Recovery Outline For

*Consolea corallicola* (Florida semaphore cactus)

August 2013

I. INTRODUCTION

This document outlines a preliminary course of action for the recovery of the *Consolea corallicola* (Florida semaphore cactus) until a comprehensive recovery plan for the species is approved.

*Consolea corallicola* is a tree-like cactus; mature plants grow 2 meters (m) (6 feet (ft)) tall with an erect main trunk, which is armed with spines. The stem branches (pads) are green, and the flowers are bright red and 1.3 to 1.9 centimeters (cm) (0.50 to 0.75 inches (in)) wide, and the fruits are yellow, egg-shaped, and 2.5 to 5.1 cm (1 to 2 in) long. This cactus occurs only in a few limited areas within the Florida Keys. Habitats that support *C. corallicola* include coastal berm, coastal rock barren, rockland hammock, and buttonwood forest.

*Consolea corallicola* was listed as an endangered species on October 24, 2013 (78 FR 63795). The primary threats to this plant include extreme curtailment of its habitat and range, habitat destruction, modification and fragmentation, small populations, illegal collection, competition from nonnative plants, and its resulting vulnerability to natural or human induced catastrophic events (e.g., hurricanes, storm surge).

**Listing and Contact Information:**

- **Listing Classification:** Endangered range-wide
- **Effective Listing Date:** November 25, 2013
- **Lead Agency, Region:** U.S. Fish and Wildlife Service, Southeast Region
- **Lead Field Office:** South Florida Ecological Services Field Office
- **Contact Biologist:** Dave Bender, 772-562-3909, David_Bender@fws.gov

II. RECOVERY STATUS ASSESSMENT

A. Biology/Threats Assessment

[Note: For a more detailed description of this cactus’ biology and an assessment of the listing factors as they relate to this plant, please see the Proposed Rule to List Chromolaena frustrata, *Consolea corallicola* and *Harrisia aboriginum* (77 FR 61836) published on October 11, 2012.]

*Consolea corallicola* is extirpated from half of the islands where it occurred in the Florida Keys, and threats of poaching, predation by the introduced *Cactoblastis cactorum* (Lepidoptera: Pyralidae) moth, competition from nonnative plant species, and habitat loss still exist in the remaining populations.
The current range of *C. corallicola* includes two naturally occurring populations, one in Biscayne National Park (BNP; Miami-Dade County) and one on Little Torch Key, a small island in the lower Florida Keys, at the Torchwood Hammock Preserve, owned by The Nature Conservancy (TNC; Monroe County) (Bradley and Gann 1999; Bradley and Woodmansee 2002). These naturally occurring populations account for fewer than 1,000 plants. As of 2013, *C. corallicola* is extant at four reintroduction sites on State-owned lands: Dagny Johnson Key Largo Hammocks State Botanical Park, Dove Creek Hammock, Florida Keys Wildlife and Environmental Area, Saddlebunch Key, and Upper Sugarloaf Key (Stiling 2007; Stiling 2009, pers. comm.; Stiling 2010; Stiling 2013; Stiling pers. com. 2013; Duquesnel 2008, 2009, 2011a, b, pers. comm.).

TABLE 1. Current and historical populations of *Consolea corallicola*.

<table>
<thead>
<tr>
<th>Population</th>
<th>Ownership</th>
<th>Size</th>
<th>Habitat</th>
<th>Threats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swan Key, Biscayne National Park</td>
<td>Federal – National Park Service</td>
<td>600 (McDonough 2010, pers. comm.)</td>
<td>rockland hammock</td>
<td>Stable</td>
</tr>
<tr>
<td>Little Torch Hammock Preserve, Little Torch Key</td>
<td>Private – The Nature Conservancy</td>
<td>9 to 11 adults, 100s of juveniles (Gun 2012, pers. comm.)</td>
<td>rockland hammock, rockland hammock–buttonwood forest ecotone</td>
<td>Declining</td>
</tr>
<tr>
<td>Dagny Johnson Key Largo Hammock State Botanical Park (reintroduced)</td>
<td>State – Florida Department of Environmental Protection</td>
<td>20 – 40 juveniles (Duquesnel 2013, pers. comm.)</td>
<td>buttonwood forest–saltmarsh ecotone, coastal rock barren</td>
<td>Declining</td>
</tr>
<tr>
<td>Upper Sugarloaf Key (reintroduced)</td>
<td>State – Florida Fish and Wildlife Conservation Commission</td>
<td>11 juveniles (Stiling pers. comm. 2013)</td>
<td>unknown</td>
<td>Declining</td>
</tr>
<tr>
<td>Dove Creek Hammock – Key Largo (reintroduced)</td>
<td>State – Florida Fish and Wildlife Conservation Commission</td>
<td>238 juveniles (Stiling pers. comm. 2013)</td>
<td>buttonwood forest, rockland hammock</td>
<td>Recent reintroduction</td>
</tr>
<tr>
<td>Saddlebunch Key (reintroduced)</td>
<td>State – Florida Fish and Wildlife Conservation Commission</td>
<td>4 juveniles (Stiling pers. comm. 2013)</td>
<td>unknown</td>
<td>Declining</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>----------------------------------------------------------</td>
<td>----------------------------------------</td>
<td>---------</td>
<td>-----------</td>
</tr>
<tr>
<td>Big Pine Key</td>
<td>unknown</td>
<td>unknown, coastal berm</td>
<td>Extirpated 1970s (Bradley and Gann 1999)</td>
<td></td>
</tr>
<tr>
<td>Key Largo</td>
<td>unknown</td>
<td>unknown</td>
<td>Extirpated 1970s (Bradley and Gann 1999)</td>
<td></td>
</tr>
</tbody>
</table>

Sexual reproduction has not been observed in *Consolea corallicola*. All documented reproduction has been vegetative (clonal), with new plants originating from pads that fall from larger plants and take root (Negrón-Ortiz 1998). Survival rates of fallen pads in research populations are low due to rot and *Cactoblastis* moth damage (Stiling 2010). Production of seeds is rare and the few seeds that have been observed are thought to be the product of asexual seed reproduction (agamospermy) (Negrón-Ortíz 1998). Two hypotheses have been suggested to explain the lack of seed production of *C. corallicola*. The genetic hypothesis is that the species is a sterile polyploid (abnormal cell division that results in more than two sets of chromosomes) (Negrón-Ortíz 1998). An alternative hypothesis is the dioecious breeding system of *C. corallicola*. Plants are functionally dioecious (i.e., with male and female flowers on separate plants), although the flowers give the appearance of a species that is hermaphroditic with perfect flowers (i.e., each flower produces stamens and ovules) (Negrón-Ortíz and Strittmatter 2004; Negrón-Ortíz 2007a; 2007b). All plants in the known populations produce only male flowers, and no female individuals have ever been located. As a result, all existing occurrences of *C. corallicola* appear to be incapable of sexual reproduction at this time (Negrón-Ortíz and Strittmatter 2004).

Cariaga et al. (2005) found no genetic diversity within the two remaining wild populations of *Consolea corallicola* and concluded that all plants within each population are likely derived clonally from a single parent plant. These data support asexual propagation as the reproductive strategy of *C. corallicola*. However, there may be a small amount of variation between the two remaining wild populations, suggesting the possibility that they originated from different parent plants (Lewis 2007). Likewise, Cariaga et al. (2005) found that a single plant collected by George Avery in 1963 from Big Pine Key and maintained at Fairchild Tropical Botanical Gardens was a unique genotype, but Lewis (2007) found it to be identical to the plants from the other populations. Thus, *C. corallicola* has extremely limited genetic diversity, consisting of just one to three genetic lines.

Destruction and modification of habitat from development throughout the species’ range continue to threaten *Consolea corallicola*. Unoccupied suitable habitat throughout the species’ former range is under intense development pressure. Development and road building were the causes of this species’ original extirpation on Big Pine Key (Bradley and Gann 1999; Bradley and Woodmansee 2002). Both
remaining wild populations are secure from habitat destruction because they are located within private and Federal conservation areas.

Collecting by cactus hobbyists is suspected to have played a part in the extirpation of *Consolea corallicola* from Big Pine Key and Key Largo in the late 1970s (Bradley and Gann 1999), and poaching remains a major threat to this species (Gann *et al.* 2002). Other species of *Consolea* are currently offered for sale by online plant distributors. Vandalism was observed at a site in Monroe County on multiple occasions, and caused the death of one *C. corallicola* plant (Slapcinsky *et al.* 2006). Although the remaining populations are somewhat protected due to their location on conservation lands, these plants remain vulnerable to illegal collection because the sites are remote and not patrolled regularly by enforcement personnel.

Predation by the moth *Cactoblastis cactorum* is considered a significant threat to *Consolea corallicola* (Stiling *et al.* 2000; Gann *et al.* 2002; Wright and Maschinski 2004; Grahl and Bradley 2005; Slapcinsky *et al.* 2006). Adult moths deposit eggs on the branches of host species. When these eggs hatch, larvae then burrow into the cacti and feed on the inner tissue of the plant’s stems. The larvae then pupate, and the cycle repeats. A fungal pathogen, *Fusarium oxysporum*, can infect *C. corallicola*, causing crown rot, a disease in which plants rot near their base (Slapcinsky *et al.* 2006; Stiling 2010). Unauthorized burning, invasive nonnative species, and occasional freezing temperatures are also threats to *C. corallicola*.

Hurricanes and their associated storm surge can modify habitat and have the potential to destroy entire populations of *C. corallicola*. Climate change may lead to increased frequency and duration of severe storms (Golladay *et al.* 2004; McLaughlin *et al.* 2002; Cook *et al.* 2004). *C. corallicola* experienced these disturbances historically, but had the benefit of more abundant and contiguous habitat to buffer them from extirpations. With most of the historical habitat having been destroyed or modified, the few remaining populations could face local extirpations due to stochastic events. Suitable habitat such as coastal rock barrens on Key Largo have been inundated with saltwater during spring and fall high tides over the past 5 to 10 years; these extreme events killed planted *C. corallicola* at one location (Duquesnel 2011a, pers. comm.). The storm surge associated with Hurricane Wilma in 2005 killed 18 of 41 plants (43.9 percent) at one reintroduction site (Stiling pers. comm. 2012). The ecology of coastal rock barrens is poorly understood; periodic storm events may help to maintain the community (Bradley and Gann 1999). There is some evidence that, over the long term, periodic hurricanes can be beneficial to *Consolea corallicola* by opening up tree canopies in hammock and coastal berm, allowing more light to penetrate, thereby creating the necessary conditions for growth.

*Consolea corallicola* occurs in habitats near sea level in areas of south Florida where considerable habitat is projected to be lost to sea level rise by 2100 (Saha *et al.* 2011; Zhang *et al.* 2011). Most populations are located less than 2 m (6.6 ft) above mean sea level, and the effects of sea level rise are expected to be a continual problem for *C. corallicola* and its habitats (Gann *et al.* 2002; Bradley *et al.* 2004; Sadle 2007, pers. comm.; Higgins 2007, pers. comm.; Duquesnel 2008, pers. comm.; Saha *et al.* 2011). Under the Intergovernmental Panel on Climate Change (IPCC) worst case, high pollution scenario, a rise of 59 cm (23.2 in) would result in the inundation of 46,539 hectares (ha) (115,000 acres (ac)) or 74.7 percent of the Florida Keys upland area by the year 2100 (TNC 2011). Using Rahmstorf *et al.* (2007) sea level rise projections of 100 to 140 cm (x-x in), 80.5 to 92.2 percent of the Florida Keys would be inundated by 2100. The Zhang *et al.* (2011) study models sea level rise up to 1.8 m (5.9 ft) for the Florida Keys, which would inundate 93.6 percent of the Keys. A 1.8 m (5.9 ft) sea level rise would completely inundate Little Torch Key and severely reduce the area of habitat remaining on Swan Key, including all areas currently supporting *C. corallicola*. In 2100, the nearest upland habitats from Little Torch Key may be as far as 100 miles north in peninsular Florida, or 100
miles south in Cuba. On Swan Key, the species may be able to disperse to the remaining higher ground, and the location could continue to support a population given a 1.8 m (5.9 ft) sea level rise.

Prior to inundation, the habitats that support *Consolea corallicola* will undergo a transition to salt marshes or mangroves (Saha *et al.* 2011) and be increasingly vulnerable to storm surge. These habitats are restricted to relatively immobile geologic features separated by large expanses of flooded, inhospitable wetland or ocean, leading us to conclude that these habitats will likely not be able to migrate as sea level rises (Saha *et al.* 2011). Because of the extreme fragmentation of remaining habitat and isolation of remaining populations, and the accelerating rate at which sea level rise is projected to occur (Grinsted *et al.* 2010) it will be particularly difficult for *C. corallicola* to disperse to suitable habitat once existing sites that support the species are lost to sea level rise. Patterns of development will also likely be significant factors influencing whether natural communities can move and persist (IPCC 2008; CCSP 2008). The plant species faces significant risks from coastal squeeze that occurs when habitat is pressed between rising sea levels and coastal development that prevents landward migration of species. The ultimate effect of these impacts is likely to result in reductions in reproduction and survival, and corresponding decreases in population numbers. The long-term future for *C. corallicola* may depend on natural or assisted migration to suitable habitat areas outside the species’ historical range, if at that time the Service determines that it is essential to the conservation of the species to do so.

**B. Conservation Actions**

*Consolea corallicola* was first recognized as a candidate species (under the species’ former name *Opuntia spinosissima*) in 1985 (50 FR 39526). It was removed from the candidate list from 1996 to 1998 because there was not sufficient information on the species’ biological vulnerability and threats to support issuance of a proposed rule. In 1999 (64 FR 57534), the Service included *C. corallicola* (under the species’ previous name *Opuntia corallicola*) again as a candidate for listing under the Act. We determined that listing was warranted, but was precluded. Throughout this timeframe, the Service has worked closely with scientific experts, land managers, and stakeholders to implement actions that will help ensure survival and long-term recovery of this cactus. *C. corallicola* is State-listed (as *Opuntia corallicola*) as endangered under Chapter 5B-40, Florida Administrative Code.

For 20 years, the Service has engaged the State of Florida (Florida Department of Agriculture and Consumer Services (FDACS), Florida Natural Areas Inventory (FNAI)), NGOs (TNC), the National Park Service (NPS, BNP), and researchers at botanical gardens and universities (University of South Florida (USF)) to locate extant populations of *Consolea corallicola*, identify remaining suitable habitats, and implement reintroductions. FDACS has conducted research and restoration through section 6 funding. USF has conducted significant research and reintroduction efforts. To date, these collaborative efforts have focused largely on 1) conducting comprehensive surveys of historic locations; 2) conducting life history research including reproductive biology and impacts of disease; 3) evaluating techniques to accurately and safely monitor extant populations; 4) improving techniques to grow *C. corallicola* in cultivation, to better ensure success in any future reintroduction efforts; 5) monitoring of the populations to remove threats, including *Cactoblastis* moth larvae; and 6) increasing public awareness of the species.

Fairchild Tropical Botanic Garden (FTBG) and Key West Botanical Garden (KWBG) maintain *C. corallicola* in their living collections. *Ex situ* conservation is critical to the overall recovery strategy for *C. corallicola* because living collections and seed banking provide backup for genetic diversity that may be lost in the wild due to threats or natural occurrences. FTBG has 11 accessions of *C. corallicola*, representing both wild populations, each of which is represented by at least 1 living specimen of at FTBG, totaling 17 living specimens. KWBG has one accession of *C. corallicola*
represented by several living specimens (Maschinski pers. comm. 2013a, b). These cacti are easily propagated from detached pads and grow readily in cultivation.

III. PRELIMINARY RECOVERY STRATEGY

A. Recovery Priority Number with Rationale

*Consolea corallicola* is assigned a recovery priority of 5, which indicates the species faces a high degree of threat, but a low recovery potential. Recovery potential is considered low for *C. corallicola* because the species has been reduced to only a few small populations and attempts to reintroduce the cactus to areas of its historic range have so far been unsuccessful.

B. Recovery Strategy

Because of the very restricted range of *Consolea corallicola*, our initial recovery strategy will be to maintain and protect the known populations in the Florida Keys and BNP. This will include working with partners to understand the natural history, population dynamics, and habitat needs of the species. It will involve continued monitoring of these populations with the help of other agencies to protect against threats such as the *Cactoblastis* moth and poaching. We are currently working to establish an effective method to successfully reintroduce the cactus to appropriate habitat in the Florida Keys. These efforts will include creation of a rigorous post-introduction monitoring protocol designed to evaluate factors influencing reintroduction failure or success. With agency (FDACS, NPS), educational institutions, and non-government partners, we will continue to conduct life history research, surveys of all historic locations, and evaluation of management techniques of known sites. In addition, known and historic locations will be examined in an attempt to continue to identify factors contributing to the decline of the cactus. We will continue to work with our partners to protect, restore, and enhance appropriate habitat on conservation lands throughout the current and historic range. We will expand our efforts to increase public awareness of *C. corallicola* and other imperiled cacti unique to South Florida that we are working to recover.

Survival of *Consolea corallicola* now depends on protecting the species’ occupied and suitable habitat from further degradation and fragmentation; restoring potentially suitable habitat within its historical range; evaluating and reducing threats from nonnative species, accidental harm from humans; increasing the current population in size; reducing the threats of illegal collection; conserving genetic diversity; and, likely, establishing populations at additional locations.

C. Initial Action Plan

*Anticipated Recovery Actions in relation to our recovery strategy described above:*

1. Work with partners to increase vigilance and enforcement of regulatory mechanisms;
2. Enhance the suitability of known sites and potential reintroduction/translocation sites;
3. Examine historic and active locations to identify possible factors that contributed to the decline of *Consolea corallicola* and reduce threats where possible to increase the likelihood of natural recolonization;
4. Establish intensive *Cactoblastis* moth monitoring programs for Swan Key and Little Torch Key;
5. Work with State (FDACS, Division of Plant Industry) and Federal partners (U.S. Department of Agriculture, Animal and Plant Health Inspection Service) to develop and implement techniques to control the *Cactoblastis* moth.
6. Increase *ex situ* holdings to include broader sample of individuals from Swan Key;
7. Conduct studies of the *Consolea corallicola*’s life history (including pollination biology, potential for sexual reproduction);
8. Establish methods to effectively reintroduce and monitor cacti;
9. Remove or reduce exotic nonnative vegetation and prevent its establishment on islands currently or historically occupied by *Consolea corallocola*;
10. Continue to coordinate with State and Federal agencies in south Florida to promote plant recovery and find innovative ways to increase public awareness of our rare cacti conservation efforts.

IV. PREPLANNING PROCESS

We will prepare a recovery plan for *Consolea corallocola* that includes objective and measurable criteria which, when met, will ensure the conservation of the species. Recovery criteria will address all meaningful threats, as well as estimate the time and the cost to achieve recovery. The recovery planning effort will be led by the South Florida Ecological Services Field Office in coordination with the Florida Keys National Wildlife Refuges Complex. The Service anticipates writing the recovery plan for *C. cor Allocola*. The draft recovery plan should be finalized and sent to the Regional Office for review in March 2015. The final recovery plan should be finalized and sent to the Regional Office for review by December 2015. These timelines may be affected by available resources and regional priorities.

During the recovery planning process, input, comments and review will be sought from multiple stakeholders within the State of Florida. These will include State, Federal and local agencies, industrial and agricultural groups, universities, conservation organizations and others. Many of these stakeholders are currently cooperating in on-going conservation efforts for *Consolea corallocola*. Primary authorship of the Recovery Plan will be the responsibility of Service staff, though State partners will be heavily involved in all phases of the planning and implementation processes. Throughout the listing process, we worked closely with our State (FDACS) and Federal (NPS) partners regarding possible conservation efforts, as well as the need for timely consultations between Federal agencies in the event of future actions which might affect *C. cor Allocola*.

Approve: ___________________________  Date: 8/27/13

*Acting* Assistant Regional Director, Region 4
REFERENCES CITED


Duquesnel, J. 2013 Email to Dave Bender. Florida Department of Environmental Protection. April 24, 2013.


