Okeechobee gourd
(Cucurbita okeechobeensis ssp. *okeechobeensis)*

5-Year Review:
Summary and Evaluation

Photo by Marc Minno

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Southeast Region
South Florida Ecological Services Office
Vero Beach, Florida

5-YEAR REVIEW
Okeechobee gourd / *Cucurbita okeechobeensis* ssp. *okeechobeensis*

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 subspecies. 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 all available information on the Okeechobee gourd. Comments and suggestions regarding the review were received from South Florida Ecological Services Office supervisors and peer reviews from outside the Service. No part of the review was contracted to an outside party. 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
Cooperating Field Office(s): Jacksonville Ecological Services Field Office, Annie Dziergowski, 904-731-3089

C. Background

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

2. Species status: Declining (2008 Recovery Data Call). Threats to habitat in the Lake Okeechobee population increased in fiscal year 2008. Unusually low water levels enabled hot fires to sweep through the marshes of northwestern Lake Okeechobee. Soon after the fires, no plants were found on the spoil islands that once supported substantial populations. However, surveys had not been conducted there since the beginning of the wet season. As noted in fiscal year 2007, moonflower (*Ipomoea alba*) has overgrown most of the islands where the gourd is found and seems to be rather competitive. Plants on Torry and Kreamer Islands and along southern rim canal (south Lake Okeechobee) are numerous. There were no current reports on the St. Johns population or associated threats.

3. Recovery achieved: 1 (0-25 percent recovery objectives achieved). Partial recovery objectives have been achieved through: conducting more regularly scheduled surveys, using provisions of section 7 of the Endangered Species Act (ESA) to protect the Okeechobee gourd, investigating the genetic variation present in the two known populations of the subspecies, management to control or remove exotic vegetation in wetlands, planting native trees or shrubs to replace exotics, locating potential translocation sites, reintroducing plants, and monitoring reintroduced plants. Although

some work has been accomplished for each of these objectives, most are ongoing and require further actions.

4. Listing history
Original Listing
FR notice: 58 FR 37432
Date listed: July 12, 1993
Entity listed: Subspecies
Classification: Endangered

Revised Listing, if applicable
FR notice: 59 FR 15345
Date listed: April 1, 1994 (Technical correction to table entry of scientific name)
Entity listed: Subspecies
Classification: Endangered

5. Associated rulemakings: N/A

6. Review History:
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: 3 (a subspecies 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: N/A

II. REVIEW ANALYSIS

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

1. Is the species under review listed as a DPS? No. The ESA defines species as including any subspecies of fish, 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 subspecies 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.

2. Adequacy of recovery criteria.

a. Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat? No. These criteria do not consider recovery actions needed for the Okeechobee gourd outside of the South Florida Ecosystem along the St. Johns River.

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 Okeechobee gourd from endangered to threatened may be considered are:

1. The Okeechobee gourd is protected at all known sites within Lake Okeechobee.

Most of the known occurrences in the Lake Okeechobee population are on public land (Minno 2009), but extent of management is not reported. The population located along the St. Johns River is found primarily on State and County-owned properties. Some colonies may be on private land. This criterion addresses listing factors A, B, D, and E.

2. Plants on Kreamer, Torry and Ritta Islands and the southern Rim Canal of Lake Okeechobee produce fruit at each of these locations at least every other year (their [i.e., fruit] absence for a period of two or more consecutive years will violate this requirement).

Consistent collection of data pertaining to fruit production on these islands has not been obtained. Torry, Kreamer, and Ritta Islands have the most stable colonies, but these also fluctuate depending on water levels (Minno 2009). Some data were collected on the islands in 2002 and 2006, and minimally in 2005 (Minno and Minno 2006a). Over 1,000 fruits were observed on Kreamer Island in 2002, no data were collected in 2005, and no fruits were observed in 2006. On Torry Island, hundreds of fruit were noted in 2002, only one-third of the occurrences were surveyed in 2005 from which fruit was absent, and no fruits were observed in 2006 (Minno and Minno 2006a). In 2007, approximately 150 fruits were observed on Torry Island (Minno 2007). Hundreds of Okeechobee gourd fruit were observed for the first time in the marsh to the east of Torry and Kreamer Islands in October 2008 during low water levels (Minno 2009). A few old fruits were observed on Ritta Island in 2002, no data were collected in 2005, and no fruits were observed in 2006 (Minno and Minno

2006a). There appears to have been little to no fruit production in 2005 in the Lake Okeechobee population. More consistent surveys are needed to be able to evaluate this criterion. This criterion addresses all five listing factors.

3. The distribution of fruiting plants is expanded within Lake Okeechobee either by the discovery of additional sites or by translocation.

As part of a lake bottom habitat restoration project during low water levels in 2001, the Florida Fish and Wildlife Conservation Commission (FWC) scraped an accumulation of organic matter into piles which became spoil islands when exposed during higher water levels in the northwestern portion of Lake Okeechobee (South Florida Water Management District [SFWMD] 2007). Gourds found during the project were transplanted to these islands, plants became established, and the plants still remain, although mostly only on the lower slopes (Decker-Walters 2002a; SFWMD 2007; Minno 2009). Fruits were found on at least one of the islands in 2002, 2005, 2006, and 2007 (Minno and Minno 2006a; Minno 2007). Following Hurricane Wilma in 2005, approximately 100 Okeechobee gourd plants growing amongst storm debris were collected and transplanted on spoil islands adjacent to Ritta Island in the southern portion of the lake (SFWMD 2007). Although plants did well soon after transplanting, few survived through 2007 (SFWMD 2007; Moyroud 2009a). This criterion addresses all five listing factors.

4. One or two sites are established outside of the southeastern quadrant of Lake Okeechobee (outside of Palm Beach County).

There are two known occurrences of gourds existing outside of the southeastern quadrant of Lake Okeechobee on the spoil islands created from dredged material along the northwestern side of the lake in Glades County (Minno and Minno 2006a). The project took place in 2001, and the gourds appear to be established and producing fruit (Minno and Minno 2006a; Minno 2007). However, these colonies seem to be waning (Minno 2009). This criterion addresses all five listing factors.

5. A stable, self-sustaining population of the Okeechobee gourd is established within the South Florida Ecosystem outside of Lake Okeechobee.

There appear to be unidentified factors that limit the distribution of the Okeechobee gourd (Minno 2009). Although suitable habitat exists in central and southern Florida, this subspecies is only known from Lake Okeechobee and a short segment of the St. Johns River. However, one population has been established in Palm Beach County. In the 1980s prior to listing, seeds collected from Lake Okeechobee were germinated in greenhouse conditions and cuttings were planted on a private property west of Lantana (Moyroud 2009b). This population has persisted and has produced flowers and fruits annually since its establishment (Moyroud 2009b). Another introduced population occurs in Putnam County (outside the South Florida Ecosystem) that has also persisted for more than 10 years (Minno 2009). This criterion addresses all five listing factors.

6. Measures of vitality are developed and monitored at each of the sites described above.

Measures of vitality are not known to have been developed for this population. This criterion addresses all five listing factors.

7. Based on the results of research on the viability of seeds following prolonged submergence and the survival of plants under rising water stages, the water regulation schedule for Lake Okeechobee is found not to jeopardize the continued existence of the Okeechobee gourd.

Studies were conducted in 2002 to determine seed properties of the Okeechobee gourd associated with possible adaptations to water (e.g., seed flotation, germination, and viability) (Decker-Walters 2002b). Approximately 73 percent of seeds survived submergence for 70 days, and viability was not dependent upon the ability of the seeds to float (Decker-Walters 2002b). However, to meet this criterion additional research is needed using larger sample sizes that are statistically robust and lengthening the study period beyond 70 days to determine the upper limit of submersion. It is thought that seeds of the Okeechobee gourd may remain viable for a long time in the soil because the subspecies tends to flourish in drier times, but nearly disappears when water levels are high (Minno 2009). The water regulation schedule will need to be evaluated in light of these new data. This criterion addresses listing factors A, D, and E.

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 Okeechobee gourd is only found in Florida in two natural populations, one on Lake Okeechobee and the other along the St. Johns River. Population trends and abundance of this subspecies are difficult to assess because the gourd is ephemeral by nature, often only growing when habitat conditions are favorable, and its growth habit of climbing amongst the tree canopy precludes the ability to count individual plants. This subspecies employs a strategy of growing on open organic soils exposed by low water levels with little to no competition, producing numerous seeds with somewhat long viability, and experiencing vegetative decline when competition increases or water levels rise (Moyroud 2009b). Therefore, surveys generally consist of observations of persistence of previously known occurrences, reporting of new sites where gourds are located, evaluating general health of the occurrences, and recording the number of fruits observed if conducting ground surveys.

In 2002, surveys were conducted for the first time in 10 years for the Lake Okeechobee population (Decker-Walters 2002a). Plants were observed on Torry and Kreamer Islands and on the FWC spoil islands, but not on Ritta Island where plants were inundated with water (Decker-Walters 2002a; 2002c). There were hundreds of mature vines and thousands of fruits estimated to occupy Kreamer Island, which was the largest observation recorded (Decker-Walters 2002a).

Following the hurricanes that impacted the Florida peninsula in 2004, water levels were high and no live gourd plants or recent fruits were observed on any of the spoil islands in the northwestern portion of the lake or on the natural islands (Ritta Island, Torry Island) or along the perimeter canal in the southern part of the lake (Minno and Minno 2005). About a dozen dried fruits were found on the ground of one of the spoil islands where the plants had appeared healthy during the 2002 survey (Minno and Minno 2005). There does not appear to have been any reproduction in 2005 on this island, despite an incidental report of live plants prior to the surveys in 2005, because fruits typically take over a year to dry out (Minno and Minno 2005). Therefore, gourd reproduction most likely occurred in 2004 (Minno and Minno 2005).

The Florida peninsula, including the Lake Okeechobee region, experienced a relatively dry year in 2006, and water levels in the lake were lower than normal (Minno and Minno 2006a). With more favorable growing conditions, gourd plants were found on the natural islands (Kreamer, Ritta, and Torry Islands) and one of the spoil islands (Minno and Minno 2006a). During this survey, gourd plants were growing only along the perimeter of the spoil island, unlike in 2002 when plants covered most of the island (Minno and Minno 2006a). Plants were previously reported from the northern and western edges of Ritta Island, but occupied only the eastern side of the island in 2006 (Minno and Minno 2006a).

Drought conditions persisted into 2007, and we expected to see the Lake Okeechobee population expand. However, Minno (2007) reported that the population appeared to have been reduced based on observations of extensive moonflower vines in areas where gourds were known. Plants and fruits were confirmed from the wildlife island where they occurred in 2006, as well as on Ritta, Kreamer, and Torry Islands (Minno 2007). However, plants on Ritta Island were not observed on the eastern part of the island, possibly due to inability to see vines under the coverage of moonflower, but returned to the northern end (Minno 2007).

Surveys along the St. Johns River were conducted for the first time in 4 years in 2002 and indicated that 8 of the 12 sites where they had been documented since 1994 (Minno and Minno 1998) were occupied in 2002 (Decker-Walters 2002a). It was estimated that the entire St. Johns River population consisted of no more than 100 plants (Ward and Minno 2002). The Okeechobee gourd

was found later at an additional site along the river, and surveys indicated that plants were present at only 2 of the 13 previously known sites in 2005 (Minno and Minno 2005). During this census, a fourteenth site was discovered and one of the previously known sites appeared to no longer be suitable due to habitat degradation and herbicide spraying (Minno and Minno 2005). In 2006, surveys indicated that plants were occupying a total of 10 sites, including 3 new sites that were discovered (Minno and Minno 2006b). In 2007, Minno (2007) reported plants at eight of the previous sites, plus four new locations.

The two populations of Okeechobee gourd appear to exhibit some different demographic features. Plants from the Lake Okeechobee population that grow on the spoil islands appear to be annuals, lasting just one season, whereas plants from the natural islands of Lake Okeechobee and along the St. Johns River are perennials and tend to grow for several years before dying back (Minno and Minno 2006c). The reason for this difference is not known. No further demographic studies have been conducted for this subspecies during the period for which this review was written.

b. Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding): Genetic isolation of the Florida populations from other gourd subspecies has occurred over time (Nee 2009). Genetic comparisons were made between Okeechobee gourds from the Lake Okeechobee and St. Johns River populations and the Martinez gourd (*Cucurbita okeechobeensis* ssp. *martinezii*) (Decker-Walters 2002c). Very little genetic variation was observed within any of the three populations evaluated, and differences between populations were minor with nothing to differentiate between the Lake Okeechobee and St. Johns River populations of the Okeechobee gourd (Decker-Walters 2002c). Fruit and flowers show several morphological differences between the Lake Okeechobee and St. Johns River populations that may indicate genetic differences (Minno 2009). Newer and more powerful genetic tests are now available that may provide a better understanding of genetic variation between and within populations.

c. Taxonomic classification or changes in nomenclature: The MSRP describes the full history of the taxonomic classification of the Okeechobee gourd leading up to its designation as *Cucurbita okeechobeensis* ssp. *okeechobeensis* (Service 1999). However, some authors do not recognize the subspecies (Ward and Minno 2002).

The recent discovery of a *C. okeechobeensis* occurrence in the Caribbean region from the Sierra de Neiba, Dominican Republic brings additional questions regarding the taxonomic classification of these similar gourds (Peguero and Jiménez 2005). The authors were unable to determine whether their discovery belonged to the subspecies *okeechobeensis* or *martinezii* or should be a different taxon (Peguero and Jiménez 2005). In response to the

conundrum, Wunderlin (2007) suggested the gourds may have been introduced from Mexico (*martinezii)*, but withheld a conclusive opinion pending additional analyses. He suggested that the taxonomic treatment of *C. okeechobeensis* into subspecies is still open to interpretation and added that the Walters, who designated the Okeechobee gourd as a subspecies (1991), should be consulted on this determination based on their definitive work on the issue (Wunderlin 2007).

In 2007, we were also made aware of potential plans to formally describe the St. Johns River population as a variety based on differences in the biology of the Lake Okeechobee and St. Johns River populations (Minno 2007). However, the taxonomic work needed to evaluate the relationships between populations has not been completed (Minno 2009). Minno (2009) suggested that the St. Johns River population may be more closely related to the Martinez gourd than the Lake Okeechobee population and noted that the subspecies from the Dominican Republic has not been compared to the two Florida populations.

Wunderlin and Hansen (2003) use a classification below the species category to refer to Florida's endemic Okeechobee gourd as *C. okeechobeensis* var. *okeechobeensis*. The Integrated Taxonomic Information System (ITIS) (2009) was checked while conducting this review. ITIS (2009) continues to recognize this taxon as a subspecies, *C. okeechobeensis* ssp. *okeechobeensis*. Until further analysis is conducted that could refute the division into subspecies, the Service concurs with the designation as *C. okeechobeensis* ssp. *okeechobeensis*.

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): The Okeechobee gourd was once locally common among the extensive pond apple (*Annona glabra*) forests that grew south of Lake Okeechobee and in hammocks along the rim and islands of the lake (Small 1922). By 1930, at least 95 percent of these pond apple forests had been destroyed (Small 1930). William Bartram also originally described the gourd in 1774 along the St. Johns River (Harper 1943), over 100 miles north of the Lake Okeechobee. Although some questioned the validity of Bartram's observation due to evidence that other cucurbits were once present in the area, the Okeechobee gourd was re-discovered along the river in 1993 (Ward and Minno 2002).

Both the Lake Okeechobee and St. Johns River populations of Okeechobee gourd currently persist. However, habitat conversion around Lake Okeechobee for agricultural purposes and water-level regulation has been the primary factor leading to the reduction of the spatial extent of the historic range (Service 1999). Gourds are currently limited to the shoreline and

islands around the southern and northwestern portions of the lake and no longer occur south of the shoreline (Minno and Minno 2006a). Plants from the St. Johns River population were reported to occur on both sides of the river along the Lake and Volusia County line from Lake Beresford south to Goat Island, a distance of approximately 4.9 miles (Ward and Minno 2002). This population is now known to occur from Lake Beresford further south than Goat Island into Lake Monroe and along the western side of Lake Jessup in Seminole County (Minno 2009).

e. Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem): Because of habitat conversion around Lake Okeechobee for farming and water-level management and degradation due to invasive competitors, habitat for the Okeechobee gourd is limited to areas along the shoreline and a few islands in the lake and along the St. Johns River (Service 1999). Habitat no longer exists south of Lake Okeechobee where extensive pond apple forests once supported healthy gourd plants.

Some habitat has been created in recent years, and efforts to restore the Everglades may provide additional habitat in the future. Restoration of habitat has occurred on the shoreline of Ritta Island in the southern portion of Lake Okeechobee, and planting of pond apple and cypress (*Taxodium* spp.) was initiated in 2006 (SFWMD 2007). Spoil islands were created from a lake bottom restoration project along the northwestern side of the lake in Glades County and provided additional gourd habitat in 2001 (Minno and Minno 2006a). However, the gourd does not compete well in higher, drier areas of the spoil islands (Decker-Walters 2002c, Minno and Minno 2006a).

f. Other: Experimental studies were conducted in 2002 to determine seed properties of the Okeechobee gourd associated with possible adaptations to water (e.g., seed flotation, germination, and viability) (Decker-Walters 2002b). The author found that seeds from fruits of varying ages and from different populations varied greatly in buoyancy and that seeds from older, drier fruits were less buoyant (Decker-Walters 2002b). This is important in nature because older seeds are most frequently released from the fruit through predation (Decker-Walters 2002b). Low germination rates indicated that seeds exhibit some dormancy properties that may respond to both environmental and physiological cues, and germination is affected by age of the seed (Decker-Walters 2002b). Approximately 73 percent of seeds remained viable after immersion in water for 70 days, and seed viability was not dependent upon whether the seed sank or remained at the surface (Decker-Walters 2002b).

Morphological differences in fruits have been noted between the Lake Okeechobee and St. Johns River populations (Minno and Minno 2006c). A total of 221 fruits from both populations were compared and measured to

confirm variation in fruit characteristics between populations (Minno and Minno 2006c). Results indicated that fruits from the St. Johns River population are longer than they are wide while those of the Lake Okeechobee population are wider than they are long with some overlap between populations (Minno and Minno 2006c). There are also some other differences (e.g., fruit coloration; peduncle width, length, and hair coverage) (Minno and Minno 2006c).

2. Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

a. Present or threatened destruction, modification or curtailment of its habitat or range: Continued habitat degradation and loss threaten the existence of Okeechobee gourd. Decker-Walters (2002c) stated that factors that reduce the availability of habitat (e.g., lack of fluctuation in water levels and aggressive weeds) pose a large threat to the subspecies. In addition, several factors related to human values (e.g., water storage, flood control, navigation) and ecological values (e.g., waterfowl, fisheries, littoral zone vegetation, water quality, snail kite recovery, and others) that affect management decisions can potentially conflict (Service 1999).

At this time, the habitat seems stable along the St. Johns River; however, proposed water withdrawals for alternative public water supplies may affect suitability for the Okeechobee gourd (Minno 2009). Water management practices associated with Lake Okeechobee directly influence the fluctuation in water levels, and, as a result, impact habitat. Water levels have typically been held between 15 and 17.5 feet above mean sea level to store water for agricultural irrigation and municipal needs, which is higher than natural levels (Walters and Decker-Walters 1991). Permanent inundation of suitable soils prevents germination of gourd seeds, and changes in water level management that would reduce the likelihood of low water can threaten the subspecies. Decker-Walters (2002c) reported that Ritta Island was inundated with water with only a small portion of the berm exposed when the lake level was around 16 feet above mean sea level, and no live plants were found that year. However, management changes that would result in more frequent low water-level events may be beneficial to the subspecies. Extended periods of low water levels generally result in increased growth and reproduction (Minno and Minno 2006a). Natural rainfall affects water levels for both populations, but especially for the St. Johns River population.

Okeechobee gourd plants are not strong competitors and are often out-competed by more aggressive plant species (Decker-Walters 2002c). Weed competitors include moonflower, common reed (*Phragmites australis*), Virginia saltmarsh mallow (*Kosteletzkya virginica*), camphorweed (*Pluchea* sp.), melaleuca (*Melaleuca quinquenervia*), *Sesbania* sp., and *Polygonum* spp. (Decker-Walters 2002a; 2002c). Moonflower appears to be especially

competitive (Minno 2007). Native trees and shrubs are often smothered by weeds and have been affected on Ritta Island in Lake Okeechobee (Decker-Walters 2002c). A stable overstory to support the growth of gourd vines is necessary for the long-term survival of the subspecies but is lacking on some of the islands of Lake Okeechobee (Decker-Walters 2002c). Interactions between competing species and the Okeechobee gourd are complex and not well understood, and individual responses to different stimuli are difficult to assess (Nee 2009).

Although necessary for control of exotic plants, herbicide use also poses a threat to the Okeechobee gourd. The occurrences at one of the sites along the St. Johns River were destroyed in 2005 where herbicide was sprayed, and the site is no longer suitable (Minno and Minno 2005). Herbicides are routinely sprayed around Lake Okeechobee to keep waterways free of aquatic vegetation. If herbicides are used carefully to control exotic woody vegetation (primarily melaleuca trees) and dense coverage of aquatic vegetation, this management practice can be compatible with recovery of the Okeechobee gourd (Service 1999).

Within the range of Okeechobee gourd in the Lake Okeechobee region, the human population is predicted to grow from nearly 11,000 to over 17,000 in Glades County between 2005 and 2060 and from approximately 1,270,000 to over 2,700,000 in Palm Beach County (Zwick and Carr 2006). Population growth is expected to increase water demands and recreational pressure on the lake. Within the range of the St. Johns River gourd population, the number of residents in Volusia County is projected to increase over the same time period from nearly 500,000 to over 940,000 and nearly triple in Lake County from just over 260,000 to more than 700,000 (Zwick and Carr 2006).

b. Overutilization for commercial, recreational, scientific, or educational purposes: At the time of listing, indiscriminate collecting of Okeechobee gourd was not known. Because it is limited in distribution and population sizes are relatively small, indiscriminate collecting could adversely affect the subspecies. Hobbyist interest in gourds raises the possibility of such collection. However, overutilization has not been documented.

c. Disease or predation: In a study conducted in Mexico to examine beetle (Chrysomelidae: Galerucinae: Luperini) parasitism on two species of the Cucurbitaceae family to which the Okeechobee gourd belongs, it was determined that the non-bitter cultivated butternut squash (*C. moschata*) was parasitized more frequently (65 percent) than the wild, bitter conspecific to Okeechobee gourd, the Martinez gourd (20 percent) (Gámez-Virués and Eben 2005). The authors believe these data show that parasitism may be affected by properties of the host plant (Gámez-Virués and Eben 2005). Decker-Walters (2002b) also observed that green fruits from wild Okeechobee gourd plants showed only minor signs of predation and suggested the chemical

properties (e.g., cucurbitacins) of the fruit deterred consumption until after they dried out.

Additionally, an experimental evaluation of the Texas gourd (*C. pepo* ssp. *texana*) indicated that plants that were inbred (selfed) succumbed to greater herbivore damage and were less resistant to viral infections than outbred gourds (Stephenson et al. 2004). Furthermore, the authors of this study stated that disease establishment within populations may occur around inbred plants (Stephenson et al. 2004).

Minno and Minno (1998) reported finding powdery mildew fungus (*Sphaerotheco fuliginea*), a hyperparasitic fungus (*Ampelomyces quisqualis*), mites (e.g., *Bevipalpus* sp., *Propvioseius meridionalis,* and *Galendromus mcgregori*), melonworm (*Diaphania hyalinata*), pickleworm (*Diaphania nitidalis*), sowbugs, grasshoppers, leaf-footed bugs, and scales (*Saissetia neglecta*) on leaves of the Okeechobee gourd along the St. Johns River. Little damage to the plants was observed except as a result of the powdery mildew fungus, melonworm, and pickleworm in which older leaves were killed and infected fruit was aborted (Minno and Minno 1998).

Insect predation was observed on Okeechobee gourd plants on one of the FWC spoil islands on Lake Okeechobee in 2002 (e.g., striped cucumber beetle [*Acalymma vittatum*], pickleworm, and melonworm) (Decker-Walters 2002a). Extensive herbivory by marsh rabbits (*Sylvilagus palustris*) was observed on one of the FWC spoil islands on Lake Okeechobee and appeared to have devastated the plants on this island; the other spoil island seemed to be unaffected by herbivory (Decker-Walters 2002c). Decker-Walters (2002c) suggested that rabbits, as well as wild pigs (*Sus scrofa*), present a threat to the subspecies through predation of seeds. Plants in the St. Johns River population were healthier in 2002 and exhibited no signs of insect damage (Decker-Walters 2002a).

During the 2002 survey on Lake Okeechobee's Torry Island, Okeechobee gourd plants appeared productive but unhealthy, and plants tested positive for several viruses, including cucumber mosaic virus, squash mosaic virus, and watermelon mosaic virus (Decker-Walters 2002a). Signs of viral infection (leaf puckering) were also seen on one of the FWC spoil islands, but few vines from the St. Johns River population exhibited signs of viral infection (Decker-Walters 2002a). The author believed that the Lake Okeechobee population may be affected by more diseases and insects as a result of local agricultural activities in the area, such as the production of squash, but suggested that reproduction may not be substantially affected (Decker-Walters 2002a). Overall, the extent of these threats is not known.

d. Inadequacy of existing regulatory mechanisms: Generally, managing agencies have limited regulatory tools. The ESA provides protection for this

subspecies and its habitat through section 7. The Okeechobee gourd 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.

e. Other natural or manmade factors affecting its continued existence: Small populations are susceptible to inbreeding depression, which compounds the effects of other threats, such as reduced resistance to herbivore damage and viral infections (Stephenson et al. 2004). Because Okeechobee gourds are ephemeral in nature, they tend to appear and disappear from sites, depending upon growing conditions (Service 1999).

No stable core population remains south of the lake to ensure survival as a result of poor growing conditions (e.g., the permanent inundation of suitable soils as a result of water-level regulation) (Service 1999). Even during natural environmental fluctuations, the subspecies may be more vulnerable to localized extinction because of small population sizes (Nee 2009). The presence of the large core population in the pond-apple forest around the lake in the past may have maintained viability of the ephemeral populations on the islands by providing a source for seeds (Nee 2009).

Fewer individuals occur along the St. Johns River, making this small population more susceptible to catastrophic events than the lake population (Decker-Walters 2002a). Growing near water and in swamps helps to buffer plants from winter freezes which can kill exposed stems and leaves (Minno 2009). Because plants of the St. Johns River population survive mostly from stems growing along the ground or through dense vegetation, they may be more susceptible to the effects of freezes (Minno 2009).

D. Synthesis

Most of the known occurrences in the Lake Okeechobee population are on public land, but extent of management is not reported. Consistent data showing fruit production at least every other year on Kreamer, Torry, and Ritta Islands and the southern Rim Canal of Lake Okeechobee have not been obtained. There are no stable, self-sustaining populations known to exist within the South Florida Ecosystem outside of Lake Okeechobee, except for the introduced population on private land west of Lantana in Palm Beach County. Finally, additional research on the viability of seeds following prolonged submergence and the survival of plants under rising water stages is needed for evaluation with the water regulation schedule for Lake Okeechobee. Overall, the reclassification criteria for downlisting have not

been met. In addition, current recovery criteria do not address the needs of the St. Johns River population, and no criteria are available for de-listing.

Overall, the current range of Okeechobee gourd is limited to the shoreline and islands around the northwestern and southern portions of Lake Okeechobee in Glades and Palm Beach Counties and both sides of the St. Johns River from Lake Beresford south to Lake Monroe and along the western side of Lake Jessup along the Volusia and Lake County line and into Seminole County. These two populations are separated by over 100 miles and do not exhibit much genetic variation. Because Okeechobee gourd plants are difficult to count, we are unable to estimate the abundance of this subspecies. Surveys in 2007 indicated that the subspecies was present on 4 of the islands in Lake Okeechobee and on 12 sites along the St. Johns River.

Where habitat remains intact, the Okeechobee gourd depends upon favorable growing conditions to persist. The largest threat to the subspecies is loss and reduction of habitat (e.g., lack of fluctuation in water levels and aggressive weeds). The Okeechobee gourd often experiences increased growth and reproduction as a result of extended periods of low water levels. Because Okeechobee gourd plants are not strong competitors, they are often out-competed by more aggressive plant species. Human population growth within the range of the subspecies is expected to increase water demands and recreational pressure. Existing regulatory mechanisms do not appear to be adequate on private lands. Habitat loss, fragmentation, and changes in land use continue, and conversion of habitat to urban use around the Lake Okeechobee region and along the St. Johns River is projected to increase over the next 50 years. The subspecies' limited distribution and small population sizes also render it vulnerable to random natural events, such as prolonged high water levels along the St. Johns River. Considering the subspecies' current status and above ongoing threats, this subspecies 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

Surveys:

- Conduct regular surveys to monitor growth and reproduction, especially from late November through mid-February when many trees are leafless and fruit are easy to see.
- Monitor the spoil islands of Lake Okeechobee to evaluate how the plants respond in a restricted environment with other competitive colonizers and observe the establishment of the seed bank.
- Monitor future translocation sites.

Research:

- Continue research to evaluate temporal changes in the prevalence of the three viruses found and to determine the extent to which the fitness of Okeechobee gourd populations is being negatively impacted.
- Conduct experiments on dry fruits from plants grown under controlled conditions (e.g., in the greenhouse) to explore the buoyancy of dried-fruit seeds in greater detail.
- Continue to assess dormancy mechanisms and test viability limits through longer immersion periods of seeds.
- Conduct buried seed experiments in Lake Okeechobee or St. Johns River soils.
- Directly evaluate each gourd population for viral loads, determine the percentage of progeny that may carry the squash mosaic virus, and conduct off-site viral-inoculation experiments of progeny to evaluate degree of tolerance and reproductive impacts.
- Re-evaluate the relationships amongst subspecies of *Cucurbita okeechobeensis* using modern molecular techniques and new morphological characteristics.
- Continue research on fluctuations in abundance of the gourd in response to water conditions, particularly extended periods of high water, to determine the level of risk to the long-term survival of the subspecies.
- Research the acute and long-term tolerance of the Okeechobee gourd and other wetland plants to herbicides commonly used to control nuisance species of aquatic vegetation.
- Conduct population viability and risk assessment studies, particularly with respect to water regulation schedule alternatives for Lake Okeechobee.

Management:

- Eradicate exotic weeds (e.g., *Ipomoea alba*) in locations that support gourds and take care when planting native trees to prevent introduction of these weeds.
- Use controlled burns to open up areas of overly dense herbaceous and/or shrubby vegetation in lake littoral zones and marshes.
- Prevent cultural (i.e., human caused) eutrophication of lakes and marshes.
- Avoid disruptive changes to the riparian habitat along the St. Johns River where the population occurs.
- Ensure that water-level regulation is compatible with management needs of the Okeechobee gourd.
- Ensure aquatic vegetation management practices are compatible with recovery of the subspecies.
- Consider Okeechobee gourd and the creation of habitat in planning phases of Everglades restoration.
- Restore habitat by planting pond apple and cypress where appropriate.
- Establish a translocation protocol, locate potential sites, and translocate plants to identified sites.
- Ensure that the St. Johns River and Lake Okeechobee populations are not grown together in collections to avoid hybridization. If hybridization is suspected, hybrid material should not be used for reintroduction.

Other:

- Develop recovery criteria for the Okeechobee gourd population along the St. Johns River.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of Okeechobee gourd (*Cucurbita okeechobeensis* ssp. *okeechobeensis*)

Current Classification Endangered
Recommendation resulting from the 5-Year Review

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
__X__ 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 8-28-09

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.

Acting
Lead Regional Director, Fish and Wildlife Service

Approve Amon L Valentine Date 9-3-09

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 Okeechobee gourd (*Cucurbita okeechobeensis* ssp. *okeechobeensis*)

A. Peer Review Method: The Service conducted peer review. Three peer reviewers and an additional reviewer were asked to participate in this review. Individual responses were received from two of the peer reviewers and the additional reviewer.

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: the complexity of interactions between competing species and their responses to different factors; the ability of the historic populations in the pond-apple forests to serve as a stable seed source to maintain viability of ephemeral occurrences along the islands; the waning of the occurrences on the spoil islands; the possibility that the subspecies may be more prone to local extinction during the usual fluctuations of the environment; the persistence of two non-natural populations established from cuttings on private land in Putnam County and in Palm Beach County outside of Lake Okeechobee; the unknown factors that may limit gourd distribution; gourd growth after hurricanes; and the first record of fruits observed in the marsh east of Torry and Kreamer Islands.

Reviewers noted that information provided in this review was thorough and sufficiently represented the assemblage of information on the biology of the subspecies, the difficulty in assessing the status of ephemeral species, the known threats, and the taxonomic status. Additional threats were noted regarding winter freezes that may affect plants along the St. Johns River that are not buffered as well from the cold and proposed water withdrawals from the river for alternative public water supplies. Clarifications were suggested regarding property ownership where gourds are found, the origin of the spoil islands in the lake, and the expansion of the range of the St. Johns River population. One reviewer commented that the gourd populations in Florida have been established for a long time and have been genetically isolated from the Martinez gourd in Mexico and the newly discovered one in the Dominican Republic. Another reviewer stated that the habitat where the gourd occurs in the Dominican Republic is quite different from that in Florida. It was noted that newer more powerful genetic analyses may show more genetic variation between and within populations that could help explain morphological differences in fruit and flowers.

Additional recommendations by peer reviewers for future actions included the importance of continuing to monitor the status of the subspecies, the necessity for more seed viability studies, and the need to place more emphasis on the long-term issue of habitat restoration and address water level management in Lake Okeechobee. It was emphasized that plants from the Lake Okeechobee and St. Johns River populations should not be grown together in collections to avoid hybridization, and any suspected hybrid material should not be used for reintroductions. To better understand the relationships between the populations, it was also suggested that the taxon in the Dominican Republic be examined further.

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

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 Paula Halupa, Acting Endangered Species Supervisor, South Florida Ecological Services Office, at 772-562-3909, extension 257, email: Paula_Halupa@fws.gov.