

Conradina glabra
(Apalachicola rosemary)

**5-Year Review:
Summary and Evaluation**



Torrey State Park, FL. Photos by Vivian Negrón-Ortiz

**U.S. Fish and Wildlife Service
Southeast Region
Panama City Field Office
Panama City, Florida**



5-YEAR REVIEW
***Conradina glabra* (Apalachicola rosemary)**

I. GENERAL INFORMATION

A. Methodology used to complete the review

This review was accomplished using information obtained from the Recovery Plan of September 1994, unpublished field survey results, reports of current research projects, peer reviewed scientific publications, unpublished field observations by Service, State, Park, and other experienced biologists, and personal communications. These documents are on file at the Panama City Field Office. In addition, a working group meeting, including those individuals working on and knowledgeable about the natural history of *Conradina glabra*, was held on August 4, 2017 to discuss past, current, and planned activities and their relationship to the recovery actions stipulated in the Recovery plan. Information from that meeting, including progress on certain recovery actions, new scientific data, management, has been incorporated into this 5-year status review. A *Federal Register* notice announcing the review and requesting information was published on August 30, 2016 (81 FR 59650). No part of this review was contracted to an outside party. Comments and suggestions from peer reviewers were incorporated as appropriate (see Appendix A). This review was completed by the Service's lead Recovery botanist in the Panama City Field Office, Florida.

B. Reviewers

Lead Field Office: Dr. Vivian Negrón-Ortiz, Panama City Field Office, 850-769-0552 ext. 231

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

Peer reviewers:

Michael Maples, Florida Department of Environmental Protection

Raya Pruner, Florida Department of Environmental Protection

Anne C. Schmidt, M.S., District 1 Administration, Panama City Division of Recreation and Parks, Florida Department of Environmental Protection

C. Background

1. FR Notice citation announcing initiation of this review: 81 FR 59650 (August 30, 2016): Endangered and threatened wildlife and plants: 5-Year Status Review of 22 Southeastern Species.

2. Species status:

2017: Stable: According to managers of Torreya State Park, Liberty County, FL (8/4/2017, pers. comm. to V. Negrón-Ortiz), the species status over the short-term

appears stable, but uncertain over the long-term. Short-term trends in plant numbers over the past years indicate a high reduction of adults in mowed plots and an increase of small (<5cm) plants vs. an increase of adults in non-mowed areas.

3. Recovery achieved: 2 (26-50% recovery objectives achieved); see section II.B.3 for details on recovery criterion and actions, and how each action has or has not been met.

4. Listing history

Original Listing

FR notice: 58 FR 37432-37443: Endangered and threatened wildlife and plants: Status for five Florida plants.

Date listed: July 12, 1993

Entity listed: species

Classification: endangered

5. Associated rulemakings:

Not applicable

6. Review History

Previous 5-year Review: July 7, 2009 (stable)

Each year, the Service reviews and updates listed species information for inclusion in the required Recovery Report to Congress. Through 2013, we did a recovery data call that included status recommendations such as “Stable” for this plant. We continue to show that species status recommendation as part of our 5-year reviews. The most recent evaluation for this plant was completed in 2016.

Recovery Plan: September, 1994

No formal 5-year reviews were conducted on *C. glabra* prior to the Recovery Plan.

7. Species’ Recovery Priority Number at start of review (48 FR 43098):

The Apalachicola Rosemary is assigned a recovery priority of 8 because the degree of threat to its persistence is moderate, it is a species, and has a high recovery potential.

8. Recovery Plan

Name of plan: Recovery Plan for Apalachicola Rosemary (*Conradina glabra*)

Date issued: September 1994

Dates of previous revisions: N/A

II. REVIEW ANALYSIS

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

Conradina glabra is a plant; therefore, it is not covered by the DPS policy and it will not be addressed further in this review.

B. Recovery Criteria

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

The recovery plan includes a recovery objective for reclassifying the species as well as the criterion. The immediate goal is to preserve *C. glabra* from extinction by maintaining naturally-reproducing wild populations on appropriate sites. For reclassifying the species from endangered to threatened the goal is to adequately protect and manage five populations (on public land or under conservation easement). The plan states that these goals will be refined as recovery tasks are implemented and better information is acquired.

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 recovery criteria were based on the available data at the time the plan was published 23 years ago.

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. The recovery plan addressed factor 1 –habitat destruction and modification, which is still a threat, and factor 4 - Inadequacy of existing regulatory mechanisms. See section II.C.2 for description of current information and threats.

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. For threats-related recovery criteria, please note which of the 5 listing factors¹ are addressed by that criterion. If any of the 5-listing factors are not relevant to this species, please note that here.

The recovery plan lists a reclassification criterion to adequately protect and manage five populations occurring on public land or under conservation

¹ 1) Present or threatened destruction, modification or curtailment of its habitat or range;
2) Overutilization for commercial, recreational, scientific, or educational purposes;
3) Disease or predation;
4) Inadequacy of existing regulatory mechanisms;
5) Other natural or manmade factors affecting its continued existence.

easements. This plant, based on best available information, is only known from one population found on approximately 1000 ha of xeric sandhills, a small geographic range in northern Liberty County, FL (Figs. 1 & 2). In section IV, we recommend for the plan's recovery criterion to be revised and better defined; in section II.C. 1 and 2, we present current information on status and threats to the species. The recovery criterion addresses factors 1 and 4. Factors 2 and 3 are not relevant to *C. glabra*. Factor 5 was not relevant to *C. glabra*, but based on current threats assessment, it is now addressed. We summarize our progress below under existing recovery actions.

Recovery action 1: Protect existing populations

1.1. Encourage conservation of existing populations on private lands
This action has not been met.

1.2. Conduct annual mapping and monitoring of all known populations

This is an ongoing action conducted by Florida Park Service staff and volunteers in recent years. Currently, 60 - 70 % of the Sweetwater Creek Track (SCT) containing *C. glabra* has been mapped (R. Pruner, Florida State Parks, 8/4/2017, pers. comm.; Fig. 2).

FNAI conducted the original mapping prior to 2004.

1.3. Manage rights-of-way

This recovery action is ongoing and conducted primarily by the Florida Department of Transportation (FDOT) and Florida Gas and Transmission. Spot application of moderately toxic herbicide Garlon 4 is used to treat exotic shrubs or trees at Torreya State Park (TSP).

1.4. Acquire habitat

Most of the known populations of *C. glabra* were acquired by the State of Florida by purchasing the Sweetwater Creek Track (SCT) from the St. Joe Timberland Company in 2002. The SCT is managed as part of the Torreya State Park. Other adjacent properties with known locations of *C. glabra* but not yet acquired are: Candence Bank, Holland Ware, and R Dell Phillips (R. Pruner, Florida State Parks, 8/4/2017, pers. comm.).

Recovery action 2: Conduct population biology studies

2.1. Study the effects of prescribed fire and forest management practices

This is an ongoing action initiated in 2005 and conducted by the Florida Park Service. This action could be considered complete when the effects of prescribed fire and forest management practices on survival, growth and reproduction of *C. glabra* is well understood. Our current state of knowledge and new information on prescribed fire, canopy removal, and mowing is reviewed in the remainder of Sec 2.1.

Fire may increase *C. glabra* density given that longleaf pine is historically

maintained by burning (Kral 1983). W. Baker (Biological Consultant, Tallahassee, FL, 2009, pers. comm.) agreed that burning is needed to maintain an open habitat, but suggested that frequent fires may be detrimental to survival of *C. glabra*. Sandhills naturally burned every 1-10 years (Myers 1990). According to Frost (1998), 1-3 years represents the historic frequency of fire in sandhills. Therefore, Pruner (8/4/2017, pers. comm.) suggested a 2-5 year fire interval for *C. glabra*. More investigations related to the effects of prescribed fire on demography are imperative to be undertaken for determining the fire intensity and season that maximizes survival, growth and reproduction of *C. glabra* population.

Florida Park Service staff has conducted two recent forest management studies:

Forest restoration:

Following four forest managed treatments and a control as part of a large restoration project, the response in ground and canopy cover, and overall *C. glabra* density and individuals under 5cm height were monitored from 2009-2013 (Table 1, Spector and Bente 2014). The treatments were conducted in 2 replicates of 4 plots with 4 transects in each plot for a total of 16 transects per treatment. The results indicated that each treatment had a positive effect on *C. glabra* abundance with higher overall abundance in the

Table 1. Restoration treatments conducted at SCT. All four treatments (1-4) were subjected to prescribed-fire and sand pine mechanical removal.

Restoration Treatments	Windrow	Groundcover planted
1. Intact- no wiregrass	intact	no
2. Intact- wiregrass	intact	yes
3. Level- no wiregrass	flatten	no
4. Level- wiregrass	flatten	yes
5. Control	-	-

level treatments (flattened windrows). Vegetative recruitment via re-sprouting of broken stems or roots (ramets) likely account for the

increase of *C. glabra* in flattened windrows (treatments 3 & 4). Recruitment from seeds was not observed, although it was suggested that *C. glabra* might be an episodic recruiter. Abundance declined in the control plots (Spector and Bente 2014). The authors suggested:

- that a combination of the level-plant and level-no plant treatments that leaves patches void of wiregrass within the sandhill areas may provide for the best combination of treatments.
- that prescribed fire should only burn 20% of the adults to maintain a stable population.
- to increase groundcover diversity in restoration zones to better mimic the historic groundcover composition
- to avoid dense planting of overstory trees to preclude declines of *C. glabra* due to canopy shading or the accumulation of large amount of flammable litter; and
- to survey for *C. glabra* prior to restoration activities

Mowing:

Forest management involving 2 mowed plots (333 & 239) with or without wiregrass planted were established in 2014 and monitored post-fire in 2015, and 2016 (Pruner 2016). Four subplots were established for each wiregrass treatment, totaling 16 subplots. Previously, 2 non-mowed plots (147 & 355) were established in 2007 with data collected until 2016 (Pruner 2016). These plots also have a total of 16 subplots. The four main plots are located in restoration zone 2 (RZ 2) of SCT and were subjected to fire in 2015.

Mowed plots

Similar results were observed for plots 333 & 239, so quantitative data is presented for plot # 333.

Table 2. Mowed plot # 333 located in RZ 2. The plot was subjected to fire in 2015.

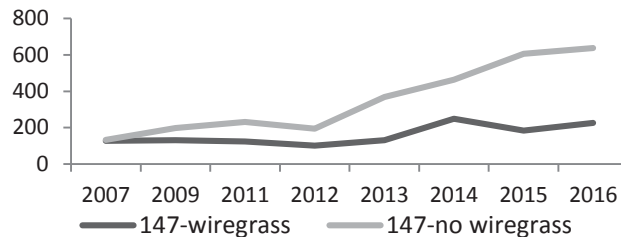
RZ 2 mowed plot 333	<i>C. glabra</i> plants			
	Treatment	2014	Burn 2015	2016
1. no wiregrass planted		688	601	935
2. wiregrass planted		1,656	66	1,109

Overall results for plots 333 & 239

- Adult plants
 - wiregrass planted: about ~92% reduction of adults immediately after the 2015 burn
 - no wiregrass: stable
- 1 year post-fire: continued loss of adults
- Overall adult number for both treatments still less than 2014
- 2016: emergence of smaller size class (<5 cm height)

Non-mowed plots

Similar trends were observed for plots 147 & 355, so results are presented for plot # 147.



Overall results for plots 147 & 355

- Overall increase of *C. glabra*:
 - similar distributions of all size classes pre and post burn, increase in all size classes
- Lower numbers where wiregrass was planted, but still stable
- Although the fire temperature was not monitored, the presence of

unburned patches could be indicative of a low burn intensity, perhaps attributed to the presence of an oak canopy

- Slight increase in smaller size classes for plots without wiregrass

Overall, *C. glabra* appears to be experiencing a population boom post-restoration as the canopy is removed, but it is still too early for a conclusive assessment. Specifically, it is unknown how much sexual and vegetative reproduction contributes to population growth.

2.2. Conduct life history studies

This is an ongoing action. This action could be considered complete when the contribution of sexual reproduction and clonal propagation to population maintenance is understood.

Demographic studies: Bladow et al. (2017) measured size structure, survival, growth, and recruitment in three re-introduced sites at The Nature Conservancy's Apalachicola Bluffs and Ravines Preserve, FL (The Nature Conservancy's ABRP) and three natural sites located at the SCT, and quantified inbreeding depression in two natural sites. Demographic projections predicted that re-introduced populations would grow at least as fast as the naturally occurring populations. Seed set was < 50% in both re-introduced and natural populations. Inbreeding depression was strong in one introduced and one wild population, and predicted to affect population growth rates only if selfing were to increase substantially. Overall, evidence identifies re-introduction as a successful conservation approach for *C. glabra*.

Seed viability and germination studies: On June 2016, about 1,881 fruits were collected from three SCT areas (treatment mowed, and non-mowed; control), dissected in the lab, and 2,701 seeds counted. Based on morphology, only 25 % were considered viable. These 676 seeds were placed in 75 germination bags (1-15 seeds/bag), tagged, and bags monitored. No germination was observed after nine months of burial. Other observations have reported low germination potential for seeds collected in 2011 and 2012 (< 10% viability; Spector and Bente 2009) and circumstantial seed germination evidence during gardening (D. Printis, The Nature Conservancy, 7/25/2017, pers. comm.). Further studies involving soil seed bank, seed viability, germination and seedling recruitment are necessary.

Pollination: Pollination studies and fruit set development were conducted by Isom and McGrane (1998) in the three translocated populations at The Nature Conservancy's ABRP (Gordon 1996). Fluorescent dye powders were used to monitor pollen transfer. Bees, butterflies, beetles, wasps, and flies were observed visiting the flowers, but insects were not seen transferring pollen. Several bees species, however, were observed with fluorescent dye adhered to their head and thorax and potentially could be involved in pollination. Seed production was observed but not quantified. According to

the authors, some seeds were small and perhaps non-viable, although germination was not attempted. Kubes (2009) reported seed production from flowers that were self-pollinated by hand.

Reproduction: *Conradina glabra*, like most plants, reproduces both sexually and asexually. Clonal growth (clonal reproduction, vegetative reproduction), which results in offspring genetically identical to the parent and potentially physiologically independent of the parent, has been observed in the field (V. Negrón-Ortiz, 7/25/2017, pers. observ.; Spector and Bente 2009).

Floral observations indicate that *C. glabra* is potentially gynodioecious (has both female and hermaphrodite plants) (Gray 1965). Gray (1965) observed one population near TSP displaying some degree of male sterility: the anthers were observed malformed or were well formed but the pollen was aborted. Outcrossing in hermaphrodites is promoted by protandry (V. Negrón-Ortiz, pers. observ.). Protandry refers to a temporal separation in male and female functions of bisexual flowers; in this case, the pollen is shed before the stigma becomes receptive. Current data is needed to verify if gynodioecy is present.

2.3. Survey for *Conradina glabra* outside its current range

This is an ongoing action conducted by FNAI, botanists, and FDOT. Surveys conducted on several sandhill areas located in Apalachicola National Forest, Washington and Walton counties contain no *C. glabra*.

***Recovery action 3:* Conduct genetic studies**

Although this action has been met (see section C1b), examination of clonality and its conservation implications are recommended.

***Recovery action 4:* Propagate *Conradina glabra* and reintroduce and/or augment populations within its historic range**

Propagation

Ex situ propagation was initiated in 1987 by the Historic Bok Sanctuary (Bok Sanctuary), Lake Wales, Florida with plants from the intersection of SR12 and 271 north of Bristol in Liberty County. Forty-eight cuttings from each of two populations located in rights of way were taken and transplanted in potting soil under greenhouse conditions. Cuttings rooting ranged from 76% to 88%, and were more abundant during the summer, although rooting occurred any time of the year (Wallace 1990).

At present, the Bok Sanctuary has 39 living specimens remaining in the collection, six from the original 1987 collection, and the rest that are second and third generations of clones from cuttings from the originals. They reported about 81% to 99% rooting success rate. Neither the Bok Sanctuary nor the National Center for Genetic Resources Preservation in Fort Collins, Co. possesses stored seeds. Bok Sanctuary currently maintains specimens of this species in the National Collection, and it is on their priority list for 2018-2019 to refresh in the

ex situ National Collection for the Center for Plant Conservation (C. Peterson, Bok Sanctuary, 8/15/2017, pers. comm.).

Translocation

Conradina glabra was reintroduced within its original range onto The Nature Conservancy's ABRP in 1991. Forty-eight plots of nine rooted cuttings were planted in each of three xeric sandhill sites at the preserve. First-year survival of planted cuttings was 94%. Prescribed fire management applied to two of the sites killed 25 % of those plants. In general, survival rate was high 1 or 2 years after transplantation. Using demographic models, Bladow et al. (2017) analyzed the reintroduced populations, and determined that these populations were projected to grow or remain stable. The analyses indicated that reintroduction is a successful conservation tool for *C. glabra* (Bladow et al. 2017).

This recent information may help in re-evaluating the utility of reintroduction, translocation, and augmentation as a tool for this species. In 2009, the utility of augmentation or translocation was questioned because the range of *C. glabra* was historically unknown and at that time within its current range on the SCT, the population was believed to be sufficient to sustain itself in the near term. Additional discussions are crucial to evaluate the benefits and risks of translocation, augmentation, and reintroduction strategies under the combined pressures of habitat fragmentation and climate change.

C. Updated Information and Current Species Status

1. Biology and Habitat

a. Abundance, population trends



Fig. 1. Map of Florida showing Liberty County and the present range of *C. glabra* at the Sweetwater Creek Track (SCT; red). Dots represent historical locations on rights-of-way and pine plantations (FNAI 2008).

Conradina glabra is a rare plant limited to Liberty County (Fig. 1) with most of the known population found on approximately 1000 ha (Spector and Bente 2014; Fig. 2) to 1,470 ha (R. Pruner, Florida State Parks, 8/29/2017, pers. comm.).

Historical extent and abundance of this species is unknown because the silviculture industry destroyed large areas of this species' sandhill habitat during the 1950's, and the species was not described until 1962. We can assume that the species was once more widespread within the sandhill habitat in this area.

Several locations occur on privately owned silvicultural land and rights-of-way (ROW) with unknown number of estimated plants. Two of the reintroduced populations at the Nature Conservancy's ABRP have > 600 individuals, but a third has fewer than 75 (A. Winn, FL State Univ., 2009, pers. comm.).

The only population on public land is found at the SCT, *Torreya* State Park (Fig. 2). This area was prepared by a bulldozer scraping topsoil and remaining vegetation into linear berms called windrows, planted in slash pine (with 500-700 stems per acre of sand pine), and then logged in the late 1980s (Spector and Bente 2009). Despite this severe alteration of habitat, SCT contains the majority of *C. glabra*. The estimated number of plants (or ramets, see recovery action 2.1) in 2009 for 102 ha was about 89,815 (Spector 2009); current and projected counts are underway (R. Pruner, Florida State Parks, 8/4/2017, pers. comm.). At present, about 15-20% of the core known habitat within the park remains to be surveyed (R. Pruner, Florida State Parks, 8/4/2017, pers. comm.). Data are collected on an ongoing basis, allowing for trend analysis as well as assessing the effects of restoration, particularly the effects of aggressive fire.

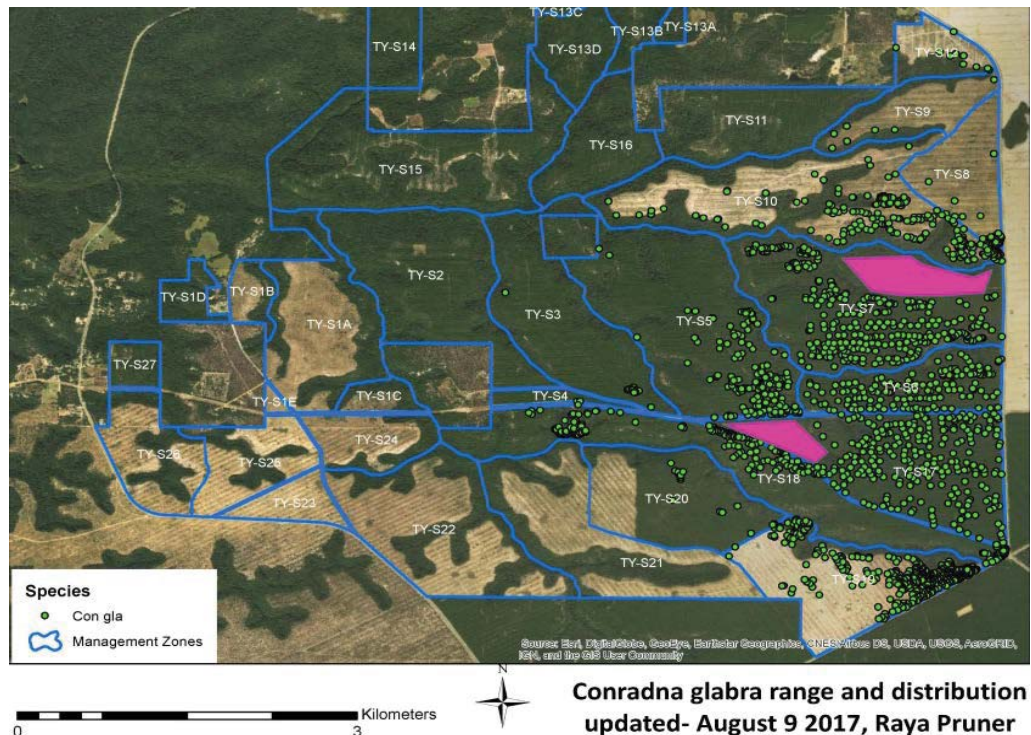


Fig. 2. The present range of *C. glabra* at the SCT and management zones; green dots = *C. glabra* plants; pink = areas with *C. glabra* but not yet surveyed.

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

Martin (1992) used starch gel electrophoresis to describe allozyme diversity and genetic structure in this endangered species and its nearest relative, *C. canescens*. The author sampled two disjunct populations: one population containing three

subpopulations of *C. glabra* in Liberty County and two *C. canescens* populations located in Santa Rosa County. The results revealed that each of the two disjunct populations was in Hardy-Weinberg equilibrium and had high levels of genetic diversity typical of an outcrossing breeding system (see section II.3 recovery action 2.2). The allozyme study showed that the *C. glabra* populations are genetically divergent from the populations of *C. canescens*. A recent study employing microsatellite data indicated that the species boundaries are reliable (Edwards 2008a). However, Martin's (1992) allozyme study misidentified the Milton/blackwater river population of *C. canescens* at Santa Rosa County as *C. glabra* (Edwards et al. 2008b). The conclusions presented here are accurate.

DNA barcoding: An ongoing project on barcoding Florida's rare plant species has included the specimens of *C. glabra* from the Bok Sanctuary (C. Peterson, 2017 pers. comm.). Three barcoding gene sequences will be uploaded to the BLASTN NIH database when this work is complete.

c. Taxonomic classification or changes in nomenclature:

Kingdom: Plantae
Division: Magnoliophyta
Class: Magnoliopsida
Order: Lamiales
Family: Lamiaceae
Genus: *Conradina* Gray
Species: *glabra* Shinnery
Common name: Apalachicola rosemary

Description: A minty aromatic, profusely branched shrub of about 1 m tall. Leaves are opposite, needle-like, linear-oblongate, sessile, and short (15 mm long and 3 mm wide). Flowers are bisexual and protandrous, 14-18 mm long, usually in axillary fascicles of 1-3 flowers. Corolla rose lavender to white, 2-lipped, lower lip with purplish dots. Stamens four; anther purple and white; style bifid, exerted, equaling or exceeding the stamens. Fruit a cluster of 4 globose nutlets to 1 mm in length.

Conradina, a morphologically homogeneous group of narrow-leaved, aromatic shrubs, is a monophyletic genus comprised of six species of which four are federally endangered or threatened (Edwards et al. 2008a, b). Species delimitations were unclear because hybridization may have potentially occurred among species (Edwards et al. 2006), thus the taxonomic status of several species were considered questionable. Although morphology and several molecular markers were used to answer this question (Edwards et al. 2006, Edwards et al. 2008b), microsatellite data revealed a clear differentiation of populations following recognized species boundaries, indicating that species have diverged from one another genetically and interspecific hybridization has not occurred recently (Edwards et al. 2008a).

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

In the mid 1900's Apalachicola rosemary was identified and collected from two disjunct locations, Liberty and Santa Rosa counties. Edwards et al. (2008) microsatellite studies identified the Santa Rosa County population as *C. canescens*, therefore *C. glabra* is restricted to Liberty County, FL (Fig. 1). Silvicultural site preparation of the sandhills in The Nature Conservancy's ABRP during the 1950s, prior to ownership by The Nature Conservancy, involved clearing the vegetation, depositing the material in linear windrows, and planting slash pines. Many species, including *C. glabra*, were probably extirpated from the site as a result of this disturbance (Gordon 1996). Thus, it is assumed that this species was once more widespread, however, the historical range and abundance are unknown. According to Spector (2009), existing evidence does not support that this species was once more widespread. Her argument is that the majority of area on the western portion of SCT shares the same land use history yet contains no individuals of *C. glabra*. In addition, a 200 acre portion of the SCT also on the western portion of SCT was planted in sand pine but site was not prepared with windrows. Wiregrass and other groundcover species sensitive to soil disturbance remained intact yet no *C. glabra* was found (Spector 2009). To date, it is not feasible to reconstruct the historic range because most of this species habitat was converted to pine plantation by the late 1950's and this species was not described until 1962 (Gordon 1996, Shinnors 1962).

Other sites with potential suitable habitat occurring on properties adjacent to SCT may contain *C. glabra*, but they have not yet been evaluated.

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

The various habitats where this species might have occurred are unknown because of the timing of its taxonomic description and the conversion of habitat for silviculture practices (Gordon 1996, Shinnors 1962). At present, Apalachicola rosemary is endemic to the xeric longleaf pine communities (sandhill) east of the Apalachicola River. It also occurs on the upper steepheads in the transition to sandhills, edges of pine plantation, and highway and utility rights-of-way.

Most favorable habitats are open areas with various degrees of cover, from bare sands to areas with other species growing nearby. Density appears to be greatest in sun or lightly shaded areas, but it decreases as areas become shadier with mature planted pine (Negrón-Ortiz, 2009, pers. observ.). According to the Park Service staff, *C. glabra* might have re-established in open sunny areas after site preparation in 1988, areas that have been slowly shaded. Plants do not seem to be as robust in the shadier areas.

Reference site: A longleaf pine site of about 10 to 25 hectares that may serve as a model for restoring the SCT ecosystem was discovered in the early summer of 2015 by the Florida State Park staff. The site appears to be an undisturbed historic sandhill that may have never been impacted by silviculture (Schmidt 2017). Abundant but scattered patches of wiregrass and sandhill associated trees, shrubs, herbaceous species were found below the scattered long leaf pines. Dense clumps of *C. glabra* were found interspersed throughout the area. Surveys and monitoring efforts are ongoing.

2. Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

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

Habitat modification remains the main threat to date for this species as a result of silviculture practices. The entire range was altered by site preparation (e.g. bulldozing of topsoil into linear berms called windrows, and possible herbicide application) and conversion to pine plantations in the 1950s (Spector and Bente 2009). A large extent of Liberty County was logged mainly for longleaf pine, and many acres were converted to slash pine. The uplands on the SCT were managed for timber for several decades. The St. Joe Timberland Company harvested slash pine in 1987, followed by sand pine plantation. Although *C. glabra* has been seen growing at the edges and sporadically within pine plantation, plant density is low compared to more open areas. Therefore, shading, due to increases in canopy cover from natural longleaf pine forests to managed pine plantations, is a threat to this species and should be evaluated.

Most of the remaining population of *C. glabra* is now protected under ownership by the State of Florida and managed by the Florida Park Service. The private land east of SCT where *C. glabra* likely occurred has been recently cut. In addition, herbicide was applied to the entire tract, limiting the likelihood of *C. glabra* persistence in the treated area (M. Maples, Florida State Parks, 9/12/2017, pers. comm.). There are other properties adjacent to SCT that have not been surveyed, but likely contain this species. Given the ownership of these surrounding properties, it is probable that they will continue to be utilized as pine plantations or converted to residential and/or commercial development in the near future. Therefore, conversion to pine plantations and residential or commercial developments are threats.

Long-term persistence of *C. glabra* in the sandhill community requires fire. Sandhill systems are characterized by natural fire frequencies of every 1-10 years (Myers 1990). *Conradina* species are found in habitats with varying fire frequencies (USFWS 1994). Among Florida scrub species, Florida rosemary (*Ceratiola ericoides*) requires longer fire cycles (15–40 year intervals) to maximize soil seed bank (Quintana-Ascencio et al. 2003). Circumstantial evidence suggests that several other members of the mint family (e.g., *Conradina*

canescens, *Calamintha ashei*) are killed by fire but recover from seed or ramets. According to Gordon (1996), low-intensity fires tend to have a more positive effect on the survival of adults *C. glabra* (although fire temperature was not monitored) than high-intensity fires.

Longleaf pine has not been introduced to the ongoing Florida Park Service forest management restoration treatments (restoration zone 2), at SCT. Introduction of longleaf pine may result in hotter fires due to needle accumulation. Also, ongoing conversations are considering a planting density of 400+ longleaf pine trees per acre to control woody species such as oak, potentially allowing for hotter fires (R. Pruner, Florida State Parks, 8/4/2017, pers. comm.). This should be closely monitored because *C. glabra* is also a woody species. Therefore, the use of a too frequent fire return interval and intensity could be a threat to the species.

The Recovery Plan mentioned that the use of the herbicide (hexazinone, Velpar) is a threat when it is used in timber regeneration areas. According to M. Ludlow (Department of Environmental Protection; 2009, pers. comm. to Negrón-Ortiz), spot application of Garlon 4 (a less toxic herbicide) is used to treat exotic shrubs or trees at TSP. In addition, there are almost no woody exotics in the area where *C. glabra* occurs. Therefore, herbicide use is currently considered a minor threat.

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

There is no evidence to suggest that this factor is a threat.

c. Disease or predation:

There is no evidence to suggest that this factor is a threat.

d. Inadequacy of existing regulatory mechanisms

Section 7(b)(4) and 7(b)(2) of the Act generally do not apply to listed plants species. However, limited protection of listed plants from take is provided to the extent that the Act prohibits the removal and reduction to possession of federally listed threatened and endangered plants or the malicious damage of such plants on areas under federal jurisdiction, or the destruction of endangered plants on non-federal areas in violation of state law or regulations or in the course of any violation of a state criminal trespass law.

Conradina glabra is protected under Florida State Law, chapter 85-426, which includes preventions of taking, transport, and the sale of the plants listed under the State Law. The rule Chap. 5B-40, Florida Administrative Code, contains the "Regulated Plant Index" (5B-40.0055) and lists endangered, threatened, and commercially exploited plant species for Florida; defines the categories; lists instances where permits may be issued; and describes penalties for violations (<http://www.virtualherbarium.org/EPAC>).

Several sites containing *C. glabra* occur on private timberland and highway and utility right of way (ROWs). While the Act requires federal agencies to carry out programs for the conservation of endangered and threatened species, no such programs are stipulated for non-federal landowners. Neither section of the Act provides protection for plants on non-federal lands as long as the activity is permissible under state/local laws. The State requires permission of private landowners for collecting of state-listed plants from their property. At present, we have not been able to comment on state park management practices, and the Service doesn't have a legal mechanism to regulate management on state lands. The next revision of the park management plan will likely start around 2020 and finalized in 2022, and the Service should be able to attend public meetings and request a copy of the draft plan for commenting (R. Pruner, Florida State Parks, 9/25/2017, pers. comm.).

Right of way maintenance activities are not always reviewed for threatened and endangered species impact. However, if there is an activity (e.g., construction, mowing, or maintenance projects) affecting federally listed species on state highway ROWs, then the Service can recommend consultation to the Florida Department of Transportation (FDOT) under the Act because FDOT recently assumed NEPA authority and is considered a federal agency for consultation purposes. The FDOT routinely consults with the Service on all major road construction activities.

Currently, these protections are inadequate for this plant and its habitat.

e. Other natural or manmade factors affecting its continued existence

Climate change

According to the Intergovernmental Panel on Climate Change Report (IPCC 2013), warming of the earth's climate is "unequivocal," as is evident from observations of increases in average global air and ocean temperatures, widespread melting of snow and ice, and rising sea level. Scientific evidence indicates a rapid and abrupt climate change, rather than the gradual changes that were previously forecasted (IPCC Report 2007), posing a significant challenge for fish, wildlife, and plant conservation. Highly specialized or endemic species, such as *C. glabra*, are likely to be most susceptible to the stresses of changing climate. Species that are already rare may become rarer. This may be even more pronounced for those species with restricted ranges, with poor dispersal ability, requiring long generation times, possessing susceptibility to extreme conditions (such as flood or drought), exhibiting extreme habitat/niche specialization, or requiring symbiotic relationships (Hawkins et al. 2008).

Using the NOAA Sea Level Rise (SLR) and Coastal Flooding Impacts Viewer (<https://coast.noaa.gov/slr/>), the projections indicated no potential impact to *C. glabra* population in Liberty County by intrusion of saltwater. Heatwave intensities and drought events, however, have strengthened in parts of the United States including the southeast (Mazdiyasi and AghaKouchak 2014) and Florida

(Gao et al. 2012), and are becoming more likely to overlap. Heatwaves can make xeric areas such as sandhills even drier, and if these concurrently occur with drought events, represent a growing threat to *C. glabra* survival. Thus, it is recommended to avoid or postpone prescribed-fire during extreme drought and heatwave conditions.

D. Synthesis

Conradina glabra is a rare species and endemic to a small geographic range in Liberty County, FL. It is characterized by having one known population found on approximately 1000 - 1,470 ha, and thus the ability to withstand catastrophic events is quite limited. The main threat for this species is habitat modification. Conversion of much of the forest land to pulpwood plantations (clearcutting, mechanical site preparation, and pine plantations) probably extirpated some populations. Overcollection is not a threat, and no problems have been detected with disease or predation.

The species occurs on both private and public lands. Plants occurring on private lands and ROW have not been estimated, but the current plant number at the SCT is quite high. Thus, a comprehensive population survey is needed, and permanent protection and management are necessary to conserve this species.

Conradina glabra continues to meet the definition of an endangered species as a result of habitat destruction or modification due to incompatible forest management practices and the effect of this threat in this plant's present narrow distribution. The recovery criterion for *C. glabra* indicates that the species may be considered for reclassification from endangered to threatened when five populations occurring on public land or under conservation easements are protected and appropriately managed. Currently, the SCT is the only protected population that is appropriately managed, however, the ability of the species to adjust to changing conditions is unknown. Therefore, we are not recommending reclassification of *C. glabra* from endangered to threatened. The existing recovery plan for *C. glabra* contains an objective, measurable criterion that needs to be updated when the recovery plan is revised.

III. RESULTS

- A. Recommended Classification:
 No change is needed

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

1. Conduct population surveys using a consistent, statistically valid, repeatable survey method (USFWS 2013). Once population numbers are known and an inventory has been conducted to find new populations throughout appropriate sandhill habitat, consistent surveys would allow for the analysis of long-term trends for this species. This information would help to determine when the species is stable and may be considered for reclassification. This

information would also help to inform conservation managers of appropriate management techniques, and whether restoration of the pine plantation back to sandhill is assisting in the recovery of the species.

- Continue and complete ongoing surveys throughout the present distribution
 - Continue regular monitoring of marked individuals (e.g., the total number of individuals, number of flowering vs. non-flowering plants, and whether seedling recruitment is occurring).
2. Conduct an inventory of sites where appropriate habitat exists. This action can include the use of aerials and species distribution modeling methods to initially determine potential sites, with subsequent field inventory of the site using a consistent, statistically valid, repeatable inventory method. If new populations are discovered, protection should be sought.
 3. Identify appropriate soil types and other environmental conditions within the *C. glabra* range and adjacent areas as well as other sandhill areas within the Florida panhandle. This action can include the use of aerials and species distribution modeling methods to initially determine potential habitat associations.
 4. An *ex-situ* plant collection should be actively pursued and implemented. Studies on the viability of seeds, germination, and seedling establishment, in addition to whether the *C. glabra* spread by rhizomes and a persistent seed bank is present should be addressed.
 5. Continue the restoration of and subsequent management of *C. glabra*'s habitat. This is crucial for the long-term population stability (Park Service staff, 2017, pers. comm.) given that the global population of *C. glabra* is only found at the TSP.
 - Determine the fire regime (intensity) and monitor the effect of this event on *C. glabra* density, fecundity, and size structure.
 6. Avoid or postpone prescribed-fire during extreme drought and heatwave conditions.
 7. Evaluate the benefits and risks of translocation, augmentation, and reintroduction strategies under the combined pressures of habitat fragmentation and climate change.
 8. Assess the occurrence of vegetative reproduction (i.e., clonality) using genetic markers and determine the conservation implications.
 9. Develop a stand-alone plan for managing listed plants at the TSP and integrate it to the restoration protocol and the Torreya State Park Unit Management Plan
 - Evaluate the reference (remnant) site and determine the relevance and utility in informing restoration.
 10. Seek partnership with private landowners to help better understand the present distribution of *C. glabra*.
 11. Acquire the following properties adjacent to SCT: Candence Bank (3 parcels), Holland Ware, and R Dell Phillips.
 12. The recovery plan should be updated to define objective measurable recovery criteria. A few key points to consider when addressing this action are: current population resiliency, effects of management and restoration efforts (particularly the effects of aggressive fire), and seedling recruitment.

V. REFERENCES

- Bladow, J.M., T. Bohner, and A.A. Winn. 2017. Comparisons of demography and inbreeding depression in introduced and wild populations of an endangered shrub. *Nat Areas J.* 37: 294-308.
- Edwards, C.E., D. Lefkowitz, D.E. Soltis, and P.S. Soltis. 2008b. Phylogeny of *Conradina* and related southeastern scrub mints (Lamiaceae) based on GapC gene sequences. *International J Plant Sciences.* 169: 579–594.
- Edwards, C.E., D.E. Soltis, and P.S. Soltis. 2008a. Using patterns of genetic structure based on microsatellite loci to test hypotheses of current hybridization, ancient hybridization and incomplete lineage sorting in *Conradina* (Lamiaceae). *Molecular Ecology.* 17: 5157–5174.
- Edwards, C.E., D.E. Soltis, and P.S. Soltis. 2006. Molecular phylogeny of *Conradina* and other scrub mints (Lamiaceae) from the southeastern USA: evidence for hybridization in pleistocene refugia? *Systematic Botany*, 31, 193–207.
- Florida Natural Areas Inventory (FNAI). 2008. *Conradina glabra* element of occurrence spatial data.
- Florida Natural Areas Inventory (FNAI). 2005. Final Report: Survey for *Conradina glabra*, Apalachicola Rosemary, in two burn zones at Torreya State Park, Sweetwater Creek Tract, Liberty County, Florida.
- Frost, C.C. 1998. Presettlement fire frequency regimes of the United States: a first approximation. Pages 70-81 in T.L. Pruden and L.A. Brennan, editors. *Fire in Ecosystem Management: Shifting the Paradigm from Suppression to Prescription*. Tall Timbers Fire Ecology Conference Proceedings, No. 20. Tall Timbers Research Station, Tallahassee, Florida.

- Gao, Y., J.S. Fu, J.B Drake, Y. Liu and J-F Lamarque. 2012. Projected changes of extreme weather events in the eastern United States based on a high resolution climate modeling system. *Environmental Research Letters*. 7: 1-12.
- Gordon, D.R. 1996. Experimental translocation of the endangered shrub Apalachicola rosemary *Conradina glabra* to the Apalachicola bluffs and ravines preserve, Florida. *Biological Conservation* 77: 19-26.
- Hawkins, B., S. Sharrock, and K. Havens. 2008. *Plants and climate change: which future?* Botanic Gardens Conservation International, Richmond, UK
- Intergovernmental Panel on Climate Change (IPCC). 2007, 2013. Summary for policymakers. *Climate Change 2013: The Physical Science Basis Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge.
- Isom, P.S., and A. McGrane. 1998. Pollen transfer between three translocated populations of the endangered mint, Apalachicola rosemary (*Conradina glabra*), at the Apalachicola Bluffs and Ravines Preserve. Annual Research Report. Florida Division of Forestry, Tallahassee.
- Kubes, A. 2009. Modeling species distributions of three endemic Florida Panhandle mints under climate change: Comparing plant and pollinator distribution shifts under future conditions. MS thesis, Florida State University, Tallahassee.
- Martin, E. Luna. 1992. Patterns of genetic diversity in the rare mine *Conradina glabra* and its nearest relative *Conradina canescens*. Master's Thesis, University of West Florida, Pensacola, Fl. Pp. 61.
- Mazdiyasi, O. and A. AghaKouchak. 2015. Substantial increase in concurrent droughts and heatwaves in the United States. *PNAS*. 112: 11484–11489.

- Myers, R. L. (1990). Scrub and high pine. In *Ecosystems of Florida*, ed. R. L. Myers & J. J. Ewel. University of Central Florida Press, Orlando, FL, pp. 150-93.
- Pruner, R. 2017. *Conradina glabra*, Torreya State Park update 2.0. Unp. Report. 37 slides.
- Quintana-Ascencio, P.F., E.S. Menges, and C.W. Weekley. 2003. A fire-explicit population viability analysis of *Hypericum cumulicola* in Florida rosemary scrub. *Conservation Biology*. 17: 443-449.
- Schmidt, A. 2017. *Conradina glabra* reference site description. Pp. 5.
- Shinners, L.H. 1962. Synopsis of *Conradina* (Labiatae). *Sida*, 1: 84-88.
- Spector, T. and J. Bente 2014. Response and recovery of endangered *Conradina glabra* (Shinners) and its habitat to multiple restoration techniques in a highly disturbed Florida Sandhill. Pp. 26.
- Spector, T. 2009. Population estimate and range of *Conradina glabra* at Torreya State Park. Pp. 12.
- U.S. Fish and Wildlife Service. 2013. How to develop survey protocols, a handbook (Version 1.0). Fort Collins, Colorado: US Department of Interior, Fish and Wildlife Service, National Wildlife Refuge System, Natural Resource Program Center.
- U.S. Fish and Wildlife Service. 2008. Endangered and threatened wildlife and plants: 5-Year Status Review of 18 Southeastern Species. *Federal Register*. 73: 20702.
- U.S. Fish and Wildlife Service. 1994. Recovery Plan for Apalachicola Rosemary (*Conradina glabra*).
- Wallace, S.R. 1990. Propagation of three endangered *Conradina* species for ornamental use. *Proc. Fla. State Hort. Soc.* 103:381-383.

Acknowledgements

Thanks to the participants of the working group from the Florida State Parks: Raya Pruner, Michael Maples, and Annie Schmidt. They provided their time, knowledge, and updates of current conservation activities. This meeting was held on August 4, 2017.

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Conradina glabra*

Current Classification: Endangered

Recommendation resulting from the 5-Year Review

No change is needed

The review was completed by botanist Dr. Vivian Negrón-Ortiz, Panama City Field Office.

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve Cath J. P. M. Date 28 Sept 2017

APPENDIX A
Summary of peer review for the 5-year review of
***Conradina glabra* (Apalachicola rosemary)**

A. Peer Review Method

The document was peer-reviewed internally by Dr. Sean Blomquist of the Panama City Field Office. Once the comments were added to the document, it was sent to five reviewers; only three provided comments. The outside peer reviewers were chosen based on their qualifications and knowledge of the species.

B. Peer Review Charge: The below guidance was provided to the reviewers.

We asked for comments on the validity of the data used, and identification of any additional new information on the *C. glabra* that was not considered in this review. We noted that we were not seeking their opinion of the legal status of this species, but rather about the best available data and analyses that were considered in reassessing its status.

C. Summary of Peer Review Comments/Report

The reviewers considered the document to be well written and an accurate summary of the current state of knowledge of *C. glabra*. A few clarifications and editorial comments were related to the current geographical range, and the introduction of longleaf pine to SCT (page 14, 1st paragraph). A map with current geographical range and a table summarizing the number of acres with *C. glabra* were provided.

D. Response to Peer Review

All peer reviewer comments were evaluated and incorporated where appropriate.