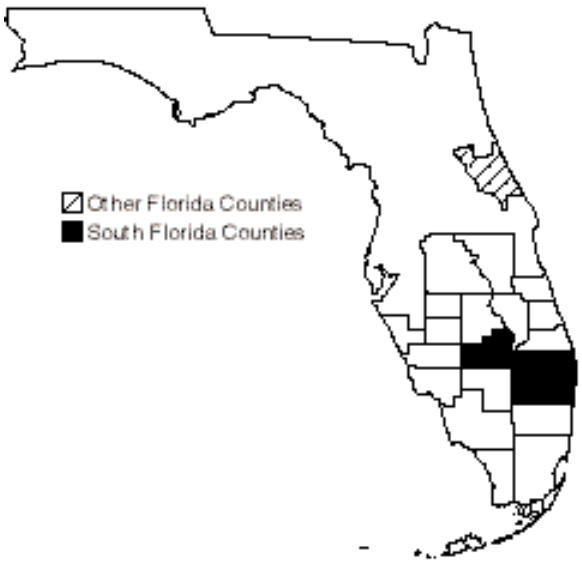
Okeechobee Gourd

Cucurbita okeechobeensis ssp. *okeechobeensis* Small

Federal Status:	**Endangered (July 12, 1993)**
Critical Habitat:	**None Designated**
Florida Status:	**Endangered**
Recovery Plan Status:	**Original (May 18, 1999)**
Geographic Coverage:	**South Florida**

Figure 1. County distribution of the Okeechobee gourd.



The Okeechobee gourd is a vine that was locally common in the extensive pond apple (*Annona glabra*) forest that once grew south of Lake Okeechobee (Small 1922). As early as 1930, at least 95 percent of the pond apple forests had been destroyed (Small 1930), and pond apple now persists as scattered trees or small stands around Lake Okeechobee and in the Everglades. The conversion of these swamps and marshes for agriculture and water-level regulation in Lake Okeechobee have been the principal causes of the reduction in range and number of Okeechobee gourd plants. The Okeechobee gourd is now restricted in the wild to two small disjunct populations— one along the St. Johns River which separates Volusia, Seminole, and Lake counties in north Florida, and a second around the shoreline of Lake Okeechobee in South Florida.

Currently, the survival of the Okeechobee gourd in South Florida is threatened by the water-regulation practices in Lake Okeechobee and the continued expansion of exotic vegetation in the lake. Careful use of herbicides to control exotic woody vegetation (primarily *Melaleuca)* and dense growths of aquatic vegetation can be compatible with recovery of the Okeechobee gourd.

This account represents the recovery plan for the Okeechobee gourd.

Description

The Okeechobee gourd is an annual or perennial, fibrous-rooted, high-climbing vine with tendrils, belonging to the gourd family (Cucurbitaceae). The Okeechobee gourd possesses heart- to kidney-shaped leaf blades, with 5 to 7 angular, shallow lobes, and irregularly serrated margins (Walters and Decker-Walters 1993). Young leaves are covered with soft hairs. The cream-colored flowers are bell-shaped, with the corolla 6 to 7 cm long. They can be distinguished from flowers of *C. martinezii* (Martinez gourd) by the presence of dense pubescence on the

hypanthium of the male flower and on the ovary of the female flower. The light green gourd is globular or slightly oblong, with 10 indistinct stripes, and hard shelled with bitter flesh. The seeds are gray-green and flat (Small 1930, Tatje 1980, Walters and Decker-Walters 1991). The stems produce adventitious roots at the nodes and will separate from the parent plant if they contact soil or water (Minno and Minno 1995).

Taxonomy

Small (1922, 1930) originally described the gourds he found in the pond apple forest surrounding Lake Okeechobee as *Pepo okeechobeensis*. Bailey (1930) transferred the Okeechobee gourd to the genus *Cucurbita*, which includes pumpkins and squashes. Bailey (1943) subsequently described two new gourd species, *C. martinezii* and *C. lundelliana*. These two gourds were proven to be closely related to the Okeechobee gourd.

Closely related gourds with cream-colored corollas (all others in the genus *Cucurbita* are bright yellow) are found in Florida and in Mexico, near the Gulf Coast. The Florida plants were described as the Okeechobee gourd (Bailey 1930) and the Mexican plants were designated (Bailey 1943) as the Martinez gourd (*C. martinezii*). However, Robinson and Puchalski (1980) showed through isozyme analysis that there was only a single allelic difference between the two varieties. The (ESA) does not allow Federal listing of disjunct populations of widespread plant species. Since the Mexican gourds are moderately abundant, and considering the findings of Robinson, the FWS originally opposed listing of the Okeechobee gourd. A later study by Walters and Decker-Walters (1991), also using isozyme analysis, showed a difference of just one allele. However, they calculated an estimated time since divergence of about 450,000 years between the Martinez and Okeechobee gourds, and concluded that they should be considered distinct at the subspecies level. Walters and Decker-Walters (1993) rearranged the nomenclature, designating the Florida gourds as *Cucurbita okeechobeensis* (Small) Bailey ssp. *okeechobeensis,* and assigning the Mexican gourds to the subspecies *C. okeechobeensis* ssp. *martinezii* (Bailey) Andres and Nabhan ex T. Walters and Decker Walters. The FWS concurred with this finding, and because the ESA allows protection of distinct subspecies, the Okeechobee gourd was subsequently listed as endangered.

Distribution

The Okeechobee gourd was historically found on the southern shore of Lake Okeechobee, in Palm Beach County, and formerly in the Everglades. The relative abundance of the Okeechobee gourd in the Everglades region south of the original pond apple forest along the southern rim of Lake Okeechobee is not known. In 1965, it was seen north of Homestead in an agricultural area of Dade County (Florida Natural Areas Inventory data, 1992). A population on a disturbed roadside north of Andytown, Broward County, was discovered in 1978 and was destroyed by road construction the following year (Tatje 1980).

In recent surveys, the species was found to be restricted to nine sites along

Okeechobee gourd.
Original drawing by Jean C. Putnam Hancock; original flower photograph by Steve Shirah; fruit photograph courtesy of U.S. Fish and Wildlife Service.

the middle St. Johns River in Volusia County (Minno and Minno 1995, 1998) and and around Lake Okeechobee in Glades and Palm Beach counties (Figure 1). It was present at 11 sites along the southeastern shore of Lake Okeechobee, including Torry Island, Ritta Island, Kreamer Island, Bay Bottom Dynamite Hole Island, South Shore Dynamite Hole Island, and the southern shore of the Lake Okeechobee Rim Canal (Walters *et al*. 1992; Walters and Decker-Walters 1993) (Figure 2)

The documented population of Okeechobee gourd around the southeastern shore of Lake Okeechobee is strongly associated with Torry muck, a soil formed in the extensive pond apple forests that once surrounded Lake Okeechobee. However, successful growth and reproduction of the gourd under cultivation suggests that the species can grow in a wider range of soils.

Habitat

Nabhan (1988) noted that the gourd seemed to need the natural trellises of pond apple branches. However, the gourd readily climbs any plant that will provide a trellis; in both Lake Okeechobee and the St. Johns River, the Okeechobee gourd grows on elderberry (*Sambucus canadensis*) and buttonbush (*Cephalanthus occidentalis*). Around Lake Okeechobee, the gourd is frequently associated with alligator nests. These disturbed sites provide areas where competition is reduced and elevated areas that promote the growth of

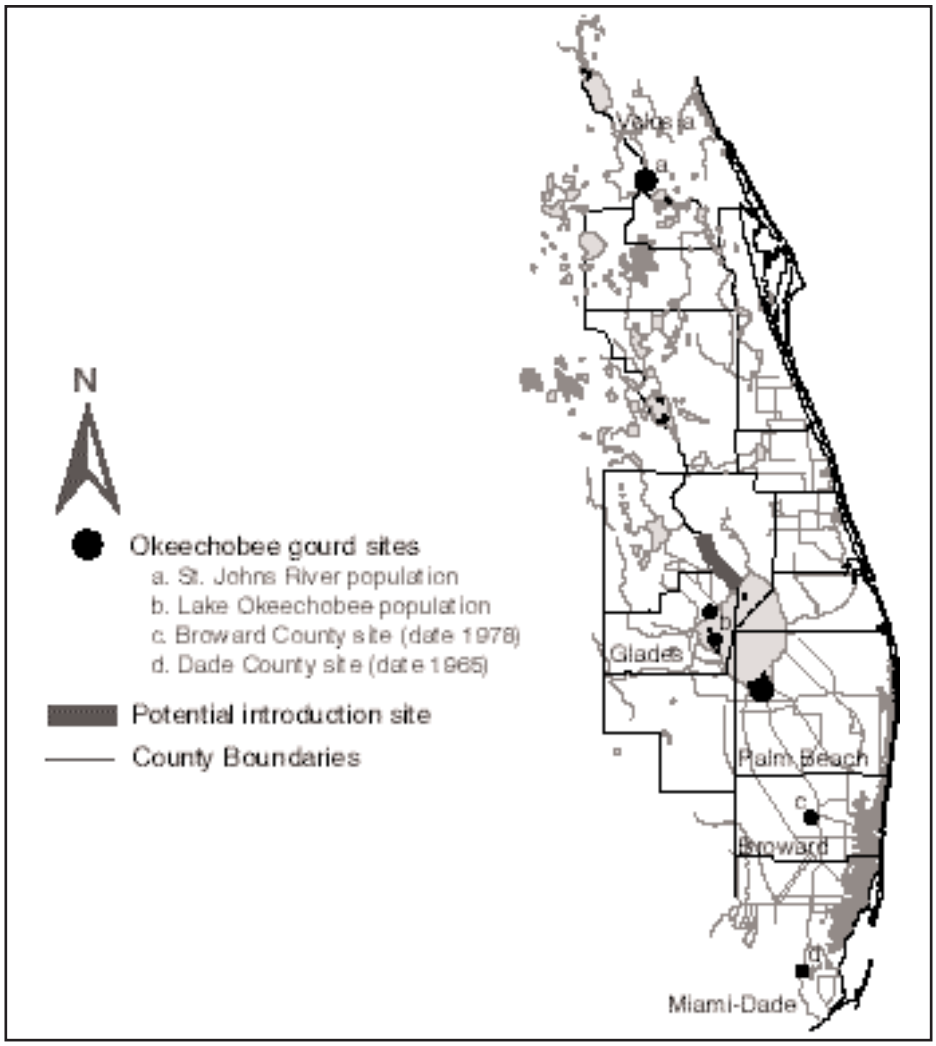


Figure 2.
Site-specific distribution of the Okeechobee gourd.

elderberry, button bush, and other erect bushes and shrubs.

Walters and Decker-Walters (1991) conclude that "...for the gourd to maintain viable healthy populations, fluctuations in lake level are necessary. High lake levels facilitate dispersal and inundate and destroy aggressive weeds in local habitats. As lake levels decrease, the cleared open habitats allow the quickly germinating Okeechobee gourd seeds to sprout and begin climbing before they have to compete with other pioneer species." Similiary, artificially disturbed sites can provide suitable habitat in some circumstances. Gourds have been observed growing in mowed powerline and road right-of-ways (M. Minno, Eco-Cognizant, Inc., personal communication (1998).

Reproduction

The flowers open at dawn and although specific pollinators have not been identified, based on closely related gourds, a variety of insects are likely to be available, including bees, flies, and squash beetles. Preliminary information indicates that pollination may be a problem for this species, especially in small

colonies. Typically, male flowers greatly outnumber female flowers and where pollinators are rare, decreased fruit set may be observed (M. Minno, Eco-Cognizant, Inc., personal communication 1998). In at least one collection of *C. okeechobeensis,* flowers must be pollinated by hand to ensure fruit set (T. Race, Bok Tower Gardens, personal communication, 1998).

The seeds germinate in early spring during the dry season. Seedlings do not tolerate water-soaked soil for extended time periods, which would account for Nabhan's (1989) discovery of a stand of Okeechobee gourds apparently in decline, inundated in 20 to 30 cm of water. By the rainy season, the vines will have climbed shrubs, avoiding complete inundation as water levels rise. The vines and fruit become most visible by early to mid-summer.

Although the exact mechanism for seed dispersal of the Okeechobee gourd is unknown, Walters *et al*. (1992) suggest that Okeechobee gourds disperse by floating in water bodies (in canals and along the shore of islands in Lake Okeechobee); however, no information is available regarding the distances seeds may disperse. Walters et al. (1992) also indicate that marsh rabbits are the main terrestrial disperser of gourd seeds, but others suggest that rabbits are only a predator of these seeds and are unlikely to be significant seed dispersers (M. Minno, Eco-Cognizant, Inc., personal communication 1998).

Relationship to Other Species

Around Lake Okeechobee, the gourd relies on pond apple trees to support its vines above rising water levels during the wet season. Other trees and shrubs, such as willow (*Salix caroliniana*) and cypress (*Taxodium distichum*), may also provide suitable support for the vines. Along the St. Johns River, Okeechobee gourds are most typically found growing on elderberry and common reed (*Phragmites* spp.)

The Okeechobee gourd also seems to readily germinate on alligator (*Alligator mississippiensis*) nests in Lake Okeechobee, which provide suitably elevated soil berms in full sun, with no competition from other plants. Although alligators do not typically construct nests in woody vegetation, they do clear herbaceous vegetation, sometimes close to shrubs and trees. After gourds germinate on the cleared ground around the nest, they begin to grow prostrate. If trees or shrubs are present nearby, the gourd plants will eventually climb. Alligators, though, do not seem to be important to survival of the gourd in the St. Johns River (M. Minno, St. Johns River Water Management District, personal communication 1996).

Walters *et al*. (1992) observed a rabbit gnawing on a green gourd and saw gnawed and broken gourds in their nests, which suggests that marsh rabbits feed on and may disperse gourd seeds. Because many insect species have evolved with specific cucurbits, the Okeechobee gourd could be a keystone species for some, as yet unidentified, pollinator. Both the Floridian and Mexican subspecies of *C. okeechobeensis* are highly resistant to many diseases which threaten economically valuable plants. The Martinex gourd is currently used as a source of disease resistance for summer squash, pumpkins, and gourds. However the Okechobee gourd has been known to be attacked by powdery mildew fungus, melon worms, and pickle worms (M. Minno, Eco-Cognizant, Inc., personal communication, 1998),but the extent to which these diseases affect the gourd population is not known.

Water management practices in Lake Okeechobee affecting the

Okeechobee gourd are also likely to affect the wood stork and the snail kite. However, the hydrologic requirements for the three species are not mutually exclusive. All three species are adapted to withstand periods of drought and high water, but prolonged periods of three or more successive years at either extreme might be adverse to their survival. The snail kite temporarily benefits from periods of high water, but prolonged periods would drown out woody vegetation needed by kites as nesting substrate. Extended periods of high water for several continuous years could possibly jeopardize the Okeechobee gourd, because the seeds would not germinate and young plants cannot tolerate deep water. On the other hand, the gourd might temporarily benefit from drought conditions, because low water provides more suitable habitat within the Herbert Hoover Dike surrounding Lake Okeechobee. However, extended periods of low water could favor dense stands of woody vegetation (including *Melaleuca*), which would not be favorable to the gourd or the overall productivity of Lake Okeechobee. More research is needed 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 survival of the species in the long term.

Status and Trends

The Okeechobee gourd persisted around Indian villages with the Seminole pumpkin, *C. moschata* (Small 1930), which is edible. The Okeechobee gourd's bitterness precluded its use for food, but it may have been used as a ball, rattle, or ceremonial cup.

Small observed and/or collected the Okeechobee gourd in 1913 and 1917 and found it to be locally common in the remnant pond apple forests surrounding Lake Okeechobee (Small 1922). At least 95 percent of this habitat had already been destroyed when he named the gourd *Pepo okeechobeensis* (Small 1930).

After 1930, the Okeechobee gourd was observed infrequently. In 1941, it was found on Observation Island in Lake Okeechobee, Glades County (Florida Natural Areas Inventory data, 1992). Robinson (1987) was unable to relocate the Okeechobee gourd there in 1984 or 1987. In 1981, the Okeechobee gourd was found in some lake, levee, and canal bank areas at Kreamer and Torry Islands (Florida Natural Areas Inventory data, 1992). Nabhan's 1988 search only turned up three gourds (the fruits of the Okeechobee gourd), and no live plants. Seeds from those gourds were planted at Bok Tower Gardens, Florida, where the plant currently thrives under cultivation.

A new population of the Okeechobee gourd was found along the shore of the middle St. Johns River in September 1993. Gourds had not been noted in this area for more than 200 years (Bartram 1774). Surveys conducted from 1995 to 1997 documented 12 locations along the St. Johns River, but only three of these localities contained Okeechobee gourds during a 1998 survey. (M. Minno, Eco-Cognizant, Inc., personal communication 1998).

Because the Okeechobee gourd flourishes when suitable soils are exposed during low water levels, the best time to survey for the species is during moderate or severe drought. The most recent surveys were conducted during drought conditions in 1990 and 1991. The species was found at a total of 11

sites along the southeastern shore of Lake Okeechobee, including Torry Island, Ritta Island, Kreamer Island, Bay Bottom Dynamite Hole Island, South Shore Dynamite Hole Island, and the southern shore of the Lake Okeechobee Rim Canal (Walters *et al*. 1992, Walters and Decker-Walters 1993). Water levels have been high in recent years (1994-1996), and no organized search has been conducted recently for the species around Lake Okeechobee.

The GFC reported finding the Okeechobee gourd in 1985 on a spoil island just west of the outlet of Harney Pond Canal along the northwestern shore of Lake Okeechobee in Glades County (Don Fox, GFC, personal communication 1996), suggesting that the species may be more widespread around the shores of the lake. More systematic and thorough searching needs to be conducted throughout Lake Okeechobee and the surrounding creeks.

Searches for the Okeechobee gourd in the past have been irregularly timed and of limited geographic scope. The FWS recommends that a complete survey be conducted along shorelines (including any islands) of Lake Okeechobee at least once a year. If surveys are limited to once a year, the best time to survey is from late December through mid-February when the trees and shrubs are leafless and the fruit more visible. If resources are available to conduct semi-annual surveys, surveys should be done in May and June in the early morning (before 10 am), when the large flowers are likely to be open. Yearly surveys would provide information necessary to begin to identify population fluctuations and long-term trends, information which is unavailable for any previous period.

Gourds are ephemeral by nature; they appear at a site for one or many years and then disappear. They tend to grow well under good conditions (appropriate hydrology and reduced competition) and subside when conditions become unfavorable. Therefore, searches should not be limited to previously documented sites. Because of the rambling growth habit of the gourd, and because plants can root at the nodes, it is difficult to count numbers of individual plants. Counting the number of fruits on the vines in the fall may provide a good index of the reproductive health of the population, rather than attempting to count individual plants.

The plant's decline is largely attributable to two factors: (1) conversion of swamp forests to agriculture and (2) water level management in Lake Okeechobee. Agricultural conversion was the principal form of habitat destruction for the gourd prior to 1940. Today, water management practices appear to be the greatest threat. Permanent inundation of suitable soils is detrimental to the species. Water regulation practices can greatly influence the timing and duration of flooding and drying cycles across remnant areas of suitable elevation and soils around Lake Okeechobee.

Because the Okeechobee gourd has been found growing along the edges of canals, and because herbicides are routinely applied around Lake Okeechobee to keep aquatic weeds from choking the waterways, aquatic vegetation management practices should be modified to ensure compatibility with recovery of the species.

Another potential threat to this plant is the proliferation of exotic plant

species around the edges of Lake Okeechobee, particularly *Melaleuca*. Although scattered *Melaleuca* trees may provide suitable support for climbing gourd plants, *Melaleuca* stands generally become a dense monoculture. Densely shaded areas in the center of *Melaleuca* stands are not suitable for the Okeechobee gourd. Control of aquatic weeds can involve spraying from airboats or airplanes, but *Melaleuca* control can be accomplished by cutting and squirting herbicide into individual tree trunks. The FWS believes *Melaleuca* control is a necessary management practice to prevent degradation of littoral zone habitat quality for a variety of animals and plants in Lake Okeechobee, including the Okeechobee gourd; the controlled use of herbicide applied directly to *Melaleuca* trees is not likely to have adverse effect on the Okeechobee gourd.

The extensive pond apple forest that once surrounded the southern shore of Lake Okeechobee most likely supported a stable core population of the gourd that allowed long-term survival of the species, despite year-to-year changes in peripheral sites that became temporarily available or unavailable in response to natural water fluctuations. Because no stable core population remains within the dike surrounding the lake, the species is more vulnerable to the threats identified above.

Management

Aside from regulation of collecting and interstate trade, management for this endangered plant is non-existent. The FWS recommended a program of habitat modification and enhancement. Should such measures prove feasible, we recommend that control or extirpation of exotic pest plants such as *Melaleuca* and Brazilian pepper in specific areas where the Okeechobee gourd is known to grow be balanced with planting of pond apple or other appropriate native woody vegetation to provide potential vine-supporting vegetation. Proposed changes to the regulation schedule of Lake Okeechobee will be evaluated for potential effects on the species, but this will be only one of several factors used to evaluate water regulation. A variety of factors related to human values (water storage, flood control, navigation) and ecological values (waterfowl, fisheries, littoral zone vegetation, water quality, snail kite recovery, and others) can potentially conflict. A balance must be found among these competing interests that will promote recovery of the Okeechobee gourd. Spraying of herbicides to control growth of aquatic vegetation should be avoided or strictly controlled in areas where habitat is being managed for recovery.

Improved coordination among agencies (principally the SWFMD, COE, DEP, FWS, and GFC) should avoid unscheduled or unannounced aquatic weed control in areas likely to support the Okeechobee gourd. Experimentation is needed to test how sensitive the Okeechobee gourd is to the chemicals currently being used. Depending on the results of that experimentation, aerial spraying may need to be prohibited in areas where the species grows. For boat-based spraying, an outreach program is needed to educate spraying crews to recognize the Okeechobee gourd and avoid spraying the plants. If spraying is unavoidable, the least vulnerable period for the Okeechobee gourd may be November and December, after plants have fully developed fruit and before seedlings emerge.

Removal of exotic woody vegetation, such as Brazilian pepper (*Schinus*

terebinthifolius), Australian pine (*Casuarina equisetifolia*), and *Melaleuca quinquenervia* along the shoreline of Lake Okeechobee should be accompanied by planting of native trees and shrubs, particularly pond apple. The primary technique for control of woody exotic vegetation should be application of herbicide to individual trees wherever practical, while aerial spraying should be used with great caution only on large *Melaleuca* heads adjacent to the Lake Okeechobee rim canal.

Recovery of the Okeechobee gourd may require special emphasis on protection and management of Ritta Island. This is the only site in Lake Okeechobee with what appeared to be more mature plants. Plants at other sites around the lake appeared to be in poor health and transitory. Lacking the large pond apple forest that likely served as a stable reserve bank of plants, Ritta Island is now the likeliest among the sites identified in 1991 to be persistent. However, we lack information on how well the plants have survived several recent years of high water levels. Dense growth of *Colocasia* appears to be blocking free dispersal of fruits at Ritta Island. Rather than attempt to remove or control *Colocasia*, it may be more effective to intervene by dispersing the seed according to a management plan.

The relationship of fire and the Okeechobee gourd is also not fully understood. Fire could be a threat in that it could destroy plants, yet it could also be a management tool because gourds sprout in areas cleared by disturbance. More frequent and more thorough surveys for the plant may reveal a pattern of response to fire or mechanical disturbances.

A recovery team meeting for the Okeechobee gourd was held in April 1996. In addition to the above-mentioned recovery actions, the group recommended introduction of plants to sites within and outside of Lake Okeechobee. Within the lake, Observation Island and Little Rocky Island should first be more thoroughly searched to see if the Okeechobee gourd is present. If not, these islands are good candidates for introduction. Public lands should be identified along the Kissimmee River that have suitable environmental conditions for introduction of the species. Because the species now occurs in two widely separated populations (Lake Okeechobee and St. Johns River), establishment of a third population between the two existing populations is considered a desirable safeguard against extinction, particularly with respect to catastrophes, such as hurricanes.

Other potential recovery actions would involve physical alteration of the environment, either removal of levees or mounding of organic material to provide substrate at appropriate elevations. It is unclear at this time whether degrading the levees at Torry and Ritta islands would promote recovery of the Okeechobee gourd. Improved water flow through these areas may promote dispersal of fruits. Mounding of organic soil on Torry and/or Ritta, islands could be part of a restoration plan for those islands and could provide a safeguard against prolonged periods of high water. Roads are present on both islands, making access of earth-moving equipment more practical. Additional contaminant sampling may be necessary on both islands to ensure that residue from previous application of agricultural chemicals does not preclude moving these sediments. Another possibility is mounding of organic berms that have built up in an area southwest of Buckhead Ridge. However, the latter project would

require water levels in the lake be held down around 4 m and may present logistical problems in terms of access and operation of machinery, which would tend to get stuck.

Isozyme analysis of Okeechobee gourds from southeastern Lake Okeechobee indicates no distinguishable differences among the specimens. No material has been analyzed from the St. Johns River. This could be done relatively easily and should be a high priority. Pending results of this study, a genetic management plan must be prepared by the FWS prior to considering crossing of Okeechobee and St. Johns plants. It appears that there is very little risk in crossing plants from these two areas, and there may be advantages in

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terms of generating heterozygosity.

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Recovery for the Okeechobee Gourd

Cucurbita okeechobeensis ssp. *okeechobeensis* Small

Recovery Objective: RECLASSIFY to threatened.

Recovery Criteria

The Okeechobee gourd has an extremely limited distribution; it is vulnerable to the highly managed hydrologic conditions in Lake Okeechobee. A significant portion of the Kissimmee River-Lake Okeechobee-Everglades watershed that once supported the gourd has been irreversibly lost, and information on the gourd's tolerance to specific environmental stressors is lacking. Consequently, the FWS can only define general conditions that could allow reclassification from endangered to threatened. This objective will be achieved when: the Okeechobee gourd is protected at all known sites within Lake Okeechobee; when 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 absence for a period of two or more consecutive years will violate this requirement); when the distribution of fruiting plants is expanded within Lake Okeechobee either by the discovery of additional sites or by translocation; when one or two sites are established outside of the southeastern quadrant of Lake Okeechobee (outside of Palm Beach County); when a stable, self-sustaining population of the Okeechobee gourd is established within the South Florida Ecosystem outside of Lake Okeechobee; when measures of vitality are developed and monitored at each of the sites described above; and when 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.

This recovery objective is an interim goal because of the limited data on the biology, ecology, and management needs of this species. It may be possible to delist the Okeechobee gourd if there is sufficient, restorable habitat that can be recolonized by additional populations; however, the feasibility of such a restoration and recolonization is still uncertain. This recovery objective will be reassessed annually based on new research, management, and monitoring information. These criteria will be refined when new information identifies ways of re-establishing populations of this species and expanding its current distribution. This recovery narrative covers recovery actions only within the South Florida Ecosystem; recovery actions for the Okeechobee gourd along the St. Johns River must be added for a complete recovery plan.

Species-level Recovery Actions

S1. Maintain information on the distribution and status of the Okeechobee gourd.

S1.1. Conduct regularly scheduled surveys. Past surveys for the Okeechobee gourd have been sporadic and not comprehensive. More thorough searching of Lake Okeechobee is needed at least once per year, preferably 3 times (spring, summer, fall) a year. Airboats are the most efficient vehicles for conducting surveys.

S1.2. Individuals should be encouraged to provide information on sightings of the Okeechobee gourd. Due to the size of Lake Okeechobee, the difficult access to interior portions of its littoral zone, and the potentially wide dispersal of floating gourds that start germination, it is impossible for professional biologists to search all potential habitat in the lake. Private citizens involved in a number of activities on the lake can provide useful information to help locate plants.

S2. Protect and enhance existing populations.

S2.1. Ensure that spraying for control of aquatic vegetation does not harm or kill Okeechobee gourd plants. The regularly scheduled surveys provide information on locations of the Okeechobee gourd; this information (using maps and GPS coordinates) must be conveyed to spray crews to reduce the likelihood of damage to the gourd. Spray crews must also be trained to recognize the gourd and the need to avoid impacts on the species.

S2.2. Assess the effect of *Melaleuca* and Brazilian pepper control efforts (both cut-and- squirt and aerial spraying methods); use techniques to avoid direct impact on Okeechobee gourd plants. Although control of *Melaleuca* and Brazilian pepper is needed for ecosystem restoration, the climbing stems of the Okeechobee gourd now use both species as support. Train crews to identify the Okeechobee gourd. Where exotic trees or shrubs are supporting living Okeechobee gourd plants, instruct the crew to avoid killing the Okeechobee gourd plants and to inject herbicide in the exotic species without cutting it down.

S2.3. Use provisions of section 7 of the ESA to protect the Okeechobee gourd. Water management of the COE's C&SF project will affect survival and recovery of the Okeechobee gourd, particularly the water regulation schedule for Lake Okeechobee. Field monitoring and experimental research are needed to determine the gourd's tolerance of water levels to effectively evaluate alternative water regulation schedules and provide effective conservation recommendations.

S2.4. Augment natural populations of the Okeechobee gourd.

S2.4.1. Establish a protocol for translocation. Source plants must be cultivated and recorded at a nursery or botanical garden.

S2.4.2. Locate potential translocation sites. First, more thorough surveys of the present range of the species are needed within Lake Okeechobee. Later, potential sites for translocation within the lake need to be assessed. Some of these are Little Rocky Island (Hendry County), Observation Island (Glades County) and other sites in Okeechobee County. Other potential translocation sites should be selected north of Lake Okeechobee, with emphasis on the islands in Lake Istokpoga and public lands along the Kissimmee River.

S2.3.3. Translocate plants to the selected sites.

S3. Initiate research on the life history and genetics of the Okeechobee gourd.

S3.1. Test experimentally the viability of Okeechobee gourd seeds kept submerged for long periods (1 to 3 years). The tolerance of Okeechobee gourd seeds to extended periods of submergence in the waters of Lake Okeechobee is a critical parameter needed to assess the potential risk to the species from extended periods of high water under various lake regulation schedules.

S3.2. Characterize the range of soil conditions where the Okeechobee gourd currently grows and provide detailed mapping of soil types in southeastern Lake Okeechobee. Although distribution of the Okeechobee gourd in Lake Okeechobee appears to be associated with the presence of muck soils formed historically in the pond apple forests that once bordered the lake, the soil profile appears to be modified in some areas where the gourd grows. Dredging of flood control canals (and lining them with revetment), construction of levees, and construction of farm roads and drainage ditches have evidently altered the soil at many of the Okeechobee gourd sites. Presence of some native organic soil appears to be necessary, but the range of soil profiles should be determined to characterize occupied habitat and assess unoccupied, but potentially suitable, habitat.

S3.3. Through field surveys, determine dates of germination under natural conditions. Because the specific locations for germination may vary from year to year, it may be difficult to identify areas to search for germinating plants, but some areas of consistently suitable habitat may be identifiable to obtain this information. Areas may need to be revisited for several years to account for interannual variation in response to water levels and temperature patterns. Timing of water management decisions relative to germination and growth of young Okeechobee gourd plants is important to survival and recovery of the species.

S3.4. Test experimentally the effect of seasonally rising water level on the survival of young plants. Determine rates of rising water level and/or depths that may reduce survival of young plants. Identify at what stage their growth rate and ability to climb adjacent vegetation make them less vulnerable to rising water level.

S3.5. After information is available from the research studies described above and the annual field surveys, conduct population viability and risk assessment studies particularly with respect to water regulation schedule alternatives for Lake Okeechobee.

S3.6. Investigate the role of animals in dispersing seeds of the Okeechobee gourd.

S3.7. Document the potential ecological relationship between the American alligator and the Okeechobee gourd. The mounds of soil around alligator nests may serve as favorable germination sites for the gourd. This relationship should be investigated, determining whether indeed gourds preferentially germinate around nests and how frequently these seedlings produce at least one mature plant at a nest.

S3.8. Investigate the genetic distance between the two known populations of the Okeechobee gourd. Isozyme analysis has indicated a single population of the gourd in southeastern Lake Okeechobee. Additional analysis should be performed on specimens from the St. Johns River. Researchers should make a recommendation to the FWS regarding the desirability of cross-breeding gourds from the two populations to provide additional variability within the populations. If a third population is established geographically between the two existing populations, a decision must be made on the genetic source of the specimens.

S4. Monitor existing populations of the Okeechobee gourd.

S4.1. Determine the most effective approach to monitor the condition of the Okeechobee gourd. Because the Okeechobee gourd generally grows in a tangle of vines and sprawling over other vegetation, it is difficult to distinguish individual plants

to estimate a total population size. The sprawling growth habit also makes the plant vulnerable to inadvertent damage by people conducting the monitoring, so the method should minimize intrusion and disruption. A combination of condition indices may be needed, such as area covered, average leaf size, and number of fruit at each site.

S4.2. After determining the most effective methods and indices, onduct monitoring on an annual basis. In addition to monitoring of condition indices at each site, the overall distribution of sites should also be recorded. Selected individual vines should be marked to determine if they are annual or persist into the following growing season. Water stage should be recorded for each day of monitoring, noting any extremes of drought or high water. Freezes should also be noted, as they will influence the condition of the population.

S5. Increase public awareness about the Okeechobee gourd. Public awareness can be addressed through a variety of strategies, including, but not limited to, classroom programs, newspaper and magazine articles, public information displays at boat ramps in Lake Okeechobee, and outreach to fishing and airboating clubs.

Habitat-level Recovery Actions

H1. Prevent degradation of existing Okeechobee gourd habitat.

H1.1. Determine water regulation practices promoting recovery of the Okeechobee gourd, assess the implications on an ecosystem-wide scale, and make appropriate recommendations to water managers. The preference and tolerance of the species to specific water regimes must first be researched and monitored as described above. This information should be evaluated in the context of the overall ecosystem health of the lake before making water management decisions.

H1.2. Control or remove exotic vegetation in wetlands. The main species of vegetation needing control are *Melaleuca quinquenervia* and *Hydrilla verticillata.* Although crews conducting control measures must be instructed to avoid impacts on the Okeechobee gourd, adjustment of the methods, timing, and pace of control measures to accommodate the gourd are required, rather than prohibition of the control program over large areas. Since populations of the Okeechobee gourd will shift from one specific location to another from year to year, areas not treated during one year could likely be treated in the following year. This added caution will require flexibility in planning control of exotic vegetation in the general range of the Okeechobee gourd.

H1.3. Plant native trees or shrubs to replace exotics. Removal of exotic trees and shrubs in areas where the Okeechobee gourd occurs should be compensated by planting of native trees and shrubs, such as willow and pond apple, to provide potential supporting vegetation.

H1.4. Use controlled burns to open up areas of overly dense herbaceous and/or shrubby vegetation in lake littoral zones and marshes. Such actions are beneficial for a variety of fish and wildlife, not just the Okeechobee gourd, which is a pioneer species in disturbed areas. Because Lake Okeechobee is too large for practical application of scheduled extreme drawdowns, burning must take place at times of naturally occurring low water levels. If the range of the species is extended to other lakes, riverine swamps, or marshes, managed extreme drawdowns may be an effective management tool in conjunction with burning.

H1.5. Prevent cultural eutrophication of lakes and marshes. Addition of nitrogen and phosphorus from agricultural and residential areas is accelerating eutrophication of Florida's lakes and marshes, particularly Lake Okeechobee. Long-term degradation of habitat caused by eutrophication leads to buildup of organic muck, overly dense herbaceous and shrubby vegetation, and oxygen depletion. Moderate eutrophication may not harm the Okeechobee gourd, but in the long term, dense growth of vegetation will impede dispersal of seeds, germination, and growth of the Okeechobee gourd. Reduction of nutrient inputs at the source needs to be addressed by best management practices, including rates of application and stormwater retention on site. Construction and maintenance of wastewater treatment plants must be improved to control discharge of nutrients in lakes and streams.

H2. Restore areas to suitable habitat.

H2.1. Restoration of Kreamer, Torry, and Ritta islands within Lake Okeechobee was included by the Governor's Commission for a Sustainable South Florida among "40 Preferred Options" in their conceptual plan for the C&SF Restudy. The FWS is unaware of any existing design criteria for restoration of these islands. Any proposal to restore these islands must consider the present habitat conditions for the Okeechobee gourd, fish, and wildlife, relative to proposed future conditions, before claiming any net benefits. Levels of contaminant residues in the soil from historic agricultural activities must be determined prior to any plan for earth movement.

H2.2. Restoration of the Kissimmee River (as presently proposed, or with inclusion of the Paradise Run segment) will affect any attempt to translocate the Okeechobee gourd to the Kissimmee floodplain. Selection of potential translocation sites must account for anticipated conditions following restoration, and monitoring of the Okeechobee gourd would be added to the monitoring program established for the restoration project.

H3. 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. The principal herbicides used in control of *Hydrilla* are SONAR (fluridone) and AQUATHOL K (dipotassium endothall). Rodeo (glyphosate) is occasionally used to control dense growths of emergent vegetation, such as cattails. The acute toxicity of each of these chemicals to the Okeechobee gourd must be determined; since fluridone is used in greater quantity and repeatedly at the same sites, its long-term toxicity to a variety of plants and animals should also be determined.

H4. Monitor habitat/ecological processes. The SFWMD, GFC, and other agencies have well-established research and monitoring activities in Lake Okeechobee. These existing efforts need to be modified or expanded to conform with the adaptive assessment strategy that will be required for the C&SF Restudy. Prior research and monitoring has included a broad range of parameters, including vegetation of the littoral zone, fish, benthic invertebrates, wading birds, phytoplankton, and water chemistry. Continued monitoring of wetland vegetation in the littoral zone of Lake Okeechobee is particularly relevant to recovery of the Okeechobee gourd. This should include assessment of the influence of dominant stressors, such as water regulation and fire, on the emergent plant communities of the littoral zone.

H5. Increase public awareness of ecological relationships, environmental stressors, and restoration activities in the South Florida Ecosystem. Among the themes of significance to

the Okeechobee gourd are the ecological and economic importance of natural resources in the littoral zone of Lake Okeechobee and awareness of the environmental issues associated with protection of the littoral zone. These issues involve a balance of potentially competing interests, including water supply, flood control, recreation, biodiversity, and productivity of the ecosystem. Information on the Okeechobee gourd's status, threats, and its ecological relationship with other species should be integrated in public education on restoration activities. Public outreach can include newsletters, newspapers, magazines, the worldwide web, and classroom materials.