

**Scrub blazing star
(*Liatris ohlingerae*)**

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



Photo by David Bender, U.S. Fish and Wildlife Service

September 2021

**U.S. Fish and Wildlife Service
South Atlantic-Gulf Region
Florida Ecological Services Field Office
Vero Beach, Florida**

5-YEAR REVIEW

Scrub Blazing Star (*Liatris ohlingerae*)

I. GENERAL INFORMATION

A. Methodology used to complete the review: In conducting this 5-year review, we relied on the best available information pertaining to historical and contemporary distributions, life histories, genetics, habitats, and threats of this species. This review includes information from the previous 5-year review (U.S. Fish and Wildlife Service [Service] 2010) that is still applicable to the species, with updated or new information incorporated, as appropriate. We announced initiation of this review and requested information in a published *Federal Register* notice with a 60-day comment period in 2019 (84 FR 28850). We received one public comment during the open comment period. We evaluated and incorporated the comment as appropriate in this review. We used a variety of information resources, including monitoring reports, surveys, and other scientific and management information. Specific sources included: The final rule (54 FR 31190; Service 1989) listing this plant under the Endangered Species Act of 1973, as amended (ESA), the Recovery Plan (Service 1999), the last 5-year review (Service 2010), the recovery plan amendment (Service 2019), peer reviewed scientific publications, and unpublished field observations by Federal, State, and other experienced biologists. The Service contracted this review to an Archbold Biological Station (ABS) plant ecologist and finalized by the lead recovery biologist for scrub blazing star in the Florida Ecological Services Field Office (FESFO), Vero Beach. Literature and documents used for this 5-year review are on file at the FESFO. All recommendations resulting from this review are a result of thoroughly reviewing the best available information on scrub blazing star. The Service did not seek additional peer review for this updated 5-year review.

B. Reviewers

Lead Region: South Atlantic-Gulf Region, Carrie Straight, (404) 679-7226

Lead Field Office: FESFO, Vero Beach, Heather Hitt, Heather.Hitt@fws.gov, (772) 469-4267

C. Background

1. Federal Register Notice citation announcing initiation of this review: June 20, 2019, 84 FR 28850.

2. Listing history

Original Listing

Federal Register Notice: 54 FR 31190

Federal Register Notice date: July 27, 1989

Effective listing date: August 28, 1989

Entity listed: Species

Classification: Endangered

3. **Associated rulemakings:** There are no associated rulemakings for this species.
4. **Review History:** Each year, the Service reviews and updates listed species information to benefit the required Recovery Report to Congress. Through 2013, we performed a yearly recovery data call. The last review conducted in 2010 showed this species as uncertain with no change recommended to the species' status due to the potential loss of unprotected populations and an ongoing high level of threats.

Recovery Plan: 1999

Recovery Plan Amendment: 2019

Previous Five-Year Reviews: 1991 and 2010, both reviews recommended no change in status for the species.

5. **Species' Recovery Priority Number at start of review (48 FR 43098): 2**

Degree of Threat: High

Recovery Potential: High

Taxonomy: Species

6. **Recovery Plan or Outline:**

Name of plan: South Florida Multi-Species Recovery Plan (MSRP) (Service 1999)

Date issued: May 18, 1999

Date of recovery plan amendment: September 24, 2019 (Service 2019)

Dates of previous plans:

January 29, 1990 (Recovery Plan for Eleven Florida Scrub Plant Species; original plan) (Service 1990)

June 20, 1996 (Recovery Plan for Nineteen Florida Scrub and High Pineland Plant Species) (Service 1996)

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 ESA 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 DPSs to only vertebrate species of fish and wildlife. Because the species under review is a plant, the DPS policy is not applicable.

B. Recovery Criteria

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

2. Adequacy of recovery criteria.

- a. Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat? Yes**
- b. Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)? Yes**

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 recovery criteria, as presented in the 2019 amendment to the 1999 recovery plan, are broken down into three criteria ([1-3] in bold below). These criteria address listing factors A) the present or threatened destruction, modification, or curtailment of its habitat or range; D) inadequacy of existing regulatory mechanisms; and E) other natural or manmade factors affecting its survival. Factors B (overutilization) and C (disease and predation) are not relevant to this species.

Scrub blazing star will be considered for delisting when:

[1] At least 40 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes.

This criterion has not been met. Scrub blazing star is not being monitored at the scale needed to consider whether 40 populations are exhibiting a stable or increasing trend. Detailed demographic data has only been collected at a portion of 3 populations (Menges et al. 2018; Rosner-Katz 2020); therefore, information on natural recruitment and age distribution is lacking for almost all populations and trends cannot be determined. For the few populations that have demographic data available, a population viability analysis (PVA) showed that this species has relatively stable population dynamics compared to many other scrub endemic plants (Herndon 1999; Tye et al. 2016). We estimated the status of populations in Table 1 based on intermittent abundance data, if available with at least one estimate within the last 5 years, and land managers or researchers familiar with the populations. Currently, there are an estimated 45 extant populations, though most are of unknown status due to lack of recent surveys, and 25 known or presumed extirpated populations (Table 1; Christman 2006; Service 2010; Menges et al. 2018; Rosner-Katz 2020; Florida Natural Areas Inventory [FNAI] 2021). Only 6 populations are considered stable, 7 are estimated to be declining, and 32 have an unknown status due to lack of recent survey data (30 populations) or being recently discovered have only one survey event reported (2 populations) (Table 1). Twelve (12) of the extant populations have been ranked by FNAI in the last 5 years for estimated viability, or probability of persistence. Of these 4 ranked as excellent or good (AB), 3 ranked as good (B), 4 ranked as good or fair (BC), and 1 ranked as fair (C) (Table 1; NatureServe 2002; FNAI 2021).

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Table 1: Summary of the status of the extant and extirpated scrub blazing star populations. Abundance data are difficult to compare to previous years due to incomplete/opportunistic surveys and gaps in survey years; therefore, only the most recent population estimate is included in this table and the status reflects the best estimates based on intermittent survey data and information from land managers and researchers familiar with the populations. EO = Element Occurrence, FNAI Rank = Estimated viability ranked by Florida Natural Areas Inventory (only reported for populations ranked within 5 years), LWRSF = Lake Wales Ridge State Forest, LWRWEA = Lake Wales Ridge Wildlife and Environmental Area

EO Number	Population Name	County	Ownership	Last Observation	Most Recent Population Estimate	Status (FNAI Rank)
49	LWRWEA Blue Lake Scrub	Polk	State	2012 ^a	30	Unknown
58	Allen David Broussard Catfish Creek Preserve State Park	Polk	State	2012 ^a	67	Unknown
54 (+68)	LWRSF Hesperides Tract	Polk	State	2012 ^a	31	Unknown
98	LWRSF Hesperides Tract	Polk	State	2012 ^a	6	Unknown
62	Crooked Lake West	Polk	County/Private	2005 ^b	31	Known Extirpated
123*	LWRSF Walk in Water Tract	Polk	State	2014 ^a	17	Unknown
63	Lake Clinch West North	Polk	Private	2005 ^b	0	Known Extirpated
9	Lake Clinch West South	Polk	Private	1961 ^a	Unknown	Known Extirpated
27 (+8, 11, 26, 28, 29, 48, 99, 101, 103)	LWRWEA Sun Ray Scrub, Lake Livingston Conservation Bank, Sun Ray Area	Polk	State, Private Conservation, Private	2020 ^a	12	Declining
5	Hickory Lake Scrub County Park	Polk	County	2012 ^a	28	Unknown
12	Saddle Blanket Scrub Preserve, Crews Groves Conservation Easement	Polk	Private Conservation	2012 ^a	14	Unknown
14 (+110, 112, 114)	LWRSF Arbuckle Tract	Polk	State	2020 ^c	92 (GF01 only)	Stable (AB)
113	LWRSF Arbuckle Tract	Polk	State	1989 ^a	<10	Unknown
30 (+17)	LWRSF Arbuckle Tract	Polk	State	2020 ^c	99 (LC01 only)	Stable (AB)
57	LWRSF Arbuckle Tract	Polk	State	2016 ^a	1	Declining (BC)

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EO Number	Population Name	County	Ownership	Last Observation	Most Recent Population Estimate	Status (FNAI Rank)
92 (+91)	LWRSF Arbuckle Tract, Pittsburg Scrubs, Trout Lake North Scrub	Polk	State, Private	2010 ^a	1	Unknown
115	LWRSF Arbuckle Tract	Polk	State	2015 ^a	4	Unknown
15	LWRSF Arbuckle Tract	Highlands/ Polk	State	2012 ^a	15	Unknown
69	Old Bombing Range Scrub	Highlands	Private	2005 ^b	200	Known Extirpated
61	Avon Park Lakes	Highlands	Private	2005 ^b	800	Unknown
67	Lake Chilton	Highlands	Private	2005 ^b	71	Unknown
21 (+55)	LWRWEA Silver Lake Scrub, Avon Park Airport Scrub	Highlands	State	2020 ^a	Unknown	Unknown (AB)
60	College Scrub	Highlands	Private	2005 ^b	15	Known Extirpated
N/A	Lake Lotela Drive	Highlands	Private	2005 ^b	1	Likely Extirpated
N/A	Lake Letta NE	Highlands	Private	2005 ^b	5	Likely Extirpated
124*	LWRWEA Sun 'N Lake	Highlands	State, Private	2018 ^a	11-50	Unknown (B)
23	Sun & Lakes Holiday Inn Scrub	Highlands	Private	2005 ^b	0	Known Extirpated
24	Schumacher Road Scrub	Highlands	Private	2005 ^b	0	Known Extirpated
18	Lake Denton Scrub	Highlands	Private	2005 ^b	0	Known Extirpated
53	Lakemont Scrub	Highlands	Private	2005 ^b	3	Unknown
2	Little Red Water Lake Scrub	Highlands	Private	2005 ^b	10	Known Extirpated
71	Bonnet Lake South Scrub	Highlands	Private	2005 ^b	0	Known Extirpated
52 (+73, 74, 116, 117)	LWRWEA Carter Creek, Bonnet Lake East	Highlands	State	2018 ^a	100-314	Stable (AB)
70 (+59, 72, 74)	Sandy Gully Easement, Lake Jackson NW, Lake Sebring SW and Lake Sebring S Scrub	Highlands	Private Conservation, Private	2011 ^a	1	Unknown
N/A	Lake Jackson West	Highlands	Private	2005 ^b	20	Likely Extirpated

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EO Number	Population Name	County	Ownership	Last Observation	Most Recent Population Estimate	Status (FNAI Rank)
118*	Highlands Hammock State Park North	Highlands	State	2014 ^a	1-3	Unknown
20	Golf Hammock Scrub	Highlands	Private	2005 ^b	0	Known Extirpated
25	Highlands Hammock State Park Highlands Hammock Scrub	Highlands	State	2014 ^a	Unknown	Unknown
19	Highlands Hammock State Park Sebring Southgate Scrub	Highlands	State	2014 ^a	22	Unknown
93	Sebring Triangle Scrub	Highlands	Private	2005 ^b	0	Known Extirpated
31	Highlands Hammock State Park Sebring Wolf Lake Scrub	Highlands	State	2014 ^a	59	Unknown
94	Lake Charlotte East Scrub	Highlands	Private	2005 ^b	4	Known Extirpated
100 (+86)	Lake Wales Ridge National Wildlife Refuge	Highlands	State	2012 ^a	1	Unknown
95 (+96)	Payne Road East Scrub, Lake Wolf South Scrub	Highlands	Private	2005 ^b	1	Known Extirpated
34	Jackson Creek - Skipper Road	Highlands	Private	2005 ^b	4	Known Extirpated
33 (+22, 38, 32, 78, 111)	LWRWEA, Josephine Road Scrub, Henscratch Road East Scrub, Lake Hill West, Lake Josephine/ Josephina Creek SE	Highlands	State, Private	2019 ^a	3	Declining (B)
121*	LWRWEA Josephine Creek NE Area	Highlands	State	2012 ^a	1	Unknown
106	LWRWEA Josephine Creek SW Area	Highlands	State, Private	2018 ^a	3-11	Stable (C)
104	LWRWEA Grassy Creek East	Highlands	State	2019 ^a	7-70	Stable
125*	Jack Creek	Highlands	State	2018 ^a	1	Unknown (BC)
37 (+81, 108)	LWRWEA Lake Hill East Scrub, Leisure Lakes North Scrub, Lake Hill SW, Leisure Lakes West Scrub	Highlands	State	2012 ^a	21	Unknown
83	LWRWEA Lake Istokpoga West Scrub and Boggy Branch	Highlands	State, Private	2012 ^a	1	Unknown

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EO Number	Population Name	County	Ownership	Last Observation	Most Recent Population Estimate	Status (FNAI Rank)
35 (+36)	LWRWEA Henscratch Rd/Miller Ave Scrub	Highlands	State, Private	2018 ^a	11-50	Declining
N/A	Oak Street Scrub	Highlands	Private	2005 ^b	147	Likely Extirpated
80 (+76)	Lake June North/Lake Henry South	Highlands	Private	2005 ^b	9	Likely Extirpated
77	LWRWEA Crews Lake North, Lake June-in-Winter Scrub Preserve State Park	Highlands	State	2014 ^a	3-5	Unknown
39	Lake June-in-Winter Scrub Preserve State Park, LWRWEA	Highlands	State	2012 ^a	7	Unknown
40 (+41)	Lake June-in-Winter Scrub Preserve State Park (Tomolka Scrub)	Highlands	State	2012 ^a	17	Unknown
51 (+65, 82, 84, 107)	LWRWEA, Istokpoga Preserve, Highlands Park Estates, Holmes Avenue East Scrub, Grassy Lake East and SE Scrub, Lake Apthorpe East	Highlands	State, Private	2019 ^a	4	Declining (BC)
79	Jones Gulley SE	Highlands	Private	2005 ^b	0	Known Extirpated
97 (+1, 64)	Placid View Road North Scrub	Highlands	Private	2005 ^b	260	Known Extirpated
90	LWRWEA Placid View Road Scrub	Highlands	State, Private	2020 ^a	2	Declining (BC)
47	LWRWEA and Northern Archbold Rosemary Scrubs	Highlands	State, Private Conservation	2005 ^b	Unknown	Unknown
102 (+42, 89)	LWRWEA McJunkin Tract, SR 70 Placid View Road Scrub, Archbold NW Scrub, Archbold Oak Scrub, and Southern Archbold Rosemary Scrubs	Highlands	State, Private Conservation, Private	2017 ^d	575 (partial count)	Stable to Increasing (B)
43	LWRWEA Horn Road Scrub, Horn Road West Scrub, Gould Road Scrub	Highlands	State, Private	2018 ^a	5-50	Declining
45 (+4, 85, 87)	US 27 and Bald Hill Rd, Hendrie Ranch	Highlands	Private	2005 ^b	235	Unknown
46	Venus Scrub	Highlands	Private	2005 ^b	0	Known Extirpated

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EO Number	Population Name	County	Ownership	Last Observation	Most Recent Population Estimate	Status (FNAI Rank)
88	Fisheating Creek/Smoak Groves Conservation Easement, Venus ENE and ESE Scrub	Highlands	Private Conservation	2012 ^a	2-10	Unknown
N/A	Carlton Ranch South B Scrub	Highlands	Private	2005 ^b	0	Known Extirpated
N/A	Bruce Sherwood Cemetery	Highlands	Private	2005 ^b	0	Known Extirpated

^a FNAI 2021, ^b Christman 2006, ^c Rosner-Katz 2020, ^d Menges et al. 2018

(+68) indicates old EO numbers that were combined with current EO

* indicates populations was discovered after 2010 review

N/A indicates occurrence was not in FNAI 2009 or 2021 EO data

AB = excellent to good estimated viability (FNAI 2021)

B = good estimated viability (FNAI 2021)

BC = good or fair estimated viability (FNAI 2021)

C = fair estimated viability (FNAI 2021)

[2] Populations (as defined in criterion 1) in rosemary scrub or scrubby flatwoods habitats are distributed across the known range of the species. (Factors A and E)

This criterion has been partially met. The 45 extant populations occur in rosemary scrub and scrubby flatwoods across the known range of the species (the Lake Wales and Winter Haven Ridges in Polk and Highlands counties). However, many acres of suitable habitat exist between populations which are either unoccupied by the species or haven't been surveyed to confirm presence.

[3] Populations are protected and managed via a conservation mechanism to a degree that enough suitable habitat is present for the species to remain viable for the foreseeable future. (Factors A, D, and E)

This criterion has been partially met. Approximately 41 of the known 45 extant populations occur either entirely or partially on public or private conservation lands (Tables 1 and 2). However, only 29 populations are entirely on protected lands, which are likely managed well enough for scrub blazing star since it has a wide recommended fire return interval and a relatively high tolerance for shade (Herndon 1999; Menges et al. 2008, 2019; Tye et al. 2016). The remaining 16 populations suffer from habitat loss, fragmentation, and degradation due to development, conversion to agriculture, overgrowth of invasive and native plants, and lack of prescribed fire (Service 2010; FNAI 2021).

Table 2: Summary of protection status of extant and extirpated scrub blazing star populations by county.

County	Extant or Unknown Status			Known or Likely Extirpated Status			Total
	Extant Completely Protected	Extant Partially Protected	Extant Completely Unprotected	Extirpated Completely Protected	Extirpated Partially Protected	Extirpated Completely Unprotected	
Polk	13	2	0	0	1	2	18
Highlands	16	10	4	0	0	22	52
Total	29	12	4	0	1	24	70

C. Updated Information and Current Species Status

1. Biology and Habitat

a. Summary of new information on the species' biology and life history:

General information on the biology and life history of scrub blazing star, a long-lived (9 years or more) perennial member of the aster, daisy, and sunflower family (Asteraceae), is summarized in the final listing rule (54 FR 31190; Service 1989), the MSRP (Service 1999), and the previous status review (Service 2010). Below we present new information pertinent to this review.

Scrub blazing star is known to rely heavily on resprouting from their corm (below ground storage organ) after a fire; although, resprouting rates (47 percent) are low compared to many other Florida scrub plants (Weekley and Menges 2003). To determine if smoke increased seed germination rates, Lindon and Menges (2008) studied the effects of aerosol smoke treatments on the seeds of scrub blazing star. They concluded that germination rates were highest with a short exposure (1 minute) to smoke and then decreased as exposure times increased to 30 minutes. This finding suggests that high fire intensities and long durations may be damaging to the scrub blazing star, especially since it does not always resprout after fire (Weekly and Menges 2003).

Contrasting with high annual survival rates, scrub blazing star has exceedingly low seedling recruitment rates, estimated at 0.02 percent annually (Weekley et al. 2008a). The cause of low recruitment rates has been investigated but is not yet fully understood. As described in the previous status review (Service 2010), scrub blazing star recruitment does not appear to be limited by inadequate seed production, seed germination, or allelopathic effects (usually inhibition of seed germination and growth) from other scrub species such as Florida rosemary (*Ceratiola ericoides*) or Evan's reindeer lichen (*Cladonia evansii*) (Herndon 1999; Hunter and Menges 2002; Weekley et al. 2008a; Quintana-Ascencio et al. 2009).

Litter type and depth may affect recruitment since scrub blazing star was shown to germinate best under shallow (0.2 centimeters [cm]) Florida rosemary litter compared to under deep (2.0 cm) rosemary litter and shallow or deep sand pine (*Pinus clausa*) or oak (*Quercus* spp.) litter (Herndon 1999; Weekley et al. 2008a; Quintana-Ascencio et al. 2008). Low seedling recruitment may also be due, in part, to herbivory on flowers and seed predators that remove or destroy seeds post-dispersal (Weekley et al. 2008a; Kettenring et al. 2009; Stephens et al. 2012; Schneider et al. 2016; Tye et al. 2016), but more study is needed (see section II.C.2.c. below).

Microbes may have effects on various aspects of the ecology of plants. However, scrub blazing star germination was shown to be unaffected by microbes (as compared to a sterilization treatment) while most other scrub specialists benefited from microbes in more stressful environments (David et al. 2020). In another experiment analyzing whether microbes exacerbate or mitigate the allelopathic effects of the Florida rosemary shrub, scrub blazing star seedlings did not show significant stress with or without the microbes, but results did trend slightly towards mitigating the allelopathic stress (David et al. 2018). More studies are needed to determine the barriers to seedling recruitment. In other scrub endemics, timing and amount of precipitation, which is affected by climate change (see section II.C.2.e. below), strongly influence seedling recruitment. Further research may indicate if this is also true for scrub blazing star.

b. Abundance, population trends, demography:

The Service estimates that scrub blazing star currently occurs in 45 extant populations in Polk and Highlands counties. At the time of listing, there were 93 known occurrences (Christman 1988) and at the time of the previous status review, there were 91 known occurrences, or populations (Service 2010). The decrease in number of populations between 2010 and 2021 can mostly be attributed to new occurrences being discovered between populations, connecting two or more previously separated populations into one larger population (FNAI 2009; FNAI 2021). Since NatureServe's 1.0-kilometer (km) (0.62-mile) distance is used to differentiate populations (NatureServe 2020) and scrub blazing star is sparsely scattered throughout the landscape, the result is fewer populations that expand over a larger area as more occurrences are discovered.

Some populations may also have been extirpated since the last review, though it is difficult to determine when extirpations have occurred due to lack of survey data. Limited detailed information is available regarding scrub blazing star abundance, population trends, and demography because there is not an established monitoring program at most populations. Abundance data are difficult to compare to previous years due to incomplete/opportunistic surveys, gaps in survey years (especially at populations occurring on private lands), and variances in how boundaries were drawn between populations by different surveyors.

The following is a summary of the best available information regarding the abundance and status of scrub blazing star populations across its range. Currently, FNAI recognizes 64 populations, or element occurrence records (EORs), 19 of which are historical or extirpated (Table 1). A range-wide survey in 2004-2005 reported 6 populations that are not included in FNAI's records, which are either known or presumed extirpated (Table 1; Christman 2006; Service 2010). The most recent abundance estimates suggest mainly small scrub blazing star populations (19 with 1-9 plants, 17 with 10-99 plants, 6 with 100-999 plants, and 3 with no plant numbers reported; Table 1). In 2011, FNAI analyzed aerial imagery to estimate the amount of remaining habitat for most scrub blazing star EORs with no recent survey reports to rank them as extirpated or extant. For some populations that were determined to be extirpated, the most recent population estimate from prior to 2011 is still reported in Table 1.

Demographic data (*sensu* Menges and Gordon 1996) has only been collected from one population at the Archbold Biological Station (ABS), one at the Lake Wales Ridge State Forest (LWRSF), and one at the Lake Wales Ridge Wildlife and Environmental Area (LWRWEA). In 2017, ABS staff conducted their final year of Level 3 monitoring (demographic monitoring of marked individuals) for scrub blazing star after 20 years of annual monitoring at LWRSF, 17 years at ABS, and 7 years at the LWRWEA Gould Road Scrub (Menges et al. 2018). The demographic data from the 11 scrub and 6 roadside monitoring plots at ABS showed stable trends in abundance, density, and survival, but a slight decrease in proportion of flowering plants. The roadside plots had significantly higher density and survival than the scrub plots in many of the years, but the proportion of flowering plants in each habitat did not differ significantly. Level 1 monitoring (occurrence and spatial extent) will continue at ABS every 5 years (Menges et al. 2019).

The 20 years of demographic data in 4 monitoring plots within the LC01 burn unit of the LWRSF showed a stable to slightly increasing trend in the number of plants, stable to slightly decreasing fecundity (number of seed heads per plant), and stable to slightly decreasing number of recruits (Rosner-Katz 2020). Staff at the LWRSF established a Level 2 monitoring (population trends) plot in the GF01 burn unit in 2020 and will continue the Level 3 monitoring in LC01 (Rosner-Katz 2020). Throughout the 10 populations at the LWRSF, there are 1,001 GPS points for scrub blazing star, representing approximately 2,646 individuals (Rosner-Katz 2020). Most of these populations have an unknown status due to lack of recent surveys. The two monitored populations are considered stable and ranked by FNAI to have excellent or good viability. One population on the Arbuckle Tract is estimated to be declining and was ranked by FNAI as having good or fair viability (Table 1).

The demographic data collected at Gould Road Scrub (Menges et al. 2018) was unavailable at the time of this review, but a PVA conducted for all three of the monitored populations showed they have relatively stable population dynamics

compared to many other scrub endemic plants (Tye et al. 2016). This is most likely due to their long-life span, ability to resprout after a fire, and a higher tolerance for shade than most other scrub endemics (Herndon 1999; Menges et al. 2008; Tye et al. 2016). Tye et al. (2016) compared the synergistic effects of herbivory, fire, and anthropogenic disturbances (roadsides) on scrub blazing star populations. The authors found that population growth rates were higher in roadside than scrub populations and declined with increasing time-since-fire (Tye et al. 2016). Herbivory (mostly by white-tail deer [*Odocoileus virginianus*]) was also higher in roadside populations and in long un-burned scrub (Tye et al. 2016). The results suggest populations in native habitats under appropriate fire management may have greater long-term viability.

Scrub blazing star is known from 15 of the 19 units of the Lake Wales Ridge Wildlife and Environmental Areas (LWRWEA; Menges et al. 2019). These are Carter Creek, Clements, Gould Road Scrub, Henscratch, Highlands Park Estates, Highlands Ridge, Holmes Avenue, Lake Blue, Lake Placid Scrub, McJunkin, Royce Ranch, Silver Lakes, Sun n Lakes (Sebring), and Sunray/Hickory Lake. Seventeen (17) populations occur either entirely or partially on the LWRWEA; of which 6 are estimated to be declining, 4 are considered stable, and 7 have an unknown status (Table 1). FNAI has ranked the estimated viability of several of the 17 populations within the last 5 years, with 2 ranked as excellent or good, 3 as good estimated, 2 as good or fair, and 1 as fair (Table 1; FNAI 2021).

Several populations of scrub blazing star also occur on state parks throughout the range, specifically Allen David Broussard Catfish Creek Preserve State Park (1), Highlands Hammock State Park (4), and Lake June-in-Winter Scrub Preserve State Park (3). However, the status of these populations is unknown since no survey data has been reported since 2012 or 2014 for any of these sites (FNAI 2021). All other populations on private lands or private conservation lands are also of unknown status due to lack of recent surveys, with the majority of populations entirely on private lands either known or presumed extirpated (Tables 1 and 2).

c. **Genetics:**

Dolan et al. (1999) conducted a genetic analysis of three endemic Florida scrub herbs, including scrub blazing star, and all three species showed low levels of genetic variation. The study showed scrub blazing star, however, had the highest genetic diversity throughout all populations sampled and the most gene flow among populations. They reported this is likely due to their self-incompatibility, scattered spatial arrangement, long lifespan, long distance pollinators (butterflies), and relatively high rates of seed dispersal (mostly by wind). The data also suggested inbreeding was currently low, but the species 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. Therefore, the preservation of large contiguous tracts of scrub should offer the best chances of successful conservation.

Menges et al. (2010) conducted a landscape genetics analysis of six Florida scrub plants, including scrub blazing star. This study generally found little effect of population size and habitat availability (presettlement and current) on genetic variation. However, they found, genetic variation of scrub blazing star was weakly positively related to both the amount of presettlement and extant habitat within 32 km (19.8 miles). This study also showed that genetic variation for scrub blazing star was negatively related to population density, potentially due to pollinators travelling longer distances in less dense populations and effectively increasing outcrossing.

d. Taxonomic classification or changes in nomenclature:

None. The Integrated Taxonomic Information System (2021) and Atlas of Florida Vascular Plants (Wunderlin et al. 2021) were checked while conducting this review and both indicate *Liatris ohlingerae* is the accepted name for scrub blazing star and it is a distinct taxon.

e. Distribution and trends in spatial distribution:

Scrub blazing star continues to occur throughout its known range on the Lake Wales Ridge and Winter Haven Ridge (one occurrence) in Highlands and Polk counties, Florida. Its range extends approximately 118 km (73 miles) from Lake Blue on the Winter Haven Ridge in Polk County to the Fisheating Creek/Smook Groves Conservation Easement at the south end of the Lake Wales Ridge in Highlands County (FNAI 2021). It occurs sparsely over the landscape and is strongly associated with rosemary scrub and scrubby flatwoods. Currently, there are an estimated 45 extant populations of scrub blazing star (Table 1). Of these, 30 (67 percent) occur in Highlands County and 18 (33 percent) in Polk County (Table 2).

Five (5) new populations have been reported since the previous status review (Service 2010), with 2 in the LWRWEA, 1 in the LWRSF, 1 in Highlands Hammock State Park, and 1 in the South West Florida Water Management District's Jack Creek (Table 1). In addition, several new locations were recorded within already known LWRSF populations, which increase the spatial extent of those populations and lessens the gaps between nearby populations (Rosner-Katz 2020). It is likely there are more unrecorded plants between populations, especially on large parcels of managed lands, that would connect known, currently separated populations. However, the majority of the scrub blazing star populations are small and increasingly fragmented with an estimated 25 known or presumed extirpated in the last 20 years (Service 2010; FNAI 2021).

f. Habitat or ecosystem conditions:

The distribution of habitat (rosemary scrub and scrubby flatwoods) within the scrub blazing star's range remains fragmented. FNAI (2010) ranks the scrub ecosystems as imperiled statewide and globally while scrubby flatwoods as rare statewide and globally. Extensive land clearing for human population growth, development, and agriculture has altered, degraded, or destroyed millions of acres

of these once abundant ecosystems. By 2006, an estimated 85 percent of upland habitat on the Lake Wales Ridge had been destroyed and about 11 percent had been protected as conservation lands (Weekley et al. 2008b). Since listing, the amount of habitat occupied by the scrub blazing star has decreased by about 50 percent. Christman (2006) estimated the total area of occupied scrub habitat was 21,818 acres in 1988 and 18,918 acres in 2005, although the species was not present throughout the entire area analyzed. According to the FNAI 2021 data, the total area of scrub habitat area supporting extant scrub blazing star populations has decreased to approximately 12,217 acres.

Scrub and scrubby flatwoods require periodic fires to maintain vegetative structure and increased development makes applying prescribed fire to remaining habitat difficult. Although scrub blazing star appears to thrive in the shade, the species needs fire to periodically reduce dense canopies, invasive species, and leaf litter to allow sufficient light levels for regeneration and seedling recruitment (Herndon 1999; Weekley et al. 2008a; Quintana-Ascencio et al. 2008). In areas recently burned (less than one year), populations showed higher seed production and lower seed predation, though the process behind the increased fecundity is unknown (Schneider et al. 2016). Since the species does not have a strong response to time-since-fire and can persist in areas not recently burned, the recommended fire return interval for scrub blazing star is wide (10-50 years; Menges et al. 2019). However, there is a backlog of long-unburned habitat within public conservation areas throughout the state. In 2008, The Nature Conservancy reported an estimated 38,359 acres on the Lake Wales Ridge as being out of appropriate fire return interval (The Nature Conservancy 2010), though an updated report was not available for this review. For most privately owned parcels the fire management condition is unknown and is highly unlikely unless they are designated conservation areas or easements.

Most (41 out of 45) extant scrub blazing star populations occur either entirely or at least partially on conservation lands (Table 2). The challenge with managing these fragmented preserves is controlling invasive plant species and applying prescribed fire within appropriate intervals. Throughout the scrub blazing star's range, undeveloped remaining scrub and scrubby flatwoods occurs on private and publicly owned lands not dedicated to or managed for conservation. Suitable habitat for scrub blazing star remaining on these lands is decreasing due to development and degradation.

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

The purpose of a 5-Year Review is to recommend whether a listed taxon continues to warrant protection under the ESA and, if so, whether it should be reclassified (from threatened to endangered or from endangered to threatened). This task requires that the analysis of the threats to the species be performed while assuming that the species is not receiving the regulatory protections, funding, recognition, and other benefits of ESA listing. Summaries of ongoing applications of ESA protections may shed light on some future activities that constitute threats to the species. However, the analysis

under Factor D (Inadequacy of Existing Regulatory Mechanisms) focuses on the adequacy of existing alternative (i.e., non-ESA) mechanisms to address the continuing and foreseeable threats.

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

Continued habitat loss, fragmentation, and changes in land use threaten the existence of scrub blazing star. In some instances, where the species or suitable habitat occurred on private or unprotected sites, development has led to both direct destruction of plants and habitat because of land clearing and indirect extirpation and habitat degradation from lack of management. For example, an estimated 25 populations have been extirpated, with the primary cause being habitat alteration, destruction, and degradation on private lands (Table 2). Threats from development and habitat degradation on private sites are expected to continue and increase. Within the two counties where the plant occurs (Polk and Highlands), by 2070, the human population is predicted to grow an average of 41 percent from 2010 levels (Carr and Zwick 2016). The scrub blazing star populations on public and private conservation lands are protected from development, but those that occur on private lands are vulnerable to habitat loss from development. As natural habitats become increasingly fragmented and isolated by development, recovery of small, isolated populations may be more unlikely since larger breaks in suitable habitat exist making natural dispersal and gene flow more difficult (Dolan et al. 1999).

Even though the populations of scrub blazing star on public and private conservation lands are not at risk of being developed, the plants on these sites may still be vulnerable to lack of or improper habitat management. One of the primary threats to scrub and scrubby flatwoods is habitat modification and degradation through inadequate fire management, which includes both the lack of prescribed fire and suppression of natural fires. Although the majority of scrub blazing star populations occur on public and private conservation lands with active habitat management programs, the ability to apply prescribed fire is limited by surrounding development, weather, and staffing.

In managed areas, prescribed fire is the preferred tool to manage scrub habitats and restore suitable conditions for endemic herbs. However, land managers also use mechanical treatments such as mowing, roller-chopping, and logging to manage scrub habitats when fire is not possible or to prepare long-unburned areas for fire (Menges and Gordon 2010). Mechanical treatments cause soil compaction, soil disturbance, and may increase invasion by non-native plant species, such as Bahia grass (*Paspalum notatum*), cogon grass (*Imperata cylindrica*), and Natal grass (*Melinis repens*) that compete for space and alter fire behavior. Scrub blazing star may suffer mortality from deep soil disturbances caused by some mechanical treatments but is likely to survive mowing (Menges et al. 2019). Also, scrub blazing star 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. Vegetation restoration and management programs are costly, and the availability of funding is never assured; therefore, habitat modification from inadequate management even on protected lands remains an imminent, though moderate, threat.

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

This was not identified as a potential threat in the original listing rule (Service 1989), the recovery plan (Service 1999, 2019), or the previous 5-year review (Service 2010) and is not known to be a current threat.

c. Disease or predation:

Disease or predation was not considered a threat to scrub blazing star at the time of listing, but the previous status review described how herbivory by white-tailed deer and arthropods is a limiting factor to flower and seed production and may impact the viability of some populations (Herndon 1999; Kettenring et al. 2009). Kettenring et al. (2009) found that 62 percent of plants from all habitats (scrub vs roadside) and disturbance regimes (time-since-fire) sampled were topped (flowers predated by deer). They found that topping occurred more frequently in recently burned (>8 years) sites and scrub than in long un-burned (<14 years) sites and roadsides. A population viability analysis completed by Tye et al. (2016) also showed that herbivory is an important driver of population changes in scrub blazing star. Population dynamics of scrub blazing star vary among anthropogenic disturbances, habitat types, and time-since-fire, all of which interact with seed predation and herbivory (Kettenring et al. 2009; Schneider et al. 2016; Tye et al. 2016). Tye et al. (2016) found that herbivory on flowers was higher with higher precipitation, for previously damaged plants, in roadsides (as compared to scrub), and in areas with longer time-since-fire, contrasting the Kettenring et al. (2009) study. In addition, a 2012 study showed that post-dispersal seed predation in degraded scrub habitats was higher than in high quality scrub habitats (Stephens et al. 2012). The seed predators that move or completely remove the seeds, likely vertebrates since the seeds are large, may benefit from increased visibility in foraging due to the decreased shrub cover in degraded scrub (Stephens et al. 2012). Also, arthropod seed predators such as the Florida harvester ant (*Pogonomyrmex badius*) and darkling beetle larvae from the family Tenebrionidae are believed to destroy seeds post-dispersal, especially in areas with thick litter accumulation (Weekley et al. 2008a), which would occur in long-unburned scrub.

Since herbivory and seed predation may increase with the degradation of scrub habitat (Stephens et al. 2012; Schneider et al. 2016; Tye et al. 2016), and most populations produce an abundant seed crop annually (Weekley et al. 2008a), predation is not currently considered a threat. Habitat degradation (see section II.C.2.a., above) may be the driving force for predation on flowers and seeds of scrub blazing star. Tye et al. (2016) recommend the need for more research to determine barriers to recruitment, effects of invertebrate herbivory, and effects of

vertebrate herbivory on vegetative plants. Additionally, all herbivory and seed predation studies to date have been primarily in the few populations at and near ABS, which is at the southern end of the scrub blazing star range. Range-wide studies should also be conducted to help determine if this is a threat to the species.

d. Inadequacy of existing regulatory mechanisms:

The ESA 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. The ESA does not provide protection for plants on non-federal lands unless it is in violation of state law.

Scrub blazing star is also listed by the Florida Department of Agriculture and Consumer Services (FDACS) as State-endangered (5B-40.0055 Regulated Plant Index). Listing by the State is not reliant on ESA protections, but the State listing does not provide any direct habitat protection. State regulations require both written permission from the owner or legal representative and a permit issued by FDACS to collect or remove plants listed as endangered on the Florida Regulated Plant Index from any property. Additionally, Title 62D-2.013 of the Florida Administrative Code prohibits the removal, destruction, or damage of plants from Florida Department of Environmental Protection, Division of Recreation and Park properties. This regulation provides protection for the populations that occur on state park lands but does rely on public adherence to the Code since monitoring is limited. County-level protection where scrub blazing star occurs is limited to surveys for listed plants and coordination with the appropriate agencies for any required permits or consultation.

Existing regulatory mechanisms do not adequately prevent the development of sites, as several properties with scrub blazing star on private lands have been developed. Rescue efforts can only take place if the Service or another qualified organization is made aware of impending development. Because this species occurs in scrub habitat on the Lake Wales and Winter Haven Ridges, which is desirable for development and other uses due to its elevation, it remains vulnerable to development pressures where it occurs on private property. Where the species occurs on public land, there is protection from development but not necessarily from habitat degradation. In conclusion, there are no existing regulatory measures that reduce or remove the threat or loss of populations or removal/destruction of plants on private property, and it has only limited protections if the species was not protected under the auspices of the ESA; therefore, existing regulatory mechanisms are inadequate to protect this species.

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

Scrub blazing star continues to be threatened by numerous natural and anthropogenic factors, including intrinsic factors (pollinator-limited dispersal;

small, isolated, and scattered populations; lack of persistent seed bank; low recruitment; restricted range), stochastic events (hurricanes, droughts, wildfires), climate change, and human disturbances. The previous status review described how intrinsic factors of the scrub blazing star's life history act synergistically with habitat fragmentation to threaten populations (Service 2010). Off-road vehicle (ORV) impacts were also documented in the previous status review within populations on both public conservation and private lands (Service 2010) and can damage or kill plants if driven directly over them. Herring (2021) recently documented ORV impacts to other endangered plants in some of the same scrub habitats on the Lake Wales Ridge where scrub blazing star occurs. ORVs remain a threat to the scrub blazing star, especially on unprotected sites.

There is currently no evidence of negative impacts to scrub blazing star from climate change factors, but this could change in the future as Florida is vulnerable to changes in rainfall and temperatures expected due to climate change. While the strong influence of ocean currents makes projecting regional climate in Florida difficult (Kirtman et al. 2017), estimates project that Florida's average annual temperatures will increase approximately 1.5 to 5.5 degrees Fahrenheit (°F) (0.8 to 3.1 degrees Celsius [°C]) by 2050 and from 2.0 to 11.5°F (1.1 to 6.4°C) by 2100 depending on the greenhouse gas emission rates and the region in Florida (Runkle et al. 2017). In addition, it is predicted that for central Florida, summer rainfall (wet season) will decrease up to 5 percent by 2050 (Runkle et al. 2017). Higher temperatures and changes in precipitation patterns could alter relative humidity levels and evapotranspiration rates, leading to the potential for more frequent and intense droughts and wildfire events. Scrub and scrubby flatwoods species, in general, can tolerate drought conditions, but it is unclear how this anticipated future threat will fully affect species like the scrub blazing star.

In addition to changes in precipitation and temperatures patterns, there are also anticipated changes to the severity of tropical storms and hurricanes. Sweet et al. (2017) predicted a 20 percent increase in both rainfall rates and wind speeds near the center of storms due, in part, to higher sea surface temperatures. Scrub blazing star, however, is probably not strongly affected by hurricanes (Menges et al. 2011). It is possible that treefall and limbfall could damage or kill plants, or that a buildup of downed tree debris could cause higher intensity fires which can be damaging to scrub blazing star (Weekly and Menges 2003). On the other hand, increased winds and storm frequency may help increase seed dispersal of scrub blazing star to new areas or closer to other populations which could reduce the chances of inbreeding (Dolan et al. 1999).

Sea-level rise is another anticipated consequence of climate change in Florida. The central Florida ridges will be spared from the direct impacts of sea level rise that are anticipated for coastal and low elevation areas. However, as sea level rises in coastal regions, development is likely to move inland, further increasing the threat of development in the higher elevation areas, such as the central Florida ridges (Volk et al. 2017).

D. Synthesis:

Scrub blazing star is a long-lived, perennial herb occurring in a narrow range of rosemary scrub and scrubby flatwoods on the Lake Wales and Winter Haven Ridges, in Polk and Highlands counties, Florida. Currently, there are an estimated 45 extant populations, though most are of unknown status due to lack of recent surveys, and 25 known or presumed extirpated populations (Table 1). Only 6 populations are considered stable, 7 are estimated to be declining, and 32 have an unknown status mostly due to lack of recent surveys (Table 1). Although demographic data have been collected at a portion of 3 populations for approximately 20 years (Menges et al. 2018; Rosner-Katz 2020), information on natural recruitment and age distribution is lacking for almost all populations; therefore, trends cannot be determined.

Habitat loss, fragmentation, and changes in land use continue. Conversion of scrub habitat to urban use in central Florida is projected to continue over the next 50 years. At least 85 percent of the available upland habitat on the Lake Wales Ridge has already been developed (Weekly et al. 2008b) and the amount of habitat occupied by the scrub blazing star has decreased by almost 50 percent since 1988 (Christman 2006; FNAI 2021). Where habitat remains intact, scrub blazing star depends upon active management to persist. Land management practices, including prescribed fire, controlling shrubs, and removal of invasive species, are important for maintaining the habitat needed for this plant. Most (41 out of 45) extant populations occur either entirely or partially on protected lands, but only the 29 entirely on conservation lands are likely receiving adequate land management. Existing regulatory mechanisms are inadequate to protect the species on private lands. The species' intrinsic factors (pollinator-limited dispersal; small, isolated, and scattered populations; lack of persistent seed bank; low recruitment; restricted range; and restriction to specialized habitat) renders it vulnerable to human disturbances, stochastic events, and potentially herbivory and climate change. Due to the above ongoing threats, documented declining and unknown population status and trends (due to lack of recent surveys and limited demographic monitoring), this species continues to meet the definition of endangered under the ESA.

III. RESULTS

A. Recommended Classification:

 X **No change is needed**

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

A detailed discussion of recovery actions and criteria are presented in the Recovery Plan and amendment (Service 1999 and 2019, respectively). During this status review, new and/or targeted potential recovery activities were identified and are included below.

Recovery Activities

- Work with State, Federal, and non-profit partners to ensure adequate fire management is achieved at sites that support scrub blazing star.
- Work with private landowners to acquire or conserve extant populations and restore scrub habitat on these sites.
- Ensure representation of scrub blazing star at the National Center for Genetic Resources Preservation in Fort Collins, Colorado.

Monitoring/Research Activities

- Determine the condition of populations on private land whose status is currently unknown.
- Continue demographic monitoring at ABS and LWRSF and expand to additional populations throughout the range to evaluate population trends.
- Conduct monitoring to document presence on protected lands at least every five years (Menges et al. 2019).
- Conduct presence/absence surveys in areas of suitable habitat within and north of the current range to discover new populations, expand extent of known populations, or to verify the species is not likely present.
- Determine the factors responsible for low seedling recruitment. Specifically, examine potential impacts from changes in the timing and amount of precipitation expected with climate change.
- Evaluate the overall threat posed by herbivory across the range and at various life stages.

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Scrub Blazing Star 5-Year Review

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of Scrub Blazing Star (*Liatris ohlingerae*)

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

- Downlist to Threatened
- Uplist to Endangered
- Delist
- No change needed

Review Conducted By: Heather Hitt, Florida Ecological Services Field Office, Vero Beach

FIELD OFFICE APPROVAL:

**Division Manager, Classification and Recovery, Florida Ecological Services Field Office,
Fish and Wildlife Service**

Approve: _____ Date: _____

* In 2021, the Classification and Recovery Division Manager in the Florida Ecological Services Field Office was delegated authority to approve 5-year reviews that do not recommend a status change.