

**Pigeon wings**  
*(Clitoria fragrans)*

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



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

## 5-YEAR REVIEW Pigeon wings (*Clitoria fragrans*)

### 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 (Service 2008) 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 2018 (83 FR 38320). We received one public comment during the open comment period. We evaluated and incorporated comments as appropriate in this review. We also used a variety of information resources, including monitoring reports, surveys, and other scientific and management information, augmented by conversations and comments from biologists familiar with the species. Specific sources included the final rule listing this plant under the Endangered Species Act of 1973, as amended (ESA) (58 FR 25746), the recovery plan (Service 1999), the 2008 5-year review, peer reviewed scientific publications, and unpublished field observations by Federal, State, and other experienced biologists. The review was contracted to an Archbold Biological Station (ABS) plant ecologist and finalized by the lead recovery biologists for pigeon wings in the Florida Ecological Services (FESO), Vero Beach. Literature and documents used for this 5-year review are on file at the FESO. All recommendations resulting from this review are a result of thoroughly reviewing the best available information on pigeon wings. The completed draft was sent to four peer reviewers for review. We received comments back from two of the peer reviewers. Comments were evaluated and incorporated into this final document as appropriate (see Appendix A).

### B. Reviewers

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

**Lead Field Office:** FESO, Emily Bauer, (772) 469-4335

### C. Background

**1. FR Notice citation announcing initiation of this review:** August 6, 2018, 83 FR 38320.

**2. Listing history**

Original Listing

FR notice: 58 FR 25746

Date listed: April 27, 1993

Entity listed: Species

Classification: Threatened

**3. Associated rulemakings:** There are no associated rulemakings for this species.

**4. Review History:**

Each year the U.S. Fish and Wildlife Service (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 5-year status review conducted in 2008 showed this species as stable with no change recommended to the species' status due to the probability of continued populations losses at unprotected sites and the lack of adequate fire management at existing protected sites (Service 2008).

Recovery Plan: 1999

Previous 5-year Review: 2008

**5. Species' Recovery Priority Number at start of review (48 FR 43098):** 14. A recovery priority number of "14" indicates that this is a species with a low degree of threat and high recovery potential.

**6. Recovery Plan**

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

Date issued: May 18, 1999

Dates of previous plan: June 20, 1996 (Recovery Plan for nineteen central Florida scrub and high pineland plants).

**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. However, the criteria included in the 1999 recovery plan require modification to reflect more updated habitat information for criterion 3 (see below).

**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. See explanation above and under criterion 3 (below).

**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. However, Factor C, disease or predation, was not directly addressed as a threat to pigeon wings in the recovery plan (Service 1999). Although observers following individually marked pigeon wings plants subsequently have noted heavy herbivory on leaves, flowers, and fruits by insects and complete predation of whole plants by vertebrates (Stout and Lewis 2004; Lewis 2007; A. Faivre, Cedar Crest College, pers. comm. 2008; C. Weekley, ABS, pers. obs. 2008), the extent of this threat at the population level is unknown and should be investigated. This factor is not considered a threat at this time and, therefore, is not addressed by any of the current recovery criteria.

**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 1999 recovery plan is broken down into four parts ([1-4] in bold below) for clarity purposes. These criteria address 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. Factor B is not currently considered relevant to the species and Factor C was not addressed in the recovery plan.

**Pigeon wings may be delisted when:**

**[1] enough demographic data are available to determine the appropriate numbers of self-sustaining populations and sites needed to ensure 95 percent probability of persistence for 100 years;**

This criterion has not been met. Limited demographic data have been collected on pigeon wings. Satisfying this criterion would require collection of detailed demographic data (*sensu* Menges and Gordon 1996) through monitoring large samples of marked individuals in multiple populations over several years. These studies provide quantitative assessments of survivorship, growth, and fecundity. Data are also needed on the reproductive biology, seed ecology, and perhaps genetic diversity of the species. In addition, to provide adequate guidelines for managing pigeon wings, population viability analysis (PVA) models will require data drawn from populations with differing fire histories because the ideal fire regime for regeneration of pigeon wings has not been identified.

At present, detailed demographic data are not being collected from any populations. The largest available demographic datasets (Stout and Lewis 2006; Weekley, pers.

comm. 2008) are based on fewer than 150 plants at each of two sites, ABS and Avon Park Air Force Range (APAFR). The Lake Wales Ridge State Forest (LWRSF) currently conducts Level 1 (location or occupancy) and Level 3 (demographic data collection involving individually marked plants; Menges and Gordon 1996) monitoring of pigeon wings at the Arbuckle, Walk-in-Water, and Hesperides tracts (Knothe 2017). Otherwise, there are no current data collections on this species beyond location data and estimates of population sizes.

Element occurrence records (EORs) are compiled by the Florida Natural Areas Inventory (FNAI). Each EOR represents a species occurrence that is a minimum of 1 kilometer (km) from another occurrence of the same species, thus a large site may have multiple EORs associated with it. In this review, we are considering an EOR as a population. At the time of the previous 5-year review (Service 2008), 77 EORs were known for pigeon wings (FNAI 2008). According to more recent FNAI data, there are 64 EORs for pigeon wings (J. Annis, FNAI, pers. comm. 2020). Forty-five (70 percent) EORs are on protected sites and 19 (30 percent) EORs are outside protected areas. Of the unprotected sites, 2 are considered extirpated and 17 are either historical or have not been revisited since the 1990s (Annis, pers. comm. 2020).

**[2] when these sites, within the historic range of *C. fragrans*, are adequately protected from habitat loss, degradation, and fragmentation;**

This criterion has been partially met through the acquisition of populations on sites protected by federal, state, county, and private conservation agencies and organizations. Protected populations occur in Lake, Polk and Highlands Counties on the Lake Wales Ridge (LWR) and Winter Haven Ridge, and on the APAFR on the Bombing Range Ridge and contiguous uplands. These populations span most of the known historic range of the species. Fifteen of the 16 managed areas listed by Turner et al. (2006) where pigeon wings occurs are on the LWR, ranging from the Warea Tract of Seminole State Forest (aka Flat Lake) in the north to ABS in the south. Three of the areas targeted for acquisition in Turner et al. (2006) have since been acquired, as has Lake Blue, the single managed area on the Winter Haven Ridge. In addition, a previously undocumented population occurs at Lake Griffin State Park on the Sumter Upland in Lake County (J. Stout, University of Central Florida, pers. comm. 2008c). Historic pigeon wings populations from Orange County (Fantz 1977; Wunderlin et al. 1980) have apparently been extirpated, but pigeon wings is now known to occur in Osceola County (where it was considered extirpated in the 2008 5-year review) at Three Lakes Wildlife Management Area.

**[3] when these sites are managed to maintain the ecotone between xeric oak scrub and high pine that supports *C. fragrans*;**

This criterion has not been met and reflects an antiquated understanding of pigeon wings' habitat requirements. Although pigeon wings does occur on the ecotone between xeric oak scrub and high pine, studies subsequent to the recovery plan have shown that pigeon wings is more of a soil generalist and occurs in several xeric upland

habitats (e.g., sandhill, turkey oak barrens, scrub, oak-hickory scrub, and oak scrub) on white, yellow, and gray sands (Stout and Lewis 2006; Menges et al. 2007b). However, the spirit of the criterion is still valid in that it requires the appropriate maintenance of pigeon wings' habitat, which can include the use of prescribed fire for those habitats. The occurrence of pigeon wings in both frequent and infrequent fire return interval habitats (i.e., both sandhill and scrub) suggests that it is tolerant of a range of fire return intervals, perhaps 3–20 years (Menges et al. 2019). Parts of some managed areas and most other areas may not be burned this frequently. However, determining the optimal fire return interval (Menges 2007) for pigeon wings populations requires data that are not currently available.

**and [4] when monitoring programs demonstrate that populations of *C. fragrans* on 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 not been met. Although there have been surveys of pigeon wings populations at APAFR (Stout and Lewis 2006; Bridges 2018), LWRSF (Clanton 2007; A. Malatesta, Florida Division of Forestry, pers. comm. 2008; Knothe 2017), Tiger Creek Preserve (B. Pace-Aldana, The Nature Conservancy, pers. comm. 2008), and at several smaller protected sites in Highlands and Polk Counties (Weekley et al. 2001; Menges et al. 2007a; Weekley, pers. comm. 2008), none provide data on changes in population sizes in well-defined areas over more than a few years. Given this species' long-life span (> 5 years) and dormancy, population trends need to be assessed over several decades to understand population viability.

## **C. Updated Information and Current Species Status**

### **1. Biology and 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:** Since the MSRP (Service 1999) was finalized, little additional data have been collected on pigeon wings. Level 2 surveys (counting individuals in defined areas) (*sensu* Menges and Gordon 1996) have been conducted at several sites (Weekley et al. 2001; Stout and Lewis 2006; Clanton 2007; Menges et al. 2007a; Malatesta, pers. comm. 2008; Pace-Aldana, pers. comm. 2008). Stout and Lewis (2006) and Lewis (2007) collected survival, density, and fecundity data on 142 plants at APAFR from 2003 to 2005.

Monitoring at APAFR found higher pigeon wings density in burned as compared to unburned plots, with a decreased plant in density at all unburned plots (Knothe 2017). In addition, the majority of flowers produced by pigeon wings were cleistogamous (CL) (self-pollinated). Biologists at LWRSF are currently collecting demographic data (Knothe 2017). To date, monitoring of seven pigeon wings sites has shown survival rates ranging from 60.0 to 96.7

percent with small proportions (2.8 to 8.2 percent) of plants flowering at only three sites.

*Abundance estimates* – EORs compiled by FNAI often have abundance estimates, although these are not standardized. Among the reports with pigeon wings abundance estimates, populations are rarely estimated as having 100–999 plants (4 EORs), while smaller populations of 10–99 plants (23) and less than 10 plants (18) are more typical (FNAI 2019). Abundance data based on counts or estimates are also available for three of the largest protected sites. At APAFR, Stout (pers. comm. 2008b) reported 2,951 plants, based on complete surveys of 59 soil polygons conducted between 2002 and 2006. Plants there were individually tagged and mapped with a GPS (Stout pers. comm. 2008c). At LWRSF, Malatesta (pers. comm. 2008) reported >1,800 plants in total throughout the Arbuckle, Walk-in-Water, and Hesperides tracts; however, the surveys were conducted over a period of three years and some populations may have been counted twice, thereby potentially inflating the final estimate. Finally, at the Tiger Creek Preserve, Pace-Aldana (pers. comm. 2008) estimated the pigeon wings population at >1,000 plants. These numbers, collected over large areas, generally provide estimates of the lower limits of population sizes at each of these three sites.

Minimum abundance estimates are also available for several of the smaller sites, including Crooked Lake Sandhill ( $n \geq 49$ ; Pace-Aldana, pers. comm. 2008), the Warea Tract of Seminole State Forest ( $n = 43$ ; Cox 2006), and the Carter Creek North ( $n = 15$ ), Silver Lake ( $n = 58$ ), and Lake Blue ( $n = 19$ ) tracts of the Lake Wales Ridge Wildlife and Environmental Area (LWRWEA) (Menges et al. 2007a; Weekley, pers. comm. 2008).

*Population trends* - In a study of the postfire responses of 12 Florida scrub endemics, Weekley and Menges (2003) characterized pigeon wings as a moderate resprouter based on the percentage of tagged aboveground individuals present two years postburn (48.4 percent). However, aboveground pigeon wings populations may fluctuate annually due to belowground dormancy (Weekley, pers. comm. 2008). Populations tend to increase markedly and flower profusely following fire, but then decline with time-since-fire (Lewis 2007; Weekley, pers. obs. 2008; H. Rosner-Katz, Florida Department of Agriculture and Consumer Services [FDACS], pers. comm. 2019). High percent flowering by postburn plants also suggests that they are more likely resprouts than seedling recruits (Weekley, pers. obs. 2008).

Data on population trends are scarce for pigeon wings because monitoring programs at most sites do not involve repeated censuses of populations within well-defined areas. However, the evidence that is available, usually based on short-term surveys of relatively few individuals, suggests substantial year to year fluctuations in aboveground population sizes. For example, annual monitoring of a small pigeon wings population (< 70 plants in all years

surveyed) at ABS from 1992 to 2000 found annual survival rates ranging from 72 to 98 percent (Weekley, pers. comm. 2008). Stout et al. (2003) recorded an annual survival rate of 68 percent (28 of 43 plants) in one APAFR population tagged in 2002 and re-surveyed one year later.

For the purpose of determining the effects of management, and given that pigeon wings has many populations, some large, Menges et al. (2019) did not recommend detailed Level 3 monitoring for this species. Instead, they suggested Level 2 monitoring every 2–5 years during peak flowering.

*Demographic features* - There are only two small datasets (< 150 records) that contain useful information on the demographic characteristics of pigeon wings populations. At ABS, annual monitoring of a small, long-unburned population from 1992 to 2000 found that 62 percent (28 of 45) of vegetative individuals tagged in the first year of the project were still alive nine years later (Weekley, pers. comm. 2008). These data provide the only estimate available for the lifespan of pigeon wings individuals and support its classification as a long-lived (> 5 years) perennial. Over the nine years of the study, sexual reproduction was negligible, and few seedlings were found (Weekley, pers. comm. 2008). The study also documented the presence of belowground dormancy in pigeon wings, with 14 percent of tagged plants re-appearing aboveground following a year or more in which they were absent.

Stout and Lewis (2006) and Lewis (2007) followed 142 plants in seven belt transects at APAFR from 2003 through 2005. Lewis (2007) reported “modest” increases in plant densities on recently burned transects, but her sample sizes were too small to detect statistical significance, and factors other than fire may explain the observed differences among transects.

The data on population growth rates in Lewis (2007) are inconclusive and highly variable. Lewis (2007) found that plants produce more CL than chasmogamous (CH) (cross-pollinated) flowers, but overall flower and fruit production were low. CL flowers do not open, and therefore do not allow cross pollination between individuals, thus all resulting seeds are self-pollinated. CH flowers, in contrast, do open, which allows outcrossing to occur, likely via insect pollination. Over the two years of her study, Lewis (2007) recorded only two fruits from CH flowers on her 83 study plants and approximately 20 percent fruit set from CL flowers. These low rates of sexual reproduction are consistent with observations in the ABS study (Weekley, pers. comm. 2008). However, other observers of postfire populations have generally noted more CH than CL flowers (Faivre, pers. comm. 2008). Stout (pers. comm. 2008c) suggests that the spike in postburn CH flowering noted by other observers is short-lived and that CL flowering predominates in subsequent weeks. However, very little data are available on postfire flowering phenology. Lewis (2007) was unable to evaluate the effect of time-since-fire or season-of-fire on fecundity.

**b. Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding):** There have been no genetic studies of pigeon wings.

**c. Taxonomic classification or changes in nomenclature:** None. The Integrated Taxonomic Information System (ITIS) (2019) was checked while conducting this review.

**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):** According to FNAI data (Annis, pers. comm. 2020), pigeon wings is found at 64 locations, mainly in Polk (33) and Highlands (24) counties, with 1–3 extant populations in Lake, Marion, and Osceola counties. The prior 5-year review (Service 2008) reported 77 EORs for pigeon wings. The last observation for each EOR ranges from 1979 to 2019, with the modal last observation for the year 1992. Frantz (1977) and Wunderlin et al. (1980) listed records from Lake, Osceola, Orange, Polk, and Highlands counties. Populations in Orange County have apparently been lost. The Osceola County populations occur in Three Lakes Wildlife Management Area and were last confirmed by FNAI in 2017. In Polk County, pigeon wings occurs in sandhill at Bok Tower Gardens (C. Peterson, Bok Tower Gardens, pers. comm. 2019). Within the current geographic range, additional loss of unprotected populations may result in the isolation of protected populations, especially on smaller sites. Additional surveys and analyses will be necessary to determine how habitat loss and fragmentation within pigeon wings' current range is affecting protected populations.

About 70 percent of known occurrences (45 of 64) of pigeon wings occur on protected areas (Annis, pers. comm. 2020). These include the LWRSF (13), several units of the LWRWEAs (13), the APAFR (8), and other managed areas with fewer occurrences (Annis, pers. comm. 2020). Most of the occurrences in both protected areas (41) and unprotected areas (20) are on the LWR, with other sites on the Bombing Range (APAFR), Winter Haven, and Mount Dora Ridges. On the LWR, pigeon wings is reasonably well distributed.

Pigeon wings is currently known from 18 areas managed for conservation on the LWR: A. D. Broussard Catfish Creek Preserve State Park, ABS, Crooked Lake Sandhill, Jack Creek, LWRSF (Arbuckle, Hesperides, and Walk-in-Water Tracts), Lake Wales Ridge National Wildlife Refuge (Carter Creek South, Flamingo Villas), LWRWEA (Carter Creek North, Holmes Avenue, Lake Placid Scrub, Mountain Lake Cutoff, Royce Ranch, Silver Lake, and Sunray/Hickory Lake Tracts), Seminole State Forest (Warea Tract), and Tiger Creek Preserve. It is also protected at LWRWEA (Lake Blue) on the Winter

Haven Ridge, and at APAFR on the Bombing Range Ridge. FNAI records show that LWRSF (13 EORs) and APAFR (8) have widely distributed populations of pigeon wings (Annis, pers. comm. 2020). Currently, there are 13 occurrences of pigeon wings on LWRWEA, compared to 7 (Carter Creek North, Holmes Avenue, Lake Placid Scrub, Mountain Lake Cutoff, Royce Ranch, Silver Lake, and Sunray/Hickory Lake Tracts) listed in the previous 5-year review (Service 2008). The additional locations include Clements, Lake Blue, and Messana (Menges et al. 2019). Although the Lake Blue site is part of the LWRWEA network, it is located on the Winter Haven Ridge. A previously undocumented population occurs at Lake Griffin State Park, on the Sumter Upland in Lake County, about 24 km northwest of the LWR (Stout, pers. comm. 2008c), but this record is not part of the FNAI database.

The fates of pigeon wings occurrences outside of protected areas are uncertain. Of the 19 occurrences outside of protected areas in the FNAI database, all but three was last checked in 1989 or earlier (at least 30 years ago); two were observed in 1998 and one was observed in 2006 (Annis, pers. comm. 2020). Many of these areas have likely been developed and may no longer support pigeon wings.

**e. Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):** Pigeon wings is a soil generalist, occurring on a yellow, white, and gray sands (Menges et al. 2007b; S. Orzell, APAFR, pers. comm. 2008; Stout, pers. comm. 2008a), although mainly on yellow sands (Menges et al. 2019). It occurs in a range of xeric upland habitats on the Lake Wales, Winter Haven, and Bombing Range Ridges and on xeric upland sites west of Bombing Range Ridge within APAFR. Generally, its habitats are sandhill, turkey oak barrens, and scrub (Menges et al. 2019). On the southern third of the LWR (i.e., the part within Highlands County), it occurs primarily on yellow sands (e.g., Astatula, Paola, and Tavares) in sandhill and oak-hickory scrub, but also on moderately well-drained white sands (Archbold), and on gray sands (Satellite) (Menges et al. 2007b). On the LWR in Polk and Lake Counties, it is also known from yellow, white, and gray sands. On APAFR, it is recorded from four gray sand types (Daytona, Narcoossee, Zolfo, and Duette), primarily in sandhill and oak scrub (Orzell, pers. comm. 2008; Stout, pers. comm. 2008a). Orzell reported a small population at APAFR on Satellite soil (Stout, pers. comm. 2008c).

FNAI (Annis, pers. comm. 2020) comments on ecosystems (which are not standardized) show 31 occurrences in scrub oak/sand pine scrub or scrubby flatwoods, 13 in sandhill, 3 in areas covering both sandhill and scrub, and 3 in transitional areas between scrub and sandhill. Seven occurrences are characterized as sand pine scrub or scrub with no information on the shrub layer. Fewer ecosystems are characterized as turkey oak scrub/yellow sand scrub or open pine woods. The FNAI database also lists associated species, again not standardized. Common associated species (more than 10

occurrences as compiled by E. Menges) include longleaf and slash pine (*Pinus palustris* and *P. elliottii*), several oaks (sand live [*Quercus geminata*], turkey [*Q. laevis*], Chapman's [*Q. chapmanii*]), and palmettos (saw [*Serenoa repens*] and scrub [*Sabal etonia*]). Other shrubs and wiregrass were rarely mentioned. At least a dozen federally listed plant species were mentioned as associates of pigeon wings. The list of species suggests, based on the autecology of these species, that pigeon wings occurs on yellow, white, and gray sands, consistent with the mapping of soil types.

Pigeon wings occurs on properties with a range of sizes, according to FNAI data. The smallest habitat patch is approximately 0.01 acre and the largest is 6,634.35 acres, with a mode and median of 2.81 and a mean of 241.00 acres. The difference between the mean and the median suggests a skewed distribution of habitat patch sizes, with many small patches and a few large habitat areas.

**f. Other:** Heavy vertebrate and invertebrate predation, including the destruction of entire seed crops or the complete removal of aboveground individuals, have been documented for pigeon wings (e.g., Stout and Lewis 2004; Lewis 2007; Faivre, pers. comm. 2008). *Clitoria* spp. are host species for the hoary edge (*Achalarus lyciades*), long-tailed skipper (*Urbanus proteus*), and southern cloudywing (*Thorybes bathyllus*) butterflies (Minno et al. 2005). Long-tailed skippers and southern cloudywings are both known to use pigeon wings as host plants (Stout and Lewis 2004; Weekley, pers. obs. 2008). The impact on pigeon wings plants of partial or complete defoliation is unknown. Other likely invertebrate predators on pigeon wings include orthopterans and possibly seed predating coleopterans. Vertebrate herbivores probably include white-tailed deer (*Odocoileus virginianus*) and eastern cottontail rabbits (*Sylvilagus floridanus*). Herbivory may threaten the persistence of local populations. Pigeon wings plants overgrown by *Cuscuta* sp., a parasitic plant, at one study site at APAFR failed to flower (Stout, pers. comm. 2008c), suggesting that competition for light or resources may limit flowering.

## 2. Five-Factor Analysis

**a. Present or threatened destruction, modification or curtailment of its habitat or range:** Pigeon wings is restricted to xeric scrub habitats in one or more of the interior Central Florida counties of Polk, Highlands, Marion, Osceola, and Lake, where habitat destruction from development continues to occur and development pressure remains high. Aerial extent of post-Columbian xeric upland habitat loss on the Lake Wales Ridge is estimated to exceed 85 percent (Weekley et al. 2008). Increasing pressure from population growth is likely to result in further loss of these habitats in the future. Carr and Zwick (2016) analyzed existing land use and landscape patterns to identify areas (including central Florida) most likely for development to

accommodate a growing human population. They suggest that Florida's 2070 population will be nearly 15 million persons greater than in 2010, for an estimated total of 33,721,828. Using these figures, they estimated relative losses to agriculture, open space, and conservation to other land uses. If trends continue, they estimate 34 percent of land will be developed by 2070, up from 19 percent in 2010. At the same time, conservation lands will increase less than 1 percent (from 9,269,000 acres in 2010 to 9,525,000 acres by 2070). Overall, loss of habitat to development, primarily on private lands, will likely continue in Central Florida, eliminating populations and reducing the area of suitable habitat for pigeon wings. Therefore, habitat on protected lands are critical for the recovery of these scrub plants.

Human development has also disrupted the natural disturbance regime for pigeon wings. Pigeon wings occurs in ecosystems that depend on fire, and fire suppression is likely to lead to habitat conversion and eventual population loss. This threat was considered under Factor E in the listing (58 FR 25746) and 2008 5-year review (Service 2008), but in the current review we have moved this threat to factor A since fire frequency directly effects the habitat available for the species. Because pigeon wings occurs in fire dependent communities with a range of natural fire return intervals, we can infer that it can tolerate a range of fire frequencies and intensities. Based on habitats where the species occurs, pigeon wings likely tolerates fire return intervals ranging from 3–20 years (Menges et al. 2019). Some data (Weekley and Menges 2003; Lewis 2007) and anecdotal evidence (Weekley, pers. obs. 2008) suggest that aboveground populations decline as the time-since-fire interval increases. In addition, for areas where pigeon wings overlaps with the Florida scrub-jay (*Aphelocoma coerulescens*), management for the scrub jay could have negative effects on pigeon wings and its habitat due to the reduced frequency and seasonal timing of burning (Orzell pers. comm. 2020). Orzell (pers. comm. 2020) reported that pigeon wings reproduction is enhanced with lightning fire season burning, which is often prevented due to the overlap with scrub-jay nesting season. Florida scrub-jay is another species listed as threatened under the ESA and also requires management to maintain its habitat. Thus, inadequacies in existing prescribed fire programs may lead to decline in pigeon wings.

In addition to management of habitat through fire, habitat can be managed through mechanical means. There is little information on the effects of mechanical treatments on pigeon wings (Menges et al. 2019). ABS's Population Dynamics of Endemic Plants (Smith et al. 2009) tracks densities in relation to management treatment. Occupancy in 5-meter radius plots one year after fire treatments (64 percent) was slightly less than pre-fire occupancy (73 percent), while fire combined with mechanical treatment with a gyro-trac produced increased occupancies from pre-treatment (56 percent) to one year (83 percent) and two years (94 percent) post-treatment (Menges, unpublished data). Fire treatments increased densities per plot from 1.64 to

2.09 after one year, while fire and mechanical treatment combinations increased densities from 3.17 to 6.89 (one year) to 6.06 (two years) (Menges, unpublished data). These sample sizes are small but suggest that pigeon wings can respond positively to management treatments.

The number of protected areas with pigeon wings has increased since the time of listing, but unprotected sites remain and their status is largely unknown. Schultz et al. (1999) recorded 18 EORs for pigeon wings from 12 Conservation and Recreation Lands (CARL) sites, 11 of which are on the LWR. All but three of these CARL sites have been acquired since 1999, including Lake Blue on the Winter Haven Ridge. Pigeon wings was among 36 imperiled LWR species evaluated by Turner et al. (2006) using protection indices for each species and for three time periods (past, current, targeted) based on number of locations, extent of occurrence, and area of occupancy. The overall protection index of  $< 2$  for pigeon wings marks it as of high conservation concern. However, three of the targeted areas in Turner et al. (2006) have since been acquired. Pigeon wings now has 45 occurrences in managed areas, mainly on the LWR. There are 19 FNAI EORs on unprotected sites. It is not known how many of these sites remain. Surveys of unprotected FNAI EORs will be required to determine if they are still extant. Out of the 45 occurrences in managed areas, 35 have received fire at some point between 2006 and 2018 according to the Florida Fish and Wildlife Conservation Commission (FWC) Fire Occurrence Dataset (2020).

**b. Overutilization for commercial, recreational, scientific, or educational purposes:** None known at this time.

**c. Disease or predation:** Observers following individually marked pigeon wings plants have often noted heavy herbivory on leaves, flowers, and fruits by insects and complete predation of whole plants by vertebrates (Stout and Lewis 2004; Lewis 2007; Faivre, pers. comm. 2008; Weekley, pers. obs. 2008). Leaf herbivory is most likely due to long-tailed skipper (*Urbanus proteus*) and southern cloudywing butterfly (*Thorybes bathyllus*) caterpillars. Flower herbivory may be due to orthopterans, and fruit and seed predation are likely due to coleopterans. Consumption of entire plants is most likely due to white-tailed deer (*Odocoileus virginianus*) and rabbits (*Sylvilagus floridanus*). It is well known that both invertebrate and vertebrate herbivory of plants can severely impact the fecundity and reproductive output at both the individual (Amsberry and Maron 2006) and population level (Maron and Crone 2006). However, the population level impact of predation specifically on pigeon wings has not been determined.

There is no evidence of disease affecting pigeon wings.

**d. Inadequacy of existing regulatory mechanisms:** Pigeon wings is listed as endangered by the State of Florida on the Regulated Plant Index (FDACS

Rule 5B-40). This law regulates the taking, transport, and sale of listed plants. However, property owners are not prohibited under this law from destroying populations of listed plants nor are they required to manage habitats to maintain populations.

Existing Federal (ESA) and state regulations (FDACS Rule 5B-40) prohibit the removal or destruction of listed plant species on public lands. However, they afford no protection to listed plants on private lands. In addition, state regulations are less stringent than federal regulations on land management practices that may adversely affect populations of listed plants. In conclusion, there are no existing regulatory measures that reduce or remove the threat of loss of populations or removal/destruction of plants on private property and existing regulatory mechanisms are inadequate to protect this species.

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

*Isolated Populations Within a Limited Geographic Range*

Pigeon wings occurs within a relatively limited geographic range consisting of five Central Florida counties. The limited geographic range in combination with the loss of habitat has resulted in a highly fragmented landscape where the remaining scrub areas that provide habitat for pigeon wings have become more and more isolated from each other, thereby making resiliency, redundancy, and representation more challenging to achieve. Given the limited geographic range of the species, a single catastrophic event could greatly reduce redundancy. In addition, the fragmented landscape may prevent ‘rescue’ or ‘repopulation’ from surrounding nearby populations.

*Climate Change*

There is currently no evidence of negative impacts to pigeon wings 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 make 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°F (0.8 to 3.1°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 amounts (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 species, in general, can tolerate drought conditions, but it is unclear how this anticipated future threat will fully affect species like pigeon wings. In addition, it is unknown how these changes will influence

pollinators, seed bank, or the ability to implement prescribed fire.

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**

In summary, minor progress has been made in meeting the recovery criteria for pigeon wings, and much more work is needed to fully achieve recovery. In terms of the acquisition of protected sites, great improvement has been made since the time of listing. Protected areas now encompass over two-thirds (roughly 70 percent) of the known populations throughout most of the historical range of pigeon wings (Turner et al. 2006; Menges et al. 2019; Annis, pers. comm. 2020). However, less than one-third (approximately 30 percent) of the known pigeon wings populations occur on unprotected sites and their status is largely unknown. Additional surveys are needed to assess the status of these unprotected sites. It is estimated that 35 EORs on managed areas have received fire at some point between 2006 and 2018 (FWC 2020), yet the lack of management of sites to maintain habitat appropriate for the species continues to be a threat for both protected and especially unprotected sites. Pigeon wings may be threatened due to the inadequate use of prescribed fire or use of mechanical substitutes for fire which may adversely affect populations.

As the human population continues to increase in Florida, development is a continued threat that will increase throughout the range of the species. Additionally, the limited geographic range and isolated populations due to habitat loss and fragmentation present additional risk for pigeon wings. Anticipated climate change factors such as altered temperature and precipitation patterns and sea-level rise will only worsen these threats. Due to the probability of continued populations losses at unprotected sites and the lack of adequate fire management at some sites, pigeon wings continues to meet the definition of threatened under the ESA.

### **III. RESULTS**

#### **A. Recommended Classification:**

  X   **No change is needed**

### **IV. RECOMMENDATIONS FOR FUTURE ACTIONS**

- Quantitative surveys (e.g., Weekley et al. 2001; Stout and Lewis 2006; Malatesta, pers. comm. 2008) of pigeon wings populations at several sites to establish the basis for level 2 monitoring (*sensu* Menges and Gordon 1996) to track changes in population size over time and in response to management treatments. These surveys should be

repeated at defined intervals (e.g., annually, bi-annually, every five years; both before and after imposition of management treatments) and take place within well-defined areas (e.g., within plots small enough to be searched thoroughly and thereby reduce inconsistencies in sampling intensity).

- Where monitoring is being conducted, data should be collected on fire and other management activities to aid in the interpretation of trends and to identify the most favorable treatments.
- Conduct surveys to assess the status of the 19 FNAI EORs that occur on unprotected sites and to evaluate the feasibility of protecting additional pigeon wings populations. Any new populations discovered should be added to the FNAI database.
- Demographic data need to be collected across the full geographic range of pigeon wings, from both scrub and high pine habitats, and from populations responding to contrasting management treatments (e.g., fire alone vs. various mechanical treatments being used as a substitute or pre-treatment to fire). Demography needs to be related to fire management parameters, including fire frequency, time-since-fire, fire intensity, and fire patchiness.
- As we learn more about the fire requirements of pigeon wings, prescriptions should be adjusted to a frequency and intensity appropriate to avoid habitat degradation.
- Study the seed production, seedling establishment, and seedling survival at various populations.
- Study the floral biology, pollination ecology, and demography in detail throughout the species' range, including comparison of pollinator numbers to chasmogamous flowers at different populations.
- Careful data collection is needed to further investigate plant dormancy, which may be an important trait allowing persistence at a site through unfavorable times.
- The extent of invertebrate and vertebrate predation on pigeon wings needs to be quantified.
- Genetic studies should be conducted to understand the genetic diversity of the species; this may aid in the identification of new acquisition needs.

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**U.S. FISH AND WILDLIFE SERVICE**  
**5-YEAR REVIEW of Pigeon Wings (*Clitoria fragrans*)**

**Current Classification:** Threatened.

**Recommendation resulting from the 5-Year Review:**

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

**Review Conducted By:** Emily Bauer, Florida Ecological Services Office, Vero Beach.

**FIELD OFFICE APPROVAL:**

**Lead Field Supervisor, Fish and Wildlife Service**

Approve \_\_\_\_\_ Date \_\_\_\_\_

\* Since 2014, Southeast Region Field Supervisors have been delegated authority to approve 5-year reviews that do not recommend a status change.

**ADDENDUM 1, APPENDIX A**  
**Peer Review**  
**Summary of peer review for the 5-Year Review of**  
**Pigeon Wings (*Clitoria fragrans*)**

**A. Peer Review Method:**

Initial draft peer review was requested from four individuals outside the Service who are knowledgeable of pigeon wings.

**B. Peer Review Charge:**

In order to ensure that the best available information was used to conduct this 5-Year Review, we conducted a peer review of the draft document. Carrie Straight, Recovery Coordinator for the Atlanta Regional Office managed the peer review. On November 2, 2020, she emailed a draft copy of the 5-Year Review Addendum to four individuals who do not work for the Service. Specifically, we asked for comments on the validity of the data used, and the identification of any additional new information regarding pigeon wings that had not been considered in this review. We specifically mentioned that we were not seeking the opinion on the legal status of this species, but rather that the best available data and analyses were considered in reassessing the status.

As part of the peer review process, we must evaluate the potential for conflicts of interest with the subject species or the action. Therefore, we asked each reviewer to fill out a Conflict of Interest form and return it with their comments.

**C. Summary of Peer Review Comments/Report:** We received peer review comments from two reviewers. They included two recommendations for future actions, an editorial issue, and updates on Florida Natural Areas Inventory element occurrence records. The following future actions were recommended: 1) to study the seed production, seedling establishment, and seedling survival at various populations and 2) to study the floral biology, pollination ecology, and demography in detail throughout the species' range, including comparison of pollinator numbers to chasmogamous flowers at different populations.

**D. Response to Peer Review:** We appreciate and agreed with all comments and concerns received from peer reviewers. Specifically, the two recommendations for future actions were incorporated, one editorial issue was addressed, and the new information on the number of element occurrence records was updated.