

**Rugel's Pawpaw  
(*Deeringothamnus rugelii*)**

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



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

**5-YEAR REVIEW**  
**Rugel's Pawpaw**  
**(*Deeringothamnus rugelii*)**

**I. GENERAL INFORMATION**

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

This review is a synthesis of the best available information since the last 5-year review (USFWS 2008) and it also relies on existing information found in the Recovery Plan for Three Florida Pawpaws (1988), unpublished field observations by experienced biologists, peer reviewed scientific publications, and personal communications. A *Federal Register* notice announcing this review and requesting information with a 60-day public comment period was published on March 25, 2014 (79 FR 16366). We received one public comment on the review of this plant. Comments and suggestions from peer reviewers were incorporated as appropriate (Appendix A). No part of this review was contracted to an outside party. The documents used in preparing this review are on file at the North Florida Ecological Services Field Office, Jacksonville, Florida.

**B. Reviewers**

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

**Lead Field Office:** Jo Anna Emanuel, North Florida Ecological Services,  
904-731-3093

**C. Background**

- 1. Federal Register Notice citation announcing initiation of this review:**  
79 FR 16366, March 25, 2017
- 2. Species status:** Stable. *Deeringothamnus rugelii* is a Florida endemic with a narrow range, known only from Volusia County, Florida. The species status has been listed as stable since 2005 as survey efforts have detected presence of this species on 6 protected, publicly-owned and managed conservation areas. Since 2005, new occurrences of *D. rugelii* were identified through survey efforts on protected conservation lands in 2012, 2014, and 2015. Protected public conservation lands with occurrences of *D. rugelii* include Deep Creek Preserve, Longleaf Pine Preserve, Port Orange City Forest, Tiger Bay State Forest, Wiregrass Prairie Preserve, Lake Monroe Conservation Area – Beck's Ranch and Lake Monroe Conservation Area Krater Tract. *D. rugelii* occurrences on the two Lake Monroe Conservation Area properties are introduced plants that were transplanted from development sites. With continued appropriate management on public conservation lands within the species' range, *D. rugelii* should remain stable. However, the continuing loss of this species' habitat on private land is

reducing its overall range. Comprehensive surveys need to be conducted to better determine the status of the species on all properties throughout its range.

3. **Recovery achieved:** 2 (25-50%) recovery objectives achieved.  
Accomplishments relative to the recovery objectives listed in the Recovery Plan for Three Florida Pawpaws (1988) are detailed in Table 1 below.
4. **Listing history:**  
Original Listing  
FR notice: 51 FR 34415  
Date Listed: September 26, 1986  
Entity listed: Species  
Classification: Endangered
5. **Associated rulemaking:** None
6. **Review History:** Previous 5-year reviews:

November 6, 1991 (56 FR 56882). In this review, the status of many species was simultaneously evaluated with no in-depth assessment of the five factors, threats, etc. as the pertained to the individual species. The notices summarily listed these species and stated that no changes in the designation of these species were warranted at that time. In particular, no changes were proposed for the status of the specie sin this review.

September 25, 2008. In this 5-year review, no change in status was recommended.

Final Recovery Plan – 1988

Each year, the Service reviews and updates listed species information for inclusion in the required Recovery Report to Congress. Through 2013, we did a recovery data call that included status recommendations such as “Stable” for this plant. We continue to show that species status recommendation as part of our 5-year reviews.

7. **Species’ Recovery Priority Number at start of review (48 FR 43098):** 2.  
*Deeringothamnus rugelii* is a species with a high degree of threat and high recovery potential.
8. **Recovery Plan:**  
**Name of Plan:** Recovery Plan for Three Florida Pawpaws  
**Date Issued:** April 5, 1988

## II. REVIEW ANALYSIS

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

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? Yes, while some conservation actions have been accomplished since the recovery plan was written in 1988, the recovery criteria still reflect the most current and best-available information on *D. rugelii* and its habitat.

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 remains the primary threat to this plant species. Threats include permanent habitat loss to urban development (destruction) and habitat degradation (modification) from lack of proper management or conversion to agriculture.

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.

The five listing factors include:

- A. Present or threatened destruction, modification or curtailment of its habitat or range;
- B. Overutilization for commercial, recreational, scientific, or educational purposes;
- C. Disease or predation;
- D. Inadequacy of existing regulatory mechanisms;
- E. Other natural or manmade factors affecting its continued existence.

In the 1988 recovery plan, the recovery criteria for *Deeringothamnus rugelii* were:

*Reclassification to threatened status if ten (10) self-sustaining populations of the species were secured. Delisting could be considered if twenty (20) such populations were secured.*

Of the five listing factors, Factor A, the present or threatened destruction, modification or curtailment of its habitat or range, was identified as the principle threat to this species in the recovery plan. Specifically, for *Deeringothamnus rugelii*, this threat includes further destruction of the habitat in which they occur in addition to successional changes in vegetation from a prolonged absence of fire or other appropriate vegetation management.

While it is unknown how many plants are needed to ensure a self-sustaining population, currently, there are known occurrences of *D. rugelii* on six sites that meet the recovery criteria of being secure. These protected sites include Deep Creek Preserve, Longleaf Pine Preserve, Port Orange City Forest, Tiger Bay State Forest, Wiregrass Prairie Preserve, and Lake Monroe Conservation Area and are considered secure or protected in that they are publicly owned lands purchased and managed for conservation purposes. Occurrence of *D. rugelii* on the Lake Monroe Conservation Area is a result of introductions from transplanting plants from development sites. This is an increase in the number of secure sites with documented occurrences of *D. rugelii* since the (2007) 5-year review which reported three protected sites. These protected sites are all subject to habitat management activities, though public land managing entities are challenged to maintain desirable management frequencies. An increase in frequency of burning or mechanical treatments or a combination of the two may benefit *D. rugelii* through reduction of competition and stimulation of flowering and fruiting.

Unsecure sites include privately owned lands, highway rights-of way, utility corridors. Unsecure sites may also include publicly owned lands which were either not purchased for, not managed for, or are otherwise not in conservation. These sites are not adequately protected and remain susceptible to loss due to habitat conversion to other land uses as well as habitat degradation resulting from inadequate management. Historical observations of this species include occurrences in unsecure locations; however, habitat loss and degradation in these areas has occurred and the status of many of these plants is unknown.

The Recovery Plan for Three Florida Pawpaws (1988) details 17 recovery actions, of which 3 are Priority 1, 8 are Priority 2, and 6 are Priority 3. Table 1 details the recovery tasks identified in the recovery plan and current status.

Table 1 – Status of Recovery Plan Tasks

Recovery Plan Task	Task Status and Accomplishments	Action Priority	2017 Status
Inform Public Agencies	Public agencies within the range of <i>D. rugelii</i> are informed and the Service is working with these agencies in meeting recovery goals.	1	Achieved
Inform and enlist private organizations	The Service has engaged private stakeholders including BOK Tower Gardens (BOK), Cincinnati Zoo and Gardens (CZG), Missouri Botanical Garden (MBG), Florida Native Plant Society (NPS), and others to assist in meeting recovery goals.	3	Achieved
Develop reintroduction procedures	Reintroduction procedures have not been developed.	2	Not Achieved
Identify reintroduction sites	Reintroduction sites for future plantings of <i>D. rugelii</i> are not identified.	2	Not Achieved
Hand pollinate flowers	While hand pollination of <i>D. Rugelii</i> was conducted as part of a larger study in 2003 (Norman 2003), it is not currently being done.	3	Not Achieved
Collect seed	Due to the paucity of seed availability and the challenges associated with long-term storage of seed, seed collection is not done. Additionally, attempts to propagate <i>D. rugelii</i> from seed have been unsuccessful.	2	Not Achieved
Propagate plants	Propagation of plants has been accomplished by the CZG utilizing tissue culture with five plants delivered to two locations. Four of the propagated plants are located at BOK in Polk County. The fifth plant remains potted and is with the city of Port Orange in Volusia County.	2	Ongoing
Reintroduce plants; monitor success; modify procedures	While introductions to sites with no known history of <i>D. rugelii</i> have occurred, <i>D. rugelii</i> has not been reintroduced into sites with previous known occurrences.	2	Not Achieved
Conserve germplasm	Long term <i>ex situ</i> preservation of germplasm for <i>D. rugelii</i> has been accomplished by the CZG using cryopreservation of tissue.	3	Ongoing
Search for additional populations	The Volusia County chapter of the NPS began annual occurrence survey efforts in 2012, which has led to the discovery of new occurrences of <i>D. rugelii</i> .	1	Ongoing
Determine population size and viability	This has not been done.	2	Not Achieved
Protect sites from destructive alteration	While occurrences of <i>D. rugelii</i> on protected conservation land are protected from destructive habitat alterations, sites on unprotected private land, utility rights-of way, and roadsides remain vulnerable.	1	Partially Achieved
Conduct prescribed burns or equivalent	Prescribed fire is applied to varying degrees of efficacy on protected conservation land but is not applied to unprotected sites on private lands, utility rights-of-way and roadsides.	2	Partially Achieved

Recovery Plan Task	Task Status and Accomplishments	Action Priority	2017 Status
Apply other management	Management activities including mowing and chopping are applied on protected conservation lands, but are largely not conducted on private lands. In some areas, utility rights-of-ways are mowed. Additionally, roadside occurrences of <i>D. rugelii</i> have been mowed.	3	Partially Achieved
Study ecological requirements	Information regarding the ecological requirements of <i>D. rugelii</i> is sparse. Investigations into soil fungal and bacterial associates are proposed.	3	Partially Achieved
Monitor populations; alter management practices if needed	Annual occurrence surveys conducted by the Native Plant Society are not conducted on all sites in all years and quantitative data is not collected. Additionally, habitat management and <i>D. rugelii</i> monitoring activities are typically asynchronous.	2	Not Achieved
Enforce available protective legislation	Protective legislation is in place and enforced when necessary.	3	Achieved

Factors B, C, D, and E have not been identified or documented as threats at this time.

### C. Updated Information and Current Species Status

#### 1. Biology and Habitat

- a. **Abundance, population trends, demographic features, or demographic trends:** *Deeringothamnus rugelii* is a narrowly endemic species found in portions of Volusia County and was first discovered in 1848 (Kral 1960). *Deeringothamnus rugelii* produces small yellow flowers with thickened petals. It germinates in spring, reaches heights of approximately 30-60cm and senesces in the fall (Helkowski and Johnson 1999).

#### Natural Populations

From the time of its initial discovery through 1998, 25 occurrences of *D. rugelii* had been located within Volusia County (Johnson and Schultz 1999), with two of the occurrences being University of South Florida Herbarium specimens. In 1998, the number of plants reported from previous surveys (Table 2) among the known populations ranged from 2,142 to 4,538 individuals with 9 of the 25 occurrences including more than 100 plants.

Table 2 - *Deeringothamnus rugelii* survey information through 1998

Survey Year(s)	Number of Occurrences	Occurrence Location	Publication
1981	5	West of New Smyrna Beach	Norman and Brothers 1981
1992	5	State Road 44 and powerline rights-of-way and private lands	Norman 1992

1995-1996	13	Port Orange City Forest, Volusia County Correctional Institute, private lands	Johnson and Schultz 1999
-----	2	Herbarium	-----

In 1997, the Florida Natural Areas Inventory (FNAI) tagged three plots of 220 plants within the Port Orange City Forest site to monitor the effects of roller chopping treatments on *D. rugelii* (Helkowski 1997). In June 1998, wildfires occurred throughout Volusia County including the area of the Port Orange City Forest and the project was redesigned to focus on the impacts of fire on *D. rugelii*. The fire appeared to stimulate flowering in *D. rugelii* from a typical 2-3 flowers per stem to 10-12 flowers per stem. In August of 1998, post-fire surveys found that the number of plants in all three plots had increased from 220 to 2,272. Eighty percent of the plants had flowered and 10% had produced fruit. It appears that the fire stimulated sprouting in plants that were either dormant or very inconspicuous prior to the fires (Helkowski and Johnson 1999). In September, 1998, a subsequent survey of the area found plants remained stimulated with additional flowers and fruit observed (Helkowski and Johnson 2000). During post fire cleanup operations, two of the three plots were disked, which likely resulted in root damage to *D. rugelii* and few plants were located. In May 1999, the second growing season post-fire surveys in the non-disked plot, results similar to those found immediately after the fire in 1998. Eighty percent of the plants were found but the percentage of flowering was less than the 10% reported the previous year, but still considerably greater than the pre-fire flowering observation of 0% (Helkowski and Johnson 2000).

In September 1998, FNAI conducted surveys in all the areas affected by the wildfires in Volusia County and found four additional sites. Two of these occurrences of *D. rugelii* were located at Tiger Bay State Forest, as well as an additional occurrence at the Port Orange City Forest and an occurrence on private lands north of Lake Ashby were found in areas burned by the wildfires (Johnson and Schultz 1999). All of these occurrences had fewer than 50 plants at the time of discovery. The discovery of these occurrences increased the number of known occurrences to 29 and the number of known plants from 4,538 to 4,639 (Johnson and Schultz 1999). As of 1999, the Port Orange City Forest was known to support the largest number of occurrences of *D. rugelii* (12 of 29) and 2,717 of the 4,639 plants known at that time (Johnson and Schultz 1999).

In 2003 and 2004, conservation lands within Volusia County were surveyed by FNAI, including areas formerly called Southern Pines and Vargal now known as the Longleaf Pine Preserve and Wiregrass Prairie Preserve. *Deeringothamnus rugelii* was identified at the former Vargal site; however, the plants located at the other sites were all vegetative and resembled the more common *Asimina pygmea* (pygmy pawpaw). *Deeringothamnus rugelii* within the Longleaf Pine Preserve responded favorably to the 1998 wildfires and subsequent prescribed fires; healthy and vigorous plants were observed. In 2009, the Indian Lake Wildfire on the Tiger Bay State Forest and subsequent salvage harvest of timber occurred in



areas of *D. rugelii*. Post-wildfire observations of the area indicated a favorable response to the wildfire (Florida Forest Service 2010). Schultz and NeSmith (2004) suggest that continuation and expansion of the prescribed fire programs on these properties will benefit this species.

In 2012, the Florida Native Plant Society (NPS) Pawpaw Chapter – serving eastern Volusia and Flagler counties – began conducting annual surveys of *D. rugelii*. These surveys are conducted in cooperation with local biologists, botanists, and noted experts on *D. rugelii*, including Dr. Eliane Norman, Professor Emeritus, Stetson University. The surveys focus on the identification of new locations and documentation of the persistence of known occurrences. To date, the NPS has provided survey information to FNAI where the element of occurrence data is stored in their Biodiversity Matrix. Since 2012, NPS surveys for *D. rugelii* have identified three new occurrences, two of which are on secure sites. These sites include Deep Creek Preserve and Tiger Bay State Forest.

As of 2017, there were 33 documented natural occurrences of *D. rugelii* in Volusia County (Table 3 and Table 4). Eighteen of the natural occurrences occur on protected conservation lands and 15 natural occurrences on unprotected private lands or highway and utility rights-of-way. It should be noted that many of the sites have not been surveyed in recent years and the status of *D. rugelii* on these sites is unknown. As a result of land use changes and inadequate management, it is possible that *D. rugelii* is no longer present on some sites. Range-wide surveys are needed to confirm persistence on all sites.

#### Introduced Populations

As of 2017, there are two protected sites with introduced occurrences of *D. rugelii*. Between 1994 and 1996, Norman (1994) collected 10 adult plants, 11 seedlings, and 69 seeds from 2 sites that were subject to development impacts. These donor sites included the Sugar Mill Road construction and private property. The collection was planted in a former pasture near State Road 415 on the Kratzert tract of the Lake Monroe Conservation Area. The property, which is public conservation land, owned and managed by the St. Johns River Water Management District, was not known to have *D. rugelii*, but does have preferred soils and is in Volusia County and *D. rugelii* is found on private land nearby. Monitoring of the introduced plants through 1996 indicated that the adult plant survival rate was higher than seeds or seedlings and seedlings had a slightly higher survival rate than seeds (Norman 1996). In 2004, in an effort to accommodate the widening of State Road 415, surviving transplants, 13 in total, were moved again to another site within the Kratzert tract. At the time of the second relocation, the site, a former cattle pasture was dominated by turf grasses and recently planted in longleaf pine (*Pinus palustris*). As of 2017, the site includes a pine canopy of approximately 90% closure with the groundcover being nearly 100% pine litter. Recent attempts to locate remaining *D. rugelii* in this area have yielded three possible plants (Henn, personal communication).

September 2017). A prescribed fire to stimulate blooming would encourage growth of *D. rugelii* and aid in survey efforts. Additionally, reducing the pine canopy and subsequent accumulation of pine litter would benefit this species.

In 2012, 256 *D. Rugelii* plants were collected from an area alongside Interstate 4 that was scheduled for roadway improvements. These plants were relocated into two areas on the Beck's Ranch tract of the Lake Monroe Conservation Area (Norman, personal communication, September 2017). As of 2017, surveys indicate 29 remaining plants (Henn, personal communication September 2017). A thorough survey of these sites should be made immediately following the next prescribed fire to verify the extent and number of remaining plants.

### All Populations

The number of individual plants per occurrence location detailed in Table 3 and Table 4 do not reflect actual numbers present in 2017 for all occurrences. Not all occurrences were surveyed in any given year as noted in the tables. Current plant counts may be larger or smaller than the reported numbers as individuals present in a population fluctuate on a yearly basis and in response to environmental conditions.

Table 3. Summary of *Deeringothamnus rugelii* occurrences on conservation lands considered protected, including site location and FNAI element occurrence (EO) number, if any; origin (natural or introduced) and first observation of the population; last observation of the population; and estimated number of individuals (FNAI 2017).

**CPO** - city of Port Orange, **FFS** - Florida Forest Service, **FNAI** – Florida Natural Areas Inventory, **SJRWMD** – St. Johns River Water Management District, **VC** - Volusia County

Site Location and Population (EO #)	County	Ownership	Origin (First Observed)	Last Observed	Estimated Individuals
Deep Creek Preserve (EO #42)	Volusia	VC	Natural 2015	2015	Unknown
Longleaf Pine Preserve (EO #19)	Volusia	VC	Natural 1995	1995	100
Longleaf Pine Preserve (EO #20)	Volusia	VC	Natural 1995	1995	8
Longleaf Pine Preserve (EO #30)	Volusia	VC	Natural 2003	2004	10
Longleaf Pine Preserve	Volusia	VC	Natural 2003	2003	10

Site Location and Population (EO #)	County	Ownership	Origin (First Observed)	Last Observed	Estimated Individuals
(EO #31)					
Longleaf Pine Preserve (EO #40)	Volusia	VC	Natural 2003	2003	4
Longleaf Pine Preserve (EO #43)	Volusia	VC	Natural 2014	2014	100
Longleaf Pine Preserve/Port Orange City Forest (EO #16)	Volusia	VC/CPO	Natural 1995	2012	15
Longleaf Pine Preserve/Port Orange City Forest (EO #41)	Volusia	VC/CPO	Natural 2003	2004	11
Port Orange City Forest (EO #12)	Volusia	CPO	Natural 1995	1999	624
Port Orange City Forest (EO #13)	Volusia	CPO	Natural 1995	1995	18
Port Orange City Forest (EO #14)	Volusia	CPO	Natural 1995	1999	720
Port Orange City Forest (EO #22)	Volusia	CPO	Natural 1996	2009	230
Port Orange City Forest (EO #28)	Volusia	CPO	Natural 1997	1999	190
Tiger Bay State Forest (EO #24)	Volusia	FFS	Natural 1998	2017	7
Tiger Bay State Forest (EO #25)	Volusia	FFS	Natural 1998	2017	12
Tiger Bay State Forest (EO #38)	Volusia	FFS	Natural 2012	2012	9
Wiregrass Prairie Preserve (EO#39)	Volusia	VC	Natural 2003	2003	40
Lake Monroe Conservation Area – Beck’s Ranch Site 1	Volusia	SJRWMD	Introduced (2012)	2017	25
Lake Monroe Conservation Area – Beck’s Ranch Site 2	Volusia	SJRWMD	Introduced (2012)	2017	4

Site Location and Population (EO #)	County	Ownership	Origin (First Observed)	Last Observed	Estimated Individuals
Lake Monroe Conservation Area – Kratzert Tract	Volusia	SJRWMD	Introduced (2004*)	2017	3

\*These plants were initially transplanted in 1994; they were relocated in 2004.

Table 4. Summary of *Deeringothamnus rugelii* occurrences on lands not considered protected, including site location and FNAI element occurrence (EO) number, if any; origin (natural or introduced) and first observation of the population; last observation of the population; and estimated number of individuals (FNAI 2016).

Site Location and Population (EO #)	County	Ownership	Origin (First Observed)	Last Observed	Estimated Individuals
Howe and Currier Parcels (EO #11)	Volusia	Private	Natural 1958	1958	Unknown
Utility ROW – North and South of Utility Line SR 44 (EO #2)	Volusia	Utility	Natural 1978	2014	80
Gautier EW Estate (EO #3)	Volusia	Private	Natural 1981	1991	17
Carthage Drive Site – Multiple Parcels (EO #4) <sup>1</sup>	Volusia	Private	Natural 1981	1991	62
Beck Property (EO #5) <sup>2</sup>	Volusia	Private	Natural 1981	1991	19
FPL Powerline Monza Drive (EO #6)	Volusia	Utility	Natural 1990	1991	300
Budd Road Site – Multiple Parcels (EO #7)	Volusia	Private	Natural 1990	1991	93
Lake Ashby Rd Site (EO #8)	Volusia	Private	Natural 1989	1991	650
Elpino/Tagana Drive Site (EO #9)	Volusia	Private	Natural 1990	1991	18
Sugar Mill Road/Cemetery Site (EO #10)	Volusia	Private	Natural 1992	1992	75
Hackamore Drive Site (EO #21)	Volusia	Private	Natural 1995	1995	Unknown
Olson Drive Site (EO #23) <sup>3</sup>	Volusia	Private	Natural 1997	1997	Unknown
Boy Scout Camp Road Site (EO #27)	Volusia	Private	Natural 1998	2015	150
195 CR 442 Site (EO #44)	Volusia	Private	Natural 2014	2015	21

Site Location and Population (EO #)	County	Ownership	Origin (First Observed)	Last Observed	Estimated Individuals
Volusia County Correctional Institute Site	Volusia	Private	Natural 1996	Unknown	Unknown

<sup>1</sup> 2017 imagery indicates most residential lots associated with this occurrence are developed; continued occurrence unknown

<sup>2</sup> 2017 imagery indicates most of the area of occurrence is converted to crops; continued occurrence unknown

<sup>3</sup> 2017 imagery indicates most of the area of occurrence is cleared and developed with small area of remnant native vegetation remaining onsite; continued occurrence unknown

**b. Genetics, genetic variation, or trends in genetic variation:** No new genetic information is available for this species.

**c. Taxonomic classification or changes in nomenclature:**

Kingdom: Plantae  
Subkingdom: Viridiplantae  
Infrakingdom: Streptophyta  
Superdivision: Embryophyta  
Division: Tracheophyta  
Subdivision: Spermatophytina  
Class: Magnoliopsida  
Superorder: Magnolianae  
Order: Magnoliales  
Family: Annonaceae – custard apples  
Genus: *Deeringothamnus* Small  
Species: *rugelii* (B.L. Rob.) Small  
Common name: Rugel's pawpaw, Rugel's false pawpaw

This continues to be reflected as a valid species (ITIS, 2017).

**d. Spatial distribution, trends in spatial distribution, or historic range:**  
Historically, *D. rugelii* has only occurred in a small area of Volusia County in northeastern peninsular Florida. It was originally discovered west of New Smyrna in 1848 by Ferdinand Rugel (Norman 1981). In 1981 and 1992, known occurrences of the plants were clustered in two areas along SR 44 near the junction with County Road 415 and Interstate 95, in one area south of State Road 44 and east of County Road 415 just north of Lake Ashby (Johnson and Schultz 1999, Norman 1992, Norman and Brothers 1981). Surveys conducted by FNAI in 1995-1996 found *D. rugelii* in a low ridge between U.S. Highway 92 to the north and County Road 418 (Pioneer Trail) to the south including the Volusia Correctional Institute property.

Surveys in 1998 found four additional sites containing *D. rugelii* (see section 3a). In 1999, two occurrences at Tiger Bay State Forest were confirmed to represent the northernmost extent of the known range of this species by several miles (Johnson and Schultz 1999). Occurrences in the Wiregrass

Prairie Preserve account for the southernmost extent of the known range (FNAI 2017). Acquisition and management of the Longleaf Pine Preserve by Volusia County has helped secure and expand the range of this species around the Port Orange City Forest property.

In addition to introduction sites at the Lake Monroe Conservation Area, since 2012, increased survey efforts have resulted in the discovery of three additional occurrences. Many of these new discoveries occur on conservation lands with resource management plans in place and active habitat management occurring, though some land managing entities are experiencing difficulties in maintaining optimal management frequencies and habitat conditions. Also benefiting this species, population introductions and transplantings from areas identified for development have occurred on conservation lands.

Recent surveys have not been conducted in all of the areas of known occurrences and in some locations, surveys have only identified presences of *D. rugelii* and quantitative data have not been collected. Subsequently, trend data for this species are lacking. Currently, there are 36 occurrences documented within Volusia County. Twenty-one occurrences occur on protected conservation lands throughout Volusia County and 15 occurrences are located on unprotected lands. It appears that land conversions have occurred on at least three of these sites; however, the persistence of *D. rugelii* in what remains of natural vegetation in these areas is unknown. While survey efforts have increased since 2012, comprehensive surveys to locate new occurrences and to determine continued persistence and extent of known occurrence are needed.

The occurrence locations of *D. rugelii* are recorded individually within the FNAI database regardless of distance of separation between points. An element of occurrence (EO) that is separated from all other occurrences of the same species by a distance of at least 1 km is considered a discrete population (NatureServe 2002). When applying a 1 km buffer to the element of occurrence data for *D. rugelii*, 9 separate potential populations are evident. Of the 9 potential populations, 4 occur mostly within protected conservation land. An additional 2 potential populations have portions of buffer areas that incorporate protected conservation land. The two transplant occurrences may constitute an additional population and occur on protected conservation land, though these plants are not currently incorporated into the FNAI database.

The potential for identification of *D. rugelii* on additional sites outside the current range and into adjacent counties such as Flagler, Brevard, and Seminole as well as other areas of Volusia is possible as appropriate soil and habitat conditions exist. These areas should be surveyed for *D. rugelii*.

- e. **Habitat or ecosystem conditions:** *Deeringothamnus rugelii* typically occurs in flatwoods with an open canopy of slash pine (*P. elliotii* var. *densa*) or longleaf pine. Groundcover assemblages within the flatwoods communities often include wiregrass (*Aristida stricta*) and a diverse array of other herbaceous plants. Other species occurring in these areas include dwarf live oak (*Quercus minima*), saw palmetto (*Serenoa repens*), shiny lyonia (*Lyonia lucida*), shiny blueberry (*Vaccinium myrsinites*), and common pawpaw (Johnson and Schultz 1999), netted pawpaw (*A. reticulata*), tarflower (*Bejaria racemosa*), and fetterbush (*Lyonia lucida*), many of which are frequently associated with *D. rugelii* (Norman 1981). This species also occurs in pastures and in road and utility rights-of-way.

*Deeringothamnus rugelii* is predominately found in mesic and wet flatwoods environments, though one occurrence is known to occur in disturbed scrub conditions (Norman 1981). Soils that support *D. rugelii* are often deep, fine textured, poorly drained sand or sandy peats (Norman 1981) mostly within the Immokalee and Myakka soil series (Service 1988). Flatwoods natural communities in Florida require periodic fire to perpetuate ecosystem health. In 1998, large wildfires occurred in Volusia County and affected areas known to support *D. rugelii*, including the Port Orange City Forest. Subsequent studies of the effects of fire on *D. rugelii* in this area indicated a favorable response to fire with post fire population counts increasing an order magnitude from 200 to 2200 plants; the percentage of plants flowering increased from 1% to 79%, and fruiting increased from 0% to 9% (Helkowski and Johnson 1999). Helkowski and Johnson (1999) also noted that the post-fire sprouting of *D. rugelii* was earlier than any associated woody species. The flowering response of this species typically occurs between 6 and 8 weeks post fire (Norman, personal communication, 5 Sept 2017). In the absence of frequent fire, mechanical treatments such as mowing and roller chopping may, to some extent, serve as a surrogate (Norman 1981), though there is some evidence to suggest that plowing, disking or other activities that result in deep soil disturbance may be detrimental to *D. rugelii*. Helkowski and Johnson (2000) found that mechanical treatments such as chopping or disking following a fire may reduce flowering and fruiting responses and that disking may also reduce re-sprouting of *D. rugelii* since it could injure underground portions of the plant. All mechanical treatments such as mowing or roller chopping should be avoided for 12 months following a fire to avoid injury and possible mortality to seedlings, and to a lesser extent mature plants.

Historically, *D. rugelii* has been difficult to propagate from seed and tissue cultures. Weigel (1993) found that cultures would germinate but developed a fungus (*Phylloporia frutica*) that then killed cultures. Tissue cultures taken from the stems of plants were used for propagation, which were unsuccessful, likely due to browning associated with polyphenols produced by the plant cells. In 1994, Weigel (1994) obtained results similar to those found in 1993 experiments during attempts to propagate additional tissue cultures.

As part of a long-term effort to expand the distribution of *D. rugelii* within the Port Orange City Forest, the city of Port Orange has worked with the Center for Conservation and Research of Endangered Wildlife (CREW) at the Cincinnati Zoo and Gardens to propagate plants. Since 2003, CREW has successfully produced plants from tissue culture. Four of these plants are planted in the conservation gardens at BOK Tower Gardens in Polk County and a fifth plant remains potted and is located with the city of Port Orange. Additionally, CREW has developed tissue culture methods used to store cell lines of *D. rugelii* cryogenically. Since *D. rugelii* produces few seeds in the wild and stored seeds lose viability quickly, the *ex situ* preservation of tissue cultures from remaining populations of *D. rugelii* may be an important means to secure germplasm of this species.

## 2. Five-Factor Analysis

- a. **Present or threatened destruction, modification or curtailment of its habitat or range:** The primary threat to this species is the destruction and modification of habitat on private lands. Additionally, degradation of habitat resulting from a lack of adequate management on public and private lands remains a threat to this species. Currently 21 of the 36 known occurrences occur on protected public conservation lands. The remaining 15 occurrences are found on private lands and utility and highway rights-of-way where they remain vulnerable to threats associated with habitat loss, habitat destruction, and cessation of necessary management. While habitat loss and destruction resulting from development is not a threat to occurrences of *D. rugelii* on protected public conservation lands, degradation of habitat as a result of inadequate management is a concern. In addition to budget constraints and the prioritization of available resources, challenging site conditions may limit the type and frequency of management actions.

Elongated fire return frequencies and in some cases, the complete absence of periodic fire, has led to degraded habitat conditions throughout the range of the species. *Deeringothamnus rugelii* occurs in mesic and wet flatwoods natural communities that under natural conditions are maintained by frequent fire. Without naturally-ignited fires or prescribed fire applications, the habitat becomes overgrown resulting in unfavorable conditions for the species. While many public conservation lands with occurrences of *D. rugelii* are being managed to maintain appropriate conditions within the flatwoods, some areas have significant challenges with the application of prescribed fire. The proximity of a conservation area to major roads and other developed areas, the presence of organic soils, and the potential impacts of the down drainage effects of smoke in nearby waterways limits the window of opportunity for land managers to safely implement prescribed fire. In these situations, mechanical treatments may be necessary to facilitate the persistence of *D. rugelii* and may be accomplished in conjunction with prescribed fire.



- b. **Overutilization for commercial, recreational, scientific, or educational purposes:** Not known as a threat at the time of listing or present.
- c. **Disease or predation:** Norman and Brothers (1981) reported that most of the populations of *D. rugelii* they surveyed had considerable damage from a particular species of caterpillar. The caterpillar was reared in a cage and developed into a moth, which was sent to the University of Florida for identification. Recent attempts to locate information regarding the identification of this specimen have been unsuccessful. Recent surveys have not reported any significant damage from caterpillars. Therefore, disease and predation are not known as a threat at this time.
- 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) limited authority to protect plants on State and private lands (primarily from the standpoint of illegal harvest). *Deeringothamnus rugelii* 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)). *Deeringothamnus rugelii* is known to occur on six protected conservation sites (Deep Creek Preserve, Wiregrass Prairie Preserve, Longleaf Pine Preserve, Port Orange City Forest, Tiger Bay State Forest, and Lake Monroe Conservation Area) , which all have active management plans.

Volusia County has existing ordinances (Ordinance 2017) that provide rules related to conservation lands within the county. Resolution 2003-80 provides general goals and objectives for the management of conservation lands. Volusia County actively manages properties to the benefit of *D. rugelii*.

Tiger Bay State Forest is owned by the State of Florida and managed by the Florida Forest Service. Acquisition of this property began in 1977 with additional parcels purchased since that time. The Florida Forest Service supports the Florida Plant Conservation Program, whose goal is to restore and maintain existing populations of listed plants on public and private lands.

Lake Monroe Conservation Area is a publicly owned conservation area managed by the St. Johns River Water Management District. The St. Johns River Water Management District purchases land with the primary goal of protecting water resources and in doing so, actively manages lands to protect native flora and fauna. Additionally, the St. Johns River Water Management

District Chapter 40C-9.210, F.A.C. prohibits the removal, destruction, or harassment of animals or plants from or on District Lands except where specifically authorized by the District.

The Port Orange City Forest is owned and managed by the City of Port Orange. Portions of this property are incorporated into the Port Orange Mitigation Bank. This mitigation bank provides up-front mitigation credits to the City of Port Orange, which are used by the City or are sold to other entities to offset impacts to wetland systems as a result of development. The City of Port Orange retains management responsibilities across the property. Additionally, within the associated mitigation plan, management emphasis is given to threatened and endangered species. Further, *D. rugelii* is specifically identified and as part of the Mitigation Bank, the City of Port Orange agreed to propagate and outplant this species into suitable habitat within the property. This work is coordinated with the Cincinnati Zoo and Gardens.

*Deeringothamnus rugelii* is known to occur along highway rights-of-way including areas along State Road 44 and Interstate 4. The Florida Department of Transportation has worked with the Service to avoid or transplant plants that could be impacted due to road maintenance, construction, or widening activities. They have also worked with the Service to mow in certain areas where the species is known to exist.

Several other occurrences of *D. rugelii* occur in utility rights-of-way or easements and on private lands where little or no protection or management occurs. Through the 2006 Partners for Fish and Wildlife Act, the Service's Partners for Fish and Wildlife Program is authorized to work with private landowners to implement habitat improvement projects on private lands (non state, non federal) for the benefit of Federal trust species. Ample opportunity exists to develop partnerships and habitat management and restoration projects on private lands and utility rights-of way or easements to protect and better manage sites for *D. rugelii*.

In the absence of protections provided under the Endangered Species Act, existing regulatory mechanisms as described above are adequate to protect this species.

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

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. 2013). 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 *D. rugelii*.

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).

Of the five listing factors; destruction, modification or curtailment of its habitat or range (Factor A) is the main threat to *D. rugelii*. Factors B, C, D, and E are not considered threats at this time.

#### **D. Synthesis**

All of the threats are addressed in the recovery plan with Factor A still the primary threat. The current recovery criteria for *D. rugelii* are objective and measureable with some recovery actions achieved, while others are ongoing. These achievements include the identification of new occurrences of *D. rugelii*, successful propagation and germplasm conservation, application of prescribed fire and other appropriate management on protected sites.

*Deeringothamnus rugelii* is known to occur at Tiger Bay State Forest, Longleaf Pine Preserve, Wiregrass Prairie Preserve, Deep Creek Preserve, Port Orange City Forest, and Lake Monroe Conservation Area, which are all located in Volusia County, Florida where they are protected and have some level of management. Proper management of these sites will provide long-term benefits to these species. Improved management across these properties, particularly in areas of appropriate soils and vegetation could provide important habitat for expansion of this species.

Recent surveys, habitat management activities, and population introductions have resulted in an increase of the species distribution and abundance. There are currently 36 occurrences of which 21 are persisting on 6 protected conservation lands that have management plans ultimately benefitting the habitat occupied by the species. The remaining 15 occurrences are located on private property, on highway rights-of-way, and in utility corridors where the species remains susceptible to habitat degradation and loss due to land use changes and lack of management. These sites should be

resurveyed to determine the continued presence of the species and to determine if any protection can be achieved.

*Deeringothamnus rugelii* is beneficially affected by fire. Wildfires occurring in 1998 provided important information on this species' response to fire. After the 1998 wildfires, the response of *D. rugelii* was dramatic with an order of magnitude increase in the number of plants observed with abundant flowering and some fruiting also observed.

*Deeringothamnus rugelii* continues to be threatened by habitat degradation and loss. The absence of fire in mesic and wet flatwoods has adverse impacts to the natural community including *D. rugelii*. Natural or prescribed fire or other surrogate disturbance is needed to ensure suitable habitat conditions for this species. Loss of habitat to development has not been well-documented where it occurs on private lands. Twenty-one of the 36 documented occurrences are on protected lands; however, it is unknown how many individual plants in a population are necessary for species viability. Therefore, it is unknown if this species meets the recovery plan criteria of 10 populations for down-listing to a threatened status or 20 populations for delisting.

This species continues to be found only in Volusia County, Florida. Additional surveys are needed to determine the extent of this species within Volusia and nearby counties where soil and habitat conditions are conducive. This species remains in danger of extinction through all or a significant portion of its range.

### III. RESULTS

#### A. Recommended Classification:

  X   No change is Needed

### IV. RECOMMENDATIONS FOR FUTURE ACTIONS

1. Conduct a range-wide survey of all existing populations and historic sites where populations formally existed that have not been developed. For all populations occurring on conservation lands; document current abundance, population trends, demographic trends, and habitat suitability. Conduct a Population Viability Analyses (PVA) to help determine a minimum viable population number.
2. When surveying plants note any associations with caterpillars and collect insects for proper identification in order to better understand the relationship between the organisms.
3. Support further research on the effects of prescribed burning and other management tools on *D. rugelii*, its life history needs, and microhabitat requirements.
4. Support further research into population genetics to better understand basic biology of the species, genetic variation within and among populations and across landscape, and whether hybridization is occurring with related and co-occurring species.
5. Support further research into microbiome and whether specific microorganisms are associated with this species, which may serve to inform future introduction sites.
6. Continue collaboration with conservation land managers to increase habitat management and suitability of occupied habitat.
7. Collect habitat management activity information from conservation land managers to inform timing of surveys and improved land management practices.
8. Actively engage private landowners and public non-conservation landowners (e.g. roadside rights-of-ways) to protect and increase management efforts to benefit occupied habitat.
9. Continue transplantings from threatened sites.

10. Conduct reintroductions and possibly augmentations on publically owned conservation lands with suitable habitat and develop best approaches for conducting introductions to assist in meeting recovery goals.
11. Develop a monitoring protocol that indicates frequency and timing for future consistency and long-term trend analysis.
12. Support continued work and research into ex situ cryopreservation to preserve cell lines of this species.

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**5-YEAR REVIEW**  
**Rugel's Pawpaw (*Deeringothamnus rugelii*)**

Current Classification Endangered

Recommendation resulting from the 5-Year Review

X            No change is needed

Review Conducted By: Jo Anna Emanuel, North Florida Ecological Services Office,  
Jacksonville, FL

**FIELD OFFICE APPROVAL:**

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

Approve

  
Jay B. Herrington

Date

1/18/2018

APPENDIX A  
Summary of peer review for the 5-year review of  
*Deeringothamnus rugelii* (Rugel's pawpaw)

**A. Peer Review Method**

Prospective peer reviewers were identified if they met one or more of the following criteria: (1) they had recent scientific publications related to Rugel's pawpaw biology, ecology, or conservation; (2) they had recently conducted research or monitoring of Rugel's pawpaw related to biology, ecology, or conservation; or (3) they had knowledge of Rugel's pawpaw biology, ecology, or conservation because of their current professional position.

Prospective peer reviewers were notified electronically on November 20, 2017, and asked for their willingness to participate in the peer review.

Three prospective peer reviewers were notified: Danny Young, Florida Native Plant Society; Cheryl Peterson, Bok Tower Gardens; and Dr. Eliane Norman, Stetson University, Biology Department, Emeritus. One comment was received in response to the request for peer review assistance.

**B. Summary of Peer Review Comments:**

Mr. Young

Mr. Young provided a single comment regarding the orientation of the cover photo he supplied. Mr. Young indicated that the image appeared to be inserted sideways.

**C. Response to Peer Review:**

Mr. Young

The image orientation was determined to be appropriately oriented.

