife Service

Approve Aaron L Valenta Date 7-7-10

The Lead Region must ensure that other regions within the range of the species have been provided adequate opportunity to review and comment prior to the review's completion. If a change in classification is recommended, written concurrence from other regions is required.

Summary of peer review for the 5-year review of Snakeroot (*Eryngium cuneifolium*)

A. Peer Review Method: The Service conducted peer review. Three peer reviewers were asked to participate in this review. Individual responses were requested and received from each of the peer reviewers.

B. Peer Review Charge: See attached guidance.

C. Summary of Peer Review Comments/Report: The reviewers found the 5-year review to be thorough, and all agreed with the conclusions of the review.

One reviewer stated that, while snakeroot has been subject to a fair amount of surveying, modeling, and analysis these data have only been collected and analyzed from a limited number of populations. This reviewer suggests that a program to collect data on the species' overall population size would be useful. The reviewer provided copies of recent papers addressing allelopathy and gap structure suggesting they might strengthen the review. This reviewer indicated the judgments made from the scientific evidence were reasonable, in that it focused on population fluctuations, proper fire management, the role of microhabitats, as well as taking a broad look at land use trends and conservation status of ecosystems in the region. The reviewer recommended efforts to improve our capacity to use this species in restorations. The reviewer found this to be a strong status review and hoped it will be useful in spurring further research and conservation actions on behalf of the species.

One reviewer indicated they did not have any comments and thought that all subjects were covered very thoroughly. This reviewer stated the document was an excellent compilation of the proper references and ecological knowledge needed to examine the status and needs of this plant. Additionally, this reviewer noted that demographic research, management, and monitoring needs covered in this document will help land managers and conservationists to a large degree.

One reviewer indicated that this review summarizes all information available on snakeroot. This reviewer stated that the information is particularly valuable since it documents the life history, distribution, management, and population dynamics of the species, which is critical to guide management and conservation decisions. The reviewer stated that while there are enough data to evaluate the species major population trends and risks, a better understanding of the extinction risks will require more research and analysis on populations in other parts of its range. The reviewer indicated more information is needed on the interaction of this species with diseases, predators, herbivores and mutualisms that may affect the remaining populations. The reviewer indicated that available information supports the need for proper prescribed fire, reduction of exotic species invasion, and restraint of off-road vehicles.

D. Response to Peer Review: The Service was in agreement with all comments and concerns received from peer reviewers. Comments were incorporated into the 5-year review where appropriate.

Guidance for Peer Reviewers of Five-Year Status Reviews

U.S. Fish and Wildlife Service, South Florida Ecological Services Office

March 27, 2009

As a peer reviewer, you are asked to adhere to the following guidance to ensure your review complies with U.S. Fish and Wildlife Service (Service) policy.

Peer reviewers should:

1. Review all materials provided by the Service.

2. Identify, review, and provide other relevant data apparently not used by the Service.

3. Not provide recommendations on the Endangered Species Act classification (e.g., endangered, threatened) of the species.

4. Provide written comments on:
   - Validity of any models, data, or analyses used or relied on in the review.
   - Adequacy of the data (e.g., are the data sufficient to support the biological conclusions reached). If data are inadequate, identify additional data or studies that are needed to adequately justify biological conclusions.
   - Oversights, omissions, and inconsistencies.
   - Reasonableness of judgments made from the scientific evidence.
   - Scientific uncertainties by ensuring that they are clearly identified and characterized, and that potential implications of uncertainties for the technical conclusions drawn are clear.
   - Strengths and limitation of the overall product.

5. Keep in mind the requirement that the Service must use the best available scientific data in determining the species' status. This does not mean the Service must have statistically significant data on population trends or data from all known populations.

All peer reviews and comments will be public documents and portions may be incorporated verbatim into the Service's final decision document with appropriate credit given to the author of the review.

Questions regarding this guidance, the peer review process, or other aspects of the Service's recovery planning process should be referred to Dana Hartley, Endangered Species Supervisor, South Florida Ecological Services Office, at 772-562-3909, extension 236, email: Dana_Hartley@fws.gov.