

**Beautiful pawpaw**  
*(Deeringothamnus pulchellus)*

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

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

## **5-YEAR REVIEW**

### **Beautiful pawpaw/*Deeringothamnus pulchellus***

#### **I. GENERAL INFORMATION**

**A. Methodology used to complete the review:** This review is based on monitoring reports, surveys, and other scientific and management information, augmented by conversations and comments from biologists familiar with the species. The review was conducted by the lead recovery biologist with the South Florida Ecological Services Office. Literature and documents on file at the South Florida Ecological Services Office were used for this review. All recommendations resulting from this review are a result of thoroughly reviewing the best available information on the beautiful pawpaw. Comments and suggestions regarding the review were received from South Florida Ecological Services Office supervisors and peer reviews from outside the Service. The public notice for this review was published on April 16, 2008, with a 60-day public comment period (73 FR 20702). No part of the review was contracted to an outside party. Comments received were evaluated and incorporated as appropriate. See the Appendix for a summary of the peer review.

#### **B. Reviewers**

**Lead Region:** Southeast Regional Office, Nikki Lamp, 404-679-7091

**Lead Field Office:** South Florida Ecological Services Office, Marilyn Knight, 772-562-3909

#### **C. Background**

**1. FR Notice citation announcing initiation of this review:** April 16, 2008. 73 FR 20702.

**2. Species status:** Uncertain (2008 Recovery Data Call). The beautiful pawpaw population has not been monitored over the past year. Because there is no information on the population trends over the past year, trends for most threats are unknown or continuing at the same level, and there are likely undocumented occurrences that are being lost to development or mismanagement, the overall status of the species is uncertain. For the purposes of this review, the term “population” refers to the collective of all plants of this species or may be used to describe groups of plants resulting from reintroductions or translocations; this includes the single natural population and any reintroduced or translocated populations. The term “occurrence” refers to fragmented remnants of the collective population. The term “site” refers to the physical location of the occurrences.

**3. Recovery achieved:** 1 (0-25% recovery objectives achieved). Partial recovery objectives have been achieved through: land acquisition of parcels containing beautiful pawpaw, management of invasive species, controlling access to sites, conducting surveys, protecting occurrences on public land, locating potential reintroduction sites, reintroducing plants to protected areas, and monitoring reintroduced plants.

#### **4. Listing history**

##### Original Listing

FR notice: 51 FR 34415

Date listed: September 26, 1986

Entity listed: Species

Classification: Endangered

#### **5. Associated:** N/A

**6. Review History:** Five-year review November 6, 1991 (56 FR 56882): In this review, different species were simultaneously evaluated with no species-specific, in-depth assessment of the five factors or threats as they pertained to the different species' recovery. 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 beautiful pawpaw.

Final Recovery Plan: 1999

Recovery Data Call: 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008

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

#### **8. Recovery Plan or Outline**

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

Date issued: May 18, 1999

Dates of previous plans: April 5, 1988 (Recovery plan for three Florida pawpaws) (Original plan)

## **II. REVIEW ANALYSIS**

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

**1. Is the species under review listed as a DPS?** No. The Endangered Species Act (ESA) defines species as including any subspecies of fish, wildlife, or plant, 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 the species under review is a plant, the DPS policy is not applicable.

### **B. Recovery Criteria**

**1. Does the species have a final, approved recovery plan containing objective, measurable criteria?** Yes. However, these criteria could be made more quantifiable when more information becomes available about the species.

## **2. Adequacy of recovery criteria.**

**a. Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat? Yes.**

**b. Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)? Yes.**

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

Criteria for when reclassification of beautiful pawpaw from endangered to threatened may be considered are:

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

Very little demographic data are available for the beautiful pawpaw. Surveys have been conducted intermittently in the past, but trend data are difficult to assess because surveys have generally only assessed a few occurrences at any one time and new occurrences have been discovered. Based upon the most comprehensive data available, there are currently thought to be approximately 5,000 pawpaw plants in 39 occurrences in Charlotte, Lee, and Orange Counties (Florida Natural Areas Inventory [FNAI] 2008). Approximately 59 percent of the occurrences are on public or managed lands and 41 percent are on private lands (FNAI 2008). The number of plants ranges from 1 to 2 plants on some sites to over 1,000 individuals on 3 sites (FNAI 2008).

Because the species is thought to be long-lived, reproductive success is not critical every year and recruitment is low (Service 1999). Other than follow-up monitoring during the first year after transplant of three transplanted populations, no long-term estimates of survival have been obtained for the species (Service 1998; Preston et al. 2004). No follow-up data have been collected. Additionally, no information has been reported on survival of individuals in natural occurrences, and life history stage and population structure data have not been collected. Norman (2009) conducted limited experiments with seed collected from Orange County and reported very low seedling survival. She suggested that the species may rely on a mycorrhizal fungal association to promote seedling survival (Norman 2009).

Because consistent annual surveys are needed to evaluate long-term population trends and additional studies need to be completed on survival and population structure

across the range of the species, there are not enough demographic data available to determine the appropriate numbers of self-sustaining populations and sites needed to ensure 20 to 90 percent probability of persistence for 100 years. This criterion addresses listing factors A, D, and E.

2. These sites within the historic range of beautiful pawpaw are adequately protected from further habitat loss, degradation, and fragmentation.

Only 5 of 21 known occurrences of beautiful pawpaw were protected 10 years ago, and 2 of these were transplanted populations (Service 1999). Currently, 59 percent of the occurrences are either in public ownership or on managed areas, while 41 percent are not (FNAI 2008). However, degradation to habitat on public land has occurred as a result of lack of management. Resources for management actions may not always be available, and habitat needed to support pawpaws will degrade in the absence of regular management. Control of exotic plant species and prescribed fire are important management strategies for maintaining healthy pawpaw populations.

The occurrences on private property are not adequately protected from further habitat loss and degradation. One of the occurrences has been extirpated, probably due to lack of management or crushing of the plants by debris (FNAI 2008). With human population expansion predicted for the counties within its historic range over the next 50 years (Zwick and Carr 2006), the species remains vulnerable to development.

Due to the vulnerability on private property and the need for regular habitat management, most sites with beautiful pawpaw are not adequately protected from further habitat loss, degradation, and fragmentation. This criterion addresses listing factors A, D, and E.

3. These sites are managed to maintain pine flatwoods to support beautiful pawpaw.

Pine flatwoods are typically maintained by fire. On many privately owned properties, fire has historically been suppressed, and habitat has not received regular maintenance. Because fragmented habitat where these plants occur is interspersed on a developed landscape, burning may also be unlikely due to proximity to neighbors. Plants on sites that are being burned regularly are generally persisting.

Some sites with beautiful pawpaw are being managed well, while others, even on public lands, may not be receiving management to meet the species' needs. Annual prescribed burns have been conducted since 1987 and 1990 on two occurrence sites located on public properties (Woodmansee and Barry 2007). It is known that two other public properties have been burned recently, but the specific fire history on these sites is not known (Woodmansee and Barry 2007). One translocated population is not receiving regular fire maintenance and has seen a large reduction in the number of plants surviving (Woodmansee and Barry 2007). Exotic plant removal is needed on several properties (Woodmansee and Barry 2007). Specific management information was not available for most of the occurrences.

Because not all of the public and private sites are adequately being managed to maintain habitat to support the species, this objective has not been met yet. This criterion addresses listing factor A.

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

Surveys have indicated that the beautiful pawpaw occurs throughout its historic range, but the population is fragmented and occurs primarily in two disjunct areas in Lee and Charlotte Counties and in Orange County (FNAI 2008). Nearly one-third of the occurrences are comprised of 15 or fewer pawpaws (FNAI 2008). Small occurrences tend to lack genetic diversity and may not be self-sustaining over time (Ellstrand and Elam 1993). They may also be more vulnerable to stochastic events. Small occurrences are very important to the recovery of the species. Conservation efforts should focus on maintaining genetic diversity of small occurrences and enhancing wherever possible.

Monitoring has not been conducted on a regular basis at any of the sites. Either a consistent monitoring program needs to be established or age structure needs to be determined to demonstrate that sites support the appropriate numbers of self-sustaining populations. This criterion addresses listing factors A, C, and E.

Although not considered to be significant problems at the time of listing, factor B was included in the original listing package because it could become an issue. At present it is still not known to be of concern and is not addressed in the criteria.

Overall, the recovery objective is an interim goal because of the limited data on the biology, ecology, and management needs of this species. There are no criteria for delisting the beautiful pawpaw.

## C. Updated Information and Current Species Status

### 1. Biology and Habitat

**a. Abundance, population trends (e.g., increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate), or demographic trends:** The FNAI reports 43 occurrence records where beautiful pawpaw has been found within its current range in Charlotte, Lee, and Orange Counties (FNAI 2008). Of these, one occurrence in Charlotte County was last observed in 1928 and is considered to be a historical record, as there has been no known survey in the last 20 to 40 years; one occurrence in Orange County has been extirpated (FNAI 2008). Two occurrence records were parent populations (i.e., a group, usually 2-3, of sub-populations) that later were reported as sub-populations

and separate occurrences, and, therefore, were not counted in the total number of occurrences.

Of the 39 remaining occurrence records, 21 are located in Charlotte County, 1 is situated along the border of Charlotte and Lee Counties, 13 are found in Lee County, and 4 are located in Orange County. There are 23 (59%) that occur on public or managed lands, and 16 (41%) occur on non-managed lands (FNAI 2008). Three of 39 occurrences are introduced: 1 in Orange County, 1 in Charlotte County, and 1 in Lee County (Service 1999, FNAI 2008).

Even though counties of occurrence differ for beautiful pawpaw and its congener Rugel's pawpaw (*D. rugelii*), these species resemble each other and occur in very similar habitats. Beautiful pawpaw is known to occur in Orange County, adjacent to Brevard County. Therefore, surveys for the species were conducted in Brevard County in conjunction with surveys for Rugel's pawpaw, but no occurrences of either species were reported (Schmalzer and Foster 2004).

Recent surveys have not been conducted on all of the known sites and trend data are lacking, but data collected over the last 10 years indicates that the total population may be in the order of about 5,000 individuals in the 39 occurrences (FNAI 2008). Similarly, Johnson (1999) conservatively estimated the total population to be 4,000 to 4,700 individuals, but only reported that the species occurred on 28 sites. The discrepancy in the number of occurrences is likely the result of newly discovered occurrences or differences in the definition of what constitutes an occurrence. The total population size is probably much smaller than that which occurred in historic times (Service 1999). The number of plants ranges from 1-2 plants on some sites to over 1,000 individuals on 3 of the sites (FNAI 2008).

Fifteen of the occurrences have been assessed since 2005 (FNAI 2008), including surveys completed on seven sites in Lee and Charlotte Counties to determine damage to pawpaw plants as a result of Hurricane Charley in 2004 (Woodmansee and Barry 2007). No damage to pawpaw plants was observed in any of the occurrences (Woodmansee and Barry 2007). Where data from these seven occurrences could be compared to data from previous years, it appears that the occurrences were either stable or declining (FNAI 2008).

Very little demographic information has been collected for the beautiful pawpaw. It is thought that the species is long-lived and that recruitment is low (Service 1999). No long-term estimates of survival have been obtained for the species, but survival was monitored in three transplanted populations. One year after transplanting, the mean overall survival rates were 39 percent in one population and 65 percent in the other (Service 1998). In another transplanting experiment, 87 percent of the plants survived the first year (Preston et al. 2004). No follow-up data have been collected.

**b. Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding):** No studies of genetic variation have been reported for this species. However, researchers have mentioned that the species has been known to form an intergeneric hybrid with the netted pawpaw (*Asimina reticulata*), although this does not seem to be a frequent occurrence (Norman 2003). Norman (2003) reported limited success with artificially producing hybrids from these two genera. Genotyping of some lines is currently being conducted to produce plants for research, reintroduction, and germplasm storage (Pence and Charls 2003).

**c. Taxonomic classification or changes in nomenclature:** The species was first named and described by John K. Small as the only species belonging to the genus *Deeringothamnus* and separated from the genus *Asimina* by its “dimorphous stems, the flat or depressed receptacle, and the narrow nearly uniform unsculptured petals” (Small 1924). Rehder and Dayton (1944) discussed placing the species in the genus *Asimina*. Because the use of the combination *Asimina pulchella* did not meet nomenclatural rules, they retained the *Deeringothamnus pulchellus* name. A subsequent treatment of taxonomy is consistent with that of Small (Kral 1960). However, Ward (2001) suggested that, due to the presence of forms that appear to be intermediates between *D. pulchellus* and its congener *D. rugelii*, they should be treated as a single species and varieties should be used to distinguish the two forms. According to Ward’s (2001) assessment, beautiful pawpaw should be named *D. rugelii* var. *pulchellus*. The scientific community, however, has not fully embraced this taxonomic change, and Ward also now considers them as two separate species (Norman 2003, 2008). The Integrated Taxonomic Information System (2009) does not indicate any formal changes to the name *D. pulchellus*.

**d. Spatial distribution, trends in spatial distribution (e.g., increasingly fragmented, increased numbers of corridors), or historic range (e.g., corrections to the historical range, change in distribution of the species’ within its historic range):** Historically, beautiful pawpaw occurred on poorly drained sands of slash (*Pinus elliottii*) and longleaf pine (*P. palustris*)-saw palmetto (*Serenoa repens*) flatwoods in Lee and Charlotte Counties in southwestern Florida and was also found in Orange County east of Orlando (Kral 1960). However, much of the suitable habitat in the historic range has been destroyed or converted for residential housing, commercial activities, and agriculture, and numbers and distribution of plants have decreased as a result (Service 1999).

Trends in spatial distribution show increasing fragmentation of beautiful pawpaw habitat as southwestern and central Florida have become developed and fire has been suppressed. Land clearing associated with the development of the town of Cape Coral on the mainland of Charlotte County probably

resulted in substantial losses of habitat and plants (Service 1999). Demands for horticulture, tropical fruit production, grazing, and residential housing have destroyed habitat and plants on Pine Island in Lee County (Service 1999). Extant occurrences in Charlotte, Lee, and Orange Counties (Woodmansee and Barry 2007) are isolated in a highly fragmented landscape. Most occurrences are located in the Charlotte Harbor and Caloosahatchee River area from Punta Gorda to Fort Myers (Service 1999). A distance of approximately 100 miles separates the occurrences in Charlotte and Lee Counties from those in Orange County (Johnson 1999).

**e. Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):** Suitable but fragmented habitat remains in all three historic counties of occurrence, but amount of habitat available and how it is distributed amongst those counties is not known. In addition to vegetative community, soil type is also a consideration when determining suitable habitat. Occurrences of this species were discovered on sites containing two soil types not previously known to support beautiful pawpaw, Wabasso sand and Malabar fine sand (Johnson 1999).

Some sites are being managed well, while others, even on public lands, may not be receiving the management needed to sustain the plants. For example, one introduced population on public property where 200 individuals were transplanted is not being burned, and only one plant was located during recent surveys (Woodmansee and Barry 2007). Two occurrences are on public lands that have been burned annually, one since 1987 and the other since 1990 (Woodmansee and Barry 2007). Two other sites have been burned recently, but the fire history was not reported on these sites (Woodmansee and Barry 2007). Specific management information was not available for most of the occurrences. Pawpaw occurrences on public sites that are being burned regularly are generally persisting (Woodmansee and Barry 2007).

As a result of the Woodmansee and Barry (2007) study to determine hurricane impacts, exotic plant removal was recommended to improve habitat conditions for at least three occurrences and initiation of fire management was suggested for two occurrences. Despite the passage of Hurricane Charley over the northern end of Pine Island in Lee County and the northwest portion of Charlotte County in 2004, no damage to habitat or plants was observed during these surveys (Woodmansee and Barry 2007).

**f. Other:** Research on the beautiful pawpaw has been conducted in the areas of phenology, pollination, reproductive structures, breeding system, germination, and hybridization (Norman 2003). Pollinators were few, but those noted during this study were a tumbling beetle (*Mordella atrata*) and two species of thrips (*Frankliniella bispinosa* and *Thrips hawaiiensis*) (Norman 2003). Flowering was observed in Orange County in mid-March and lasted for 6 weeks (Norman 2003). Disturbance to the plants, such as

mowing or fire, generally results in stimulating flower production (Helkowski and Johnson 2000; Norman 2003). No intermediate forms of beautiful pawpaw and Rugel's pawpaw were observed to occur naturally (Norman 2003).

Additionally, research is being conducted on this species in the area of in vitro collecting and tissue culture lines (Pence and Charls 2003). Shoot tips were used to establish culture lines from 27 percent of the species' genotypes (Pence and Charls 2003). Bok Tower Gardens has tried propagating the species in an *ex situ* collection, but plants have not survived and storage of seed is not successful (Peterson et al. 2008). Researchers plan to continue seed collection and propagation techniques this year with hopes of producing a healthy, viable *ex situ* population (Peterson et al. 2008). Experimental translocations of adult plants have taken place; these populations have been monitored for the year following the experiment with good success. The mean overall survival rates were 39 percent and 65 percent for two of the populations (Service 1998) and 87 percent in another population (Preston et al. 2004).

## 2. Five-Factor Analysis

**a. Present or threatened destruction, modification or curtailment of its habitat or range:** Continued habitat loss, fragmentation, and changes in land use threaten the existence of beautiful pawpaw. Where plants occur on private sites, development has led to both direct destruction of habitat as a result of land clearing and habitat degradation from lack of management. One of the occurrences in Orange County has been extirpated (FNAI 2008). The property where this occurrence was reported was located adjacent to houses, the site was overgrown with Brazilian pepper (*Schinus terebinthifolius*), and trash was deposited in the area (FNAI 2008). It is likely that the plants were either crushed by debris or the habitat degraded to the point of being unsuitable for the species.

Occurrences on private land are vulnerable to destruction and habitat loss. Currently, 41 percent of the occurrences of beautiful pawpaw are at-risk (FNAI 2008). Threats from development and habitat degradation on private sites are expected to continue and increase. Within the range of beautiful pawpaw, the human population is predicted to grow from over 160,000 to nearly 336,000 in Charlotte County, from just over 537,000 to nearly 1,370,000 in Lee County, and from over 1,042,000 to more than 2,469,000 in Orange County between 2005 and 2060 (Zwick and Carr 2006).

Approximately 10 years ago, only 5 of 21 occurrences were protected (Service 1999). Two of these were transplanted populations on public lands, of which plant numbers have been severely reduced on one, likely due to lack of management (Woodmansee and Barry 2007). Currently, 59 percent of the

occurrences of beautiful pawpaw are either in public ownership or on managed areas (FNAI 2008). Despite protection from development, continuing management will be necessary for plants to persist in these areas.

This small shrub rarely exceeds 0.5 meter in height and does not persist where it must compete for light with tall grasses and larger shrubs. Habitat management is typically needed to reduce competition, especially from exotic plant species (Service 1999). Fire suppression and lack of management has led to the overgrowth and degradation of habitat (see Factor E).

Even though the majority of occupied sites are not at risk of being developed, plants on these sites may still be vulnerable to habitat degradation from encroachment of exotic plant species and lack of fire or other mechanical treatment. If sites are not properly managed, ecosystem health may deteriorate. Because the sites are fragmented on a developed landscape, fire management may not always be feasible and encroachment by exotic plant species from neighboring properties is likely. Therefore, habitat loss, degradation, and fragmentation due to increasing development, lack of management, and encroachment of exotic plants will continue to threaten the beautiful pawpaw. Because some sites are on protected lands and are being managed properly, the overall threat level to the species is considered to be moderate and non-imminent.

**b. Overutilization for commercial, recreational, scientific, or educational purposes:** At the time of listing, indiscriminate collecting of beautiful pawpaw was not known, but caution was suggested to ensure that increased publicity did not spark such collecting. Because beautiful pawpaw is limited in distribution and population sizes are relatively small, indiscriminate collecting could adversely affect the species. However, overutilization has not been documented.

**c. Disease or predation:** No incidences of disease have been reported for the beautiful pawpaw. When listed, some insect damage was occurring to the leaves of the plants. Norman (2003) reported destruction to buds, leaves, flowers, and young fruits by the caterpillar stage of the leaf roller (*Chloristoneura parallela*). Occasionally, larvae of the zebra swallowtail butterfly (*Eurytides marcellus*) were found on beautiful pawpaw plants, but very little damage occurred (Norman 2003).

Herbivores, such as whitetail deer (*Odocoileus virginianus*), may also consume leaves from pawpaw plants, but foraging on pawpaws is not considered to be extensive because deer primarily browse on higher vegetation rather than graze on low-growing plants (Service 1999). It is probable that eastern cottontail rabbits (*Sylvilagus floridanus*) and gopher tortoises (*Gopherus polyphemus*) opportunistically consume pawpaw fruits because forbs and small shrubs are seasonally important components of the

diets of these two species (Service 1999). If so, these species may aid in the dispersal of seeds (Service 1999). These incidences of predation are not known to constitute serious threats to the beautiful pawpaw.

**d. Inadequacy of existing regulatory mechanisms:** Generally, managing agencies have limited regulatory tools. The ESA provides protection for this species and its habitat through section 7. The beautiful pawpaw is also listed by the Florida Department of Agriculture and Consumer Services (FDACS) as endangered (5B-40.0055 Regulated Plant Index), but this legislation does not provide any direct habitat protection. Existing Federal regulations prohibit the removal or destruction of listed plant species on Federal lands. State regulations require both written permission from the owner or legal representative and a permit issued by FDACS to collect or remove plants listed as endangered on the Florida Regulated Plant Index. However, these regulations afford no protection to listed plants on private lands.

Lee County offers some protection for the beautiful pawpaw through a listed species ordinance which requires mitigation for adverse effects to State and federally listed species (Lee County 1998). However, this ordinance does not apply to agricultural lands or those being re-zoned for agriculture, and part of the threat of habitat loss where pawpaws occur is a result of clearing for agricultural purposes.

In some situations, existing regulatory mechanisms do not appear to be adequate, as several private properties with pawpaws have been developed. Because this plant occurs in habitat which is desirable real estate for development along the southwestern coast and inland near Orlando, this species remains vulnerable to development pressures where it occurs on private property.

**e. Other natural or manmade factors affecting its continued existence:** This species occurs in pine flatwoods habitat, which is typically maintained by fire. This species is adapted to live in pine flatwoods habitat where frequent ground fires are not hot enough to kill mature pine trees but do remove or thin understory vegetation and reduce competition with larger grasses and shrubs (Service 1999). During the first growing season after fire, the beautiful pawpaw takes advantage of newly-created openings by flowering and setting fruit (Service 1999). Therefore, land management practices such as prescribed fire are very important to maintaining and working towards recovery of the beautiful pawpaw.

Lack of management is a concern on some protected sites. Vegetation restoration and management programs are costly, and the availability of resources is never assured; therefore, habitat degradation and modification from inadequate management even on protected lands remains an imminent, though moderate, threat.

On many privately owned sites, fire has historically been suppressed, and habitat has not received regular maintenance. Where this species occurs on fragmented landscapes interspersed with development, burning may be unlikely due to proximity to neighbors. In areas that cannot be readily burned, mowing is sometimes used as a management strategy. In mowed habitat, the growth habit of this species is more prostrate with woody stems lying on the ground, while in fire-maintained habitat, it grows more erect with arching stems (Service 1999).

If sites are not regularly maintained through fire or mechanical treatment, the overall health of the ecosystem may be compromised. Research on the effects of fire on Rugel's pawpaw indicated that vegetative growth, flowering, and fruit set are stimulated by fire, and the author suggested that the same is true for beautiful pawpaw (Helkowski and Johnson 2000). Norman (2003) verified that fire enhances flowering of the beautiful pawpaw. Pawpaws respond well to frequent (every 1 to 3 years), low-intensity winter burns or mechanical disturbance, but this regime does not seem to favor associated species (Johnson 1999; Service 1999). It is thought that pawpaw response to spring and summer burns should be similar and that associated species may be favored (Johnson 1999; Helkowski and Johnson 2000).

In the absence of site maintenance, a threat to pawpaws is the establishment of invasive plant species such as Brazilian pepper, melaleuca (*Melaleuca quinquenervia*), and earleaf acacia (*Acacia auriculiformis*). However, herbicides used to control overgrowth, if not properly applied, also may pose a threat to the beautiful pawpaw.

Another threat identified when the species was listed was damage by all-terrain vehicles in at least a portion of the species' range. It is presumed that this threat continues on occurrence sites where access is not restricted. Feral hogs (*Sus scrofa*) may also pose a threat to beautiful pawpaw plants.

The species' limited distribution and its limited reproductive capacity also renders it vulnerable to random natural events, such as hurricanes and drought. However, Hurricane Charley crossed the northwest portion of the species' range in Lee and Charlotte Counties in 2004, and no apparent damage occurred to the beautiful pawpaws (Woodmansee and Barry 2007). During this hurricane, storm surge did not impact the occurrences but could in cases where storm surge is greater. The possibility of future hurricanes and tropical storms striking Florida is likely; this threat is expected to continue.

**D. Synthesis** - The species' recovery plan contains objective, measurable reclassification criteria, but does not include delisting criteria. The reclassification criteria for downlisting have not been met because there are not enough demographic data available to determine the appropriate numbers of self-sustaining populations and sites needed to ensure persistence;

not all sites within the historic range are adequately protected from further habitat loss, degradation, and fragmentation; some of these sites are not being managed to maintain pine flatwoods to support beautiful pawpaw; and there are not appropriate numbers of self-sustaining and stable populations throughout the historic range of the species. Consistent annual surveys are needed to evaluate long-term population trends and additional studies need to be completed on survival and population structure. Only 59 percent of the occurrences are either in public ownership or on managed areas, and not all of the public and private sites are adequately being managed to maintain habitat to support the species. Monitoring has not been conducted on a regular basis at any of the sites.

Overall, the current range of beautiful pawpaw is limited to Lee, Charlotte, and Orange Counties, Florida. The occurrences are fragmented and isolated within the range; approximately 100 miles separates the occurrences in Lee and Charlottes Counties from those in Orange County. There are approximately 5,000 plants remaining in 39 occurrences.

Where habitat remains intact, beautiful pawpaw depends upon active management to persist. Land management practices, especially prescribed fire used for the reduction of tall grasses and larger shrubs, are extremely important for maintaining the health of the pine flatwoods ecosystem in which this species occurs. The removal of invasive plant species is especially important for maintaining habitat for the species. Where some sites have received regular site maintenance, plants are persisting, but other sites on private lands have been lost to habitat degradation. Existing regulatory mechanisms do not appear to be adequate on private lands. Because this plant occurs in habitat along the southwest coast of Florida and near Orlando, which is desirable real estate for development, this species remains vulnerable where it occurs on private property. Habitat loss, fragmentation, and changes in land use continue, and conversion of habitat to urban use along the coast and near Orlando is projected to increase over the next 50 years. The species' limited distribution and its limited reproductive capacity also renders it vulnerable to random natural events, such as hurricanes and drought. Considering the species' current status and above ongoing threats, this species continues to meet the definition of endangered under the ESA.

### **III. RESULTS**

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

  X   **No change is needed**

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

#### **Management:**

- Continue management actions to include removal of hogs, debris, and exotic plants. Depending upon site, management efforts may include: licensed hunting or trapping of hogs, careful application of herbicides, controlling public access, and reintroduction of prescribed fire into the ecosystem.

- Restore habitat in potential areas where plants could occur but are not currently reported, and provide follow-up surveys post-disturbance to determine if natural occurrences are present.
- Identify additional reintroduction sites and establish reintroduced populations; augmentations should also be implemented.
- Focus conservation efforts on marginal and small occurrences to preserve the genetic diversity of the species.

**Research:**

- Conduct research on the response of beautiful pawpaw to fire and fire prescriptions necessary to benefit the species.
- Monitor burned and mowed sites to assess which technique is most beneficial to pawpaw reproduction and survival.
- Continue research on the biology, ecology, genetics, and management needs of the species.
- Conduct demographic studies to determine the age class structure and long-term viability of the species, especially in areas with active recruitment, and determine critical life stages.
- Conduct genetic characterizations on occurrences, and apply this knowledge to future introductions and augmentations.
- Continue to evaluate insect pollinators associated with the species over the long-term, and evaluate impacts to pollinators from aerial mosquito spraying.
- Conduct seed germination studies and make efforts to develop additional outplanting techniques.
- Continue propagation efforts and establish techniques for long-term germplasm storage; make sure all occurrences are represented in the Center for Plant Conservation's National Collection of Endangered Plants.
- Evaluate the effects of climate change on the species, including those that result from precipitation pattern changes and temperature rise.

**Surveys:**

- Continue to survey potential habitat and pursue conservation agreements, implement management recommendations, and/or acquire land and investigate incentives to encourage land managers to manage pine flatwoods for ecosystem health and listed species.
- Conduct additional surveys for beautiful pawpaw on all known (particularly Estero Bay Preserve State Park, Pine Island Flatwoods Preserve, and the newly acquired Babcock Ranch) and potentially suitable sites in the three counties of occurrence; provide updated information to FNAI for consistent tracking.
- Continue monitoring both reintroduced and natural occurrences.

**Other:**

- Promote partnerships to share information, conduct collaborative research on pine flatwoods habitat conservation, and provide land managers and the interested public with information about the ecosystem, threats, recovery actions, and associated rare biota.

- Seek opportunities to include the media in conservation efforts to provide information about this species to the public.

## V. REFERENCES

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**U.S. FISH AND WILDLIFE SERVICE**  
**5-YEAR REVIEW of Beautiful pawpaw (*Deeringothamnus pulchellus*)**

Current Classification Endangered  
Recommendation resulting from the 5-Year Review

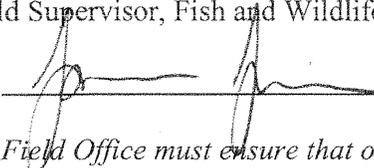
- Downlist to Threatened
- Uplist to Endangered
- Delist
- No change is needed

Appropriate Listing/Reclassification Priority Number, if applicable \_\_\_\_\_

Review Conducted By Marilyn Knight

**FIELD OFFICE APPROVAL:**

Lead Field Supervisor, Fish and Wildlife Service

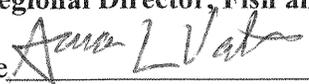
Approve  Date 4/29/09

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

**REGIONAL OFFICE APPROVAL:**

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

Lead Regional Director, Fish and Wildlife Service

Approve  Date 6-17-09

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

**Summary of peer review for the 5-year review of beautiful pawpaw (*Deeringothamnus pulchellus*)**

**A. Peer Review Method:** The Service conducted an influential level of peer review. Peer reviewers were selected by the Service. Two peer reviewers were asked to participate in this review. Individual responses were requested and received from each of the peer reviewers.

**B. Peer Review Charge:** See attached guidance.

**C. Summary of Peer Review Comments/Report:** Peer review comments were substantial and provided insights that were beneficial in conducting this review. Reviewers noted that information provided in this review was thorough and adequately described the current status of the species. One reviewer stated that the need for additional data collection and management was sufficiently identified in the review. One reviewer commented that clarification should be made regarding the rarity of the species as a result of low seedling survival. It was suggested that a mycorrhizal fungal association may be needed to promote seedling survival.

**D. Response to Peer Review:** The Service was in agreement with the comments and concerns received from peer reviewers, and comments were incorporated.

**Guidance for Peer Reviewers of Five-Year Status Reviews**  
U.S. Fish and Wildlife Service, South Florida Ecological Services Office

March 27, 2009

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

Peer reviewers should:

1. Review all materials provided by the Service.
2. Identify, review, and provide other relevant data apparently not used by the Service.
3. Not provide recommendations on the Endangered Species Act classification (e.g., endangered, threatened) of the species.
4. Provide written comments on:
  - Validity of any models, data, or analyses used or relied on in the review.
  - Adequacy of the data (e.g., are the data sufficient to support the biological conclusions reached). If data are inadequate, identify additional data or studies that are needed to adequately justify biological conclusions.
  - Oversights, omissions, and inconsistencies.
  - Reasonableness of judgments made from the scientific evidence.
  - Scientific uncertainties by ensuring that they are clearly identified and characterized, and that potential implications of uncertainties for the technical conclusions drawn are clear.
  - Strengths and limitation of the overall product.
5. Keep in mind the requirement that the Service must use the best available scientific data in determining the species' status. This does not mean the Service must have statistically significant data on population trends or data from all known populations.

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

Questions regarding this guidance, the peer review process, or other aspects of the Service's recovery planning process should be referred to Paula Halupa, Acting Endangered Species Supervisor, South Florida Ecological Services Office, at 772-562-3909, extension 257, email: [Paula\\_Halupa@fws.gov](mailto:Paula_Halupa@fws.gov).