

Spigelia gentianoides
Gentian pinkroot

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



S. gentianoides var. *alabamensis*



S. gentianoides var. *gentianoides*

**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This review was accomplished using information obtained from peer-reviewed scientific publications, several unpublished research projects, unpublished field observations by U.S. Fish and Wildlife Service (Service), State and other experienced biologists, and personal communications.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 April 16, 2008 (73 FR 20702). 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

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C. Background

1. **FR Notice citation announcing initiation of this review:**
73 FR 20702 (April 16, 2008)
2. **Species status:** Stable (Recovery Data Call 2008); populations seem to be stable based on surveys and recent observations for the Bibb County glades (AL), The Nature Conservancy (TNC) *Spigelia* tract (Calhoun County, FL), recent observations for Geneva State Forest (AL), Three Rivers State Recreational Area (SRA) and Apalachee Wildlife Management Area (Apalachee WMA; Jackson County, FL).
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 Historic Bok Sanctuary (Sanctuary), Lake Wales, FL, and at the State Botanical Garden of Georgia, Athens, GA; endorsement of a grant to prepare a historic vegetation analysis for Apalachee WMA; 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:**
Status Review, 1991: In this 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.

Recovery Data Calls: 2003; 2004; 2005; 2006; 2007; 2008 (stable).
7. **Species' Recovery Priority Number at start of review (48 FR 43098)**
2. This ranking is based on a high degree of threat due to habitat destruction, a high recovery potential, and its status as a species.
8. **Recovery Plan**
A draft recovery plan is currently being reviewed by the Regional Office.

II. REVIEW ANALYSIS

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

Spigelia gentianoides is a plant; therefore, the DPS policy does not apply. The Act defines species as including any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate wildlife. This definition limits listing DPS to only vertebrate species of fish and wildlife. Because the species under review is a plant and the DPS policy is not applicable, the application of the DPS policy to the species listing is not addressed further in this review.

B. Recovery Criteria

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

No. Currently, a recovery plan is being prepared for this plant.

C. Updated Information and Current Species Status

1. Biology and Habitat

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

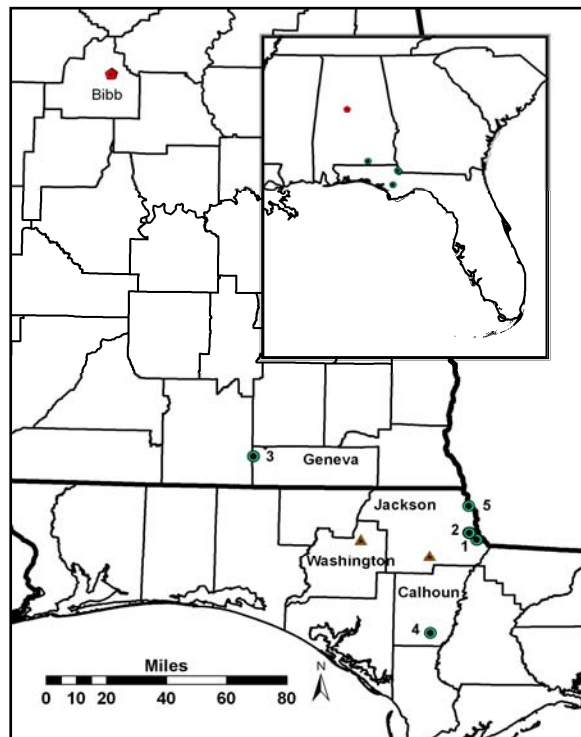





Fig. 1. Location of *S. gentianoides* populations in Florida and Alabama.  Var. *alabamensis*;  Extirpated populations of var. *gentianoides*;  Extant populations of var. *gentianoides*. Numbers represent population sizes from high (1) to low (5).

Spigelia gentianoides Chapman ex A. de Candolle is composed of two varieties (Gould 1996): *S. gentianoides* var. *gentianoides* (hereafter var. *gentianoides*) restricted to five locations within three counties in the Florida Panhandle and southern Alabama, and *S. gentianoides* var. *alabamensis* K. Gould (hereafter var. *alabamensis*) limited to Bibb County, Alabama (Weakley 2007; Fig. 1). The populations are located on both public and private lands.

Originally, var. *gentianoides* was restricted to four counties west of the Apalachicola River: Washington, Calhoun, and Jackson counties in Florida, and Geneva County in Alabama (Fig. 1). The Washington County population was revisited in

2005 (B. Martin, pers. comm., 2005) but plants were not located, consequently it is thought to be extirpated. Additionally, one of the four populations in Jackson County is also considered to be extirpated; a survey in 2000 indicated that the site consisted of a few large trees with no mid-story or ground cover with no evidence of the plants.

To date, only five extant populations are known for var. *gentianoides* (Fig. 1). One of the largest populations is located in Jackson County, Florida at Apalachee WMA (Fig. 1, # 2). This site is managed by the Florida Fish and Wildlife Conservation Commission (FFWCC) in cooperation with the U.S. Army Corps of Engineers. This population, discovered in June 2007 by biologist Nathan Bunting of FFWCC, is composed of more than 1,700 individuals in two element occurrences or subpopulations. These subpopulations were located in two distinct areas in pine-oak-hickory woods habitat. A second large population is also located in Jackson County, Florida at Three Rivers SRA (Fig. 1, # 1). The population was estimated to be over 1,000 individuals in 2005, but due to implementation of prescribed fire, more plants have been found increasing the population to an estimated 2,000 plants in 2008. The third largest population is found in Geneva County, Alabama, within Geneva State Forest. There are approximately 400 plants located in the Forest according to surveys performed in June 2005 and July 2007 by Service biologists. Located in Calhoun County, Florida, the fourth population of var. *gentianoides* is on a site owned by TNC. TNC has conducted two prescribed burns on the property since acquisition, the most recent in June 2008. This population contains approximately 100 plants. The last known site, privately owned by Guy Anglin, is

found north of Jackson County approximately 10 miles north of the Three Rivers SRA (B. Martin, 2005, pers. comm.). This site contains only three plants (Fig. 1, # 5).

Var. *alabamensis* is located at the Bibb County glades (Figs. 1 and 2, and see e. habitat conditions for a description of this type of habitat), the most biologically diverse area known in the state of Alabama

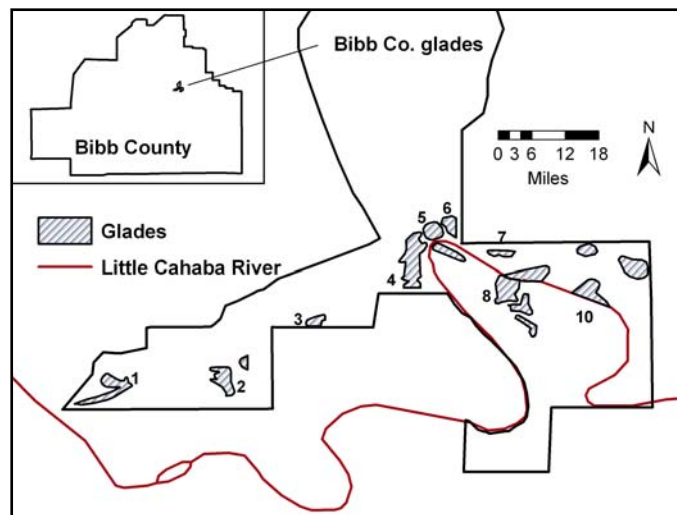


Fig. 2. Map of Bibb County Glades, Bibb Co., AL, showing the locations of a few glades. Glades # 3, 4, 5, & 7 were surveyed by Negrón-Ortiz and collaborators in 2008. Numbers were given by TNC.

(<http://www.nature.org/wherewework/northamerica/states/alabama/preserves/art902.htm>). The plants are found at 17 of 40 Ketona dolomite glade locations (See e. habitat conditions for further detail on the Ketona dolomite rock formation).

Currently, no inventory exists for the total number of individuals present at these glades. During a recent visit to the glades in 2008, Negrón-Ortiz and collaborators censused four glades (Fig. 2) using belt transects and covering approximately 85 to 90% of each glade, and estimated 126 - 1,526 plants per glade for an estimated total of 3,653 plants.

Basic demographic data (e.g., total number of individuals, number of flowering vs. non-flowering plants, presence of visitors to the flowers, whether seedling recruitment is occurring, density and abundance of plants) in addition to the effect of fire on population size for each glade are not currently known (see Recommendations for Future Actions section).

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

Electrophoretic studies indicated that the genetic identity between the *S. gentianoides* varieties is high. The Florida sample used in the study, presently growing at the Historic Bok Sanctuary (Sanctuary), from seeds collected at Calhoun County, included a relatively narrow subset of the genetic variation found in the *alabamensis* populations (Affolter 2005). The majority of allozyme diversity in var. *alabamensis* was found to be distributed within rather than among glades, therefore the author suggested that nearly all the genetic diversity will be captured by preserving the largest glades.

DNA sequences of the Internal Transcribed Spacer of nuclear ribosomal DNA suggested that gentian pinkroot and *S. marilandica* (L.) L. (pinkroot, Indian pink, worm-grass) 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: Magnoliopsida
Order: Gentianales
Family: Loganiaceae
Genus: *Spigelia* L.
Species: *gentianoides* Chap. ex. A. DC.
Varieties: *gentianoides*
alabamensis Gould

Common names: gentian pinkroot, purple flower pinkroot

Spigelia gentianoides is a perennial herb belonging 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. Var. *alabamensis* was first found in 1992 by James R. Allison and collaborators, and later described by Gould (1996). The taxonomic ranking was

based on morphological differences in the leaf shape and floral traits, and more obviously, by the number of flowers per inflorescence (Affolter 2005) and the behavior of the corolla lobes at anthesis (Table 1). Floral morphological differences were maintained when both varieties were grown in a common greenhouse (Affolter, 2007, pers. comm.), thus these varieties are valid taxa and possibly could represent two different species (see Recommendations for Future actions sections for suggested studies).

Spigelia gentianoides is a small 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 1 cm 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 of *S. gentianoides* var. *gentianoides* are partially open, occasionally fully divergent; whereas the corolla lobes of var. *alabamensis* are always fully divergent. The green sepals are 4-6 cm long. Peak flowering season occurs between May and June, however, plants have been seen flowering as early as April and as late as October.

Table 1. Morphological characters distinguishing both varieties.

Characters	Varieties of <i>Spigelia gentianoides</i>	
	<i>alabamensis</i>	<i>gentianoides</i>
Leaves	Lanceolate to elliptic	Broadly ovate
# of flowers/inflorescence	2-4	3-8
Corolla length	36-50 mm	25-30 mm
Corolla lobes at anthesis	Reflexed ¹	Barely open or not reflexed

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

At the time the species was listed, only three populations from Florida were known. Since then, additional populations have been found in Florida, two sites are considered to be extirpated, and new findings have extended the species range into Alabama (Fig. 1). In addition, two varieties have been recognized (Gould 1996). Liberty and Levy counties were included as part of *S. gentianoides* distribution (Wunderlin 1980), but the collection was subsequently determined to be *S. loganioides* (Wunderlin, 2005, pers. comm.).

Fire management practices (i.e., winter burns), implemented by TNC on their property (Calhoun County) and reduced soil disturbance practices, have resulted in a slight increase of var. *gentianoides*. In Geneva State Forest, var. *gentianoides* 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 SRA for several years and the population remains large and is increasing in numbers.

¹ Reflexed: bent or curved backward

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 are not known 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:



Fig. 3. Habitat of *var. gentianoides*. Apalachee WMA, Jackson Co., FL. Photo by V. Negrón-Ortiz, 2007.

Var. 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-prone 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 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).

Var. alabamensis is found in glades (open, almost treeless areas within woodland) that have developed over an ancient rock formation known as Ketona Dolomite (mindspring.com/~jallison/lostworld.htm). 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



Fig. 4. Ketona Dolomite glade, habitat of *var. alabamensis*, Bibb County Glades Preserve, Alabama. Photo by V. Negrón-Ortiz, 2008.

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, var. *alabamensis* is quite abundant, and mainly found in small clumps adjacent to rocks.

f. Other

Propagation and ex-situ collection

Spigelia gentianoides can be propagated vegetatively and from seeds. Affolter (2005) successfully propagated var. *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.

Ex-situ populations of var. *gentianoides* are located at the Bok Sanctuary (Peterson and Campbell 2007). They have 870 seeds that were collected in 1989 and 20 collected from their progeny in the collection beds in 2005. In 2004, the Sanctuary maintained 50 individuals as part of their collection (from seeds collected in Calhoun County in 1988), but as of 2007 the plants were reduced to one with the cause of reduction being unknown. According to Affolter (2008, pers. comm.), the plants growing in the State Botanical Garden in Athens under greenhouse conditions seemed to become less vigorous with time, and most died off after a few years.

Reproductive biology

Prior to floral anthesis, anthers of var. *alabamensis* dehisce² on the short bristles of the style (Affolter 2005), presenting the pollen on a structure other than the anther. This mechanism is called secondary pollen presentation, and appears to be also present in var. *gentianoides* (Negrón-Ortiz, 2007, pers. observ.). Hand pollination experiments suggested that the var. *alabamensis* is capable of both self-fertilization and outcrossing, consequently it possesses a mixed mating system. However, slightly higher seed production occurred within the outcrossing treatment. Treatments have not been conducted for the var. *gentianoides*, but it is logical to hypothesize that it exhibits the same mating system.

According to Affolter (2008, pers. comm.), when rainfall is adequate, mature fruits with numerous viable seed are fairly common in the Bibb County populations, thus var. *alabamensis* is capable of reproducing sexually in natural populations. In addition, he also observed numerous established seedlings although the most common form of surviving summer droughts and winter temperatures is re-growth from underground parts.

² Dehisce: to open at definite places, discharging pollen

Affolter (2005) observed about 25 insect visitors on var. *alabamensis*, including a green swallowtail butterfly (*Battus philenor*) and a large bee fly (*Bombylius* spp.), and Rogers (1988) documented visitors such as bumblebee, ants, beetles, and a moth. At the Geneva State Forest population, small Halictidae bees (sweat bees) were observed entering and exiting the flower of the var. *gentianoides*.

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

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

Spigelia gentianoides var. *gentianoides* is restricted to two counties in Florida, and one county in southern Alabama (Fig. 1). Conversion of much of the upland forest land in these counties to pulpwood plantations (clearcutting, mechanical site preparation, and pine plantations) possibly extirpated other populations. Clearcutting and/or selective thinning are of concern since typical silviculture operations often result in soil disturbance and compaction. 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. If fires are needed for seedling establishment, or maintenance of a suitable habitat, then fire suppression is a threat. Several studies have shown that frequent prescribed fire regimes are important for maintenance of longleaf pine-wiregrass ecosystem (Hiers et al. 2007). However, frequent fires could also be detrimental if plants are eradicated without promoting recruitment, and *S. gentianoides* does not appear to grow in habitats that are dependent on one or perhaps two year fire intervals. Potentially, frequent prescribed burnings of 3 – 5 year intervals could be needed to maintain optimal *S. gentianoides* populations.

Habitats converted to farm land and pine plantation, and managed without fire have created a shaded canopy. In addition, pine plantation management induces severe soil disturbance. According to Kral (1983), var. *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 TNC *Spigelia* tract (Calhoun Co.) 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 (B. Martin 2005, pers. comm.). Similarly, Guy Anglin's plants emerged in a former pine plantation.

Var. *alabamensis* is restricted to one county in northern Alabama. It is found in 17 glades, some of which are protected by TNC. 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 disease nor predation is currently known to be a threat to this species.

d. Inadequacy of existing regulatory mechanisms:

The Endangered Species Act of 1973, as amended (Act) 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. Var. *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. The State of Alabama does not have an endangered species act, and/or a formal biodiversity policy (<http://wildlifelaw.unm.edu/statbio/alabama.html>). The 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. Alabama does not protect plants (J. Lewis, ALDCNR, 2008, pers. comm.). The records ALDCNR have in their Natural Heritage Section database of plant and animal distributions occur only in Bibb County. Many of these are on the Nature Conservancy's Bibb County Glades property. TNC manages their properties for the benefit of unique plant and animal species found there. Damage or destruction would be trespass and vandalism of private property.

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) has been found in the vicinity of var. *gentianoides* and is becoming problematic in areas of the southeast. Similarly, *Ligustrum sinense* Lour. (Chinese privet) poses a potential threat to var. *alabamensis* (D. Borland, 2007, pers. comm.) due to its presence in counties near where this variety occurs in addition to its ability to successfully compete with and displace native vegetation (<http://plants.usda.gov/>).

D. Synthesis

Spigelia gentianoides has a very narrow distribution in addition to a low population density. Var. *gentianoides*, originally found in four counties (Washington, Calhoun, and Jackson counties in Florida, and Geneva County in Alabama) and composed of seven populations, is currently restricted to three counties and five populations. In these locations, the plants are not abundant and the numbers range from three to about 2,000 individuals. Surveys indicate that the species is stable and increasing in the Three Rivers SRA, Geneva State Forest, and TNC *Spigelia* Tract. Var. *alabamensis* is restricted to the Ketona Dolomite formation and glades of Bibb County, AL. This variety, found at 17 out of 40 glades, appears to be fairly abundant but the current number of individuals at these glades is unknown, except at four glades.

This species occurs in fire-prone habitats. Lack of fire or reduced fire frequency, and subsequent growth of shrubs and saplings in the understory, reduces var. *gentianoides* abundance in areas where it was previously at high density. Var. *alabamensis* requires surveying to further investigate its current status and threats. No problems have been detected with disease and predation.

The species occurs on both private and public lands. One of the five populations of var. *gentianoides* occurs on a private property in Florida, and the landowner has a cooperative agreement with the State of Florida to manage his property under the Landowner Incentive Program. Some of the 17 glades where var. *alabamensis* 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. Permanent protection and management are necessary to conserve this variety.

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). However, Matthies et al. (2004) study of 379 populations of eight threatened species in northern Germany demonstrated that very small populations face a considerable risk of extinction, while the risk for populations with more than 1000 individuals was very small. Consequently, since many of the *S. gentianoides* populations have less than 1000 individuals, any impact to existing populations could cause this species to decline.

III. RESULTS

A. Recommended Classification:

 x **No change is needed**

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

1. Foster a working partnership with the Bibb County glades' landowners in order to initiate species' protection in privately owned glades.
2. Establish protection agreements with landowners.
3. Conduct surveys/inventories on each known population, and implement monitoring for both Florida and Alabama populations. 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.

Monitoring should examine density and abundance of individuals. 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. Conduct seed germination studies with var. *gentianoides* similar to those completed for var. *alabamensis*.
5. Monitoring and managing for invasive species

Frequent inventories or surveys of the Florida population 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 SRA populations conducted by the Park staff.

6. Conduct surveys/inventories on potentially new sites, between northern Florida and Alabama. This action can include the use of species distribution modeling methods to initially determine potential sites for gentian pinkroot, with subsequent validation or inspection of the sites for plants
7. Establish new occurrences within the historic range of var. *gentianoides*, specifically in the sites where the plants have been extirpated.
8. Coordinate conservation practices with the Florida Department of Transportation for highway rights-of-way (i.e., reintroduce var. *gentianoides* within their historic range on appropriate habitat on highway rights-of-way).
9. Conduct reproductive studies

Since site disturbance occurs within the populations of var. *gentianoides*, it is likely that it will 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). Var. *alabamensis* exhibits both self- and cross-fertilization, i.e., a mixed mating system, but there are no data available for var. *gentianoides*. Therefore, floral morphological analysis and experimental hand-pollinations should be performed.

10. Conduct taxonomic studies

A taxonomic study using a multi-data approach (e.g., morphology, molecular studies) is encouraged for discerning whether the two varieties represent distinct species. If the results suggest that the varieties represent distinct species, then both should be considered for federal protection.

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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 *Jessie M. [Signature]*

Date 1/14/09

Cooperating Field Office Supervisor, Fish and Wildlife Service

Approve *[Signature]*
Deputy FS, Alabama ES FO

Date 1/13/09

REGIONAL OFFICE APPROVAL:

Lead Regional Director, Fish and Wildlife Service

Approve *Franklin [Signature]*
ACTING Assistant Regional Director
Ecological Services

Date 1/21/2009

APPENDIX A

Summary of peer review for the 5-year review of *Spigelia gentianoides*

A. Peer Review Method:

The document was reviewed internally by Lorna Patrick and Janet Mizzi in the Panama City Field Office. Once their comments were added to the document, it was sent to three outside reviewers (see below). 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.

1. Review all materials provided by the Service.
2. Identify, review, and provide other relevant data that appears not to have been used by the Service.
3. Do not provide recommendations on the Endangered Species Act classification (e.g., endangered, threatened) of the species.
4. Provide written comments on:
 - Validity of any models, data, or analyses used or relied on in the review.
 - Adequacy of the data (e.g., are the data sufficient to support the biological conclusions reached). If data are inadequate, identify additional data or studies that are needed to adequately justify biological conclusions.
 - Oversights, omissions, and inconsistencies.
 - Reasonableness of judgments made from the scientific evidence.
 - Scientific uncertainties by ensuring that they are clearly identified and characterized, and those potential implications of uncertainties for the technical conclusions drawn are clear.
 - Strengths and limitations of the overall product.
5. All peer reviews and comments will be public documents, and portions may be incorporated verbatim into our final document with appropriate credit given to the author of the review.

C. Summary of Peer Review Comments/Report

Ms. Amy Jenkins provided a few editing comments. She considered the following statement “However, *S. gentianoides* does not appear to grow in habitats that are dependent on frequent fire” to be contradictory, since by definition the longleaf pine wiregrass ecosystem has historically had frequent fire. Similarly, **Mr. Brian H. Martin** suggested revising the same statement; specifically to determine “what is frequent”. He recommended taking into account what dominant vegetation is present and what is the typical growth rate of that vegetation (e.g. 3-5 or 2-7 year regime) and suggested that the plants should not be burned on an annual basis.

Dr. J. Affolter provided a detailed review. His thoughts are summarized below:

He considered the document an excellent summary of the current state of our knowledge of this highly endangered species. According to the reviewer: the strength of the review was the clear

presentation of what can be determined (the number, distribution, ecological characteristics, and ownership of the surviving populations); the analyses of the threats, conservation, and management needs were reasonable and well justified; and the *Recommendations for Future Actions* were well chosen, comprehensive, and justified by the content of the review.

Additional comments:

1. Pages 4-5: it was not clear whether the 4 Bibb County glades that were censused using belt transects were chosen because they were the largest, or because they were “average” in size, or because they were most accessible, etc. Can you make any comment about how the estimate of 3,653 plants might relate to the total number of plants in all *Spigelia* 17 glades?
2. Page 6: Var. *alabamensis* occurs in 17 glades owned by TNC and private landowners. Can you state how many are protected vs. private?
3. Page 8, paragraph 3: Is it possible to provide any explanation for why the number of plants in the Bok Tower *ex situ* collection declined from 50 to 1 (i.e., did it appear that the plants inevitably die-off in long term cultivation or was there some disturbance such as herbivory or disease)?
4. Page 8, paragraph 5: I am not sure if it is clear to the reader that we observed 25 insect visitors to flowers, as opposed to 25 different kinds of pollinators.
5. An additional *Recommendation for Future Actions* might include conducting seed germination studies with var. *gentianoides* similar to those completed for var. *alabamensis*.

D. Response to Peer Review

Most of the peer reviewers’ comments were incorporated into the document. Dr. Affolter comments 2, 3, and 5 were included in the document. Comment 1 was partially answered. We do not have sufficient data or information to relate the estimated number of plants in the four glades to the total number of plants in all *Spigelia* 17 glades. We do not have an answer from TNC for comment 2. The issue of visitor vs. pollinator (comment 4) relates to the definition of those terms. Pollinators transfer pollen grains to the stigma of the flower; the term visitor is more general and should be used if the transfer of pollen grains was not observed, recorded, or was ambiguous.