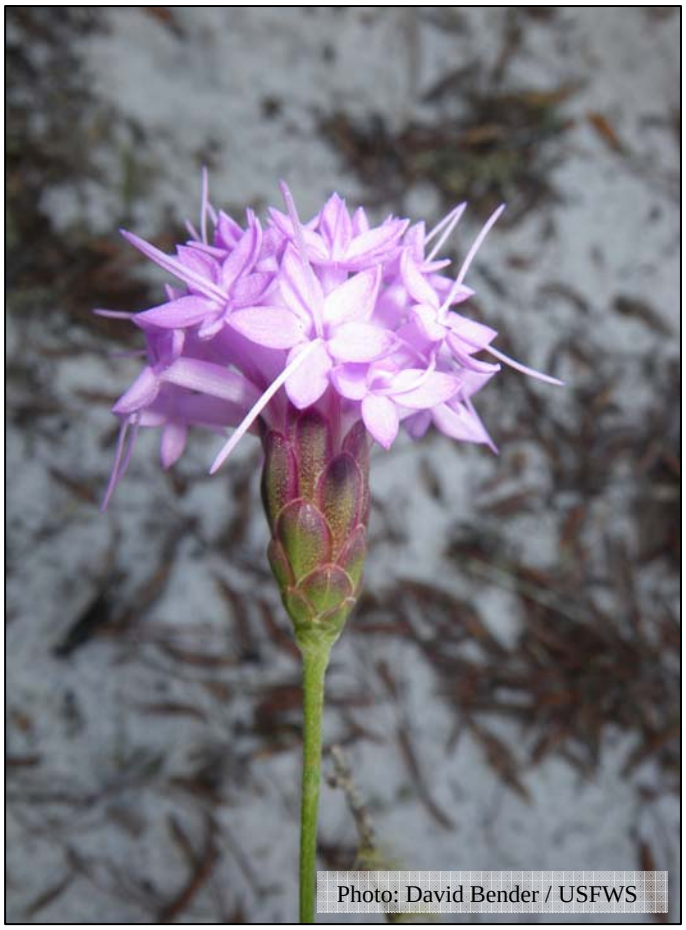
Scrub Blazingstar
(Liatris ohlingerae)

5-Year Review:
Summary and Evaluation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U.S. Fish and Wildlife Service
Southeast Region
South Florida Ecological Services Field Office
Vero Beach, Florida

5-YEAR REVIEW
Scrub blazingstar / *Liatris ohlingerae*

I. GENERAL INFORMATION

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

B. Reviewers

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

Lead Field Office: South Florida Ecological Services Field Office, David Bender, 772-562-3909

C. Background

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

2. Species status: (2009 Recovery Data Call). Florida Natural Areas Inventory has 91 extant occurrence records, 62 of which are protected on 23 managed areas. Fire suppression and habitat loss continue to be threats to occurrences on private land, except those owned by Archbold Biological Station and The Nature Conservancy. Inadequate prescribed fire implementation remains a significant threat at many managed sites. Most scrub sites are not burned frequently enough to support viable populations and mechanical surrogates may not provide the same benefits as fire. Further loss of unprotected populations is likely as development continues on the Lake Wales Ridge. Unprotected habitat continues to be developed for agriculture, housing, and other uses. Trends in threats are continuing at the same level. Rangewide survey data are lacking for populations over the past year, therefore the status of the species is uncertain.

3. Recovery achieved: 2 (2 = 26-50 percent of recovery objectives achieved).

4. Listing history
Original Listing
FR notice: 54 FR 31190
Date listed: July 27, 1989
Entity listed: Species
Classification: Endangered

5. Associated rulemakings: None

6. Review History
5-year review, November 6, 1991 (56 FR 56882). In this review, different species were simultaneously evaluated with no species-specific in-depth assessment of the five factors or threats as they pertained to the species' recovery. The notices stated that the Service was seeking any new or additional information reflecting the necessity of a change in the status of the species under review. The notices indicated that if significant data were available warranting a change in a species' classification, the Service would propose a rule to modify the species' status. No changes were proposed for the status of scrub blazingstar**.**

Recovery Plan for Nineteen Florida Scrub and High Pineland Plant Species (June 20, 1996).
Recovery plan for eleven Florida scrub plant species January 29, 1990 (original plan).
South Florida Multi-Species Recovery Plan (MSRP) (May 18, 1999).
Recovery Data Call: 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, and 2009.

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

8. Recovery Plan
Name of plan: South Florida Multi-Species Recovery Plan (MSRP)
Date issued: May 18, 1999
Dates of previous plan: Recovery Plan for nineteen central Florida scrub and high pineland plants June 20, 1996 (revised plan). Recovery plan for eleven Florida scrub plant species January 29, 1990 (original plan).

II. REVIEW ANALYSIS

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

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

B. Recovery Criteria

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

2. Adequacy of recovery criteria.

a. Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat? No. The criterion of 20 to 90 percent probability of persistence over 100 years is flawed. It allows for a possible 80 percent chance of extinction at the lower end of the range of probability of persistence.

b. Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)? No, herbivory is not addressed by the recovery criteria. Herbivory rates are high in some populations, resulting in lower fecundity (Kettenring et al. 2009). More research is needed to determine spatial and temporal patterns of herbivory and the severity of the threat.

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

The stated recovery objective is to reclassify from endangered to threatened. Delisting criteria have not been developed.

Scrub blazingstar may be reclassified from endangered to threatened when:

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

This criterion has been partially met. Twelve years of detailed demographic data (Level 3 monitoring *sensu* Menges and Gordon 1996) have been collected from multiple populations at several sites across a range of conditions (Menges et al. 2009). Demographic data (Menges et al. 2009) and observations (Herndon 1999) both suggest that populations are relatively stable. A population viability analysis (PVA) is needed to determine the number of populations required by the stated probability of persistence criteria. This criterion addresses factor A.

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

This criterion has been partially met. The number of populations required to satisfy this criterion has yet to be established, as described above. Sixty-two of 91 extant occurrences (68 percent) are protected on publicly or privately owned conservation areas. Twenty-nine of 91 extant occurrences (32 percent) are located on private property (FNAI 2009, Christman 2006) and have no protection. As habitat loss continues, remaining habitat becomes more fragmented and occurrences become more isolated. While many occurrences remain unprotected on private land, no distinct geographic gap in protection exists. Occurrences are protected throughout the species range, including those at the north, south, east, and west edges of the range. Some of the protected sites are not adequately managed, especially with regard to prescribed fire (TNC 2010a, b). This criterion addresses factors A and E.

3. When these sites are managed to maintain the rosemary bald of the xeric oak scrub community to support scrub blazingstar.

This criterion has been partially met. Prescribed fire is not likely to be implemented on the 29 unprotected sites located on private land. On protected lands, 23 of 62 extant occurrences (37 percent) have not been managed with prescribed fire since the properties were acquired (TNC 2010a). Unprotected occurrences are susceptible to habitat loss or degradation and are unlikely to be managed with prescribed fire (Turner et al. 2006). Sites with inadequate fire management become overgrown and less suitable to scrub blazingstar (Herndon 1999, Menges et al. 2009). The mechanical treatments (e.g. mowing, roller chopping, logging) used by many land managers may produce unfavorable conditions for some scrub endemic plants (Menges and Gordon 2010). This criterion addresses factor A.

4. When monitoring programs demonstrate that these sites support the appropriate numbers of self-sustaining populations, and those populations are stable throughout the historic range of the species.

This criterion has been partially met. The Service assumes that the ‘appropriate numbers of self-sustaining populations’ refers to a number that would be arrived at through a PVA. Since no PVA has been conducted, this number is not known. However, protected sites adequately represent the species range, with no distinct geographic gap in protection. Monitoring programs cover occurrences in only part of the historic range. Demographic data (Menges et al. 2009) and observations (Herndon 1999) both suggest that populations are relatively stable. This criterion addresses factor A and E.

C. Updated Information and Current Species Status

1. Biology and Habitat

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

Plant Description

The scrub blazingstar (*Liatris ohlingerae*), a member of the sunflower family (Asteraceae), is a long-lived (9 years or more), deciduous perennial herb up to 1 meter (m) tall. Its stems are erect and usually unbranched, but often become multi-stemmed when browsed ('topped') by herbivores. Its leaves are fleshy and narrow (1.0 to 2.5 millimeters [mm]), and generally 3 to 8 centimeters (cm) long, forming a basal rosette. The plants have a thickened, cylindrical underground organ (called a corm), from which they can resprout following fire. Flower heads are well separated on the stem with individual disc flowers up to 1 cm wide; the inflorescences are up to 3 cm across. Flower heads consist of 20 to 25 tubular, bright purple to pink, perfect disk flowers per head, and several heads per flowering stem. The corollas are bright purplish-pink in color. Seeds are 8 to 9 mm and feature an umbrella-like structure (pappus) that promotes wind-dispersal. The broad flower heads and narrow leaves distinguish scrub blazingstar from the eight other *Liatris* species in central Florida (Wunderlin et al. 1980, Evans et al. 2003).

Current Distribution

Scrub blazingstar is extant on the Lake Wales Ridge (roughly 90 to 100 occurrences) and Winter Haven Ridge (one occurrence) in Highlands and Polk Counties, Florida. Its range extends from Lake Blue in Polk County south along the Lake Wales Ridge to Archbold Biological Station (ABS) at the south end of the Ridge in Highlands County (FNAI 2009).

Habitat

Scrub blazingstar occurs in rosemary scrub and scrubby flatwoods, most commonly on white-sand soils (Menges et al. 2007). Rosemary scrub or 'rosemary balds' as they are also known, is a unique community type within the Florida scrub ecosystem. Rosemary scrub is largely dominated by Florida rosemary (*Ceratiola ericoides*) and has extremely well-drained, droughty, low-nutrient sandy soils. Rosemary scrub appears as small 'islands' separated from each other, often by considerable distances. Scrubby flatwoods often surround rosemary scrub (Boughton et al. 2006), and are dominated by clonal oaks (*Quercus* spp.) and have a lower density of open-sand gaps and terrestrial lichens (Menges 1999). Scrub blazingstar also colonizes anthropogenic sites within its natural habitat, such as fire lanes and roadsides (Menges et al. 2009). Occurrences of scrub blazingstar are generally small, with scattered plants at low densities over large areas (Dolan et al. 1999, Christman 2006).

Scrub blazingstar has important microhabitat requirements, particularly its preference for shade. Unlike most other scrub endemics, scrub blazingstar appears to thrive in lightly shaded areas and does not specialize in open microsites (Herndon 1999, Weekley et al. 2008a). Herndon (1999) found that 26 percent of scrub blazingstar plants were found in open areas in direct sun while 32 percent were found along the edges of canopies in partial shade. Nearly half (42 percent) of the plants were typically found under canopies of other vegetation. Furthermore, flowering and fruiting are more abundant for individuals in shaded microhabitats. Plants in open and edge habitats produce one-quarter as many mature flower heads (Herndon 1999). Germination rates and seedling survival are also higher in shaded microsites (Weekley et al. 2008a, Quintana-Ascencio et al. 2009).

Life History

Scrub blazingstar is a long-lived plant whose lifespan is likely measured in decades. Plants may remain as juveniles (non-flowering) for several growing seasons (Herndon 1999), and as long as 10 years in some cases (Menges et al. 2009). Above-ground growth is winter-deciduous, with growth of new basal leaves beginning in March and the elongation of flowering stems in April. Flowering begins in May or June, but the peak occurs in August with a rapid decline toward the middle of September. Seed heads mature from late July through October. The seeds start to disperse in August and peak in October. The seeds of this species are adapted for short-distance wind dispersal, having bristles and hairs that increase lift (allowing them to stay airborne longer) and help to correctly orient the seed upon landing. All above-ground growth dies back in October to November or by the first freeze. Plants can remain in a dormant state through at least one growing season (Herndon 1999) and plants have been observed to be dormant for up to 3 years before resprouting (Menges et al. 2009).

Mating System

Scrub blazingstar is self-incompatible (requires cross-pollination to reproduce) and is dependent on insect pollinators (Herndon 1999, Evans et al. 2003). The purple color, tubular corolla, and nectar production capacity of scrub blazingstar flowers all suggest butterfly pollination. Multiple species of butterflies, especially skippers (Hesperiidae), sulfurs (Pieridae), and swallowtails (Papilionidae) are consistent, though somewhat infrequent visitors (Evans et al. 2003). Cross-pollination in scrub blazingstar is promoted through insect-pollination, as well as spatial separation of anthers (male) and stigmas (female) flower parts (aka herkogamy), and maturation of staminate (male) flowers before pistilate (female) flowers (aka protandry) (Evans et al. 2003).

Evans et al. (2003) suggest that seed production could be limited in scrub blazingstar at times by pollinator abundance or behavior. Pollination experiments determined that seed-set in flowers given open access to insect visitors was significantly improved upon by hand-pollination with cross pollen and that insect visitation rates were low. The requirement of insect pollination and the evidence for potential

pollinator limitation warrants concern since scrub blazingstar populations typically consist of widely scattered plants, and many populations are isolated from other occurrences by large areas of development, agriculture, or otherwise unsuitable habitat.

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

Fire Ecology and Demography

Fire is the predominant natural disturbance in Florida and a primary driver in the demography of all Florida scrub plants that have been studied (Menges 2007). Both rosemary scrub and scrubby flatwoods are pyrogenic (fire-maintained) communities. Historical fire return intervals in rosemary scrub ranged from 20 to 100 years, while scrubby flatwoods have a 5 to 20 years average fire return interval (Menges 1999). Menges (2007) recommended fire return intervals of 5 to 12 years for oak-dominated scrub to 15 to 30 years for rosemary scrub, based on maximizing regeneration of gap specialist endemic herbs. Scrubby flatwoods have smaller, less-persistent gaps and a shorter fire return interval (5 to 15 years) than rosemary scrub. Under natural conditions, scrubby flatwoods will burn up to and occasionally into rosemary scrub. Over time unburned rosemary scrub develops canopies that are dense enough to carry fire. Fire is critical to maintaining the ecotones between these communities (Boughton et al. 2006).

Fire consumes the top growth of scrub blazingstar, but the plants are capable of resprouting from their corm after fire; although resprouting rates (47 percent) are lower compared to many other Florida scrub plants (Weekley and Menges 2003). Below-ground dormancy complicates assessment of resprouting to some degree for this species (Weekley and Menges 2003), but resprouting appears to be the primary mechanism for scrub blazingstar regeneration following fire (Menges and Kohfeldt 1995), while seedling recruitment is temporally and spatially patchy and seedling growth slow (Herndon 1999, Menges et al. 2009).

In 2000, ABS began a demographic monitoring study (Menges et al. 2009) of scrub blazingstar populations at three sites (Lake Wales Ridge State Forest [LWRSF], ABS, and the Gould Road unit of the Lake Wales Ridge Wildlife and Environmental Area [LWRWEA]). They have collected and analyzed data from 13 scrub populations and 6 roadside populations. Throughout the period of study (2000 to 2009), average annual survival rates (for individual plants) across all populations was greater than 70 percent in most study years, and ranged from 53 to 100 percent. None of the 10 years of the study showed low survival across all populations, and no population has had low survival across all years (Menges et al. 2009). Multiple studies have found high survival rates for germinated seedlings (Herndon 1999, Weekley et al. 2008a,

Quintana-Ascencio et al. 2009). Cumulative survival for experimentally sown plants in two trials was 15 percent over 8 years, and 24 percent over 6 years, respectively. Few (10 to 15 percent) of the surviving plants have flowered, indicating that new recruits can require as much as 8 years to flower, and that most new plants die before they reach that point (Menges et al. 2009).

Contrasting with high annual survival rates are exceedingly low seedling recruitment rates, estimated at 0.02 percent annually (Weekley et al. 2008a). The cause of low recruitment rates is not fully understood. Seed production is commonly observed in scrub blazingstar. Herndon (1999) estimated that each plant produced 1.18 seed heads per year (averaged over two years), and that each flower head produces approximately 8 to 10 filled (presumably viable) seeds per head. Significant differences in number of seeds per head occurred in samples from different months and years. Scrub blazingstar does not appear to be limited by inadequate seed germination (Herndon 1999, Weekley et al. 2008a). Experimental germination rates for scrub blazingstar are higher than recorded for many other Florida scrub endemics. Weekley et al. (2008a) found experimental germination rates from 6.2 to 87.8 percent across a range of field conditions, with the highest (84.0 percent) rates in shallow rosemary litter and lowest (18.0 percent) in deep pine needle litter. Both the type and depth of litter had significant effects on germination rates – with rates twice as high in shallow (0.2 cm) litter than deep (2.0 cm) litter, and lower rates in oak and pine litter versus rosemary litter (Weekley et al. 2008a). Quintana-Ascencio et al. (2009) found that scrub blazingstar seed germinated at an average rate of 33 percent across a range of sites. In this study, germination rates were 16 percent for litter with no canopy cover, 56 percent for litter with shrub cover, and 30 percent for bare sand. Thus, while able to grow on bare sand, scrub blazingstar germinates best under shrubs with litter. However, the depth and type of litter are important factors (Weekley et al. 2008a). It seems Herndon (1999) was correct in his assessment that seeds get trapped in dense litter and fail to successfully germinate.

Low seedling recruitment may also be due in part to seed predators that remove seeds post-dispersal. In one experiment, Weekley et al. (2008a) found that almost half (48 percent) of the seeds placed out for field germination trials were either missing or showed evidence of predation. However, in other experiments, no seed predation occurred. Predator exclusion studies by Quintana-Ascencio et al. (2009) found that scrub blazingstar seeds were removed in higher frequency by vertebrates. When vertebrates were excluded, very few seeds were removed. The southern harvester ant (*Pogonomyrmex badius*) (Formicidae) and larvae of the darkling beetle (Tenebrionidae: Coleoptera) are likely litter-dwelling seed predators (Weekley et al. 2008a). The identity of the suspected vertebrate seed predator is unknown. A rodent or bird is a likely candidate.

Some rosemary scrub endemics, such as Florida rosemary, produce chemicals that have allelopathic effects (usually inhibition of seed germination and

growth). Hunter and Menges (2002) demonstrated that the allelopathic effects of Florida rosemary litter do not suppress germination of scrub blazingstar under greenhouse conditions. Weekley et al. (2008a) found significantly higher germination rates in rosemary litter than under sand pine or oak litter. Moreover, scrub blazingstar is commonly observed growing under rosemary bushes. It is often missing from dense stands of rosemary, but Herndon (1999) found that the shade produced by dense stands of rosemary was more limiting than their allelopathic effects. Single or widely spaced rosemary shrubs are more likely to shelter individuals of scrub blazingstar. Weekley et al. (2008a) also evaluated the effects of a lichen, *Cladonia evansii*, which can grow in profusion in rosemary scrub and is suspected of competing for space with herbaceous plants. They concluded that neither the presence of lichen nor their allelopathic leachates had strong effects on germination rates of scrub blazingstar. More studies are needed to determine the barriers to seedling recruitment. In other scrub endemics, seedling recruitment is strongly influenced by timing and amount of precipitation. Further research may indicate if this is also true for scrub blazingstar.

Numerous scrub plants establish a persistent soil seed bank which they depend on for regeneration following fire (Menges and Kohfeldt 1995). Quintana-Ascencio et al. (2009) investigated the soil seed bank in rosemary scrub, disturbed scrub, and pasture. Seeds of 52 species were identified, including other listed species, but no scrub blazingstar seeds were found in any of the nearly 9,000 random samples. In seed germination trials, more than 80 percent of seeds germinate within a few weeks, suggesting that scrub blazingstar has little capacity to maintain a sizeable, persistent seed bank (Weekley et al. 2008a). Instead, it relies heavily on resprouting for regeneration following fire (Menges and Kohfeldt 1995).

Vertebrate herbivory and invertebrate seed-predators can have significant effects on the demographic performance of scrub blazingstar. Herbivory is a limiting factor for flower production (Herndon 1999, Kettenring et al. 2009). Browsing of plants (‘topping’) by vertebrate herbivores (mainly white-tailed deer [*Odocoileus virginianus*]) reduces the size and reproductive output of plants. Flower-bearing stems are not replaced if lost late in the season or if ‘topped’ multiple times throughout the growing season. However, stems eaten early in the season will likely be replaced and produce flowers (Herndon 1999). Kettenring et al. (2009) determined that 62 percent of plants in their study were topped one or more times in one year. Topped plants often have more stems, but are; (1) less likely to flower, (2) often have flowering delayed until later in the season (by as much as 2 to 4 weeks), and (3) produce fewer inflorescences and seeds compared with un-topped plants. The number of fully developed achenes (seeds) was 47 percent lower in topped plants than in un-topped plants. They estimated that vertebrate topping resulted in a 30 percent reduction of mean fecundity in the study population (Kettenring et al. 2009). The degree to which herbivory reduces fecundity is variable across the range of habitat conditions in which scrub blazingstar grows. Herndon (1999)

found that topping was more likely to occur in shaded versus open microsites (54 percent versus 42 percent). Kettenring et al. (2009) determined that topping occurs more frequently in scrub than in roadside sites, and in recently burned areas (3 to 8 years) more than in long-unburned sites. In scrub sites, plants are able to partially compensate for losses to herbivory through regrowth and delayed flowering. Topped plants in roadside populations showed no reduction in fecundity.

In addition to losses due to vertebrate herbivory, Herndon (1999) found that 30 percent of all buds are destroyed by borers. The smaller buds are destroyed by an excavator that consumes the ovaries. On larger buds, a lepidopteran borer is responsible for entering the bud at an unknown stage and consuming the ovaries. These buds reach mature size, but fail to open. In the Herndon (1999) study, 42 percent of buds failed to reach maturity. Of those, 30 percent were due to the borer and the remaining 12 percent had an unknown cause. No data is available on frequency and severity of borer impacts across years. More studies are needed to fully evaluate this pre-dispersal seed predator.

Characteristics of scrub blazingstar plants, including post-fire resprouting and higher tolerance for shade, and their populations, including low mortality of adult plants, abundant seed production, and relatively high rates of seed germination, contribute to greater demographic stability than other imperiled scrub herbs. Herndon (1999), Evans et al. (2003), and Menges et al. (2009) reported that the populations of scrub blazingstar they studied were stable with no evidence of immediate or overall decline. While seed production may be somewhat modest due to herbivores and seed predators, a lack of specialization to open-habitats and ability to tolerant moderate habitat succession promotes higher survivorship and thus fewer seeds are required to maintain populations.

Summary of Known Occurrences

Christman (1988) surveyed 216 scrubs in Polk and Highlands Counties, and found 94 scrub sites where scrub blazingstar was present. Christman (2006) re-surveyed 200 of the 216 scrubs in 2004 to 2005, and found 88 scrubs where scrub blazingstar was present. This number includes 21 scrubs from which the species was not reported in 1988. Some of the 1988 surveys were conducted during times of the year when scrub blazingstar was not in flower and would have been difficult to detect. Notably, 43 of 218 scrubs (20 percent) were considered ‘lost’ by Christman (2006) because they had been mostly developed. Scrub blazingstar was found in 80 of 170 ‘viable scrubs’ and 8 ‘lost scrubs’. In some of the ‘lost scrubs’, scrub blazingstar occurred in very low numbers, typically a few plants persisting in an undeveloped lot or along a road shoulder. Within the 80 viable scrubs there was an estimated 9,660 individual plants (Christman 2006). The eight lost scrubs had an estimated 223 individual plants. In 1988, scrub blazingstar was recorded on

seven scrub sites that were at least partly protected from development. In 2005, it was recorded on 43 scrub sites that are at least partly protected. Christman (2006) estimated there were about 6,775 individual plants occupying about 1,861 acres within the 43 scrubs that are at least partly protected. Population estimates provided for the 91 extant occurrences range from 1 to 1,100 plants. Twenty occurrences had fewer than 10 plants, 58 occurrences had fewer than 100 plants, and only three sites had populations larger than 1000 plants (Christman 2006). Population sizes are likely to be underestimated for scrub blazingstar because the species is cryptic when not in bloom, has a tendency to live nestled among other species, topped individuals may be overlooked, and a proportion of individuals are dormant in a given season (Herndon 1999).

Long-term demographic monitoring of scrub blazingstar is ongoing at three sites. ABS collects demographic data annually at Lake Wales Ridge State Forest, ABS, and Gould Road Scrub (Menges et al. 2009). Staff at Bok Tower Gardens conducted surveys of four occurrences located on private land in 2008 (Bok Tower Gardens unpubl. data 2009a). FNAI maintains a database of Element Occurrence Records (EORs) for rare plants and animals of Florida. Each EOR identifies a place on the landscape where a rare plant or animal has been observed. FNAI (2009) has 110 EORs for scrub blazingstar, but the majority of them have not been updated since 2000. Christman's (2006) surveys were conducted from 2004 through 2005, and surveyed 105 (95 percent) of the FNAI EORs, but these updates have not been incorporated into the FNAI database.

The following analysis draws on records from FNAI (2009) and Christman (2006), and updated occurrence data from Bok Tower Gardens (unpubl. data 2009a). Of FNAI's (2009) 110 EORs, three (EORs 13, 42, and 47) overlap with two separately managed areas. Because the adequacy of management is not equal across all protected sites, these occurrences are split for the purposes of this evaluation. EOR 13 also overlaps The Preserve, a site managed by Highlands County Department of Parks and Recreation, but we consider this EOR questionable. The record is of historic origin, resulting from a plant list for Highlands Hammock State Park (FNAI 2009). The area represented in the spatial data for EOR 13 is a grossly oversized circle that extends well beyond the boundaries of the Park. While Christman (2006) supports records for Highlands Hammock State Park and the Silver Lake LWRWEA, it does not provide a record for The Preserve. We could find no other basis to support this record, thus, we have removed it from our analysis. Christman (2006) also identified 12 sites with scrub blazingstar that did not spatially overlap any FNAI EOR, which we included in our analysis. This brings the total number of occurrences to 125 for analysis in this review. Nearly all occurrences lack up-to-date (within the past year) survey data. Surveys by Christman (2006) in 2004 to 2005 were the last time most of the occurrences were assessed in the field.

Our analysis ranked each occurrence as ‘known extirpated’, ‘likely extirpated’, or ‘presumed extant’. All protected occurrences are presumed extant based on their protected status, unless data show otherwise. Christman (2006) reported zero plants for EOR 54 [LWRSF Hesperides], 33, 106 [both Henscratch LWRWEA], and 40 [Lake June in Winter State Park]. Based on Christman (2006), we ranked these four occurrences as 'likely extirpated', but further surveys are needed to determine whether scrub blazingstar has truly been extirpated from these protected sites. Fifteen unprotected occurrences were ranked as ‘likely extirpated’ because they corresponded to a scrub that Christman (2006) considered lost (even though a few plants might have still been present), and aerial photos from 2008 showed little or no suitable habitat remaining (7 occurrences, FNAI EOR 2, 60, 75, 76, and 80, plus two from Christman (2006), HIGH47 and HIGH81); or because Christman (2006) reported few plants (1 to 5) and aerial photos from 2008 showed little or no suitable habitat remaining (3 occurrences, FNAI EOR 95, plus two from Christman [2006], HIGHT10, and HIGHT23); or because plants were not observed when the site was surveyed by Christman (2006), but aerial photos from 2008 showed a significant amount of suitable habitat remaining (5 occurrences, FNAI EOR 23, 24, 63, 98, and 103). Fifteen unprotected occurrences were ranked as ‘known extirpated’ because scrub blazingstar was not observed when the site was surveyed by Christman (2006) and were either in scrubs he considered 'lost' (10 occurrences, FNAI EOR 18, 22, 64, 71, 79, 92, and 93, plus three from Christman [2006], HIGH68, HIGHT36, and POLK79) or the site where they were mapped contained little or no suitable habitat in 2008 aerial photos (5 occurrences, FNAI EOR 20, 28, 46, 70, and 74).

In summary, out of 125 occurrences evaluated, 34 are either known or presumed extirpated, while 91 are presumed extant. Of the 91 extant occurrences, 62 (68 percent) are protected on publicly owned land (54 occurrences) or private conservation land (8 occurrences) on 23 separate managed conservation areas. Twenty-nine (32 percent) of 91 occurrences are located on private property (excluding those on private conservation lands) where they have no protection from development and are threatened by lack of fire and other types of active management.

The status of each occurrence, as far as it is known, is summarized in Table 1. Occurrences are summarized by county in Table 2.

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

Dolan et al. (1999) conducted a genetic analysis of three endemic Florida scrub herbs, including scrub blazingstar, and all three species showed low levels of genetic variation. Variation was comparable to or lower than those generally reported for rare plants with restricted geographic ranges. Scrub blazingstar had more than twice the expected heterozygosity of the other two

species in the study, and a greater proportion of genetic variation was found within than among populations indicating that substantial gene flow occurs. The data also suggest that inbreeding is low (Dolan et al. 1999). These findings are consistent with a self-incompatible, butterfly-pollinated plant such as scrub blazingstar, with relatively stable population dynamics, a long lifespan, and the ability to resprout following fire.

Scrub blazingstar colonizes anthropogenic sites within its natural habitat, such as fire lanes and roadsides (Menges et al. 2009). Since roadside populations may experience different selective pressures than populations in scrub habitat, it has been suggested that selection for traits suited to roadsides may ill-equip plants for survival in their native scrub habitat (Quintana-Ascencio et al. 2007). However, Weekley et al. (2008a) compared germination rates of seeds produced by plants in both roadside and scrub and found no significant difference in germination rates across a range of field conditions.

Scrub blazingstar, with scattered, low-density populations and the requirement of cross-pollination, may be sensitive to the negative effects of inbreeding from decreases in population size and pollinator-mediated gene flow, due to loss and fragmentation of habitat (Dolan et al. 1999). As such, the preservation of large contiguous tracts of scrub should offer the best chances of successful conservation.

c. Taxonomic classification or changes in nomenclature:

The taxonomy of scrub blazingstar is reviewed in the MSRP (Service 1999). The taxonomy of scrub blazingstar has not been revised since the species was listed. *Liatris ohlingerae* is recognized as a valid taxon by the Integrated Taxonomic Information System (ITIS) (ITIS 2010). This taxonomy follows the Guide to the Vascular Plants, Second Edition (Wunderlin and Hansen 2003).

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

Scrub blazingstar is known in the U.S. only from Florida. It occurs sparsely over the landscape and is strongly associated with rosemary scrub. Connectivity between the islands of habitat is very important to this species due to its cross-pollination needs (Dolan et al. 1999). The distribution and abundance of scrub blazingstar has undoubtedly decreased over the past 100 years as the central Florida has been transformed by commercial and residential development. Large-scale destruction of upland habitat on the LWR began in the 1880s. Many sites potentially supporting scrub blazingstar were converted to citrus production in the early decades of the 20th century.

Thus, habitat loss has played a large role in the current abundance and distribution of scrub blazingstar.

In the South Florida MSRP, the Service (1999) stated that scrub blazingstar had been extirpated at TNC's Tiger Creek Preserve. TNC later reported that the earlier record was in error, and the species does not occur at Tiger Creek Preserve, which does not support any areas of rosemary scrub (B. Pace, TNC, pers. comm. 2005).

Since regular monitoring programs are not in place at every site that supports scrub blazingstar, it is possible that localized extirpations have occurred. The evaluation conducted for this review suggests that as many as 34 historic occurrences are extirpated, mostly from loss of habitat to development.

While many occurrences remain unprotected on private land, occurrences are protected throughout the species range, as are populations at the north, south, east, and west edges of the range. There is no distinct geographic gap in protection (FNAI 2009).

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

A detailed discussion of the habitat of scrub blazingstar is provided in the MSRP (Service 1999). Important features are summarized below.

Weekley (et al. 2008b) estimated that approximately 85 percent of upland habitat on the LWR was destroyed by 2006, mainly to agriculture, ranching, commercial and residential development. About 11 percent of the Lake Wales Ridge is currently protected in conservation lands Weekley et al. (2008b).

Scrub blazingstar occurs in rosemary scrub and scrubby flatwoods, fire-dependent plant communities with differing species composition, structure, and fire regime. Historical fire return intervals in rosemary scrub probably ranged from 20 to 100 years, while scrubby flatwoods have a 5 to 20 years average fire return interval (Menges 1999). To maximize regeneration of gap specialist endemic herbs, Menges (2007) recommended fire return intervals of 5 to 12 years for oak-dominated scrub to 15 to 30 years for rosemary scrub. In both communities, gaps close with time-since-fire, but gaps are far more persistent in rosemary scrub due to the xeric conditions, allelopathic effects of Florida rosemary, and a predominance of species that do not resprout following fire (Menges and Hawkes 1998). Fire has been suppressed over large parts of the LWR for the last 70 years, allowing these habitats to become densely overgrown. While scrub blazingstar is more tolerant of shading than many other scrub endemic herbs and apparently does not decline as rapidly with time-since-fire, eventually the light levels beneath the dense shrub canopies of long-unburned scrub become unsuitable to allow regeneration (Herndon 1999). At the same time, the lack of shade immediately after a fire

may cause a delay in seedling recruitment for scrub blazingstar. This may be especially important for sparsely-vegetated rosemary scrubs, where open conditions prevail for several years following fire (Menges and Hawkes 1998).

In managed areas, prescribed fire is the primary tool used to manage scrub habitats and restore suitable conditions for endemic herbs. However, there is a backlog of long-unburned habitat within conservation areas on the Lake Wales Ridge. For example, 16 of the 63 Lake Wales Ridge conservation sites have not received any fire management since they were acquired. TNC's fire history database showed that in 2008 (the last year for which data analysis was completed) 123,484 acres are within the recommended fire return interval and 38,359 acres are outside the recommended fire return interval (TNC 2010b). The fire management condition of most privately owned parcels is unknown. Fire management is highly unlikely on private properties unless they are designated conservation areas. Undeveloped private sites are likely to be overgrown due to fire suppression (Turner et al. 2006).

f. Other:

Land Acquisition

In the mid 1980s, there were only four large conservation sites on the Lake Wales Ridge. In 1991, the state launched a $3 billion land acquisition program, Preservation 2000. Its successor, Florida Forever, was launched ten years later. Since 1992, the State of Florida has spent over $68 million to acquire nearly 25,000 acres of land on the LWR, with plans to acquire an additional 25,000 acres (FDEP 2008). The Service established the first national wildlife refuge in the country designated primarily for plants, the LWRWNR. Particularly problematic and challenging have been the acquisition projects known as megaparcel sites, which include extensive areas of scrub habitat that were previously subdivided and sold to numerous lot owners. To date, over 14,000 such lots have been purchased for conservation within the megaparcel sites, in a checkerboard manner, but nearly as many lots remain to be bought (Turner et al. 2006).

Land acquisition to date has placed nearly half (21,597 acres, or 48.9 percent) of the remaining 44,157 acres of scrub and sandhill habitat on the LWR within protected areas. However, many species are likely to remain at great risk of extinction despite ongoing conservation efforts, primarily because even the most optimistic acquisition scenarios will protect only 7.5 percent of the original LWR habitats, most having already been destroyed (Turner et al. 2006). The protected fragments are surrounded by residential neighborhoods, citrus groves, and other anthropogenic habitats.

A recent analysis of Florida scrub conservation progress based on land acquisition included scrub blazingstar among the 36 rare species of the LWR.

Turner et al. (2006) calculated protection indices for each species based on number of locations, extent of occurrence, and area of occupancy. The overall protection index of 1.5 identified scrub blazingstar as 'endangered' in their ranking system (Turner et al. 2006).

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

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

Habitat loss on the Lake Wales Ridge is detailed in the MSRP (Service 1999). Current threats to the habitat of scrub blazingstar include habitat loss from development and habitat modification due to long-term fire suppression and damage from off-road vehicles (ORVs). On private lands, scrub blazingstar is threatened primarily by habitat loss to development, and secondarily by fire suppression. Twenty-nine of 91 extant occurrences (32 percent) are located on private property where they have no protection from development and prescribed fire is unlikely (FNAI 2009, Turner et al. 2006). The current status of most of these occurrences is unknown, and most have not been surveyed since 2005. On public lands, scrub blazingstar is protected from development, but is threatened by inadequate fire management at some sites. These threats are discussed below.

Development

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

Fire suppression and inadequate fire management

As discussed above, fire is necessary to maintain the habitats that support scrub blazingstar. Fire suppression started on a regional scale on the Lake Wales Ridge about 70 years ago. Due to the extent of residential and agricultural development on the Lake Wales Ridge, fire has all but disappeared from the region as a widespread, natural phenomenon.

In managed areas, prescribed fire is needed to manage scrub habitats and restore suitable conditions for scrub blazingstar. Prescribed fire has not been implemented at numerous sites since they were acquired for conservation (TNC 2010b). Because there is little chance of prescribed fire being implemented to maintain habitats on private land, imperiled species on unprotected sites will almost certainly disappear over time (Turner et al. 2006). Scrub blazingstar does not maintain a persistent seed bank (Weekley et al. 2008a); therefore, recovery is unlikely for populations that have been extirpated for years due to fire suppression.

Land managers also use mechanical treatments such as mowing, roller-chopping, and logging to manage scrub habitats. The long-term effects on scrub vegetation dynamics, and the response of species to these novel disturbances are not well-understood (Menges and Gordon 2010). Mechanical treatments cause soil compaction, soil disturbance, and may increase invasion by non-native plant species (Menges et al. 2008). Menges and Gordon (2010) recommend that mechanical treatments be used only when prescribed fire is precluded because of a site's proximity to the urban interface, or perhaps in the initial phases of restoring severely overgrown sites to a natural fire condition (i.e. as a complimentary treatment to accelerate the restoration process rather than a surrogate for fire).

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

Overutilization was not considered a threat to scrub blazingstar at the time of listing. The genus *Liatris*, especially *L. spicata*, is economically important as a source of garden perennials and cut flowers. Though easily grown from seed, there is no known demand for scrub blazingstar in the horticultural trade (Service 1999). Since listing, there has been no evidence to suggest that overutilization, for any purpose, is a threat to scrub blazingstar.

c. Disease or predation:

Disease or predation was not considered a threat to scrub blazingstar at the time of listing. No diseases have been reported to affect scrub blazingstar. A substantial amount of research has been conducted to determine the effects of herbivory on scrub blazingstar. An endemic grasshopper (*Melanoplus tequestae*) has been frequently observed on scrub blazingstar and may be an

important herbivore. White-tailed deer (*Odocoileus virginianus*) and eastern cottontail (*Sylvilagus floridanus*) are also suspected of grazing on scrub blazingstar (Herndon 1999). Kettenring et al. (2009) identified deer as the primary vertebrate herbivore.

Herbivory is a limiting factor for flower production (Herndon 1999, Kettenring et al. 2009). Kettenring et al. (2009) determined that 62 percent of plants in their study were topped one or more times. Topping reduces the size and reproductive output of plants. The number of fully developed achenes (seeds) was 47 percent lower in topped plants than un-topped plants. They estimated that vertebrate topping resulted in a 30 percent of mean fecundity across all sites (Kettenring et al. 2009).

In addition to losses due to vertebrate herbivory, 30 percent of all buds are destroyed by boring arthropods. In the Herndon (1999) study, 42 percent of buds failed to reach maturity. Of those, 30 percent was due to herbivory and the remaining 12 percent had an unknown cause. Arthropod seed predators may also destroy seeds post-dispersal, especially in areas with thick litter accumulation (Weekley et al. 2008a).

While herbivory was frequent and had measureable effects in terms of reduced fecundity, Kettenring et al. (2009) concluded that vertebrate herbivory may not be a threat to scrub blazingstar because it is a relatively long-lived plant with high annual survival and stable populations (Menges et al. 2009). However, they also state that 'reduced seed production due to vertebrate herbivory may compromise the long-term persistence of some populations." Weekley et al. (2008a) stated that, "despite vertebrate herbivory on flowering stems and invertebrate herbivory of developing seed heads, most populations produce an abundant seed crop annually." Rather than herbivory, they hypothesize that low recruitment is a more limiting factor for the species. More research is needed to determine barriers to recruitment and multi-year patterns of arthropod and vertebrate herbivores. Deer overpopulation is a common phenomenon in Florida and elsewhere because of suburbanization, a loss of predators, and a reduction in hunting pressure. If future studies demonstrate that herbivores reduce population size and increase the extinction risk of scrub blazingstar populations, aggressive management of overabundant herbivore populations may be necessary (Kettenring et al. 2009).

d. Inadequacy of existing regulatory mechanisms:

Scrub blazingstar is listed as endangered by the State of Florida on the Regulated Plant Index (Florida Department of Agriculture and Consumer Services Rule 5B-40). This law regulates the taking, transport, and sale of listed plants on State and Private lands. It does not prohibit private property owners from destroying populations of listed plants on their property nor require landowners to manage habitats to maintain populations. Existing Federal and State regulations prohibit the removal or destruction of listed

plant species on public lands. However, such regulations afford no protection to listed plants on private lands. The ESA only protects populations from disturbances on Federal lands or when a 'Federal nexus' is involved for other lands, meaning any action that is authorized (e.g. permitted), funded or carried out by a Federal agency. In addition, State regulations are less stringent than Federal regulations toward land management practices that may adversely affect populations of listed plants on private land. Existing regulatory mechanisms are inadequate to protect scrub blazingstar.

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

Small Populations

Small population size can be an issue for self-incompatible plant species such as scrub blazingstar. If compatible mates are not available within the effective dispersal distance of pollinators, inbreeding depression and low seed set may result (Dolan et al. 1999).

Off-road vehicles (ORVs)

ORV impacts have been observed on natural areas on the Lake Wales Ridge (Schultz et al. 1999) and throughout central Florida. Off-road vehicles crush, uproot and tear plants as they drive over them. Roads facilitate and intensify illegal collection of rare plants and serve as corridors for exotic plant invasion. Overall, the Service considers ORV disturbance to be a significant threat to scrub blazingstar, especially on unprotected sites.

Non-native plant species

Bahia grass (*Paspalum notatum*), cogon grass (*Imperata cylindrica*), and Natal grass (*Rhynchelytrum repens*) invade scrub habitats and have negative effects through direct competition and by altering fire behavior. These species are reported at numerous sites supporting scrub blazingstar (Schultz et al. 1999).

Ex situ measures

Standard *ex situ* conservation measures are in place for scrub blazingstar. Bok Tower Gardens maintains living plants as part of the Center for Plant Conservation National Collection of Endangered Species. Seeds produced in cultivation in 2007 are in ambient storage at Bok Tower Gardens. Approximately 1,600 seeds collected in 1990 were provided to the National Center for Genetic Resources Preservation (NCGRP) in Fort Collins, Colorado (Bok Tower Gardens, unpubl. data, 2009b). Until the longevity of seeds beyond 5 years is determined, restocking banks with fresh seeds every 5 years may be necessary to ensure viability of stored seed.

D. Synthesis

Scrub blazingstar is a long-lived, perennial herb occurring in rosemary scrub and scrubby flatwoods on the Lake Wales Ridge, in Polk and Highlands County, Florida. It prefers sites that are open or have widely scattered shrubs that provide the semi-shade microsites most favorable for recruitment and reproduction. ABS long-term monitoring data indicate that populations are stable, but have low rates of seedling recruitment and protracted maturation**.** Low recruitment is not due to low seed production or low germination rates, both of which are high compared with other scrub endemics. Topping of plants by vertebrate herbivores (mainly deer and perhaps rabbits) causes reduced fecundity, but additional research is needed to determine the level of threat posed by herbivores. Fire is critical to maintaining the habitat for scrub blazingstar, but the species is less sensitive to fire return intervals than other scrub endemics. Populations can persist on long-unburned sites, especially along fire lanes.

Large areas of scrub have been converted to pine plantations, citrus groves, pastures, and residential or commercial development over the past 50 years. Of 125 occurrence records evaluated in this review, 34 are either known or presumed extirpated, and 91 are presumed extant. Twenty-nine of 91 extant occurrences (32 percent) are located on private property where they have no protection. Occurrences on private, unprotected sites are threatened by habitat loss to development and lack of fire.

The acquisition of scrub sites for conservation has greatly benefited scrub blazingstar, which is now protected within 31 conservation areas. However, none of the recovery criteria identified in the MSRP have been fully achieved to date. Inadequate fire management threatens some occurrences on public lands. Twenty-three of the 62 occurrences (42 percent) on public land have yet to be managed with fire. Monitoring programs are ongoing at several sites, but no PVA has been produced. Protected occurrences adequately represent species throughout its range, but uncertainty remains as to the number and size of populations required to ensure persistence. For these reasons, scrub blazingstar continues to meet the definition of endangered under the ESA.

III. RESULTS

A. Recommended Classification:

__X__ **No change is needed**

B. New Recovery Priority Number _N/A_

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

- Acquire private sites with existing populations from willing sellers.
- Work with State, Federal, and non-profit partners to ensure adequate fire management is achieved at sites that support scrub blazingstar.
- Work with private landowners to conserve extant populations.
- Determine the factors responsible for low seedling recruitment.
- Evaluate the overall threat posed by herbivory.

- Ensure representation of scrub blazingstar at the National Center for Genetic Resources Preservation in Fort Collins, Colorado.
- Continue demographic monitoring at multiple sites and produce a PVA.

V. REFERENCES

Bok Tower Gardens. 2009a. Monitoring data for *Liatris ohlingerae*. Unpublished raw data.

Bok Tower Gardens. 2009b. *Liatris ohlingerae* ex situ holdings at Bok Tower Garden. Unpublished raw data.

Boughton, E.A., P.F. Quintana-Ascencio, E.S. Menges, and R.K. Boughton. 2006. Association of ecotones with relative elevation and fire in an upland Florida landscape. Journal of Vegetation Science 17:361–368.

Christman, S.P. 1988. Endemism and Florida's interior sand pine scrubs. Final Project Report Number GFC-84-101. Submitted to Florida Game and Fresh Water Fish Commission, Division of Wildlife, Nongame Wildlife Section, Tallahassee, Florida.

Christman, S.P. 2006. Distribution and status of three endemic Lake Wales Ridge scrub plants. Final Report for Cooperative Agreement No. 401813J035, Part 2: Rangewide Status Surveys for *Polygonella myriophylla, Polygonella basiramia* and *Liatris ohlingerae*. Final report submitted to U.S. Fish and Wildlife Service. Vero Beach, Florida.

Dolan, R.W., R. Yahr, E.S. Menges, and M.D. Halfhill. 1999. Conservation implications of genetic variation in three rare species endemic to Florida rosemary scrub. American Journal of Botany 86:1556–1562.

Evans, M.E.K., E.S. Menges, and D.R. Gordon. 2003. Reproductive biology of three sympatric endangered plants endemic to Florida scrub. Biological Conservation 111: 235–245.

Florida Department of Environmental Protection. 2008. The Florida Forever five-year plan, September 2008 report. Board of Trustees of the Internal Improvement Trust Fund of the State of Florida. Tallahassee, Florida.

Florida Natural Areas Inventory. 2009. Element population records for *Liatris ohlingerae*. Florida Natural Areas Inventory. Tallahassee, Florida.

Herndon, A. 1999. Life history of *Liatris ohlingerae* (Asteraceae), an endangered plant endemic to the Lake Wales Ridge, Florida. Final report, project number NG91- 016, Florida Game and Fresh Water Fish Commission. Tallahassee, Florida.

Hunter, M.E. and E.S. Menges. 2002. Allelopathic effects and root distribution of *Ceratiola ericoides* (Empetreace) on seven rosemary scrub species. Amer. J. Bot. 89: 1113–1118.

Integrated Taxonomic Information System. 2010. Retrieved April 8, 2010 from ITIS website: http://www.itis.gov/servlet/SingleRpt.

Kettenring, K., C.W. Weekley and E.S. Menges. 2009. Herbivory delays flowering and reduces fecundity of Liatris ohlingerae, an endangered, endemic plant of the Florida scrub.

Journal of the Torrey Botanical Society 136: 350–362.

Menges, E.S. 1999. Ecology and conservation of Florida scrub. p. 7–22. In: Anderson, R.C., J.S. Fralish, and J. Baskin (eds.). The savanna, barrens, and rock outcrop communities of North America. Cambridge University Press, Cambridge, Massachusetts.

Menges, E.S. 2007. Integrating demography and fire management: an example from Florida Scrub. Australian Journal of Botany 55: 261-272.

Menges, E.S., and D.R. Gordon. 1996. Three levels of monitoring intensity for rare plant species. Natural Areas Journal 16: 227-237.

Menges, E.S., and D.R. Gordon. 2010. Should mechanical treatments and herbicides be used as fire surrogates to manage Florida's Uplands: A Review. Florida Scientist 73(2): 145–172.

Menges, E. S., and C. V. Hawkes. 1998. Interactive effects of fire and microhabitat on plants of Florida scrub. *Ecological Applications* 8: 935-946.

Menges, E.S. and N.M. Kohfeldt. 1995. Life history strategies of Florida scrub plants in relation to fire. Bulletin of the Torrey Botanical Club 122: 282–297.

Menges, E.S., C.W. Weekley, R.L. Pickert, and S. Hamze. 2007. Soil preferences for listed plants on the Lake Wales Ridge in Highlands County, Florida. Florida Scientist 70: 24–39.

Menges, E.S., C.W. Weekley, S.I. Hamzé, and R.L. Pickert. 2007. Soil preferences for listed plants on the Lake Wales Ridge in Highlands County, Florida. Florida Scientist 70: 24-39.

Menges, E.S., C.W. Weekley, and M.A. Rickey. 2008. Sandhill restoration studies and experimental introduction of Ziziphus celata at Lake Wales Ridge National Wildlife Refuge. Annual Report to Florida Fish and Wildlife Conservation Commission, Gainesville, Florida.

Menges, E.S., C.W. Weekley, S.J. Haller, and S.A. Smith. 2009. Demographic Research on Four State-listed Lake Wales Ridge Endemic Plants. Interim report to Division of Plant Industry. Archbold Biological Station, Lake Placid, Florida.

Pace, B. 2005. Email to Dave Martin. The Nature Conservancy. Babson Park, Florida. March 27, 2005.

Quintana-Ascencio, P.F., E. Stephens, J. Navarra, M. Beg, L.M. Castro Morales, and H. McArdle. 2009. Seed germination and seedling survival of *Eryngium cuneifolium, Hypericum cumulicola, Liatris ohlingerae, Paronychia chartacea,* and *Polygonella basiramia* in native and disturbed scrub habitats Final Report to Division of Forestry. Tallahassee, Florida.

Quintana-Ascencio, P.F., C.W. Weekley, and E.S. Menges. 2007. Comparative demography of a rare species in Florida scrub and road habitats. Biological Conservation 137:263–270.

Schultz, G.E., L.G. Chafin, and S.T. Krupenevich. 1999. Rare plant species and high quality natural communities of twenty-six CARL sites in the Lake Wales Ridge Ecosystem. Florida Natural Areas Inventory, Tallahassee, Florida.

The Nature Conservancy. 2010a. The Lake Wales Ridge Fire History GIS Database (shapefile LWRFHGD2008_allfire [ESRI shapefile]). The Nature Conservancy, Lake Wales Ridge Program. Babson Park, Florida.

The Nature Conservancy. 2010b. A Decade of Dedicated Fire: Lake Wales Ridge Prescribed Fire Team. The Nature Conservancy, Lake Wales Ridge Program. Babson Park, Florida.

Turner, W.R., D.S. Wilcove, and H.M. Swain. 2006. State of the scrub: conservation progress, management responsibilities, and land acquisition priorities for imperiled species of Florida's Lake Wales Ridge. Archbold Biological Station. Lake Placid, Florida.

U.S. Fish and Wildlife Service. 1999. South Florida multi-species recovery plan. Atlanta, Georgia.

Weekley, C.W. and E.S. Menges. 2003. Species and vegetation responses to prescribed fire in a long-unburned, endemic-rich Lake Wales Ridge scrub. Journal of the Torrey Botanical Society 130: 265–282.

Weekley C.W., E.S. Menges, and R.L. Pickert. 2008b. An ecological map of Florida's Lake Wales Ridge: a new boundary delineation and an assessment of post-Columbian habitat loss. Florida Scientist 71: 45–64.

Weekley, C. W., J. Tucker, S. Valligny, and E.S. Menges. 2008a. Germination Ecology of *Liatris ohlingerae* (S.F. Blake) B.L. Rob. (Asteraceae), an Endangered Herb Endemic to Florida Scrub. Castanea 73(4): 235–250.

Wunderlin, R. P., and B. F. Hansen. 2003. Guide to the Vascular Plants of Florida, Second Edition. University Press of Florida. Gainesville, Florida.

Wunderlin, R. P., D. Richardson, and B. Hansen. 1980. Status report on *Liatris ohlingerae*. Submitted to U.S. Fish and Wildlife Service. Atlanta, Georgia.

Zwick P. D., and M.H. Carr. 2006. Florida 2060: A population distribution scenario for the state of Florida. 1000 Friends of Florida. Tallahassee, Florida.

Table 1. Summary of the Status of known scrub blazingstar occurrences (data from Christman 2006, Bok Tower Gardens unpubl. data 2009, FNAI 2009).

FNAI EOR No.	County	Site Name	Christman (2006) Site Name	Managing Agency	Status	Last Observation			
						Citation	Year	Population Estimate	Comments
Protected Occurrences									
58	Polk	Allen David Broussard Catfish Creek Preserve State Park	Catfish Creek	FDEP	extant	Christman 2006*	2005	24	
7	Highlands	Archbold Biological Station	not surveyed	ABS	extant	FNAI 2009	2000	10 to 99	
10	Highlands	Archbold Biological Station	not surveyed	ABS	extant	FNAI 2009	1979	no est.	
42	Highlands	Archbold Biological Station	Archbold Rosemary Scrubs	ABS	extant	Christman 2006*	2005	1000	
47	Highlands	Archbold Biological Station	Archbold Rosemary Scrubs	ABS	extant	Christman 2006*	2005	1000	
89	Highlands	Archbold Biological Station	Archbold South (0), Archbold Rosemary Scrubs (1000)	ABS	extant	Christman 2006*	2005	1000	
102	Highlands	Archbold Biological Station	Archbold Rosemary Scrubs	ABS	extant	Christman 2006*	2005	1000	
88	Highlands	Fisheating Creek/Smoak Groves Conservation Easement	Venus ESE Scrub	FDEP	extant	Christman 2006*	2005	100	
none	Highlands	Fisheating Creek/Smoak Groves Conservation Easement	Venus ENE Scrub	FDEP	extant	Christman 2006*	2005	20	
5	Polk	Hickory Lake Scrub County Park	Hickory Lake South Scrub	Polk Co. Env. Svcs. Dept.	extant	Christman 2006*	2005	12	
13	Highlands	Highlands Hammock State Park	Sebring Southgate Scrub, Highlands Hammock Scrub, Sebring Wolf Lake Scrub	FDEP	extant	Christman 2006*	2005	156	
19	Highlands	Highlands Hammock State Park	Sebring Southgate Scrub	FDEP	extant	Christman 2006*	2005	50	
25	Highlands	Highlands Hammock State Park	Highlands Hammock Scrub	FDEP	extant	Christman 2006*	2005	6	
36	Highlands	Highlands Ridge LWRWEA	Henscratch Rd/Miller Ave Scrub	FFWC	extant	Christman 2006*	2005	1100	
111	Highlands	Jack Creek WMA	Lake Josephine South Scrub	SFWMD	extant	Christman 2006*	2005	0	
39	Highlands	Lake June-in-Winter Scrub State Park	Lake June in Winter NW Scrub	FDEP	extant	Christman 2006*	2005	74	
40	Highlands	Lake June-in-Winter Scrub State Park	Lake June in Winter SW Scrub	FDEP	likely extirpated	Christman 2006*	2005	0	
41	Highlands	Lake June-in-Winter Scrub State Park	Tomolka Scrub	FDEP	extant	Christman 2006*	2005	179	
86	Highlands	LWRNWR Flamingo Villas	U.S. 98 South	USFWS	extant	Christman 2006*	2005	130	
100	Highlands	LWRNWR Flamingo Villas	Flamingo Villa	USFWS	extant	Christman 2006*	2005	10	

Table 1. (continued)

FNAI EOR No.	County	Site Name	Christman (2006) Site Name	Managing Agency	Status	Last Observation			
						Citation	Year	Population Estimate	Comments
14	Polk	LWRSF Arbuckle Tract	Lake Godwin South Scrub	FDOF	extant	Christman 2006*	2005	20	
15	Polk	LWRSF Arbuckle Tract	Bonnet Creek Scrub	FDOF	extant	Christman 2006*	2005	50	
17	Polk	LWRSF Arbuckle Tract	Livingston Creek Scrub	FDOF	extant	Christman 2006*	2005	0	site had recently been logged, thus 0 plants
30	Polk	LWRSF Arbuckle Tract	Lake Livingston East Scrub	FDOF	extant	Christman 2006*	2005	40	
56	Polk	LWRSF Arbuckle Tract	Alico Access Rd. East	FDOF	extant	Christman 2006*	2005	0	
57	Polk	LWRSF Arbuckle Tract	Lake David North	FDOF	extant	Christman 2006*	2005	40	
110	Polk	LWRSF Arbuckle Tract	Alico Access Road North	FDOF	extant	Christman 2006*	2005	20	
112	Polk	LWRSF Arbuckle Tract	not surveyed	FDOF	extant	FNAI 2009	1989	< 20	
113	Polk	LWRSF Arbuckle Tract	not surveyed	FDOF	extant	FNAI 2009	1989	< 10	
114	Polk	LWRSF Arbuckle Tract	not surveyed	FDOF	extant	FNAI 2009	1989	< 40	
115	Polk	LWRSF Arbuckle Tract	Bonnet Creek North Scrub (50), Route 64 Railroad (0)	FDOF	extant	Christman 2006*	2005	50	
54	Polk	LWRSF Heperides Tract	Flaming Arrow Scrub (0), Walk-in-the-Water Rd. Scrub (0)	FDOF	likely extirpated	Christman 2006*	2005	0	
83	Highlands	LWRWEA Apthorpe Royce Clements	Boggy Branch	FFWC	extant	Christman 2006*	2005	5	
104	Highlands	LWRWEA Apthorpe Royce Clements	Grassy Creek East	FFWC	extant	Christman 2006*	2005	10	
none	Highlands	LWRWEA Apthorpe Royce Clements	Lake Apthorpe East	FFWC	extant	Christman 2006*	2005	3	
52	Highlands	LWRWEA Carter Creek	Grassy Pond NE Scrub	FFWC	extant	Christman 2006*	2005	12	
73	Highlands	LWRWEA Carter Creek	Bonnet Lake East	FFWC	extant	Christman 2006*	2005	12	
116	Highlands	LWRWEA Carter Creek	Bonnet Lake East	FFWC	extant	Christman 2006*	2005	12	
117	Highlands	LWRWEA Carter Creek	Carter Creek West	FFWC	extant	Christman 2006*	2005	120	
none	Highlands	LWRWEA Carter Creek	Carter Creek South Scrub	FFWC	extant	Christman 2006*	2005	5	
62	Polk	LWRWEA Crooked Lake West	Crooked Lake Scrub	FFWC	extant	Christman 2006*	2005	31	
43	Highlands	LWRWEA Gould Road	Horn Road Scrub, Gould Road Scrub	FFWC	extant	Christman 2006*	2005	860	
33	Highlands	LWRWEA Henscratch Road	Lake Josephine South Scrub	FFWC	likely extirpated	Christman 2006*	2005	0	
78	Highlands	LWRWEA Henscratch Road	Henscratch Road East Scrub	FFWC	extant	Christman 2006*	2005	2	
106	Highlands	LWRWEA Henscratch Road	Josephine Creek SW US27	FFWC	likely extirpated	Christman 2006*	2005	0	mostly developed
37	Highlands	LWRWEA Highlands Ridge	Lake Hill East Scrub	FFWC	extant	Christman 2006*	2005	300	
38	Highlands	LWRWEA Highlands Ridge	Lake Hill West Scrub	FFWC	extant	Christman 2006*	2005	1100	

Table 1. (continued)

FNAI EOR No.	County	Site Name	Christman (2006) Site Name	Managing Agency	Status	Last Observation			
						Citation	Year	Population Estimate	Comments
77	Highlands	LWRWEA Highlands	Crews Lake North	FFWC	extant	Christman	2005	72	
81	Highlands	LWRWEA Highlands Ridge	Lake Hill SW	FFWC	extant	Christman 2006*	2005	500	ORV damage present
108	Highlands	LWRWEA Highlands Ridge	Leisure Lakes West Scrub	FFWC	extant	Christman 2006*	2005	50	
none	Highlands	LWRWEA Highlands Ridge	Leisure Lakes North Scrub	FFWC	extant	Christman 2006*	2005	130	ORV damage evident
51	Highlands	LWRWEA Holmes Avenue	Holmes Avenue East Scrub	FFWC	extant	Christman 2006*	2005	25	
107	Highlands	LWRWEA Holmes Avenue	Holmes Avenue East Scrub	FFWC	extant	Christman 2006*	2005	25	
49	Polk	LWRWEA Lake Blue	Blue Lake Scrub	FFWC	extant	BTG unpubl. data 2009	2008	40	
1	Highlands	LWRWEA Lake Placid	Placid View Road North Scrub	FFWC	extant	Christman 2006*	2005	260	
47	Highlands	LWRWEA Lake Placid	Lake Placid South Shore Scrub* (0), SR70 Placid View Road Scrub*(2)	FFWC	extant	Christman 2006*	2005	2	
90	Highlands	LWRWEA Lake Placid	Placid View Road Dicerandra Scrub	FFWC	extant	Christman 2006*	2005	22	
42	Highlands	LWRWEA McJunkin	Archbold NW Scrub	FFWC	extant	Christman 2006*	2005	880	
13	Highlands	LWRWEA Silver Lake	County Line East (0), Sebring Sun N Lakes Scrub (11)	FFWC	extant	Christman 2006*	2005	11	
21	Highlands	LWRWEA Silver Lake	Sun & Lakes Silver Lake Scrub	FFWC	extant	Christman 2006*	2005	1	
55	Highlands	LWRWEA Silver Lake	Avon Park Airport Scrub	FFWC	extant	Christman 2006*	2005	250	
11	Polk	LWRWEA Sun Ray Hickory Lake South	not surveyed	FFWC	extant	FNAI 2009	1961	"infrequent"	
27	Polk	LWRWEA Sun Ray Hickory Lake South	Sun Ray South Scrub	FFWC	extant	Christman 2006*	2005	26	
99	Polk	LWRWEA Sun Ray Hickory Lake South	Lake Streety NE Scrub	FFWC	extant	Christman 2006*	2005	13	
12	Polk	Saddle Blanket Scrub Preserve	Saddle Blanket Lakes	TNC	extant	Christman 2006*	2005	91	
101	Polk	Sun Ray Scrub	Sun Ray Water Tower Scrub	TNC	extant	Christman 2006*	2005	50	
13	Highlands	The Preserve	not surveyed	Highlands Co. Parks and Rec.	erroneous record	FNAI 2009	1966	none	
Unprotected Occurrences									
4	Highlands	private property	Hendrie Ranch North Scrubs, Hendrie Ranch Middle Scrub	n/a	extant	Christman 2006*	2005	120	
85	Highlands	private property	Venus NE Two Mile Scrub	n/a	extant	Christman 2006*	2005	60	
87	Highlands	private property	Hendrie Ranch West Scrub	n/a	extant	Christman 2006*	2005	5	
6	Highlands	private property	not surveyed	n/a	extant	BTG unpubl. data 2009	2008	12 to 15	

Table 1. (continued)

FNAI EOR No.	County	Site Name	Christman (2006) Site Name	Managing Agency	Status	Last Observation			
						Citation	Year	Population Estimate	Comments
2	Highlands	private property	Little Red Water Lake Scrub	n/a	likely extirpated	Christman 2006*	2005	10	lost scrub; developed residential
18	Highlands	private property	Lake Denton Scrub	n/a	known extirpated	Christman 2006*	2005	0	lost scrub; developed residential
20	Highlands	private property	Golf Hammock Scrub	n/a	known extirpated	Christman 2006*	2005	0	developed residential
22	Highlands	private property	Josephine Creek SE US27	n/a	known extirpated	BTG unpubl. data 2009	2008	0	lost scrub; converted to citrus grove
23	Highlands	private property	Sun & Lakes Holiday Inn Scrub	n/a	likely extirpated	Christman 2006*	2005	0	
24	Highlands	private property	Schumacher Road Scrub	n/a	likely extirpated	Christman 2006*	2005	0	
31	Highlands	private property	Sebring Wolf Lake Scrub	n/a	extant	Christman 2006*	2005	100	
32	Highlands	private property	Josephine Road Scrub	n/a	extant	Christman 2006*	2005	6	
34	Highlands	private property	Jackson Creek - Skipper Road	n/a	extant	Christman 2006*	2005	4	
35	Highlands	private property	Henscratch Rd/Miller Ave Scrub	n/a	extant	Christman 2006*	2005	1100	
45	Highlands	private property	US27 & Bald Hill Road Scrub	n/a	extant	Christman 2006*	2005	50	
46	Highlands	private property	Venus Scrub	n/a	known extirpated	Christman 2006*	2005	0	converted to pasture
53	Highlands	private property	Lakemont Scrub	n/a	extant	Christman 2006*	2005	3	
59	Highlands	private property	Avon Park C Scrub	n/a	extant	Christman 2006*	2005	20	
60	Highlands	private property	College Scrub	n/a	likely extirpated	Christman 2006*	2005	15	lost scrub; developed residential
61	Highlands	private property	Avon Park Lakes	n/a	extant	Christman 2006*	2005	800	in unaquired portion of FF Avon Park Lakes
64	Highlands	private property	Bear Hollow Scrub	n/a	known extirpated	Christman 2006*	2005	0	lost scrub; citrus groves
65	Highlands	private property	Grassy Lake SE Scrub (20), Highlands Ave. Scrub (25)	n/a	extant	Christman 2006*	2005	45	in unacquired portion of FF SunN'Lakes South
67	Highlands	private property	Lake Chilton	n/a	extant	Christman 2006*	2005	71	
69	Highlands	private property	Old Bombing Range Road Scrub	n/a	extant	Christman 2006*	2005	200	
70	Highlands	private property	Lake Jackson NW	n/a	known extirpated	Christman 2006*	2005	0	extremely overgrown
71	Highlands	private property	Bonnet Lake South Scrub	n/a	known extirpated	Christman 2006*	2005	0	lost scrub; developed residential
72	Highlands	private property	Lake Sebring South Scrub	n/a	extant	Christman 2006*	2005	4	lost scrub; developed residential
74	Highlands	private property	Hartt Road West A Scrub	n/a	known extirpated	Christman 2006*	2005	0	developed residential, remaining habitat very overgrown or scraped
75	Highlands	private property	Lake Sebring Southwest	n/a	likely extirpated	Christman 2006*	2005	3	lost scrub; developed residential, ORV track

Table 1. (continued)

FNAI EOR No.	County	Site Name	Christman (2006) Site Name	Managing Agency	Status	Last Observation			
						Citation	Year	Population Estimate	Comments
76	Highlands	private property	Lake Henry South Scrub	n/a	likely extirpated	Christman 2006*	2005	11	lost scrub; developed residential
79	Highlands	private property	Jones Gulley SE	n/a	known extirpated	Christman 2006*	2005	0	lost scrub; converted to citrus grove
80	Highlands	private property	Lake June North	n/a	likely extirpated	Christman 2006*	2005	9	lost scrub; converted to citrus groves and residential
82	Highlands	private property	Grassy Lake East Scrub	n/a	extant	Christman 2006*	2005	24	lost scrub; developed residential, rest overgrown
84	Highlands	private property	Highlands Park Estates	n/a	extant	Christman 2006*	2005	15	
93	Highlands	private property	Sebring Triangle Scrub	n/a	known extirpated	BTG unpubl. data 2009	2008	0	lost scrub; commercial development
94	Highlands	private property	Lake Charlotte East Scrub	n/a	extant	Christman 2006*	2005	4	
95	Highlands	private property	Payne Road East Scrub	n/a	likely extirpated	Christman 2006*	2005	1	converted agricultural and sparse residential; overgrown
96	Highlands	private property	Lake Wolf South	n/a	extant	Christman 2006*	2005	150	
97	Highlands	private property	Placid View Road North Scrub	n/a	extant	Christman 2006*	2005	260	
none	Highlands	private property	Lake Josephine / Josephine Creek S	n/a	extant	Christman 2006*	2005	6	just outside boundary of Jack Creek SWFMD
none	Highlands	private property	Grassy Lake East Scrub	n/a	likely extirpated	Christman 2006*	2005	24	lost scrub; mostly developed; weedy, long unburned
none	Highlands	private property	Carlton Ranch South B Scrub	n/a	known extirpated	Christman 2006*	2005	0	lost scrub; developed residential
none	Highlands	private property	Oak Street Scrub	n/a	likely extirpated	Christman 2006*	2005	147	lost scrub; now a golf course
none	Highlands	private property	Lake Letta NE	n/a	likely extirpated	Christman 2006*	2005	5	small site, extremely overgrown
none	Highlands	private property	Lake Lotela Drive	n/a	likely extirpated	Christman 2006*	2005	1	small site, extremely overgrown
none	Highlands	private property	Bruce Sherwood Cemetery	n/a	known extirpated	Christman 2006*	2005	0	lost scrub; developed residential
8	Polk	private property	Sun Ray North Scrub	n/a	extant	Christman 2006*	2005	5	
9	Polk	private property	Lake Clinch West South	n/a	extant	FNAI 2009	1961	"infrequent"	
26	Polk	private property	Sun Ray Motel & Restaurant	n/a	extant	Christman 2006*	2005	6	
28	Polk	private property	Sun Ray Northeast	n/a	known extirpated	Christman 2006*	2005	0	scraped
29	Polk	private property	Sun Ray North Scrub	n/a	extant	Christman 2006*	2005	5	
48	Polk	private property	Sun Ray Water Tower Scrub	n/a	extant	Christman 2006*	2005	50	ORV damage evident

Table 1. (continued)

FNAI EOR No.	County	Site Name	Christman (2006) Site Name	Managing Agency	Status	Last Observation			
						Citation	Year	Population Estimate	Comments
63	Polk	private property	Lake Clinch West South	n/a	likely extirpated	Christman 2006*	2005	0	
68	Polk	private property	Hesperides West	n/a	extant	Christman 2006*	2005	50	in unacquired portion of FF Hesperides West
91	Polk	private property	Trout Lake North Scrub	n/a	extant	Christman 2006*	2005	35	in unacquired portion of FF Trout Lake
92	Polk	private property	Pittsburg Scrubs	n/a	known extirpated	Christman 2006*	2005	0	lost scrub; converted to citrus grove
98	Polk	private property	Lake Aurora SE Scrub	n/a	likely extirpated	Christman 2006*	2005	0	sparse residential; overgrown
103	Polk	private property	Sun Ray East	n/a	likely extirpated	Christman 2006*	2005	0	in unacquired portion of Sun Ray Hickory Lake South
none	Polk	private property	Lake Clinch West North	n/a	known extirpated	Christman 2006*	2005	0	lost scrub; developed as an RV park

ABS Archbold Biological Station
BTG Bok Tower Gardens
FDEP Florida Department of Environmental Protection
FDOF Florida Division of Forestry
FFWC Florida Fish and Wildlife Commission
LWRNWR Lake Wales Ridge National Wildlife Refuge
LWRSF Lake Wales Ridge State Forest
LWRWEA Lake Wales Ridge Wildlife and Environmental Area
SWFWMD South Florida Water Management District
TNC The Nature Conservancy
USFWS U.S. Fish and Wildlife Service
None occurrence was not in FNAI 2009
* Christman 2006 is based on surveys conducted in 2004 to 2005

Table 2. Occurrences by County (data from Christman 2006, Bok Tower Gardens unpubl. data 2009, FNAI 2009).

County	Extant		Extirpated		Total
	Protected	Unprotected	Protected	Unprotected	
Polk	20	7	1	6	34
Highlands	42	22	3	24	91
Total	**62**	**29**	**4**	**30**	**125**

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW OF SCRUB BLAZINGSTAR (*Liatris ohlingerae*)

Current Classification Endangered
Recommendation resulting from the 5-Year Review

____ **Downlist to Threatened**
____ **Uplist to Endangered**
____ **Delist**
_X_ **No change is needed**

Review Conducted By David Bender, Botanist

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve _____ Date 6/11/10

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

REGIONAL OFFICE APPROVAL:

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

Acting
Lead Regional Director, Fish and Wildlife Service

Approve Aaron L Valenta Date 8-16-10

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

Summary of peer review for the 5-year review of scrub blazingstar *(Liatris ohlingerae)*

A. Peer Review Method: The Service conducted peer review. Three peer reviewers were selected by the Service. Individual responses were requested and received from each of the peer reviewers.

B. Peer Review Charge: See attached guidance.

C. Summary of Peer Review Comments/Report: The reviewers found the 5-year review comprehensive and all agreed with the main conclusions of the review.

A reviewer stated that the status review had included all of the best available information on the species and he endorsed the conclusions made in the review. He emphasized that further long-term studies are needed to strengthen our understanding of the viability of populations. He also recommended further research on the interaction of this species with diseases, predators, and herbivores.

A second reviewer stated that the review was thorough and that the information presented would be helpful to land managers and conservationists.

A third reviewer (actually a team of two staff from Bok Tower Gardens) stated that the review contained the most current and accurate information available on scrub blazingstar, and had no other comments.

D. Response to Peer Review:
In response to the peer review comments, the Service incorporated additional research needs into the Recommendations section of the Review. No other changes were needed.

Guidance for Peer Reviewers of Five-Year Status Reviews

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

March 27, 2009

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

Peer reviewers should:

1. Review all materials provided by the Service.

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

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

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

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

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

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