Spigelia gentianoides
Gentian pinkroot

5-Year Review:
Summary and Evaluation

Spigelia gentianoides
Three Rivers State Park, Florida (2018)

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

5-YEAR REVIEW
Spigelia gentianoides (Gentian pinkroot)

I. GENERAL INFORMATION

A. Methodology used to complete the review

This review was accomplished using information obtained from peer-reviewed scientific publications, several unpublished research projects, unpublished field observations by U.S. Fish and Wildlife Service (Service), State and other experienced biologists, and personal communications. These documents are on file at the Panama City Field Office. A *Federal Register* notice announcing the review and requesting information was published on August 30, 2016 (81 FR 59650). Comments received and suggestions from peer reviewers were evaluated and incorporated as appropriate (see Appendix A). No part of this review was contracted to an outside party. 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, vivian_negronortiz@fws.gov

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

Peer Reviewers:
Dr. James Affolter, State Botanical Garden of Georgia, and Professor, UGA Dept. of Horticulture 2450 S. Milledge Ave. Athens, GA 30606
Ms. Amy Jenkins, Florida Natural Areas Inventory, 1018 Thomasville Road, Suite 200-C Tallahassee, FL 32303
Bashira Chowdhury, Auburn University, AL

C. Background

1. **Federal Register Notice citation announcing initiation of this review:** 81 FR 59650 (August 30, 2016)

2. **Species status: Stable.** Populations seem to be stable based on surveys and recent observations in Florida [The Nature Conservancy (TNC) *Spigelia* Preserve (*Spigelia* Preserve, Calhoun Co.), Three Rivers State Recreational Area (Three Rivers SRA) and Apalachee Wildlife Management Area (Apalachee WMA, Jackson Co.), and Rock Hill TNC Preserve (Rock Hill Preserve; Washington Co.)], and Alabama [Geneva State Forest (Geneva SF)].

3. Recovery achieved: 2 (26 – 50 % recovery objectives achieved); a few conservation measures have been conducted and include development of propagation protocols from seeds and vegetatively; establishment of an *ex-situ* collection at the Bok Tower Gardens (Bok Tower), Lake Wales, FL and at the State Botanical Garden of Georgia, Athens, GA; management; and surveys.

4. Listing history

Original Listing
FR notice: 55 FR 49046
Date listed: November 26, 1990
Entity listed: species
Classification: endangered

5. Associated rulemakings:

Not applicable

6. Review History:

In our last 5-year Review (January 21, 2009), no status change was recommended.

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. The most recent evaluation for this plant was completed in 2017.

In 1991 review (56 FR 56882), different species were simultaneously evaluated with no species-specific, in-depth assessment of the five factors and threats as they pertained to the different species' recovery. In particular, no changes were proposed for the status of this plant in the review.

The Recovery Plan was written and approved after the last 5-year review (January 24, 2012).

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

2. This ranking is based on a high threat due to habitat destruction, a high recovery potential, and its status as a species.

8. Recovery Plan

Recovery Plan for *Spigelia gentianoides* (Gentian pinkroot).
Date issued: January 24, 2012.

II. REVIEW ANALYSIS

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

Spigelia gentianoides is a plant; therefore, it is not covered by the DPS policy and it will not be discussed further in this review.

B. Recovery Criteria

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

Yes. The recovery plan includes five dowlisting criteria. Development of quantitative delisting criteria will be completed during FY19.

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 six years ago. For instance, Weakley et al. (2011) elevated *Spigelia gentianoides* var. *alabamensis* as a distinct species, *Spigelia alabamensis* (K.R. Gould) K.G. Matthews & Weakley (see section II.C.1.c Taxonomic classification or changes in nomenclature). In the 1990 listing rule, only three populations were mentioned (Calhoun, Jackson, and Washington); the Bibb County glades and var. *alabamensis* plants were not cited; therefore, we should consider revising the Recovery Plan.

b. Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria?

Yes. The recovery plan addressed all of the listing factors that are relevant to the species. See section II.C.2 for description of current information on 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 factors are addressed by that criterion. If any of the 5 listing factors are not relevant to this species, please note that here.

Criteria 1, 2, 4 and 8 were initiated and are ongoing. Criteria 3, 5-7, and 9 have not been initiated nor are data available. Recovery criteria address factors A (criteria 1-8), D (criteria 3-7), and E (criteria 3, 5, & 7). Neither factor B nor C are currently known to be threats to this species.

Downlisting of *S. gentianoides* from endangered to threatened status will be considered when:

(1) extant populations and recently discovered sites are identified and mapped.

This is an ongoing effort conducted by the Florida State Park, FNAI, FWS staff, and other stakeholders.

(2) inventories (i.e., the total number of individuals, number of flowering vs. non-flowering plants, presence of pollinators, and whether seedling recruitment is occurring) have been conducted across the species' historic sites and/or on new locations

Complete and new ongoing inventories in Alabama, Florida, and Georgia

Location	Date surveyed	Surveyor	Funding source	Results/no. of plants
Southeast Alabama	May-July 2018	Auburn Univ. (AU)	FWS	35 sites surveyed: no plants found
Florida: Calhoun County	July 2013, May 2018	Florida Native Plant Society/ FWS staff	-	6 plants
Florida: Washington County	2013/ 2015	FDACS, DEP, and FSU staff	-	384 plants
Georgia: Lake Seminole WMA & Silver Lake WMA	May 2011	FNAI	FWS	No plants found on 10 sites of conservation land and one private timberland on the east side of Lake Seminole.

(3) monitoring programs and management protocols on selected populations (e.g., largest populations) are established for at least 15 years to track threats to the species and its habitat (e.g., control exotic species, minimize site disturbance, urban development)

(4) the extant populations (including subpopulations at the Ketona Glades, Bibb Co., Alabama) located on public land are stable[1] for at least 15 years

- Based on survey efforts, populations seem stable or increasing at *Spigelia* Preserve, Three Rivers SRA, Apalachee WMA, Rock Hill Preserve, and Geneva SF (see IIC.1.a).

(5) the minimum viable population (MVP) has been determined for each variety using PVA

(6) research on key aspects related to demography (e.g., density, effect of fire on seedling establishment), reproductive biology, and seed ecology is accomplished

(7) viable germplasm representing > 50% of the populations for each variety is maintained in ex-situ.

(8) Var. *gentianoides*: (1) increase sizes of populations #1 to #4 (Table 3 of Recovery Plan) via prescribed burns until plant numbers are stabilized over a period of 15 years; (2) find one new population; (3) and re-establish at least one population within the historic range, specifically in the sites where the plants are currently known to be extirpated.

[1] Evidence of a stable (or increasing) population trend is indicated if 95% probability of persistence is achieved for at least 15 years based on data obtained from accepted standardized monitoring methods and population viability analyses (PVAs).

- We have ongoing effort at (1) Spigelia Preserve, Three Rivers SRA, and Apalachee WMA; and (2) two new populations were documented in 2013 (Calhoun and Washington counties, see IIC1.a).

(9) Var. *alabamensis*: (1) protect 50% of the glades known to support the variety on private land through conservation agreements, easements, and/or land acquisition.

When the FWS considers revising the 2012 Recovery Plan (RP), we could likely consider altering or removing several criteria. For instance:

- We recommend criterion 5 to be removed from the RP because recent studies raised questions about the utility of the minimum viable population (MVP) for conservation planning (Flather et al. 2011).
- Based on morphology and genetic studies, recent taxonomic studies recognized *Spigelia gentianoides* var. *alabamensis* as a different species, *Spigelia alabamensis* (K.R. Gould) K.G. Matthews & Weakley (Weakley et al. 2011). Therefore, we recommend removing criterion 9, and information pertinent to Bibb County site for criteria 4 and 7 (see II.C.1.c).

C. Updated Information and Current Species Status

1. Biology and Habitat

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

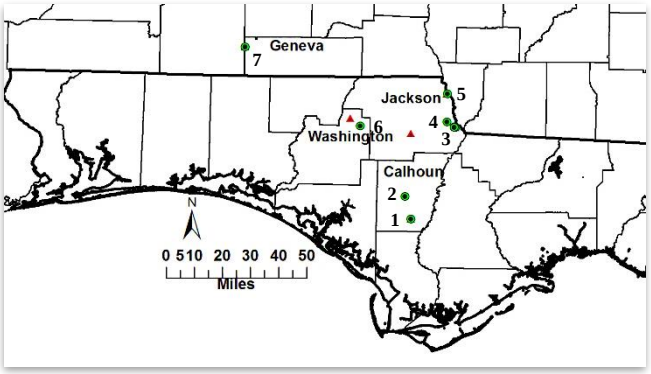


Fig. 1. Location of extirpated (triangle) and extant (circle) *S. gentianoides* populations: 1= TNC-Spigelia Preserve; 2= CR 4; 3= Guy Anglin; 4= Three Rivers SRA; 5= Apalachee WMA; 6= Rock Hill Preserve; 7= Geneva SF

Spigelia gentianoides var. *gentianoides* Chapman ex A. de Candolle is currently restricted to seven extant sites within four counties west of the Apalachicola River: Calhoun, Jackson, and Washington counties in Florida, and Geneva County in Alabama (Fig. 1, Table 1). These sites support about 3,900 plants. The species was originally recorded from nine sites but two sites are considered extirpated (Fig. 1, USFWS 2012). Of the seven extant sites, two new were noted in 2013 (FNAI 2017). The extant sites are located on both public and private lands in fire-dependent longleaf pine-wiregrass and pine-oak-hickory ecosystems.

Florida Counties

Calhoun: Two populations are currently reported for this county (Fig. 1, Table 1). One population occurs on the TNC-owned Spigelia Preserve, which is 32 acres in size and dominated by a pine flatwoods community. TNC has conducted five

prescribed burns on the property since acquisition, the most recent in May 2017 (J. Mott, TNC, 5/11/2018, pers. comm.). A survey in the spring of 2005 documented 78 plants (Russo 2006), however, the overall count of 30 plants recorded during a 2018 survey was consistent with 2006 (33 plants) and 2009 surveys (33 plants, FWS survey). It is unknown whether the plants documented in 2005 represented individual plants or close groupings of plants (W. Baker, consultant, *in* FNAI 2018). Based on 2006, 2009, and 2018 survey data, the population at this site seems stable.

A second population was documented in 2013 along County Road 4 (CR 4) and was comprised of six plants. The plants were found in a slightly disturbed woodland ecotone between the road and a pine plantation (A. Johnson, FNAI, 2013, pers. comm.). Only one fruiting plant was found in a 2018 survey (Negrón-Ortiz, 2018 survey).

Jackson: Four populations were recorded for this county, but one population, near Oakdale is considered extirpated. This population near Oakdale was documented in the1970s and was resurveyed in 2000. It consisted of a few large trees with no mid-story or ground cover and no evidence of the plants.

One of the largest extant populations is located at Apalachee WMA (Fig. 1, Table 1). Currently, it is composed of about 1,895 plants (comparable with the 2007 total of about 1,700 plants) in two element occurrences or subpopulations (FNAI 2017). These subpopulations are located in pine-oak-hickory woods (upland mixed woodland) habitat. The population was discovered in June 2007 by biologist Nathan Bunting of the Florida Fish and Wildlife Conservation Commission (FWC). The site is managed by the FWC in cooperation with the U.S. Army Corps of Engineers.

A second population is located at the Three Rivers SRA (Fig. 1). Surveys in 2010 (< 400 plants), 2013 (341 plants, zones TH: A=2, B=316, C= 23), and 2018 [379 plants, zones TH: B=214, C=44, D=121, I=0] detected similar plant abundances. However, a survey in 2011 estimated the population at 600-800 individuals with each cluster counted and estimated; it is unknown whether the reported counts overestimated the size of this population.

The last known population, occurring on land owned by Guy Anglin, is found approximately 10 miles north of the Three Rivers SRA. This population was reported to have one individual in 2004 and three plants in 2005 (FNAI 2018).

Washington: The first sighting of *S. gentianoides* was in Chipley in 1940 (herbarium specimen # 245, FLAS). A biologist revisited this population in 2005 but plants were not located. This population is currently thought to be extirpated (Fig. 1, USFWS 2012).

A population of 292 plants (FNAI 2018; J. Mott, TNC, 6/01/2018, pers. comm.) at Rock Hill Preserve, a 378 acre TNC property southeast of Chipley, was discovered in 2013 (Fig. 1). The plants were found in semi-shade of recently burned pine-oak woods hickory (FNAI 2018). The population was resurveyed in 2015 and documented an increase of 92 plants totaling 384 plants.

Alabama: Geneva County. The Geneva SF encompasses 7,120 acres and has several well established stands of mature longleaf pines. The forest is managed using prescribed fire, and timber production is the primary goal for the forest with wildlife and recreation as secondary objectives. Recent counts by B. Chowdhury (AU, 6/11/2018, pers. comm.) reported approximately 1,200 *S. gentianoides* plants (compared to 400 plants reported in 2005 and 2007 surveys).

Table 1. *Spigelia gentianoides*: populations and estimated number of plants

Location	2005-2011	2013-2018
TNC Spigelia Preserve	32	30
CR 4		3
Guy Anglin	3	No data
Three Rivers SRA	< 400/600-800	~379
Apalachee WMA	1,746	1,895
Rock Hill Preserve		384
Geneva SF	400	~1,200

Spigelia gentianoides* var. *alabamensis [now recognized as distinct from *S. gentianoides* as *Spigelia alabamensis* (K.R. Gould) K.G. Matthews & Weakley, Weakley et al. 2011; see section C2b below; hereafter *Spigelia alabamensis*] is located at the Bibb County Glades, the most biologically diverse area known in the state of Alabama. The plants are found at 17 of 40 Ketona Glade locations. Currently, no inventory exists for the total number of individuals present at these glades.

Negrón-Ortiz and collaborators censused four glades in 2008 using belt transects and covering approximately 85 to 90 % of each glade, and estimated 126 - 1,526 plants per glade for an estimated of 3,653 plants. In 2017, J. Affolter (UGA, 7/3/17, pers. comm.) and collaborators spent time inspecting Goat Glade and adjacent glades and observed numerous healthy *S. alabamensis* plants, including some in bud and flowers.

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

Hershberger et al. (2015) used AFLP marker to determine genetic differences within and among populations of *S. marilandica* (SM) and the two *S. gentianoides* varieties [vars. *gentianoides* (SGG) and *alabamensis* (SGA) sensu Gould 1996]. Analysis of molecular variance and estimates of gene diversity showed that the majority of variation found in *Spigelia* occurs within populations. SM has greater genetic variability than SGG and SGA. Overall, both among-species and among-

population variation was low; and three main groups were shown: one with two samples of SGG from one population, one with 13 individuals from both SGG populations used in the study, and one with all of the SM, SGA, and remaining SGG individuals. The authors speculated the results were likely the effect of common ancestry as well as relatively frequent introgression among individuals (and populations) of *Spigelia*.

> **Note**: This 5 yr-review agrees that genetic similarity among individuals or species is attributable to common descent. However, introgression between individuals or populations of different *Spigelia* species seems unlikely, given the geographic separation and morphological distinction. The findings from the STRUCTURE analyses are likely due to common descent. The hypothesis of introgression would be supported if future research revealed in-situ hybridization or individuals with intermediate morphology.

Electrophoretic studies indicated that the genetic identity between the *S. gentianoides* and *S. alabamensis* (previously recognized as varieties of *S. genianoides)* is high. The Florida sample used in the study, presently growing at the Bok Tower, from seeds collected at Calhoun County, included a relatively narrow subset of the genetic variation found in the *S. alabamanesis* populations (Affolter 2005).

DNA sequences of the Internal Transcribed Spacer of nuclear ribosomal DNA suggested that gentian pinkroot and *S. marilandica* (L.) L. (pinkroot, Indian pink) are sister species (Gould and Jansen 1999), although floral morphology and growth habits are quite distinct. The two species, however, have similar vegetative characters, which may have generated taxonomic problems related to species recognition when the collected specimen was not fertile.

c. Taxonomic classification or changes in nomenclature

Kingdom: Plantae
Division: Magnoliophyta
Class: Magniolopsida
Order: Gentianales
Family: Loganiaceae
Genus: *Spigelia* L.
Species: *gentianoides* Chap. ex. A. DC.
Common names: gentian pinkroot, purple flower pinkroot

The U.S. Fish and Wildlife Service listed *S. gentianoides* as an endangered species on November 26, 1990. In 1996, a new variety (var. *alabamensis*) of endangered *S. gentianoides* was described by Gould. The status evaluation of 2009 and the 2012 RP of *S. gentianoides* considered both varieties. Both documents, however, suggested the possibility that the two taxa warranted specific rank and recommended taxonomic studies using a multi-data approach (e.g., morphology, molecular studies) for discerning whether the two varieties represent distinct species. Weakley et al. (2011) reassessed the appropriate ranks of these taxa based

on herbarium and field studies and elevated variety *alabamensis* to species. In addition, molecular studies using AFLP further supported the taxonomic separation of *S. gentianoides* and *S. alabamensis* (Hershberger et al. 2015). Therefore, *Spigelia gentianoides* var. *alabamensis* is both morphologically and genetically unique, and it is recognized as a distinct species and separated from *Spigelia gentianoides* as *Spigelia alabamensis* (K. Gould) K.G. Mathews & Weakley. The Service supports the current classification. The name in FWS system remains the same, *S. gentianoides,* as the entity listed in 1990. In this rule, only three populations were mentioned (Calhoun, Jackson, and Washington); the Bibb County glades and var. *alabamensis* plants were not cited.

Spigelia gentianoides belongs to the Loganiaceae. Gentian pinkroot was first collected in north Florida by Alvan Wentworth Chapman in 1837, probably from the west side of the Apalachicola River, in either Jackson or Calhoun counties. It is a small, perennial herbaceous plant of about 10-30 cm long. The leaves are opposite and sessile, largest at the top of the stem, 3-5 cm long, with lowest leaves smaller. Flowers are borne in a short, few-flowered, terminal, spike-like raceme. The flower consists of a narrow pink corolla tube of about 25-50 mm long, with five lobes, each 5-6 mm long. The stamens are inserted within the flower (Kral 1983), and the pollen grains are deposited along the bristles of the style (secondary pollen presentation). At anthesis the corolla lobes are partially open, occasionally fully divergent. The green sepals are 25-30 mm long. Peak flowering season occurs between May and June, however, plants have been seen flowering as early as April and as late as October.

d. Spatial distribution, trends in spatial distribution, or historic range

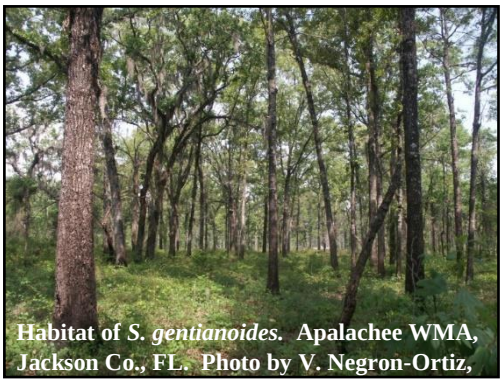
At the time the species was listed only three populations from Florida were known. Five additional populations were found in Florida and Alabama, and two are considered extirpated. Liberty and Levy counties were included as part of *S. gentianoides* distribution (Wunderlin et al. 1980), but the collection was subsequently determined to be *S. loganioides*. Two varieties were recognized (sensu Gould 1996), extending the species range into northern Alabama. However, variety *alabamensis* in now recognized as a distinct species (Weakley et al. 2011); therefore, the geographic range for *S. gentianoides* is reduced to four counties, 3 in Florida and 1 in Alabama.

Fire management practices, i.e., winter burns, implemented by TNC on their properties (Calhoun and Washington counties) and reduced soil disturbance practices, have resulted in a slight increase of *S. gentianoides* on the Spigelia Preserve and Rock Hill Preserve. In Geneva SF, the plants responded well to growing season prescribed fire with plants flowering about 7-8 weeks after the burn. Similarly, growing season prescribed burns have been implemented at the Three Rivers SRA and Apalachee WMA (2 year fire return interval) for several years and the population remains stable in numbers. Although emergence of *S. gentianoides* plants has occurred in recently burned areas, the role of fire frequency

and timing (early vs. late in the growing season) on this variety is not well understood.

Spigelia alabamensis (syn. *Spigelia gentianoides* var. *alabamensis*) occurs in 17 glades owned by TNC and private landowners. TNC created the Kathy Stiles Freeland Bibb County Glades preserve in 1996. Their management strategies include control of visitor use, restoration, prescribed burning, monitoring and inventory. The trends in spatial distribution because basic inventory data (e.g., the total number of individuals, number of flowering vs. non-flowering plants, presence of visitors to the flowers, and whether seedling recruitment is occurring) in addition to the effect of fire on population size for each glade are not currently available or known.

e. Habitat or ecosystem conditions



Habitat of *S. gentianoides.* Apalachee WMA, Jackson Co., FL. Photo by V. Negron-Ortiz,

Spigelia gentianoides can be found growing as a solitary individual or in small clumps in predominately well drained upland pinelands where it is a component of a fire-maintained longleaf pine-wiregrass ecosystem, in areas where limestone outcrops and calcareous soils are widespread, and in soils somewhat dry but rich in humus. It is also found in pine-oak-hickory woods (upland mixed woodland) at Apalachee WMA (Jenkins and Diamond 2007), which consists of two soil types, Blanton coarse sand and Chipola loamy sand. The Blanton series consists of very deep, somewhat excessively drained to moderately well drained, moderately to slowly permeable soils on uplands and stream terraces in the Coastal Plain (USDA 2006).

Spigelia alabamensis is found in glades (open, almost treeless areas within woodland) that have developed over an ancient rock formation known as Ketona Dolomite. The Ketona formation contains a pure form of dolomite, crystalline in texture with only about 2% of siliceous impurities (Garland 2008). The glades vary in size from about 0.1 to 5 hectares with soil high in magnesium and calcium, low in phosphorus and potassium, and a pH ranging from 7.4 to 7.6 (Grossman et al. 1994). The topography varies from flat to sometimes very strongly sloping. There are patches of exposed rock and thin-soiled areas dominated by grasses and other herbaceous vegetation. The plants in these glades are exposed to extreme heat and drought. At these sites, plants are quite abundant, and mainly found in small clumps adjacent to rocks.

f. Other

1. Propagation and ex-situ collection

Spigelia gentianoides can be propagated vegetatively and from seeds. The Bok Tower (Peterson and Campbell 2007) has 870 seeds that were collected in 1989 and 20 collected from their progeny in the collection beds in 2005. In 2004, the Bok Tower maintained 50 individuals as part of their collection (from seeds collected in Calhoun County in1988), but as of 2007 the plants were reduced to one with the cause of reduction unknown. The Bok Tower staff has not worked with the species since 2007 (C. Peterson, Bok Tower, 6/25/2018, pers. comm.).

Affolter (2005) successfully propagated *S. alabamensis*: by transplanting entire plants from the field to well drained potting mix; from stem cuttings, and by germinating seeds using cold stratification (2°C) or gibberellic acid (500-1000 ppm) treatments. Eight weeks of cold stratification provided excellent germination rates. At present, there are 20-30 plants, primarily hybrids between *S. marilandica* and *S. alabamensis*, growing outdoors in raised beds at the State Botanical Garden (J. Affolter, UGA, 6/6/2018, pers. comm.). The State Botanical Garden staff no longer grow any *Spigelia* in the greenhouse.

2. Reproductive biology

Secondary pollen presentation, a mechanism presenting the pollen on a structure other than the anther, appears to be present in *S. gentianoides* (Negrón-Ortiz, 2007, pers. observ.) and *S. alabamensis*; pollen was observed in the short bristles of the style. At the Geneva SF population, small Halictidae bees (sweat bees) were observed entering and exiting the flower of the *S. gentianoides*.

A student from Auburn's Department of Biological Sciences is working on a MS thesis involving *Spigelia* pollination in the Southeast (B. Chowdhury, AU, 7/6/2018, pers. comm.). In addition, B. Chowdhury and collaborators are tracking flowering, herbivory, nectar robbing, and plant growth (B. Chowdhury, AU, 7/10/2018, pers. comm.) for *S. alabamensis*.

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

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

Conversion of much of the upland forest land in the four counties to pulpwood plantations (clearcutting, mechanical site preparation, and pine plantations) has possibly extirpated other populations. Clearcutting and/or selective thinning are of concern since typical silviculture operations often result in soil disturbance and compaction. In particular, site preparation practices resulting in soil disturbance, change in canopy cover from tree harvest, and change in fire frequency and seasonality are of concern. Land conversion coupled with disruption of pre-historical and historical fire regimes of the longleaf pine-wiregrass ecosystem is responsible for the rapid decline of the ecosystem where *S. gentianoides* is found. Several studies have shown that frequent prescribed fire regimes are important for maintenance of longleaf pine-wiregrass ecosystem (Hiers et al. 2007). Prescribed

burnings at 3 – 5 yr intervals seem to maintain optimal *S. gentianoides* populations. However, areas at Apalachee WMA are on a 2-year fire rotation where the largest population of *S. gentianoides* appears to be stable (A. Jenkins, FNAI, 8/15/2018, pers. comm.). However, it is unknown 1) if frequent fires is detrimental to recruitment, and 2) the implications of fire seasonality to *S. gentianoides* survival.

Habitats converted to pine plantation, and managed without fire have created a shaded canopy. In addition, pine plantation management induces severe soil disturbance. According to Kral (1983), *S. gentianoides* would not survive the mechanical site preparation used in pine monoculture. This observation seems accurate due to the fragile nature of these plants, but the population located at the *Spigelia* Preserve seems to have survived, at least over the short term, after cutting and planting. Nevertheless, the population exhibited a decline immediately after the last timber harvest. Similarly, the population in Jackson Co. on land owned by Guy Anglin emerged in a former pine plantation.

Urban development also threaten *S. gentianoides*. Conversion of much of forest land to residential development has possibly extirpated many populations. More than a third of Florida's land is projected to be developed by 2070 along with a growh of about 33.7 million residents–almost 15 million more people than in 2010 (University of Florida GeoPlan Center 2017).

Spigelia alabamensis is restricted to one county in northern Alabama. It is found in 17 glades, and TNC own and protect about a dozen larger glades and some smaller glades. Populations on private property are threatened by future development for home-sites, agriculture, logging of associated hardwoods, recreational facilities, or other purposes.

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

Spigelia gentianoides has not been tested for potential drug uses, and there is no evidence of overexploitation. Other species within the genus have been exploited for their medicinal and/or poisonous properties (Rogers 1986).

c. Disease or predation:

Neither diseases nor predation are currently known to be major threats to this species. However, minor herbivore damage was noted at Three Rivers SRA and Geneva SF (B. Chowdhury, AU, 6/11/2018, pers. comm.) populations.

d. Inadequacy of existing regulatory mechanisms:

The Endangered Species Act (Act) of 1973, as amended prohibits the removal 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. However, the Act does not provide protection for plants on non-federal lands unless it is in violation of state law.

Florida. *S. gentianoides* is listed as endangered under the Preservation of Native Plant Flora of Florida Act (PNPFF Act) (Rule: 5B-40.0055, Section 581.185-187, Florida Statutes; https://www.flrules.org/gateway/RuleNo.asp?ID=5B-40.0055). The PNPFF Act addresses the protection of endangered, threatened, or "commercially exploited" plants (http://www.sfrc.ufl.edu/Extension/florida_forestry_information/planning_and_assistance/threatened_and_endangered_species.html). The removal of protected plants from a property, whether for transplant, sale, or any other purpose, requires both the written permission of the landowner and a permit from the Florida Department of Agriculture and Consumer Services.

Alabama. Alabama State Constitution provided the necessary authority to add plants to Alabama's section 6 cooperative agreement. Department of Conservation and Natural Resources has a policy to protect, conserve and increase the wildlife of the state [Ala. Code 9-2-2 (1)], but provides little direction as to how this is to be accomplished. While the state's Natural Heritage Program maintains lists of non-game species considered endangered, threatened, of special concern or poorly known, it does not apply penalties for taking listed species or for altering their habitats. The Nongame Wildlife Program, which was started in 1984, helps administer endangered and threatened species projects on federally and state-listed species, and also issues scientific collecting permits to enable a wide range of projects and collect the data for fishes, amphibians, reptiles, birds, and mammals (http://www.outdooralabama.com/wildlife/nongame-wildlife-program).

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

Non-native plant interactions. Currently, non-indigenous plants within or near extant populations of *S. gentianoides* do not pose a threat. However, *Lygodium japonicum* (Thunb. ex Murr.) Sw. (Japanese climbing fern) and *Lonicera japonica* Thunb. (Japanese honeysuckle) have been found in the vicinity of *S. gentianoides,* and both are becoming problematic in areas of the Southeast.

D. Synthesis

Spigelia gentianoides has a very narrow distribution in addition to a low population density. Taxonomic rank changes and population extirpations have led to a reduction of this species' range and overall genetic diversity. It is currently restricted to four counties west of the Apalachicola River (Washington, Calhoun, and Jackson counties in Florida, and Geneva County in Alabama), and seven populations. In these locations, the plants numbers range from three to about 2,000 individuals. Surveys indicate that the species is stable at Spigelia Preserve and Three Rivers SRA, increasing at Apalachee WMA, Rock Hill Preserve, and Geneva SF, and declining at Calhoun CR 4. The trend remains unknown in the Guy Anglin's population.

The main threat to this species is habitat loss and modification. Conversion of much of the historical forest land to commercial pine plantations has possibly

extirpated many populations. According to Teranto et al. (2014), the SLEUTH urban growth model suggests the extent of urbanization in the Southeast is projected to increase by 101% to 192%. Projected changes would have substantial effects on the region's ecosystems, posing particularly threat to already imperiled species and systems such as the longleaf pine ecosystem. More than a third of Florida's land is projected to be developed by 2070 along with a growth of almost 15 million more people than in 2010 (Teranto et al. 2014); therefore development pressures in the Florida panhandle are extreme.

This species occurs in fire maintained habitats. Lack of fire and subsequent growth of shrubs and saplings in the understory, reduces *S. gentianoides* abundance in areas where it was previously at high density.

No problems have been detected with disease and predation.

The species occurs on both private and public lands. One of the seven populations occurs on a private property in Florida, but the landowner has a cooperative agreement with the State of Florida to manage his property under the Landowner Incentive Program. Populations on private property are potentially threatened by future development for home-sites, agriculture, logging of associated hardwoods, recreational facilities, or other purposes. Permanent protection is necessary to conserve this population. In addition, a stand-alone plan for managing all extant *S. gentianoides* populations is crucial to maintain this species stable.

Spigelia gentianoides continues to meet the definition of an endangered species due to threats like habitat destruction or modification due to development, the plant's present narrow distribution, and its general low population numbers. Studies have demonstrated variation among the number of plants necessary for a population to survive risks of extinction (Given 1994, Matthies et al. 2004, Menges 1990). Because most of the *S. gentianoides* populations have less than 1000 individuals, any impact to existing populations could cause extirpation of these populations (Matthies et al. 2004). A long-term monitoring and demographic study is necessary to assess population trends and trajectories, and where in the life cycle the management should be targeted.

Spigelia alabamensis (***S. gentianoides* var. *alabamensis***, *sensu* Gould 1996) is restricted to the Ketona Dolomite formation and glades of Bibb County, AL. This species seems to be abundant but the current number of individuals at these glades is unknown; therefore, population trends are also unknown for *S. alabamensis.* Some of the 17 glades where this species is found are owned and protected by TNC. Populations on private property are potentially threatened by future development for home-sites, agriculture, logging of associated hardwoods, recreational facilities, or other purposes. Since *S. alabamensis* is recognized as a distinct species from *S. gentianoides*, the current RP must to be updated.

III. RESULTS

A. Recommended Classification:
__x__ No change is needed

B. New Recovery Priority Number ___N/A__

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

1. Establish protection and management agreements with landowners.
2. Conduct surveys/inventories on each known population. For each extant population, the following data should be collected once a year: the total number of individuals, number of flowering vs. non-flowering plants, presence of visitors to the flowers, and whether seedling recruitment is occurring.
3. Conduct a long-term study using populations distributed throughout the species' historical range for 10 years to document both distribution and abundance changes. Observations of flowering and fruiting are important and should be integrated with variables such as plant size and seedling data. Since gentian pinkroot occurs in fire prone habitats, the effect of this disturbance (including winter vs. growing season prescribed fire, fire frequency, intensity, duration, and timing) on survival and fecundity should be also monitored. Such studies should be conducted on large populations. Plants should be monitored several times during a 12-month cycle (e.g., flowering and fruiting seasons) the first year, then annually or biannually over an extended number of years.
4. Investigate if there is a soil seed bank persistence of *S. gentianoides* seeds throughout the species' geographic range.
5. Conduct germination studies and investigate whether seedling recruitment is occurring.
6. Monitoring and managing for invasive species
   Frequent inventories or surveys of the Florida populations for invasive plant species should be established, which will help with the early detection and eradication of small patches of exotic invasive plants within the sites. This is an ongoing action for the Three Rivers SRA population conducted by the Park staff.
7. Conduct surveys/inventories on potentially new sites in Northern Florida and Alabama. This action can include the use of aerial photographs and species distribution models to 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.
8. Reintroduce plants within the historic range, specifically in the sites where the plants have been extirpated.
9. Conduct reproductive studies
   Since site disturbance occurs within the populations of *S. gentianoides*, it may pose problems to pollinator diversity (Kevan and Phillips 2001). Therefore, it is important to determine which insects are pollinators, and understand the value and pollinators' requirements so that actions can be taken to incorporate specific management or protection plans.

Knowledge of the type of mating systems is essential for conservation of rare plant taxa because mating systems affect genetic diversity within and among populations (Navarro and Guitian 2002). Therefore, floral morphological analysis and experimental hand-pollinations are all recommended.

10. Revise the downlisting criteria and incorporate delisting criteria to the current Recovery Plan.
11. Evaluate whether protection for *Spigelia alabamensis* under the Federal Endangered Species Act may be warranted.

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U.S. FISH AND WILDLIFE SERVICE 5-YEAR REVIEW OF

SPIGELIA GENTIANOIDES

Current Classification: Endangered

Recommendation resulting from the 5-Year Review

__X__ **No change is needed**

Appropriate Listing/Reclassification Priority Number, if applicable: N/A

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

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve CATHERINE PHILLIPS Digitally signed by CATHERINE PHILLIPS Date: 2018.09.21 14:45:11 -05'00' Date_____

APPENDIX A
*S*ummary of peer review for the 5-year review of *Spigelia gentianoides*

A. Peer Review Method:

The document was peer-reviewed internally by Dr. Sean Blomquist in the Panama City Field Office. A neighbor FO coordinated peer-review for this species and was sent to four outside reviewers; only three provided comments.. The outside peer reviewers were chosen based on their qualifications and knowledge of the species.

B. Peer Review Charge:

We indicated our interest in all comments the reviewers may have about the document, including validity of the data used, and identification of any additional new information on the *Spigelia gentianoides* that has not been considered in this review.

C. Summary of Peer Review Comments/Report

The reviewers considered the document to be an accurate summary of the current state of knowledge of *S. gentianoides*. A few editorial comments and clarifications were provided related to pollination biology, and populations and plant abundance in Florida.

D. Response to Peer Review

All peer reviewer comments were evaluated and incorporated where appropriate.