

Fragrant prickly-apple
(Cereus eriophorus var. fragrans)

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



Photograph by Steve Woodmansee

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

5-YEAR REVIEW

Fragrant prickly-apple/*Cereus eriophorus* var. *fragrans*

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 fragrant prickly-apple. Comments and suggestions regarding the review were received from peer reviews from outside the Service. The public notice for this review was published on April 9, 2009, with a 60-day public comment period (74 FR 16230). No part of the review was contracted to an outside party. Comments received were evaluated and incorporated as appropriate.

B. Reviewers

Lead Region: Southeast Region, Kelly Bibb, (404) 679-7132

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

C. Background

1. Federal Register Notice citation announcing initiation of this review: April 9, 2009. 74 FR 16230.

2. Species status: Declining (2009 Recovery Data Call). No survey results were reported for the previous year. In 2008, the Savannahs Preserve State Park (SPSP) population was still in the process of recovering from hurricane damage in 2004. Because it is presumed that this large population has not yet recovered and threats continued and increased over the year, the status of the species is declining.

3. Recovery achieved: 2 (26-50% recovery objectives achieved). Recovery objectives for this cactus are being achieved through land acquisition, management of invasive species, controlling access to sites containing plants, conducting surveys, protecting plants on public land, conserving germ plasm and maintaining an *ex situ* population, and conducting demographic studies. Before potential reintroduction sites can be located, a better understanding of the historic range is needed.

4. Listing history

Original Listing

FR notice: 50 FR 45618

Date listed: November 1, 1985

Entity listed: Variety

Classification: Endangered

5. 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 as they pertained to the different species' recovery. In particular, no changes were proposed for the status of the fragrant prickly-apple. Final Recovery Plan: 1999
Recovery Data Call: 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, and 2009

6. Species' Recovery Priority Number at start of review (48 FR 43098): 3 (a subspecies [variety] with a high degree of threat and high recovery potential).

7. Recovery Plan

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

Date issued: May 18, 1999

Dates of original plan: August 29, 1988 (Recovery plan for fragrant prickly-apple cactus)

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 defines species as including any subspecies of fish, wildlife, or plant, and any distinct population segment of any species of vertebrate fish or wildlife. This definition limits listing a 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? No. There are no recovery criteria specified in the recovery plan for downlisting or delisting. There are criteria for preventing extinction and stabilizing the population. Fragrant prickly-apple may be considered stabilized when existing populations, within the historic range, are self-sustaining and are adequately protected from further habitat loss, degradation, exotic plant invasion, and fire suppression. These sites must also be managed to maintain xeric coastal scrub to support fragrant prickly-apple. Nine of the ten confirmed sites where this species occurs are found on or around the Savannas Preserve State Park (SPSP). Six of these sites are on State property and are protected from development, and three are partially

protected. The State is working to restore and manage these lands utilizing prescribed fire, mechanical treatment, and exotic plant removal.

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:

Information on the habitat and life history of the fragrant prickly-apple is summarized in the Service's Recovery Plan for Fragrant Prickly-apple Cactus (1988) and revised in the MSRP (1999). Important information is updated and summarized below.

FNAI (Florida Natural Areas Inventory, 2009) reported that fragrant prickly-apple occurs on 10 confirmed sites and 1 unconfirmed site and occurred historically on 1 other site. Six of the 10 confirmed sites are protected, 2 are on privately owned properties, and 3 are partially protected (a portion of the site where plants occur is privately owned) (FNAI 2009). Nine of the 10 confirmed sites occur on or around SPSP in St. Lucie County (FNAI 2009). The other confirmed site is in Volusia County (Woodmansee in litt. 2006; FNAI 2009). The unconfirmed site is from Indian River County (Woodmansee et al. 2007; FNAI 2009). Woodmansee et al. (2007) also reported two extirpated populations from Brevard County that were not included in the FNAI records.

Between 1988 and 1993, Rae and Ebert (2002) noted declines in numbers of fragrant prickly-apple of 27.2 percent and 32.6 percent on two study sites in the northern and central portions of the range. They attributed these decreases primarily to low recruitment rates and high mortality (Rae and Ebert 2002). From 1993 to 1996, plants on these sites declined by approximately 40 percent (Rae 1994; Rae and Ebert 2002). Since these population surveys, conducted between 1988 and 1996, had indicated that the plants may be in decline, a preliminary program was initiated in 1998 by the Institute for Regional Conservation (IRC) and the Florida Department of Environmental Protection (FDEP) to monitor the entire population.

Following this initial population survey in which 802 plants were located in 1998 and mapped, a study was implemented from 1999 to 2002 to continue the monitoring program and evaluate the status of the population (Bradley et al. 1999). The population estimate was determined to be 879 in 1999; 1,206 in 2000; and 1,744 in 2001 (Bradley et al. 2002a). Some of these newly reported plants were those that were overlooked in previous surveys or in areas not initially surveyed, but others were new recruits from seed or broken

stem fragments of adults that rooted on the ground (Bradley et al. 2002a). Overall, the population trend was reported to be stable (Bradley et al. 2002a).

Bradley et al. (2002b) reported approximately 2,150 plants in 2002 in the nine subpopulations at SPSP, approximately 63 percent of which were actually on protected lands rather than on inholdings or the railroad right-of-way. They estimated that the total population may number up to 3,000, with some plants occurring on private lands (Bradley et al. 2002b). According to data collected from 1999-2002, the population remained relatively stable with a slight increase in the last year of study (Bradley et al. 2002b).

A more recent monitoring study of three of the subpopulations showed that the population declined from 1,094 plants in the winter of 2003 to 739 plants in the winter of 2007 (Bradley and Hines 2007). The authors suggested that the decline in numbers of plants may have been due to hurricane impacts in 2004 (Bradley and Hines 2007). In an effort to evaluate hurricane impacts, current and historic sites were surveyed in 2006 and 2007, and the fragrant prickly-apple was re-discovered in Volusia County at Canaveral National Seashore (Woodmansee in litt. 2006; Woodmansee et al. 2007). The site in Indian River County is yet to be confirmed (Woodmansee et al. 2007). Approximately 96 cacti were located during visits to the Volusia County site, and the plants appeared to be healthy (Woodmansee et al. 2007). A total of 62 plants were confirmed on 14 private sites that were surveyed around SPSP in 2006 and 2007 (Woodmansee et al. 2007).

Demographic monitoring of fragrant prickly-apple has been conducted in varying capacities since 1987 (Rae 1995; Rae 1996; Bradley and Gann 2002). To evaluate population status, the following data were collected on plants at SPSP: annual population monitoring; plant height; canopy cover (shade, sun, partial shade); numbers of stems, fruits, and flowers; associated plants; mean monthly vegetative growth; monthly timing and intensity of flowering and fruit set; and monthly mortality (Rae 1994; Rae 1995; Rae 1996; Bradley and Gann 2002).

Bradley and Hines (2007) noted that fragrant prickly-apple can survive for at least 19 years, based on the identification of individuals in 2007 that were tagged as adults in 1988. An attempt was made between 2003 and 2007 to determine causes of mortality of adult plants, but only mortality due to extenuating circumstances was readily attributable (Bradley and Hines 2007). Eight causes of mortality were identified: all-terrain vehicle (ATV) or other vehicle damage, vandalism (chopped by machete), herbicide damage, burial by sand, over-shading by love-vine (*Cassytha filiformis*), feral hogs, blown down by hurricane winds, and crushed by falling trees (Bradley and Hines 2007). The majority of the dead plants found were killed by hurricane winds and treefall.

These results were similar to those of another study from 1999 to 2002 at SPSP in which mortality was due to falling debris, over-shading, and fire (Bradley et al. 2002b). Some mortality (37 percent of cacti in the project area) occurred at SPSP as a result of management actions to clear a portion of habitat in preparation for a prescribed burn in late 2002 (Bradley et al. 2004). Desiccation is a source of mortality reported for very young seedlings (Moore 2009). If rains do not occur during these important weeks of development when plants are small, they tend to dry out because they do not have enough water stored (Moore 2009). Seedlings that grow under the shade of other plants often become viable adults whereas those growing in the open often die within a few years from desiccation (Rae in litt. 2010). Rae and Ebert (2002) noted that the two primary causes of mortality in the sites they studied were over-shading (not enough sunlight) and over-exposure to sunlight resulting in desiccation.

The nine subpopulations at SPSP experienced 10 percent mortality and 10 percent recruitment per year during a study between 1999 and 2002 (Bradley et al. 2002b). Bradley and Hines (2007) reported that mortality rates more than tripled in 2004 as a result of hurricane impacts. Five size classes ranging from greater than 10 centimeters (cm) to 320 cm bore fruit; however, the very smallest class that included plants less than 10 cm did not bear fruit (Bradley et al. 2002b). Approximately 27 percent of cacti growing in full sun produced fruit, more frequently than those growing in other conditions (Bradley et al. 2002a). Mortality rates of cacti in smaller size classes were higher than tall plants (Bradley et al. 2002a).

A population viability analysis using demographic data from two sites in the northern and central portions of the species' range estimated that the time before these populations go extinct may be as little as 20 years (Rae and Ebert 2002). The fragrant prickly-apple is characterized as a long-lived species with late maturity, low fecundity, and low adult mortality (Rae and Ebert 2002). Larger plants tend to have higher fecundity and lower mortality rates (Rae and Ebert 2002); therefore, the larger individuals in the population are extremely important to overall population health (Rae and Ebert 2002).

b. Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding): Genetic samples of cacti classified in the same genus as fragrant prickly-apple are being collected throughout Florida to determine taxonomic relationships (National Park Service [NPS] 2007). No other genetic studies for fragrant prickly-apple are known.

c. Taxonomic classification or changes in nomenclature: The type specimen was collected by John K. Small in 1917 along sand dunes approximately 6 miles (mi) south of Ft. Pierce, Florida, and treated as *Harrisia fragrans* (Britton and Rose 1920). It was separated from other

species partly on the basis of having one longer spine than the other 9 to 13 spines per areole (Britton and Rose 1920). Austin (1984) followed the treatment of Lyman Benson (1982) in which *Harrisia* and other cacti were joined together in the genus *Cereus*. Since then, fragrant prickly-apple has consistently been referred to by its former name, *Harrisia*, in references to the flora of the United States and Florida (Chafin 2000; Gann et al. 2002; Flora of North America 2003; Wunderlin and Hansen 2003). The Integrated Taxonomic Information System (2010) was also checked while conducting this review and indicated that the accepted name is *Harrisia fragrans*. Because *Harrisia fragrans* is the name used in peer-reviewed literature and is accepted by the scientific community, we concur with this nomenclature.

d. Spatial distribution, trends in spatial distribution (e.g., increasingly fragmented, increased numbers of corridors), or historic range:

Historically, fragrant prickly-apple occurred in coastal hammock habitats on the east coast of Florida in St. Lucie, Indian River, Brevard, and Volusia Counties, although some accounts in other areas were erroneously reported due to misidentification with Simpson's prickly-apple (*Cereus gracilis* var. *simpsonii*) (Service 1985; Service 1999; Woodmansee et al. 2007). Fragrant prickly-apple was reportedly collected in Everglades National Park (ENP), but this is not confirmed (NPS 2007; Sadle 2009). Because Simpson's prickly-apple commonly occurs in ENP, there is much confusion over identification of these two species, there is no voucher specimen available in herbarium collections for confirmation, the fragrant prickly-apple is limited in distribution, and ENP lacks the habitats believed to support fragrant prickly-apple, it is thought that the species was misidentified (NPS 2007; Sadle 2009).

At the time of listing, fragrant prickly-apple was only known from St. Lucie County (Service 1985). Surveys for fragrant prickly-apple were conducted on Brevard County's public lands in 2003, but no cacti were found (Schmalzer and Foster 2003). Woodmansee et al. (2007) reported two extirpated populations of fragrant prickly-apple from Brevard County because cacti could not be re-located on these sites in 2006 and 2007. They presumed that the sites were extirpated due to habitat alteration and possibly past freezes (Woodmansee et al. 2007).

Although the species occurs in disjunct locations within its historic range, most of the suitable habitat has been destroyed or converted for residential housing and commercial activities (Service 1999). The species is now known to occur in Volusia and St. Lucie Counties, primarily on or around SPSP where the site covers an area approximately 10.0 mi long and 0.5 mi wide and is bisected by the Florida East Coast railway (Bradley et al. 2002a; Bradley and Gann 2002; Woodmansee et al. 2007; FNAI 2009). These cacti are often found to occur in distinct clusters (Bradley et al. 2002a; Woodmansee et al. 2007). The occurrence of fragrant prickly-apple in Indian River County is yet unconfirmed because only a single sterile plant was observed on a coastal

berm when surveys were conducted in 2006 (Woodmansee et al. 2007; FNAI 2009). Although only confirmed in Volusia and St. Lucie Counties, it is possible that the current range of the species includes Brevard and Indian River Counties, as these counties occur between confirmed locations and appropriate habitat is available (Woodmansee et al 2007).

Much of the known range of the species is protected from development where it occurs on SPSP. Also, just over 2 acres (ac) of private property east of the railroad tracks near SPSP that contains fragrant prickly-apple were placed under conservation easement to protect native vegetation and remove invasive plants in 2008 (Alger 2010). Cacti on this property most likely belong to one of the nine populations on or around SPSP. Despite these protections, trends in spatial distribution show increasing fragmentation of fragrant prickly-apple habitat as the coastal ridge has become developed and habitat has become overgrown.

e. Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem): The fragrant prickly-apple is mostly associated with coastal hammocks along the east side of the Atlantic Coastal Ridge, although no conclusive historical data exists to link the species to a particular habitat prior to changes in land use that introduced pineapple farming in 1879 (Bradley and Hines 2007). This species seems to grow best in conditions with only partial sun rather than full sunlight (Bradley et al. 2002a; 2002b).

The geographic area where fragrant prickly-apple occurs may be different from other portions of the ridge to the north and south of SPSP because of its proximity to the Indian River on the east side and a large wetland swale directly to the west (Bradley and Hines 2007). It is hypothesized that these landscape features may not have favored frequent natural fires, resulting in more climax community types (*i.e.*, hammock) that replaced sand pine (*Pinus clausa*) (Bradley and Hines 2007). Although the species primarily occurs in sand pine scrub at SPSP, it is thought that it was not typically associated with this community (Bradley and Hines 2007). However, most of the hammock communities have now been destroyed by human development. The SPSP population, where the majority of the population occurs, covers an area of approximately 3,200 ac (1,295 ha) (Bradley et al. 2002a; Bradley and Gann 2002).

Habitat management is needed to maintain conditions that are suitable for this species. Many of the sites where fragrant prickly-apple occurs are impacted by the growth of invasive plant species, which increase the canopy cover and pose a physical hazard to cacti resulting from falling limbs and trees not able to withstand hurricane winds (Bradley and Hines 2007). Without management, canopy growth limits the amount of sunlight needed for survival of the fragrant prickly-apple (Bradley et al. 2002b). Many of the sites where

the species occurs are publically owned, and habitat on these sites is receiving management.

A recent project assessed the fragrant prickly-apple and its current and historical habitat following the 2004 and 2005 hurricane seasons, which impacted Florida as far north as Volusia County at the northern limit of the species range (Woodmansee et al. 2007). Impacts to fragrant prickly-apple habitat ranged from no measurable effect in Volusia and Brevard Counties to moderate damage in Indian River and St. Lucie Counties (Woodmansee et al. 2007). Moderate damage was defined as having more than 5 fallen trees within the habitat and no storm surge (Woodmansee et al. 2007). Damage was attributed to coastal erosion, tidal wash, broken limbs, and debris (Woodmansee et al. 2007).

f. Other: Fragrant prickly-apple seeds can be stored using various methods, and the species is being maintained in a Center for Plant Conservation (CPC) *ex situ* collection. Seed studies showed that seeds stored at room temperature germinated faster than those that were refrigerated (Frances 2004). Approximately 16 to 50 percent of refrigerated seeds germinated, while germination rates for fresh seeds ranged from 0 to 78 percent (Frances 2004). Seeds that were desiccated for 3 days and frozen for 16 hours also germinated (Frances 2004). Preliminary steps have been taken to further develop germination protocols for fragrant prickly-apple using scarification and acid soaking treatments (Dehgan and Perez 2005).

Germination experiments were conducted in the field in areas dominated by sand pines at SPSP, although not considered to be ideal habitat (Bradley and Hines 2007). Seed boxes were installed in three sites, seed germination took between 12 and 24 months, and preliminary germination rates were only 1.76 percent (Bradley and Hines 2007). However, seed bank studies indicate that seed may remain viable for up to 19 months without losing much viability, with germination rates ranging from 64 to 100 percent (Bradley and Hines 2007).

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 fragrant prickly-apple. 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. For example, Woodmansee et al. (2007) suggested that the two extirpated sites in Brevard County were probably lost due to habitat alteration or destruction and severe freezes. Moore (2009) stated that another private site known to contain fragrant prickly-apple was to be sold for development a few years ago. After obtaining permission to salvage the cactus from the property, he returned to

find that it had already been removed (Moore 2009).

Threats from development and habitat degradation on private sites are expected to continue and increase. Within the range of fragrant prickly-apple, the human population is predicted to grow from just below 500,000 to nearly 1,000,000 in Volusia County and from approximately 193,000 to more than 563,000 in St. Lucie County between 2005 and 2060 (Zwick and Carr 2006).

Even though 63 percent of the sites around SPSP containing fragrant prickly-apple are publicly owned and not at risk of being developed, the 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. Because population densities tend to vary over time, even those sites with high population densities may be vulnerable if not monitored carefully (Rae in litt. 2010). Therefore, habitat loss, degradation, and fragmentation due to increasing development and lack of management in coastal scrub habitat and the encroachment of exotic plants continue to threaten fragrant prickly-apple.

b. Overutilization for commercial, recreational, scientific, or educational purposes: At the time of listing, overutilization was identified as a potential threat for fragrant prickly-apple, but indiscriminate collecting was not known to occur. Because it is limited in distribution and population sizes are relatively small, indiscriminate collecting could adversely affect the species. Like many other species of cacti, fragrant prickly-apple is vulnerable to unlawful exploitation and collection due to the activities of some collectors and hobbyists. Enforcement is difficult due to insufficient resources and the remoteness of the plants. There is minor horticultural interest in this species (Bradley and Gann 2002). During the 5 years of monitoring that took place at SPSP, there was no evidence of poaching (Bradley and Gann 2002). However, the salvage of a fragrant prickly-apple from a property slated to be sold for development was planned but never occurred because the plant was mysteriously removed before the rescue could be implemented (Moore 2009). The Service believes that there is a continuing threat from overutilization for commercial or recreational purposes.

c. Disease or predation: When the fragrant prickly-apple was listed as endangered, disease and predation were not known to be threats. However, insects may damage cacti. Moore (2009) noted that young seedlings were damaged when unidentified caterpillars ate the sprouts. A native scale insect, *Diaspis echinocacti*, has been found to destroy stems of the fragrant prickly-apple in SPSP; however, it does not appear to kill the host plant (Bradley et al. 2002a; Bradley and Gann 2002). Root parasitism may occur when fragrant

prickly-apple grows in association with tallow wood (*Ximenia Americana*) or graytwig (*Schoepfia chrysophylloides*) but has not been directly observed (Bradley and Gann 2002). Fragrant prickly-apple may also be parasitized by love-vine. There is evidence that birds eat the fruit and serve as a mechanism to disperse seeds (Service 1999). It is also thought that rodents or gopher tortoises may distribute seeds (Service 1999). These occurrences of predation and parasitism are not known to constitute serious threats to the fragrant prickly-apple.

d. Inadequacy of existing regulatory mechanisms: The ESA provides limited protection for the species and its habitat. Existing Federal regulations prohibit the removal or destruction of listed plant species on Federal lands. The fragrant prickly-apple 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. 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. Title 62D-2.013 of the Florida Administrative Code prohibits the removal, destruction, or damage of plants from FDEP, Division of Recreation and Park properties. This regulation provides protection for much of the population where it occurs on SPSP.

Existing regulatory mechanisms do not appear to be adequate, as several properties with fragrant prickly-apple on private lands have been developed. Fragrant prickly-apple was potentially impacted in 2005 when heavy equipment was used to push debris into habitat where the species was presumed to occur along the railroad right-of-way (Kaufmann 2005). Multiple portions of potential habitat along the railroad tracks are being purchased and used to dump dredged material from the Intracoastal Waterway along the Indian River.

Because this plant occurs in habitat along the Atlantic coastal ridge, which is desirable for development and other uses due to its elevation, it remains vulnerable to development pressures where it occurs on private property. Where the species occurs on public land, there is protection from development but not necessarily from habitat degradation.

e. Other natural or manmade factors affecting its continued existence: Land management practices such as prescribed fire are important to maintaining the scrub ecosystem. However, the fragrant prickly-apple is intolerant of fire (Bradley and Gann 2002). Because it is thought that the species was historically located along the perimeter of scrub habitat in xeric hammocks, it may not have been affected as frequently by fires that were occurring in adjacent scrub (Bradley and Gann 2002). A large source of habitat degradation is the establishment of invasive plant

species such as Brazilian pepper (*Schinus terebinthifolius*), rosary pea (*Abrus precatorius*), white cypress pine (*Callitris glaucophylla*), golden trumpet (*Allamanda cathartica*), cathedral bells (*Kalanchoe pinnata*), chandelier plant (*K. tubiflora*), swamp mahogany (*Eucalyptus robusta*), guinea grass (*Panicum maximum*), and Crow's foot grass (*Dactyloctenium aegyptium*) (Bradley and Gann 2002; Bradley et al. 2002b). These invasive species may impact fragrant prickly-apple growth, reproductive potential, and recruitment by competing for space and nutrients and blocking sunlight (Bradley and Gann 2002). The species frequently grows beneath the canopy of these invasives to take advantage of partial shade and also can be crushed beneath falling limbs or trees not able to withstand hurricane winds (Bradley and Hines 2007). However, herbicides used to control overgrowth, if not properly applied, also pose a threat to the fragrant prickly-apple. Bradley and Hines (2007) noted mortality as a result of off-target herbicide application at SPSP.

Degradation to habitat can also occur from damage by feral hogs (Engeman et al. 2003, 2004). Bradley and Hines (2007) recorded an incident in which feral hog damage killed a fragrant prickly-apple plant. Gopher tortoises may also bury small cacti at the mouth of burrows (Bradley and Gann 2002). Vegetation restoration and management programs are costly, and the availability of funding is never assured; therefore, habitat modification from inadequate management even on protected lands remains an imminent, though moderate, threat.

The species' restriction to specialized habitat, its limited distribution, and its limited reproductive capacity also renders it vulnerable to random natural events, such as freezes and hurricanes. Sea level rise may also threaten cacti on sites with low elevation, such as those at Canaveral National Seashore (Woodmansee et al. 2007). Woodmansee et al. (2007) suggested that freezing temperatures may have led to the extirpation of the species at one location in Brevard County. Although the species did well through the Category 1 hurricane in 2000 and the Category 2 and 3 storms in 2004 and 2005 (Bradley and Gann 2002; Woodmansee et al. 2007), specific conditions such as storm surge and amount of debris dumping following the event vary greatly with each hurricane and may render sites with few plants vulnerable to destruction.

Hurricanes have the potential to adversely affect fragrant prickly-apple populations in other ways. High winds can bring surrounding vegetation crashing down on top of individual cacti, injuring or killing them. Bradley and Hines (2007) found that mortality rates more than tripled at SPSP as a result of hurricane impacts. One colony that was particularly affected was located beneath invasive white cypress pine trees which were not equipped to handle hurricane winds and either fell or lost numerous branches that crushed the cacti below (Bradley and Hines 2007). However, hurricanes also open hammock canopies, allowing light to penetrate and stimulating flowering

activity, thus providing conditions that may be favorable to cactus regeneration (Bradley and Gann 2002; Woodmansee et al. 2007).

D. Synthesis - The species' recovery plan does not contain objective, measurable reclassification or delisting criteria. The known current range of fragrant prickly-apple is limited to Volusia and St. Lucie Counties, but is projected to include Brevard and Indian River Counties. With the recent identification of the cacti in Volusia Counties, the current range of the species has been expanded; however, the sites where it occurs are fragmented, mainly along the Atlantic coastal ridge. With population declines of the three monitored subpopulations noted in 2007, a total of less than 3,000 fragrant prickly-apples are thought to remain on 10 sites, primarily on or around SPSP.

Where habitat remains intact, fragrant prickly-apple depends upon active management to persist. Land management practices, including prescribed fire applied across multiple burn units used for the reduction of dense canopies and the creation of open areas, are important for maintaining the health of scrub ecosystems where this plant resides. The removal of exotic species is especially important for maintaining habitat and preventing competition with fragrant prickly-apple. Existing regulatory mechanisms are inadequate on private lands, because this plant occurs in habitat which is desirable for development due to its elevation, and plants have limited protection on private lands. Habitat loss, fragmentation, and changes in land use continue, and conversion of scrub and xeric hammock habitat to urban use along the Atlantic coastal ridge is projected to continue over the next 50 years. The species' restriction to specialized habitat, its limited distribution, and its limited reproductive capacity also renders it vulnerable to random natural events, such as freezes and hurricanes. Due to the above ongoing threats, this species continues to meet the definition of endangered under the ESA.

III. RESULTS

A. Recommended Classification:

No change is needed

B. New Recovery Priority Number: 2C (upon name change). After the Service officially adopts the change in nomenclature for the fragrant prickly-apple, the Recovery Priority Number for the species should be changed from 3 to 2C because of name changes that will designate the taxon as a species rather than a subspecies (variety) and because current and projected development in southeastern Florida conflicts with the recovery of the species. Fragrant prickly-apple still falls within the category of high threats with high recovery potential.

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

Surveys:

- Continue monitoring the SPSP and Volusia County populations on an annual basis and after stochastic events, such as fires.

- Conduct additional surveys on other parts of Hutchinson Island South in St. Lucie County, Sebastian Inlet State Park in Brevard and Indian River Counties, spoil islands in Indian River and St. Lucie Counties, Pelican Island National Wildlife Refuge and the southern end of Pine Island in Indian River County, and other potential locations within the historic range.
- Re-survey the Pine Island location to confirm the identity of the plant in question.

Management:

- Continue management actions to remove invasive species with particular care in using mechanical means and herbicide application that may damage cacti; control public access to these areas to avoid human disturbance and to improve habitat conditions.
- Continue application of prescribed fire to habitats that support the species while maximizing the number of burn units rather than applying fire to large expanses of habitat.
- Consider reducing the canopy in areas where cacti are impacted by too much shade.
- Restore coastal hammocks along the eastern slope of the Atlantic Coastal Ridge.
- Where unable to restore coastal hammocks, maintain the threeawn (*Aristida gyrans*)/Sabal palm (*Sabal palmetto*) habitat that fragrant prickly-apple now occupies for the long-term existence of the species.
- Control public access and eliminate dumping in areas where fragrant prickly-apple occurs.
- Focus conservation efforts on marginal and small sites to preserve the genetic diversity of the species.
- Evaluate the feasibility of acquiring private property in Brevard County for reintroduction of the species, identify suitable habitat for additional reintroduction sites in protected areas, and establish reintroduced populations.
- Increase the genetic diversity of the species at existing and reintroduced locations.

Research:

- Conduct demographic studies using a metapopulation approach to understand spatial and temporal variation. Incorporate surveys to evaluate flower and fruit production.
- Develop a model to evaluate long-term population growth in relationship to microhabitat conditions (*i.e.*, shade, partial shade, and sun).
- Develop mechanisms to improve seedling survival and continue to study seed germination to determine habitat preferences of the species. Evaluate the role of nurse plants that provide shade in the early development of seedlings.
- Conduct research on recruitment, mortality, seed bank characteristics, and soil moisture.
- Conduct parallel studies on the other two similar cacti in Florida, Simpson's prickly-apple and Aboriginal pricklyapple (*Harrisia aboriginum*), to gain additional insight into fragrant prickly-apple biology and to delineate these species.
- Continue genetic research and appropriately apply these results to listing status of all *Harrisia* species in Florida.
- Conduct a population-level genetic study using microsatellite markers to determine genetic variation within the species and gene flow in and among sites and to better understand the reproductive mode at low population densities.

- Conduct research on the response of fragrant prickly-apple to fire and fire prescriptions necessary to benefit the species.
- Identify pollinators and evaluate impacts to insect pollinators from aerial mosquito spraying.
- Continue propagation efforts and collect germ plasm from the remaining sites not currently represented in the CPC's National Collection of Endangered Plants, primarily from the Volusia County population.
- Evaluate the effects of climate change on the species, including those that result from precipitation pattern changes and temperature rise.

Other:

- Pursue conservation agreements/implement management recommendations and/or acquire land and investigate incentives to encourage land managers to manage habitat for ecosystem health and listed species.
- Acquire private inholdings within the SPSP when willing sellers are identified.
- Consider acquiring the Pine Island tract in Indian River County and determine the status of Fairchild Tropical Botanic Garden's *ex situ* population of plants from this site.
- Promote partnerships to share information, conduct collaborative research on coastal scrub habitat conservation, and provide land managers and the interested public with information about the ecosystem, threats, recovery actions, and associated rare biota.
- Consider nomenclatural changes to officially designate the name of the fragrant prickly-apple as *Harrisia fragrans*.
- Conduct an ad hoc meeting to compile new information, discuss recovery actions, share land management strategies, and set and prioritize 5- and 10-year goals.
- Seek opportunities to include the media in conservation efforts to provide information about this species to the public.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of Fragrant prickly-apple (*Cereus eriophorus* var. *fragrans*)

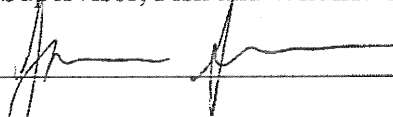
Current Classification Endangered
Recommendation resulting from the 5-Year Review

X **No change is needed**

Review Conducted By Marilyn Knight

FIELD OFFICE APPROVAL:

fo Lead Field Supervisor, Fish and Wildlife Service

Approve  Date: 5/13/10

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.

Acting
Lead Regional Director, Fish and Wildlife Service

Approve  Date 6-24-10

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 fragrant prickly-apple (*Cereus eriophorus* var. *fragrans*)

A. Peer Review Method: Peer reviewers were selected by the Service. Four peer reviewers were asked to participate in this review. Individual responses were requested and received from three 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. Comments and concerns covered a variety of topics including: (1) minor editorial comments, (2) additional older references that could be incorporated, (3) the possibility that some of the populations may have been taxonomically divided into subpopulations differently by various researchers, (4) the need for a metapopulation approach to studies, (5) concurrence with nomenclatural changes, and (6) the usefulness of this review to land managers and conservationists. Reviewers noted that information provided in this review was thorough and sufficiently represented the biology of the species and conclusions reached; showed the importance of habitat management using control methods for invasive species and prescribed fire; identified the need for monitoring, even in high density populations; and summarized the quality and depth of the research that has been completed on this species. In regard to population declines discussed in the document, reviewers commented that densities vary over time and even large populations should be monitored.

Additional recommendations by peer reviewers for future actions that would benefit the fragrant prickly-apple included: (1) researching nurse plants to understand their role in shading seedlings during early development, (2) conducting population-level genetic studies using microsatellite markers to understand genetic variation within the species and gene flow in and among sites, using genetic studies to delineate *Harrisia* species, (3) identifying locations for reintroducing the species to protected areas, and (4) increasing the genetic diversity of the species through reintroductions and augmentations of existing sites. A suggestion was also made to use caution and not provide specific plant location data to the public as part of media outreach.

D. Response to Peer Review: The Service was in agreement with the comments and concerns received from peer reviewers, and comments were largely incorporated. There was a question regarding whether or not the hammock community was considered a climax community. However, this was cited in the review as a hypothesis given by specific researchers and left as written.

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

February 20, 2007

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 Cindy Schulz, Endangered Species Supervisor, South Florida Ecological Services Office, at 772-562-3909, extension 305, email: Cindy_Schulz@fws.gov.