

**Wide-leaf Warea  
(*Warea amplexifolia*)**

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



**Seminole State Forest Warea Tract, Lake County. Photo: Todd Mecklenborg**

**U.S. Fish and Wildlife Service  
Southeast Region  
North Florida Ecological Services Office  
Jacksonville, Florida**

**5-YEAR REVIEW**  
**Species reviewed: Wide-leaf Warea (*Warea amplexifolia*)**

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**5-YEAR REVIEW**  
**Wide-leaf Warea (*Warea amplexifolia*)**

**I. GENERAL INFORMATION**

**A. Methodology used to complete the review**

On September 23, 2014, the U.S. Fish and Wildlife Service (hereafter the Service) published a notice in the *Federal Register* (79 FR 56821) announcing the new 5-year review of this plant and requesting new information concerning the biology and status of this species. A 60-day comment period was opened, but no comments were received from the public.

This review incorporates information found in the final rule listing this species under the Endangered Species Act of 1973, as amended (Act), the *Warea amplexifolia* (Clasping Warea) Recovery Plan (1993), our previous 5-year reviews, research project reports, unpublished field observations, and personal communications. We relied on the best available information pertaining to historic and current distributions, life history, threats, and habitat of the species. Comments and suggestions from peer reviewers were incorporated as appropriate (see Appendix A). No part of this review was contracted to an outside party. This review was completed by the Service's species lead recovery biologist. The documents used to complete this review are on file at the North Florida Ecological Services Office, Jacksonville, Florida.

**B. Reviewers**

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

**Lead Field Office:** Todd Mecklenborg, North Florida Ecological Services Field Office, 904-731-3029

**Cooperating Field Office:** David Bender, South Florida Ecological Services Field Office, 772-469-4294

**C. Background**

1. **Federal Register Notice citation announcing initiation of this review:** 79 FR 56821, September 23, 2014
2. **Species status:** The number of natural populations has declined since the previous 5-year review. Ten extant natural populations were identified in the 2007 review of which five of these populations are now extirpated: an additional population's most recent survey (2016) failed to observe any plants, and another population only one individual plant was observed when surveyed in 2015.

Currently, nine extant natural populations are known in Lake, Marion, and Polk counties. During this review, the nine natural extant populations identified consist of the previous five populations known in the 2007 review and four natural populations not reported or discovered at the time of the previous review. Of these nine extant natural populations, two natural populations in Polk County were known as far back as the mid to late nineties on private lands but were not noted in the previous 5-year review. A third natural population was discovered on private property in Marion County in 2007. A fourth natural population was reported in Lake County along a private road/utility easement in 2014. Four of the currently known natural populations occur on publically protected lands; however, long-term population viability is uncertain for three of the sites.

Six population introductions and one population augmentation have occurred since 2011 (Section II.C.1.a. defines the use of these terms). Only three population introduction efforts were still extant in the fall of 2016 (excluding an introduced population with one plant observed in 2016), but the long-term viability of the three introduced populations is unknown.

To summarize, nine natural extant populations and three introduced populations remain. This information is detailed in Table 1 and Table 2.

3. **Recovery achieved:** 2 (26-50% recovery objectives achieved)
4. **Listing history:** Original Listing  
FR notice: 52 FR 15501  
Date Listed: April 29, 1987  
Entity listed: Species  
Classification: Endangered
5. **Associated rulemakings:** None
6. **Review History:** The initial 5-year review for this plant was noticed on November 6, 1991 (56 FR 56384). No changes in status were recommended for this plant at that time.

A second 5-year review was announced September 27, 2006 (71 FR 56545). The 2007 review noted that 10 sites were historically known in 3 counties; however, the status of the population at several locations was unknown. Lack of management and monitoring at most sites remained a concern. Drought and fire suppression were noted as having negative effects on the species in sandhill habitat. Summarizing the review, habitat loss and degradation continued to threaten *W. amplexifolia* existence. The Service did not recommend a change in listing classification or status in the 2007 review.

Final Recovery Plans: 1993 and 1999 (see below under 8.)

Each year, the Service reviews and updates listed species information to benefit the required Recovery Report to Congress. Through 2013, the Service completed a recovery data call that included showing status recommendations like “Declining” for this plant. The Service continues to show the species status recommendation as part of our 5-year reviews. The most recent evaluation for this plant was completed in 2016.

7. **Species’ Recovery Priority Number at start of review (48 FR 43098): 2C.** The “2” indicates a high degree of threat and high recovery potential; the “C” reflects a degree of conflict with development.

8. **Recovery Plan:**

**Name of plan:** *Warea amplexifolia* (Clasping Warea) Recovery Plan

**Date issued:** February 17, 1993

**Name of plan:** South Florida Multi-Species Recovery Plan (identifies recovery contributions for the South Florida Ecological Service’s Field Office area of responsibility)

**Date issued:** May 18, 1999

## II. REVIEW ANALYSIS

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

1. The Act defines species as including any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate wildlife. This definition limits listing DPS to only vertebrate species of fish and wildlife. Because this species 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?** Since the recovery plan was written in 1993, new information has been collected and analyzed on the species biology and habitat requirements. During this timeframe, several of the noted recovery actions addressing threats in the plan including acquisition and protection of existing populations; research to determine adequate timing and frequency of habitat management, habitat attributes, and monitoring; and new population establishment parameters have been accomplished. The gained knowledge has resulted

in an increased understanding of many of the attributes identified in the plan to aid in alleviating the stressors.

In general, the recovery actions in the recovery plan adequately identify basic information required on population biology to inform a reassessment of the criteria if necessary. Based on the actions identified in the plan, conservation partners continue to gather important biological and ecological data on the species. As noted in the plan, eventually the acquired information will aid in determining if the number and size of the populations identified in the criteria are adequate to constitute stable, self-sustaining populations.

- b. Are the 5 listing factors that are relevant to this species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)?** Yes, Factor A (habitat destruction) was noted as the primary threat to the species particularly development (housing and agriculture), sand mining, and fire exclusion and lack of habitat management. Although not listed as threats in the recovery criteria, invasion of exotic species and rainfall amount and timing (drought) were noted as recovery actions addressing threats (Factor E).

- 3. List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information. For threats-related recovery criteria, please note which of the 5 listing factors are addressed by that criterion. If any of the 5-listing factors are not relevant to this species, please note that here.** *“Warea amplexifolia could be considered for reclassification from endangered to threatened status when 10 geographically discrete, self-sustaining populations are protected and managed for 10 years. Delisting could be considered when 20 such populations are protected and managed, and each has been monitored for at least 8 years. Recovery will require a minimum of 10 years (until 2003), if establishment of new populations is prompt and obviously successful.”*

Habitat loss and destruction, from development and sand mining (Factor A), are the primary threat to the species. Fire exclusion (Factor E) was also included as a threat. These threats are addressed in the recovery criteria by protecting (Factors A and D) and managing (Factor E) populations. However, drought and exotic species encroachment (*Melinis repens*) have impacted areas occupied by *W. amplexifolia* and should be addressed if the recovery plan is updated or revised. Factors B and C are not considered threats at this time.

A total of 12 populations are known to occur in Lake, Marion, and Polk counties: nine natural extant populations and three extant recently introduced populations (excluding an introduction with one plant observed in 2016). Four of the natural populations occur on publicly protected lands. Of the natural populations existing on managed public lands, only one population appears to be self-sustaining. The

long-term viability of the three introduced populations is unknown at this time since they have not been managed nor monitored for a sufficient number of years per the recovery criteria. This information is detailed in Table 1 and Table 2.

## C. Updated Information and Current Species Status

### 1. Biology and Habitat

- a. **Abundance, population trends, demographic features, or demographic trends:** As noted in the literature and the previous 5-year review, *W. amplexifolia* is an annual species that has dramatic fluctuations in plant numbers within populations on a yearly basis. The seed bank appears to be very resilient over time, but germination of the seed is dependent on open sandy areas typically resulting from periodic fire or other types of soil disturbance and the amount and timing of rainfall occurring in December through the early spring growing season (HBS 1994, Cox 2006). Complete reproductive failure in unfavorable years, high seed production in favorable years, low rates of seed germination, and a persistent seed bank are consistent with predictions for an annual species in a variable habitat (Weekley et al. 2007). Given these ecological conditions necessary for successful seed germination annually, assessing abundance and population trends are a very difficult endeavor even with long-term monitoring data.

For instance, a population at Mountain Lake Estates disappeared in 1991 having no individual plants observed over the next 19 years. After a burn occurred and apparently ensuing favorable rainfall, 10 individual plants were observed the following growing season. Also validating the species seed bank resiliency was an experimental propagation effort by Bok Tower Gardens (BTG) in 1994. They documented seeds that had been sown into field plots germinated two to four years later indicating the importance of seed banking for this species until favorable habitat conditions occur.

An example that illustrates variable individual abundance is the monitoring data from Seminole State Forest's Warea Tract (EOR #6, formally Flat Lake). For three years (2004-2006), no individual plants were observed at the site. The following year 2,034 adult specimens were observed in the fall of 2005. By the end of 2006, only 53 plants reached maturity. This site is currently the largest population and once again rebounded from 5 individuals in 2015 to an estimated 8,793 individuals in September of 2016 after a prescribed fire occurred in the summer of 2015 (Peterson 2016).

A second population located at Lake Griffin State Recreation Area (EOR #1) also has relatively long-term monitoring data. Periodic monitoring

data since the early 1990's authenticates a similar pattern. Beginning in 1990, 40 individuals were documented in suitable habitat. Three years later the population was estimated at 800 plants (1993). By 1996, the population was roughly similar to the 1990 counts with a total of 45 plants present. The 2000 census data recorded 251 plants, followed by a 300 plant count in 2003. The most recent series of surveys (2012, 2013, 2014, and 2016) recorded 22, 23, 36, and 0 individuals respectively (Peterson 2012, 2014, 2016).

However, researching management effects among populations in close proximity may aid in an increased understanding of the ecological conditions that influence population abundance. For example, if rainfall is relatively similar in timing and frequency between two sites among years, a comparison between populations (flourishing versus sparse or absent) could signify if habitat conditions from management – timing, type, or time since management – result in positive or negative outcomes.

### Natural Populations

The most recent data suggest there are over 10,000 plants in the 9 extant natural populations (Peterson 2016); however, the Warea Tract in Lake County and the Ocklawaha property (Ocklawaha North EOR #28 and Ocklawaha South EOR #30) in Marion County typically account for greater than 95% of the plants range-wide. Lake Griffin State Recreation Area historically had a larger population, but the recent surveys suggest the population appears to be declining. The remaining six populations generally have low population numbers (Table 1).

Five of the populations identified in the 2007 review are among the remaining natural extant populations plus an additional four natural populations not reported during the previous review. Of the 10 total populations noted in the 2007 review five populations are now extirpated (one of the existing populations had no plants observed during the most recent survey but it is not yet considered extirpated and at another population only one plant was detected). The additional four natural populations include: 1. a population in Lake County (Bissett Property EOR #3) that was known as far back as 1997 at a private nursery but was not noted in the 2007 5-year review (conservation easement in 2010); 2. a natural population that was identified in the mid-nineties on private land in Polk County (Mountain Lake Estates EOR #26), which was inadvertently included as part of a public parcel (Mountain Lake Scrub); 3. a population that was discovered on private property in Marion County in 2007 (Ocklawaha North and Ocklawaha South); and, 4. a population that was reported in Lake County along a private road/utility easement in 2014 (Twin Lakes EOR #27).

Currently, four of the nine extant populations (Lake Griffin State Recreation Area, Warea Tract, Sugarloaf Mountain, and Schofield Sandhill) occur on public lands, four populations (Ferndale Ridge, Bissett Property, Mountain Lake Estates, and Ocklawaha North and South) are under private ownership, and one population (Twin Lakes) occurs on private property and in a road/utility easement. Given the vast majority of the plants occur at two sites and only one of the two large populations occurs on managed public conservation lands, the species remains vulnerable to extinction.

The following table is a comparison of the reported extant populations for the 2007 and the 2017 species 5-year reviews. The information in the following table provides the specific details of the natural population's site name, Florida Natural Areas inventory (FNAI) Element Occurrence Records (EOR) number, the county where they occur, the property ownership, and the number of plants counted and year surveyed.

Table 1. Extant natural population and plant numbers in 2006 and 2016.

EOR	Site	County	Ownership	Plants 2006	Plants 2016
#1	Lake Griffin State Recreation Area	Lake	Florida State Park	300 (2003)	36 (2014) 0 (2016)
#3	Castle Hill	Lake	Private Ownership	Not reported (2006)	Extirpated
#6	Warea Tract	Lake	Florida Forest Service	2,034 (2005) 53 (2006)	8,793 (2016)
#7	Bok Tower Sandhill (HBS)	Polk	Private Conservation Land	8 (2004) 0 (2006)	Extirpated
#9	Sugarloaf Mountain	Lake	St. Johns River Water Management District	Not reported (2006)	7 (2015)
#10	Lake Davenport	Osceola	Private Ownership	Not reported (2006)	Extirpated
#11	Schofield Sandhill	Lake	City of Orlando and Orange County	Not reported (2006)	40 (2015)
#13	Ferndale Ridge	Lake	Private Ownership	Not reported (2006)	1 (2015)
	Mountain Lake Scrub	Polk	Florida Fish and Wildlife Conservation Commission	Not reported (2006)	Extirpated
	Hills of Minneola	Lake	Private Ownership	Not reported (2006)	Extirpated
#23	Bissett Property	Polk	Private Ownership Conservation Easement		~10 (2015)
#26	Mountain Lake Estates	Polk	Private Ownership		61 (2016)
#27	Twin Lakes	Lake	Private Ownership and Utility Easement		27 (2015)
#28, #30	Ocklawaha North and South	Marion	Private Ownership		2,600 (2014)

Warea amplexifolia Introductions

Securing a sufficient number of self-sustaining populations on protected, managed lands is one of the recovery objectives identified in the recovery plan (Service 1993). To accomplish this, population introductions and population augmentations were identified as recovery actions to aid in achieving the recovery criteria (Service 1993, Service 1999).

Population introductions first occurred in 2011 and have continued through 2016. These efforts were performed by BTG and to date six population introductions and one augmentation in each of Lake, Orange, and Polk counties have been completed (Peterson 2016). A population introduction is a situation where the species has been propagated at a nursery and then planted in what appears to be suitable habitat on conservation lands within the historic range of the species where the species has never been observed. An introduction can also be a direct seeding into suitable habitat. All of the population introductions were propagated individuals from a nursery setting. The term suitable habitat would be an area with similar flora assemblages, soils, and vegetative structures and openness to a naturally occurring population. The term augmentation refers to a recipient site where there is an existing population but the numbers of individuals present are few or the population has shown a significant decline over time.

The following table summarizes the introductions and augmentation that have occurred.

Table 2. Population introductions and augmentations.

Location	County	Introduction Year	Augmentation Year	2016 Plant Present
Scrub Point Preserve	Lake	2011, 12, 13		yes
Mountain Lake Estates	Polk		2011, 12, 13, 14	yes
Ferndale Preserve	Lake	2013		yes (1 plant)
Oakland Nature Preserve	Orange	2014		No
Palatlahaha River Park and Boat Ramp	Lake	2014		No
Crooked River Preserve	Lake	2014		yes
Lake Louisa State Park	Lake	2016		yes

Three of the introduced sites – Scrub Point Preserve, Crooked River Preserve, and Lake Louisa State Park – had extant populations during the fall 2016 surveys. At the Ferndale Preserve introduction site, only one plant was observed. The introduced populations having no plants present during the most recent surveys appear to have failed: however, a seed bank may have been created that has the potential to yield plants in the future. The augmented population at Mountain Lake Estates occurs on private lands in an area that forms a buffer between the development and its associated golf course. Continued monitoring will be required to

determine the definite fate of these sites. The long-term viability for the remaining introduced extant populations is unknown at this point.

To summarize, of the entire currently occupied habitat, only one population occurring on protected, managed conservation land (Warea Tract) appears to have long-term viability. The three introduced populations having plants present in 2016 have not been monitored for the minimum number of years to determine if they will be self-sustaining long-term. The reclassification metric (endangered species to threatened species) requires 10 geographically distinct, self-sustaining populations to be protected and managed for 10 years.

- b. Genetics, genetic variation, or trends in genetic variation:** An understanding of the genetic variation within and between populations is essential for maintenance of extant populations and successful introductions of healthy, self-sustaining populations (Peterson 2016). Gene flow among populations of *W. amplexifolia* is probably limited because they are widely separated so the individuals in the populations may be genetically distinct and locally adapted, as commonly occurs in plants (Frankham et al. 2009) and as has been documented for *W. carteri* (Evans et al. 2000).

During population surveys and monitoring in 2014 and 2015, BTG collected leaf samples from each of the remaining natural populations of *W. amplexifolia* for population genetic analysis. Whole genomic DNA was extracted from each sample. No microsatellite markers have previously been developed for this species (Peterson 2016).

Since those surveys, microsatellites specific to *W. amplexifolia* have been successfully developed. Over 4,000 polymorphic microsatellites were identified, and 48 loci were selected as optimum for primer development. A primer is a short strand of RNA or DNA that serves as a starting point for DNA synthesis. DNA extractions were completed for roughly 80% of the leaf samples collected for this project, and screening of the DNA using 20 of the most optimum primer pairs is currently underway (Peterson 2016).

**c. Taxonomic classification:**

Kingdom:	Plantae
Subkingdom:	Viridiplantae
Infrakingdom:	Streptophyta
Superdivision:	Embryophyta
Division:	Tracheophyta
Subdivision:	Spermatophytina
Class:	Magnoliopsida

Superorder: Rosanae  
Order: Brassicales  
Family: Brassicaceae  
Genus: *Warea*  
Species: *amplexifolia* (Nuttall) Nutt.  
Common name: wide-leaf warea, wideleaf pinelandcress

\* Retrieved 1/24/2017, from the Integrated Taxonomic Information System on-line database, <http://www.itis.gov> .

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

*Warea amplexifolia* is endemic to the Lake Wales Ridge of central peninsular Florida. The FNAI has assigned 30 EOR for *W. amplexifolia*; however, over time extirpated populations are often eliminated from the database if: the habitat no longer exists, the species was misidentified, or multiple EORs are combined because of proximity to one another (< 1 kilometer). The current database suggests that there have been 25 historically known sites occurring in Lake, Orange, Osceola, Marion, and Polk counties.

Prior to listing the species was known to occur in Lake, Orange, Osceola, and Polk counties at 10 locations (Judd 1980). When it was listed in 1987, only four locations were known with two occurrences in Lake County and two occurrences in Polk County (Service 1987); the species was considered extirpated from four sites in Orange County, one site in Osceola County, and one site in Lake County (Judd 1980). The 1993 *Warea amplexifolia* Recovery Plan noted 10 populations existed in Lake and Polk counties.

In 1994 and 1995, FNAI performed surveys in Lake County for Lake County Water Authority and the St. Johns River Water Management District. This effort identified 17 sites within the Lake County boundary during this time period. Two extant sites remained in Polk County at this time and an additional site was documented in 1996/1997 also in Polk County (Service 1999).

In 2000, FNAI reported less than 20 populations remained range-wide. By 2005 the data from BTG suggested that only 10 populations remained. Currently, nine extant natural populations are known in Lake, Marion, and Polk counties (Table 1.). Three introduced populations in Lake County continue to persist that were introduced from 2011 through 2016 (Table 2.).

Summarizing the trends in special distribution, nine natural populations and three introduced populations currently have occupied habitat of varying degrees for a total of 12 populations range-wide.

- e. **Habitat or ecosystem conditions:** *Warea amplexifolia* is endemic to high pine ecosystems of Florida. The high pine refers to the hilly portions of the ecosystem rather than the stature of the pines themselves. The undulating xeric sand ridges supporting the high pine are known as sandhills and the entire community is referred to by the same term. Sandhills are maintained under natural conditions by frequent patchy summer fires sparked by lightning. The resulting habitat condition is an open, often sparse over-story plant assemblage of longleaf pine (*Pinus palustris*), longleaf pine/turkey oak (*Quercus laevis*), or live oak/bluejack oak (*Q. geminata/Q. incana*) with an open, park-like understory. The ground cover consists of perennial grasses and forbs interspersed with deciduous clonal oaks (Myers 1990). *Warea amplexifolia* occurs on well-drained, sterile, yellow sands and is typically widely scattered in the sunny openings of the sandhills.

A site described prior (II.C.1.a.) currently with the largest population on public lands, the Warea Tract is an epitome of a classic restored sandhill community providing optimal habitat conditions for this species to thrive. The site was acquired in 1997 by the Florida Forest Service for the sole purpose of protecting rare endemic Florida flora. The 120 acre parcel was acquired with the goal of restoring the overgrown sandhill to support robust plant populations and potentially serve as a seed source for other sites. The parcel has three management units (Northwest, Northeast, and Southeast). Two of the management units have had restoration management activities (mechanical reduction of vegetation and prescribed fire) post acquisition. Prescribed fire has been applied to the Northwest Unit in 2004, 2011, and 2015. The Northeast Unit was burned in 2007 and 2015. The current habitat conditions are very similar to the desirable description noted in the beginning of this section. All *W. amplexifolia* observations occur in these management units. No management has occurred in the Southeast Unit and no plants have been observed within the unit's boundary.

- f. **Other:** BTG first began propagating this species in 1986 primarily to increase plant numbers and seed production. Since 2003, BTG has focused on recovery actions addressing threats identified in the recovery plan and recommendations for future actions detailed in the 5-year review completed in 2007. Accomplishments described in the previous 5-year review are not included in this review.

The most recent research efforts include pollination biology, spatial seedling recruitment patterns, and demography. Additionally, BTG is also working to identify factors, such as drought and changes in habitat that may influence *in situ* recruitment, survival and phenological responses. Their ongoing microhabitat research is building on the previous study

(Peterson 2012) and is incorporating management and vegetation influences over time, and through climate change studies. Many of these efforts are underway but will require many years of monitoring to adequately determine the influence of management and climate. Other studies will require additional funding to be accomplished and completed.

Propagation of seedlings for the Lake Louisa State Park introductions by BTG began in February 2016. Germination experiments were designed to propagate seedlings for the introductions, and data influencing *in situ* seedling recruitment. Three main factors were explored in the 2016 germination experiments: viability across collection sites, the influence of maternal genotype on viability, and the influence of rainfall on germination and seedling survival. The data on the impact of maternal genotype on seed viability was analyzed in late 2016 and showed a significant variation between source site and maternal parent. Greenhouse germination experiments showed a marked influence on seedling recruitment and survival with calculated average low and average high springtime rainfall levels for Lake County. The results suggest seeds do not readily germinate without sufficient, regular rainfall. Very late-germinating seeds can compensate for the reduced growth time with a higher growth rate, but very few are able to reach reproductive capability before senescence<sup>1</sup> (Peterson 2016).

## 2. Five-Factor Analysis

- a. **The present or threatened destruction, modification or curtailment of its habitat or range:** Habitat destruction, modification, and degradation on private lands remain the primary threat to the species range-wide. Populations occurring on private lands remain subject to habitat destruction or fragmentation due to development. In addition, the absence of habitat management on private lands results in unsuitable conditions for the species to successfully flourish and reproduce.

Publicly owned conservation lands typically are afforded controlled access and may even have enforcement personnel on-site to prevent destructive activities. These lands also have management plans to create, restore, or maintain desirable habitat conditions; however, budget shortfalls and staffing constraints may preclude beneficial activities in some years. Also, depending on the management plan for various public lands, not all public conservation lands where the species occurs are specifically managed to benefit *W. amplexifolia*. The management is often a balance of the multi-use activities occurring on the sites and prioritized accordingly to available budget and respective mission (e.g. state park, state forest, county or city utility property, etcetera).

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<sup>1</sup> Senescence: deteriorative processes that terminate naturally the functional life of an organ or organism; it is controlled by hormones (Allaby 1998).

Currently, four of the extant populations (Lake Griffin State Recreation Area, Warea Tract, Sugarloaf Mountain, and Schofield Sandhill) occur on public lands, four populations (Ferndale Ridge, Bissett Property, Mountain Lake Estates, and Ocklawaha North and South) are under private ownership, and one population (Twin Lakes) occurs on private property and in a road/utility easement.

- b. Overutilization for commercial, recreational, scientific, or educational purposes:** Not known as a threat at the time of listing or at present.
- c. Disease or predation:** Not known as a threat at the time of listing or at present.
- d. Inadequacy of existing regulatory mechanisms:** The Florida Administrative Code 5B-40 (Preservation of Native Flora of Florida) provides the Florida Department of Agriculture and Consumer Services (FDACS) with limited authority to protect plants on State and private lands (primarily from the standpoint of illegal harvest). *Warea amplexifolia* is listed as an Endangered Plant under this statute, which requires anyone wishing to “willfully harvest, collect, pick, remove, injure, or destroy any plant listed as endangered growing on the private land of another or on any public land or water” to “obtain the written permission of the owner of the land or water or his legal representative” (FAC 5B-40.003(1)(a)). A permit is also required to transport “for the purpose of sale, selling, or offering for sale any plant contained on the endangered plant list which is harvested from such person’s own property” (FAC 5B-40.003(1)(c)).

Lake Griffin State Recreation Area was acquired by the state of Florida in 1946 to conserve, protect, and manage the property for outdoor recreation under the Murphy Lands Act of 1937 (FDEP 2004). In 1968, the Board of Trustees of the Internal Improvement Trust Fund conveyed management authority to the Division of Recreation and Parks under a lease due to expire in 2067. The unit management plan for these lands under the requirements of Sections 253.034 and 259.032, Florida Statutes, Chapter 18-2, Florida Administrative Code, intends to be consistent with the State Land Management Plan. The conservation land has an approved unit management plan in place to protect and monitor *W. amplexifolia* (FDEP 2004).

The Warea Tract was acquired in 1997 and is now managed by the Florida Forest Service as part of the Warea Archipelago project for the Conservation and Recreational Lands program. The Warea Tract is one of six sites in the Warea Archipelago project targeted for long-term preservation of the rapidly disappearing upland biodiversity of the

northern Lake Wales Ridge. This tract is one of several permanent preservation sites consisting of sandhill and associated ecosystems on the Lake Wales Ridge (Cox 2006).

- e. **Other natural or manmade factors affecting its continued existence:** Drought, fire suppression, and invasive plant species encroachment continue to negatively affect *W. amplexifolia* populations.

The Intergovernmental Panel on Climate Change (IPCC) concluded that warming of the climate system is unequivocal (Pachauri et al. 2014). Effects associated with changes in climate have been observed including changes in arctic temperatures and ice, widespread changes in precipitation amounts, ocean salinity, and wind patterns and aspects of extreme weather including droughts, heavy precipitation, heat waves, and the intensity of tropical cyclones (Pachauri et al. 2014). Species that are dependent on specialized habitat types, limited in distribution, or at the extreme periphery of their range may be most susceptible to the impacts of climate change (Byers and Norris 2011; Anacker et al. 2012). However, while continued change is certain, the magnitude and rate of change is unknown in many cases. The magnitude and rate of change could be affected by many factors (e.g., circulation patterns), but we have no additional information or data regarding these factors with respect to *W. amplexifolia*.

There is evidence that some terrestrial plant populations have been able to adapt and respond to changing climatic conditions (Franks et al. 2013). Both plastic (phenotypic change such as leaf size or phenology) and evolutionary (shift in allelic frequencies) responses to changes in climate have been detected. Both can occur rapidly and often simultaneously (Franks et al. 2013). Relatively few studies are available, however, that (1) directly examine plant responses over time, (2) clearly demonstrate adaptation or the causal climatic driver of the responses, or (3) use quantitative methods to distinguish plastic versus evolutionary responses (Franks et al. 2013).

## D. Synthesis

Currently there are nine naturally occurring populations. Four of these populations existed on public properties and the remaining five occur on private property. Only one population occurring on public property appears to have long-term viability based on the monitoring data and reoccurring habitat management (Table 2.)

Recent population introduction have shown some success; however, the long-term viability of these efforts will not be determined for many years to come. Including the extant introduced population, a total of 12 populations existed during this review effort.

Acquisition of populations on private lands and active management coupled with long-term monitoring for all populations are of immediate importance. The species remains in danger of extinction throughout all or a significant portion of its range. Of the five listing factors, Factor A (habitat destruction, modification and fragmentation or curtailment of its habitat or range) is the main threat to *W. amplexifolia*. Factor E that includes drought, fire suppression, and invasive plant species encroachment continue to be a threat to the plant species. Factors B and C are not considered threats at this time. The species is still considered endangered because the number of protected, managed sites have not been achieved that are identified in the recovery plan; many of the remaining populations are declining; and drought and invasive species encroachment continue to negatively affect population size.

### III. RESULTS

#### A. Recommended Classification:

  X   No change is Needed

### IV. RECOMMENDATIONS FOR FUTURE ACTIONS

1. Acquisition and management of the remaining known populations on private lands. Areas within the Ocklawaha and Ferndale Ridge developments where native sandhill habitat still exists would be the primary areas to target near-term.
2. Active management of the four natural populations on public lands to maintain or create openness of the habitat and to control the invasive plant species encroachment.
3. Yearly monitoring of the natural populations and the introduced populations on public lands will be necessary to accurately determine future population viability.
3. Continued research on life history, biology, and ecology (population genetics, seed germination, spatial seedling recruitment patterns, demography, pollination biology, microhabitat factors, etcetera).
4. Update range-wide survey to determine number of extant populations and individual plant abundance at each location.
5. Continue population introductions and population augmentations.
6. Compare sites with long-term data sets from different locations within close proximity to one another and their associated management to increase the understanding of the ecological conditions that influence population abundance.

## V. REFERENCES

- Allaby, M. 1998. Dictionary of plant sciences, Oxford University Press, Oxford New York.
- Anacker, B.L., M. Gogol-Prokurat, K. Leidholm, and S. Schoenig. 2013. Climate change vulnerability assessment of rare plants in California. *Madroño*, 60(3).
- Byers, E. and S. Norris. 2011. Climate change vulnerability assessment of species of concern in West Virginia. West Virginia Division of Natural Resources, Elkins, WV.
- Cox, A.C. 2006. Management and monitoring of clasping warea (*Warea amplexifolia*) and listed plant species on the Warea Tract Seminole State Forest. Final report submitted to the Florida Department of Agriculture and Consumer Services Division of Administration (FDACS)/Division of Forestry, Tallahassee, Florida.
- Evans, M., R. Dolan, E. Menges, and D. Gordon. 2000. Genetic diversity and reproductive biology in *Warea Carteri* (Brassicaceae), a narrowly endemic Florida scrub annual. *American Journal of Botany*. 2000 Mar 1;87(3):372-81.
- Florida Department of Environmental Protection [FDEP]. 2004. Lake Griffin State Park Unit Management Plan. Florida Division of Recreation and Parks, Tallahassee, Florida.
- Frankham, R., J. Ballou, and D. A. Briscoe. 2009. Introduction to Conservation Genetics. Cambridge University Press, UK.
- Franks, S.J., J.J. Weber, and S.N Aitken. 2013. Evolutionary and plastic responses to climate change in terrestrial plant populations. *Evolutionary Applications*, 7(1).
- Historic Bok Sanctuary [HBS]. 1994. Experimental reintroduction project for *Warea amplexifolia*. Anonymous report, 1 March 1994. Files of the U.S. Fish and Wildlife Service, Jacksonville, Florida.
- Judd, W.S. 1980. Status report on *Warea amplexifolia*. Unpublished report prepared under contract with U.S. Fish and Wildlife Service, Jacksonville, Florida.
- Karl, T.R., 2009. Global climate change impacts in the United States. Cambridge University Press.
- Myers, R.L. 1990. Scrub and high pine. Pages 150-174 in R.L. Myers and J.J. Ewell, editors. *Ecosystems of Florida*. University of Central Florida Press, Orlando, Florida.
- Pachauri, R.K., M.R. Allen, V.R. Barros, J. Broome, W. Cramer, R. Christ, J.A. Church, L. Clarke, Q. Dahe, P. Dasgupta, and N.K. Dubash. 2014. Climate change 2014: synthesis report. Contribution of Working Groups I, II and III to the fifth assessment report of the Intergovernmental Panel on Climate Change. IPCC.

- Peterson, C.L. 2016. Phase IV *Warea amplexifolia* conservation efforts: population introductions and monitoring, *ex situ* germplasm preservation, characterizing recruitment patterns and the development of microsatellites for population genetic analysis. Final Report to the Florida Forest Service for Agreement No. 22871. Rare Plant Conservation Program, Bok Tower Gardens, Lake Wales, FL.
- Peterson, C.L. 2016. An Integrated Conservation Program for the Protection of Florida's Rare and Endangered Flora-North and Central Region. Final Report for Florida Department of Agriculture and Consumer Service, Agreement No. 022645.
- Peterson, C.L. 2014. An Integrated Conservation Program for the Protection of Florida's Rare and Endangered Flora-North and Central Region. Final Report for Florida Department of Agriculture and Consumer Service, Agreement No. 020160.
- Peterson, C.L. 2012. An Integrated Conservation Program for the Protection of Florida's Rare and Endangered Flora-North and Central Region. Final Report for Florida Department of Agriculture and Consumer Service, Agreement No. 017165.
- U.S. Fish and Wildlife Service (Service). 1999. South Florida Multi-Species Recovery Plan. U.S. Fish and Wildlife Service, Southeast Region. Atlanta, GA. 4-951-63.
- U.S. Fish and Wildlife Service (Service). 1993. *Warea amplexifolia* Recovery Plan. Atlanta, Georgia. 15 pp.
- Weekley, C.W., E.S. Menges, and P.F. Quintana-Ascencio. 2007. Seedling emergence and survival of *Warea carteri* (Brassicaceae), an endangered annual herb of the Florida scrub. *Botany*, 85(7):621-628.

**5-YEAR REVIEW**  
**Wide-leaf Warea (*Warea amplexifolia*)**

Current Classification Endangered

Recommendation resulting from the 5-Year Review

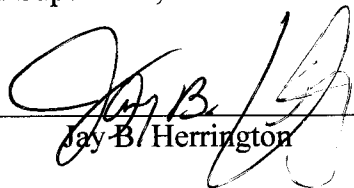
  X   No change is needed

Review Conducted By: Todd Mecklenborg, North Florida Ecological Services Office,  
Jacksonville, FL

FIELD OFFICE APPROVAL:

Lead Field Supervisor, U.S. Fish and Wildlife Service

Approve

  
Jay B. Herrington

Date

8/18/17

Appendix A. Summary of peer review for the 5-year review of Wide-leaf warea (*Warea amplexifolia*)

- A. Peer Review Method: Initial draft review was requested from four knowledgeable individuals outside the Service (Cheryl Peterson, Bok Tower Gardens; Dr. Jack Stout, University of Central Florida; Alice Bard, Florida Park Service; and Michael Jenkins, Florida Forest Service). We also requested internal review from Vivian Negron-Ortiz in our Panama City Ecological Services Field Office and David Bender in our South Florida Ecological Services Field Office before sending the document to external peer reviewers.
- B. Peer Review Charge: External peer review comments received included Dale Suiter (Raleigh Ecological Services Field Office), April Punsalan (South Carolina Ecological Services Field Office), and Amy Jenkins (Florida Natural Areas Inventory).
- C. Summary of Peer Review Comments/Report: No substantive comments were received from the peer review. Comments received were incorporated in to review.
- D. Response to Peer Review: No response needed.