

**A Species Action Plan for the
Lower Keys Population of the Florida Brown Snake
(*Storeria victa*)**

**Final Draft
November 1, 2013**



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EXECUTIVE SUMMARY

The Florida Fish and Wildlife Conservation Commission developed this plan in response to the determination that the Florida brown snake (Lower Keys population) (*Storeria victa*) be maintained as a Threatened species on the Florida Endangered and Threatened Species List. The goal of this plan is to improve the conservation status of the Lower Keys population of the Florida brown snake to the point that the species is secure within its historical range.

Three objectives are outlined in this plan. The first objective is to maintain the area of occupancy and extent of occurrence of the Florida brown snake in the Lower Keys. The second objective is to maintain or improve the size and quality of habitat available for the Florida brown snake in the Lower Keys. The third objective is to improve conservation of the Lower Keys population of the Florida brown snake until the species exceeds 10,000 mature snakes with at least 1 known location supporting more than 1,000 individuals.

There are 2 high-priority actions for these objectives. This first is to acquire, restore, conserve, and manage as much suitable habitat as possible. The second is to continue the removal of non-native species.

This plan details the actions necessary to improve the conservation status of the Florida brown snake. A summary of this plan will be included in the Imperiled Species Management Plan (ISMP), in satisfaction of the management plan requirements in Chapter 68A-27, Florida Administrative Code, Rules Relating to Endangered or Threatened Species. The ISMP will address comprehensive management needs for 60 of Florida's imperiled species and will include an implementation plan; rule recommendations; permitting standards and exempt activities; anticipated economic, ecological, and social impacts; projected costs of implementation and identification of funding sources; and a revision schedule. The imperiled species management planning process relies heavily on stakeholder input and partner support. This level of involvement and support is also critical to the successful implementation of the ISMP. Any significant changes to this plan will be made with the continued involvement of stakeholders.

TABLE OF CONTENTS

FLORIDA BROWN SNAKE ACTION PLAN TEAM ii
EXECUTIVE SUMMARY iii
LIST OF TABLES v
LIST OF FIGURES vi
GLOSSARY OF TERMS AND ACRONYMS..... vii
INTRODUCTION 1
 Biological Background..... 1
 Conservation History..... 3
 Threats and Recommended Listing Status 3
CONSERVATION GOALS AND OBJECTIVES 7
CONSERVATION ACTIONS 9
 Habitat Conservation and Management 9
 Population Management..... 11
 Monitoring and Research 11
 Law Enforcement 14
 Incentives and Influencing 15
 Education and Outreach 15
 Coordination with Other Entities 16
LITERATURE CITED 19

LIST OF TABLES

Table 1. Conservation Action Table 17

LIST OF FIGURES

Figure 1. Typical hardwood hammock habitat of the Florida brown snake (Lower Keys population)..... 1
Figure 2. Locality records from the Florida Museum of Natural History and the Florida Natural Areas Inventory for the Florida brown snake in the Lower Keys..... 2

GLOSSARY OF TERMS AND ACRONYMS

Area of Occupancy: The area within its extent of occurrence (see Extent of Occurrence), which is occupied by a taxon, excluding cases of vagrancy. This reflects the fact that a taxon will not usually occur throughout the area of its extent of occurrence, which may contain unsuitable or unoccupied habitats (as defined by the International Union for Conservation of Nature [IUCN]).

BRG: Biological review group, a group of taxa experts convened to assess the biological status of taxa using criteria specified in Rule 68A-27, Florida Administrative Code, and following the protocols in the Guidelines for Application of the IUCN Red List Criteria at Regional Levels (Version 3.0) and Guidelines for Using the IUCN Red List Categories and Criteria (Version 8.1).

BSR: Biological status review report, the summary of the biological review group's findings. Includes a Florida Fish and Wildlife Conservation Commission (FWC) staff recommendation on whether or not the species status meets the listing criteria in Rule 68A-27.001, Florida Administrative Code. These criteria, based on IUCN criteria and IUCN guidelines, are used to help decide if a species should be added or removed from the Florida Endangered and Threatened Species List. In addition, FWC staff may provide within the report a biologically justified opinion that differs from the criteria-based finding.

Endemic: Found only in a particular locality or region.

Extent of Occurrence: The geographic area encompassing all observations of individuals of a species, including intervening areas of unoccupied habitat. Synonymous with range. See Also Area of Occupancy (as defined by IUCN).

F.A.C.: Florida Administrative Code. The Department of State's Administrative Code, Register and Laws Section is the filing point for rules promulgated by state regulatory agencies. Agency rulemaking is governed by Chapter 120, Florida Statutes, the Administrative Procedures Act. Rules are published in the Florida Administrative Code.

FLMNH: Florida Museum of Natural History

FKE: Florida Keys Ecosystem

FKWEA: Florida Keys Wildlife and Environmental Area

FNAI: Florida Natural Areas Inventory

F.S.: Florida Statutes

FWC: The Florida Fish and Wildlife Conservation Commission, the state agency constitutionally mandated to protect and manage Florida's native wildlife species.

GIS: Geographic Information System

ISMP: Imperiled Species Management Plan

IUCN: International Union for Conservation of Nature, a professional global conservation network

IUCN Red List (IUCN Red List of Threatened Species): An objective, global approach for evaluating the conservation status of plant and animal species, the goals of which are to: Identify and document those species most in need of conservation attention if global extinction rates are to be reduced; and provide a global index of the state of change of biodiversity.

Less-than-fee acquisition: The acquisition of limited property rights by an outside entity on lands owned by a landowner, usually through a written contract. Less-than-fee acquisitions can occur through direct purchase of specified and agreed upon rights by the outside entity, or through donation of those rights by the landowner. Examples of less-than-fee acquisitions include the purchase/donation of easements, leases, limited use permits, cooperative agreements, etc.

NWR: National Wildlife Refuge

SLAMM: Sea Level Affecting Marshes Model

Tropical hardwood hammock: Also called rockland hammock, is a highly diverse upland forest rich in rare and endemic plant and animal species. The forest floor is mostly covered with a thin layer of well-drained organic soil and leaf litter. Exposed limestone and solution holes are common. Over 120 species of native trees and shrubs can be found in tropical hardwood hammocks along with a number of rare epiphytes, cacti and herbaceous plants. Many of the plant species are also native to the Bahamas, the West Indies, and the Yucatan peninsula, and most occur in Florida at the northern limit of their range. Typical canopy trees include gumbo limbo (*Bursera simaruba*), wild tamarind (*Lysiloma latisiliquum*), pigeon plum (*Coccoloba diversifolia*), strangler fig (*Ficus aurea*), Jamaican dogwood (*Piscidia piscipula*), poisonwood (*Metopium toxiferum*), and West Indies mahogany (*Swietenia mahagoni*). In the continental United States, remaining tropical hardwood hammock only occurs in southern Florida, where it is restricted to coastal areas of southern Miami-Dade County, the Florida Keys, and a small area of Big Cypress National Preserve in Monroe and Collier counties.

INTRODUCTION

Biological Background

Taxonomy

This plan is for the Lower Keys population of the Florida brown snake (*Storeria victa*). Although Christman (1980) presented evidence suggesting the Florida brown snake (Hay 1892) warranted status as a distinct species, it was generally considered a subspecies of the brown snake (*Storeria dekayi*) until Crother (2000) concurred with Christman. The herpetological community has yet to completely accept this distinction. Christman (1980) found that most snakes in peninsular Florida have 15 instead of 17 dorsal scale rows at the mid-body; 2 instead of 3 preocular scales on each side of the head; and the wider end of the dark, tear-shaped blotch on the temporal scale directed anteriorly. Duellman and Schwartz (1958) noted an observable resemblance in ventral and sub-caudal counts between brown snakes from the Lower Keys and northern Florida, and Christman (1980) found a similar phenomenon of preocular counts and ventral dark coloration. The fact that Florida brown snakes in the Keys are more similar to brown snakes in northern Florida, not the nearer mainland population, is evidence of the distinctiveness of the Lower Keys population. Duellman and Schwarz (1958) and Christman (1980) contend that the Lower Keys were once connected to the central Florida mainland when the Upper Keys were still submerged. When southern Florida and the Upper Keys later emerged, they were colonized by populations from the north and diverged from the original stock, many of whose characteristics have been retained by populations of some reptile species on the isolated Lower Keys. Christman (1980) suggested that the Lower Keys population could be assigned sub-specific status (this has not occurred) because it is differentiated even less than peninsular snakes. The Lower Keys population is likely representative of an ancient genetic lineage that differs from mainland populations, making it sufficiently distinct to warrant listing.

Life History

In the Lower Keys, brown snakes are more terrestrial than their mainland counterparts (Weaver et al. 1992), which are rarely found far from water (Carr 1940, Gibbons and Dorcas 2005). Lazell (1989) found them regularly in hardwood hammocks (Figure 1) on Middle Torch Key. He found them most often where there was “no open fresh water.” However, in records of the Florida Natural Areas Inventory (FNAI), snakes were found in hardwood hammocks containing freshwater and brackish marshes or very small freshwater ponds. This species is tolerant of some habitat disturbance and has been found in an old suburban development on Little Torch Key (FNAI 2011). Snakes in Everglades National Park gave birth from June through September to 6 to 13 young (Dalrymple et al. 1991). Florida brown snakes are



Figure 1. Typical hardwood hammock habitat of the Florida brown snake (Lower Keys population). Photograph by Randy Grau, FWC.

primarily nocturnal and have been found crossing roads at night in the Keys (Lazell 1989, Weaver et al. 1992). Slugs and earthworms are the most common prey, but snakes, insects, isopods, spiders, and small fish and amphibians are sometimes eaten (Ernst and Ernst 2003).

Description

The Florida brown snake is a small snake with a maximum length of around 30.5 cm (12 in). Their overall color is brown, as the name implies, although some specimens are olive colored. There is often a light mid-dorsal stripe flanked by a row of dark spots on either side. The Florida brown snake is distinguished from Dekay’s brown snake (*Storeria dekayi*) by the number of ventral scale rows present. The Florida brown snake has 15 ventral scale rows whereas Dekay’s brown snake has 17. The head is darker than the body, and a light white or cream neck band is usually present, even in adults (Bartlett and Bartlett 2003, Ernst and Ernst 2003).

Geographic Range

The Florida brown snake ranges from extreme southeastern Georgia to the Florida Keys. In the Lower Keys, brown snakes have been found on Big Pine, Little Torch, Middle Torch, No Name, and Sugarloaf keys (Duellman and Schwartz 1958, Lazell 1989, Weaver et al. 1992, (Florida Museum of Natural History [FLMNH] 2011 and FNAI 2011) (Figure 2). In the Upper Keys, there are records from Key Largo and Upper Matecumbe Key (FLMNH 2011).

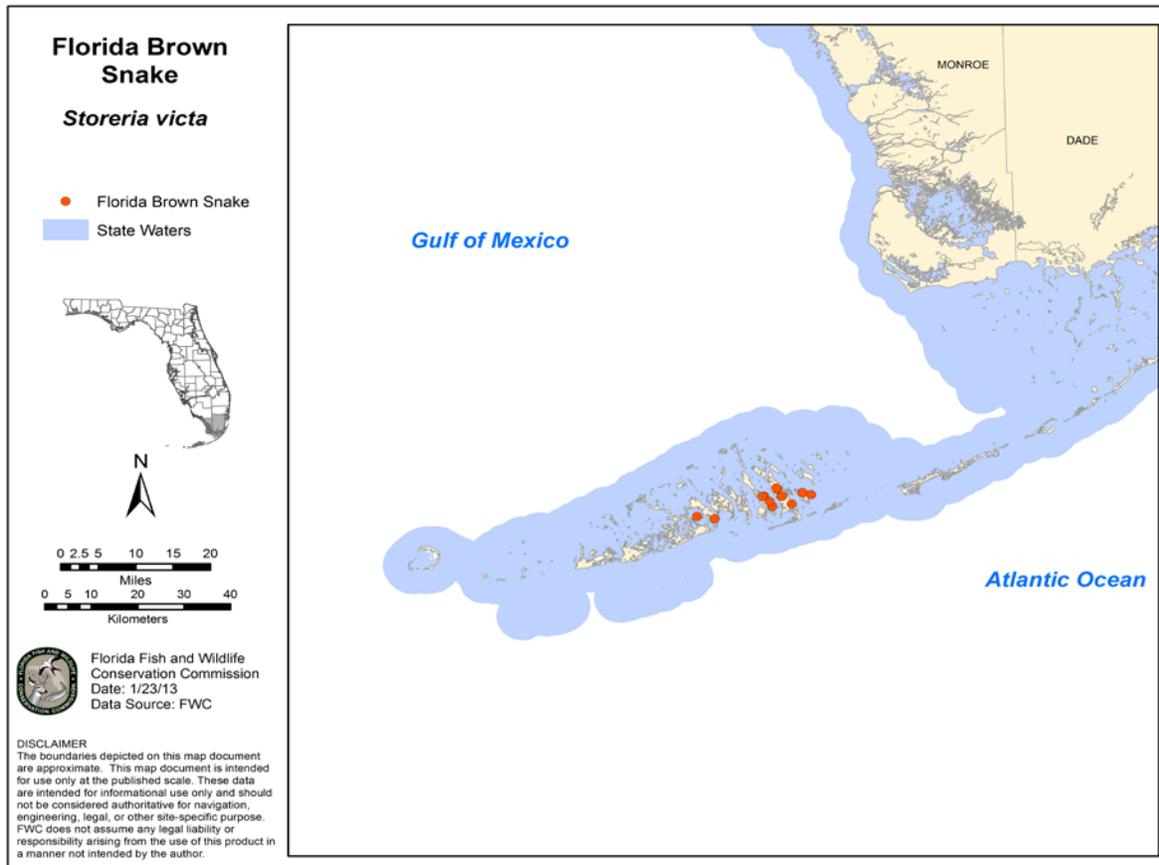


Figure 2. Locality records from FLMNH and FNAI for the Florida brown snake in the Lower Keys. Specific localities are from Krysko et al. (2011).

Conservation History

The State of Florida listed the Lower Keys population of Florida brown snakes as a Threatened species in 1975. This listing prohibited take without a permit. Through the Florida Forever land acquisition program and its predecessors, the state has acquired significant tracts of native habitat throughout the Florida Keys supporting numerous imperiled species, including the Florida brown snake Lower Keys population. There are currently 2 active Florida Forever projects in the Lower Keys. The Coupon Bight Key Deer project located on Big Pine Key and No Name Key was approved in 1985, and as of February 2012, 6.9 km² (2.7 mi²) of the total 13.5-km² (5.2-mi²) project have been acquired. The largest project, the Florida Keys Ecosystem (FKE) was created in 1995 by combining 2 existing projects, the Hammocks of the Lower Keys and Tropical Flyways. These projects were created in 1991 and 1992 under the sponsorship of The Nature Conservancy and the National Audubon Society to preserve disappearing tropical hardwood hammocks, imperiled plant and animal species, and to protect critical foraging and resting habitat for numerous migratory bird species. In 2004, the Florida Fish and Wildlife Conservation Commission (FWC) and the United States Fish and Wildlife Service (USFWS) co-sponsored a major expansion of the FKE project in the Lower Keys, which resulted in a major acquisition of habitat for Keys species. Additional amendments since 2005 by multiple sponsors have brought the entire acreage of the FKE project to 52.9 km² (20.4 mi²). As of February 2012, 18.2 km² (7 mi²) of the FKE has been placed in public ownership leaving 34.7 km² (13.4 mi²) remaining to be acquired. FWC manages the majority of the FKE lands as the Florida Keys Wildlife and Environmental Area (FKWEA). With the exception of several significant parcels acquired by donation, the entire FKWEA consists of lands purchased under Florida Forever.

Threats and Recommended Listing Status

Habitat Loss and Fragmentation

Clearing of hammocks and areas around wetlands has likely eliminated Florida brown snakes from some areas, particularly if snakes are restricted to habitats near sources of fresh water surrounded by grassy and shrubby vegetation. However, populations may persist in areas where the landscape has been cleared and left vacant to undergo ecological succession, especially where freshwater sources remain. Vehicle-caused mortality removes adults from the population, as indicated by literature, museum, and FNAI records (Paulson 1968, Lazell 1989; FLMNH and FNAI records). Besides direct mortality, roads fragment snake populations, making them more vulnerable to extinction through the reduction of genetic diversity (Jochimsen et al. 2004). With its dense network of roads, Big Pine Key may be a prime area for vehicle-caused mortality. The Florida brown snake was the most commonly killed snake species on a highway crossing Paynes Prairie in northern Florida (Dodd et al. 2004).

Sea Level Rise and Hurricanes

Florida brown snakes and their prey, especially amphibians, are probably impacted by storm surges that increase the salinity of freshwater wetlands. Their persistence indicates that they are either resistant to or recover from storm surges. The level of storm surge required to extirpate these species is unknown. Hurricanes and associated seawater surges and short-term flooding of upland habitats in the Keys may kill some snakes and their prey. For example, after Hurricane Georges, a Category 2 hurricane, 4 of 15 monitored freshwater holes in the Lower Keys had salinities > 15 parts per thousand from the storm surge; some remaining months later (Lopez et

al. 2004). A stronger storm (i.e., greater than Category 3) would have a greater impact due to stronger winds and greater storm surge. A storm surge of 4 m (13 ft) would result in the complete submersion of Big Pine Key and No Name Key, which together provide about 51% of the 276 freshwater sources for the Key Deer (*Odocoileus virginianus clavium*) and presumably for the Florida brown snake (Lopez et al. 2004). In 2005, Hurricane Wilma (Category 3) passed just north of the Florida Keys, causing 2 storm surges. The second storm surge caused maximum storm tides 1.5 to 1.8 m (5 to 6 ft) above mean sea level in Key West, flooding approximately 60% of the city. Hurricane Wilma caused a storm surge of 1.5 to 2.4 m (5 to 8 ft) on Boca Chica and Big Pine keys (Kasper 2007). Although the species has survived many hurricanes, severe saltwater overwash from very large storms has the potential to increase salt content of freshwater and brackish ponds to an extent that would eliminate them as suitable habitat. Sea level rise will increase the maximum high tides and will likely exacerbate the effects of storms surges (Florida Oceans and Coastal Council 2009), which would probably have greater impacts to this species.

Climate change and associated sea level rise present exceptional challenges to vulnerable species in the Florida Keys. Globally, sea level is rising at an increasing rate (Florida Oceans and Coastal Council 2009). Sea level rose in Key West approximately 22.25 cm (8.76 in) between 1913 and 2006, a rate of about 2.24 mm (0.04 in) per year. This rate appears to be increasing, according to trend analyses by the National Oceanic and Atmospheric Administration (2013). While sea level rise is a gradual change, it compounds the effects of many other weather events, including spring tides and storm surges, causing habitat damage, migration, elimination, and conversion into other habitat types. Sea level rise has been modeled extensively for the Florida Keys, especially for the National Wildlife Refuges. [SLAMM \(Sea Level Affecting Marshes Model\) modeling](#) shows that there will likely be significant habitat loss in the Florida Keys that will affect many Keys species. For example, SLAMM modeling for the Great White Heron National Wildlife Refuge (NWR) in the lower and middle Keys is predicted to lose 77% of mangrove habitat, 98% of beach, 94% of irregularly flooded marsh, and 69% of regularly flooded marsh (Warren Pinnacle Consulting 2011a). Similarly, SLAMM predicts that Crocodile Lake NWR in the upper Keys will be moderately impacted. Up to 98% of refuge mangrove, which comprises the vast majority of the refuge, is predicted to be lost. Simulations using SLAMM predict Key West NWR will be severely impacted under every sea level rise scenario tested. Under the scenario where sea level rises 1.5 m (4.9 ft) by 2100, the entire refuge would be under water (Warren Pinnacle Consulting 2011b).

Non-native species

The non-native cane toad (*Rhinella marina*) and Cuban treefrog are known to eat small snakes (Maskell et al. 2003, Meshaka et al. 2004) and may be a threat to Florida brown snakes. Florida brown snakes are preyed upon by spiders, toads, Cuban tree frogs (*Osteopilus septentrionalis*), and a variety of mammals, birds, and snakes (Ernst and Ernst 2003, Maskell et al. 2003). Specific predators of snakes in the Lower Keys are unknown, but feral and domestic cats, dogs, raccoons (*Procyon lotor*), crabs (*Brachyura* spp.), large anurans, and raptors eat small snakes. Opossums (*Didelphis virginiana*) from the Upper Keys have been recently introduced to the Lower Keys, which were not previously inhabited by opossums (R. Grau, FWC, personal communication). These potential predators are in higher numbers due to human alteration of natural environment (intentional and unintentional). Unnatural levels of predation may be a significant threat, especially in combination with other threats.

Declines

The Lower Keys population of the Florida brown snake is assumed to have declined due to development of suitable upland habitat, road mortality, and invasive species. The most recent recorded sighting of the species in Big Pine Key is from 1975, Little Torch Key from 1984, Middle Torch Key from 1984, No Name Key from 1895, and Sugarloaf Key from prior to 1958. The lack of recent records makes it impossible to estimate the status of the Lower Keys population. We are aware of only 10 records from Big Pine Key, 2 records from Little Torch Key, and 1 record each from Middle Torch, No Name, and Sugarloaf keys. However, Lazell reportedly considered the species “common” at a site on Middle Torch Key (FNAI 2011) and noted “road-killed specimens but plenty of live ones around” at a site on Little Torch Key (FNAI 2011).

Recommended Listing Status

In 2010, FWC directed staff to evaluate the status of all species listed as Threatened or Species of Special Concern that had not undergone a status review in the past decade. To address this charge, staff conducted a literature review and solicited information from the public on the status of the Lower Keys population of the Florida brown snake. The FWC convened a biological review group (BRG) of experts on the Lower Keys population of the Florida brown snake to assess the biological status of the species using criteria specified in Chapter 68A-27.001, Florida Administrative Code (F.A.C.). This rule includes a requirement for BRGs to follow the Guidelines for Application of the International Union for Conservation of Nature (IUCN) Red List Criteria at Regional Levels (Version 3.0) and Guidelines for Using the IUCN Red List Categories and Criteria (Version 8.1). FWC staff developed an initial draft Biological Status Review report (BSR), which included the BRG’s findings and a preliminary listing recommendation from staff. The draft was sent out for peer review, and the reviewers’ input was incorporated into a [final report](#).

The Florida brown snake (Lower Keys population) BRG concluded that the Lower Keys population of the Florida brown snake met criteria necessary to warrant listing it as Threatened on the Florida Endangered and Threatened Species List (in accordance with [FWC listing criteria](#)). The BRG concluded from the biological assessment that 2 criteria were met for listing. The Florida brown snake (Lower Keys population) met criterion B(b)(1), Extent of Occurrence less than 20,000 km² (7,722 mi²) (estimated to be the 137 km² [52.9 mi²] for the Florida brown snake) and B(b)(2), Area of Occupancy less than 2,000 km² (772.2 mi²) (estimated as 19 km² [7.3 mi²] for this species). For the Criterion B to be triggered, the species or population must be experiencing 2 of the following: severe fragmentation, a decline (in extent of occurrence, area of occupancy, number of locations or subpopulations, or number of mature individuals), or extreme fluctuations (in extent of occurrence; area of occupancy; area, extent, and/or quality of habitat; number of locations or subpopulations; number of mature individuals). Criterion D(2) was triggered because the estimated area of occupancy (19 km² [7.3 mi²]) was less than 20 km² (7.7 mi²). The BRG found that the Florida brown snake in the Lower Keys is severely fragmented and is experiencing a decline in habitat extent and quality. Although the extent of occurrence and fragmentation result from the Florida brown snake’s natural distribution in the Lower Keys, area of occupancy and declines in habitat are reversible. Maintaining the quality and extent of the Florida brown snake’s habitat in the Lower Keys are critical to minimizing the risks identified by the listing criteria and reducing the probability of extirpation. Because the small land area of the

Lower Keys naturally limits the Florida brown snake's natural range, it will always meet Criterion D(2), Population with a Very Restricted Area of Occupancy. As a result, it is expected that this population will always remain on the Florida Endangered and Threatened Species List. However, the continuing decline documented in the [BSR](#) can be addressed through implementation of actions within this plan. Plan objectives are designed to maintain or improve the quality of existing habitat, expand the amount of available habitat where possible, maintain the integrity of existing populations, and ensure that existing populations maintain as much protection from stochastic events as can realistically be achieved.

CONSERVATION GOALS AND OBJECTIVES

Goal

The conservation status of the Lower Keys population of the Florida brown snake is improved to the point that it is secure within the Lower Keys.

Objectives

I. Maintain the area of occupancy and extent of occurrence of the Florida brown snake in the Lower Keys.

Rationale

According to the [BSR](#) for the Florida brown snake in the Lower Keys, Criteria B and D were triggered in part by an estimated area of occupancy of 18 km² (7 mi²) with 1 or 2 locations and an extent of occurrence of 137 km² (53 mi²). Because this population is found on a spatially limited island chain, it is unlikely that the area of occupancy will increase beyond the minimum area of occupancy that triggers Criterion D. However, the current area of occupancy and extent of occurrence can be maintained, and possibly even slightly expanded, through the protection and management of existing potential habitat. This should help stabilize habitat quantity and quality declines, reducing the risk that Florida brown snakes will be extirpated from the Lower Keys.

II. Maintain or improve the extent and or quality of habitat available for the Florida brown snake in the Lower Keys.

Rationale

Future development within the Keys is expected to lead to a reduction in the limited amount of suitable habitat currently present for this population. The potential for expanding suitable habitat within the spatially restricted area of the Florida Keys is limited. Therefore, maintaining and improving habitat quality within its extent of occurrence is the most critical objective for securing the Florida brown snake within its historical range. Actions taken toward completing this objective should help stabilize habitat quantity and quality declines, reducing the risk that Florida brown snakes will be extirpated from the Lower Keys.

III. Ensure that the Lower Keys population of the Florida brown snake exceeds 10,000 mature individuals, with at least 1 location having more than 1,000 individuals.

Rationale

The Florida brown snake population in the Lower Keys is suspected to be between 1,000 and 10,000 mature individuals (FWC 2011). FWC listing Criterion C (adapted from IUCN listing criteria for Vulnerable) gives the threshold for a stable population as 10,000 mature individuals. Criterion D gives the threshold of 1,000 individuals at a minimum of 1 location. If these population numbers are maintained, then the risk of extirpation of Florida brown snakes from the Lower Keys will also be reduced. Although the [BSR](#) for this species concluded that its population size likely exceeds these thresholds and did not consider this as a criteria for listing, there is little population information for the Lower Keys population of the Florida brown snake; the conclusion that this criteria did not apply to the species was based on indirect evidence. As a

CONSERVATION GOALS AND OBJECTIVES

result, it is important to ensure that actions are taken to confirm that the population truly does exceed these numbers. Further actions should also be taken to increase the population if estimates indicate that listing criteria thresholds are met.

CONSERVATION ACTIONS

The following sections describe the conservation actions that will make the greatest contribution toward achieving the conservation objectives. Actions are grouped by category (e.g., Habitat Conservation and Management, Population Management). The Conservation Action Table ([Table 1](#)) provides information on action priority, urgency, potential funding sources, likely effectiveness, identified partners, and leads for implementation.

Habitat Conservation and Management

Action 1 Apply management that accommodates the needs of the Florida brown snake within its known range.

Many public conservation lands are required to have a management plan approved by the Acquisition and Restoration Council or their governing board. Specifically, s. 253.034(5), Florida Statutes (F.S.), says in part that all land management plans shall include an analysis of the property to determine if significant natural resources, including listed species, occur on the property. If significant natural resources occur, the plan shall contain management strategies to protect the resources. The Florida Forever Act (s. 259.105, F.S.) adds that all state lands that have imperiled species habitat shall include, as a consideration in the management plan, restoration, enhancement, management, and repopulation of such habitats. For lands identified by the lead management agency as having Florida brown snakes (Lower Keys population) or the potential to support them, the FWC should be consulted (as statutorily required), and the lead management agency is encouraged to include FWC as part of the management plan advisory group. If implemented, this action would direct management of conservation lands in the Lower Keys toward the needs of the Florida brown snake which will aid in stabilizing declines in habitat quantity and quality.

Action 2 Maintain suitable habitat, restore degraded habitat, and acquire or conserve as much potential habitat as possible for the Florida brown snake in the Lower Keys.

Imperiled species endemic to the Florida Keys present a unique conservation challenge because the total habitat available is constrained by the geography of a relatively small chain of islands (the total area of the Florida Keys is estimated at about 356 km² [137.5 mi²]). The limited size of these islands also constrains human use of the land, leading to more intense land usage that is often incompatible with the needs of imperiled species. While historic Florida brown snake sightings are known from moderately disturbed areas, they are thought to be generally intolerant of high-intensity alterations or extensive urbanization. In addition, only a limited subset of the land area within the Florida Keys may be suitable for this particular species. Our current best estimate indicates that less than 25% of the potential habitat for Florida brown snakes is on publicly managed lands (Endries et al. 2009). A geographic information system (GIS) analysis of public land with potential brown snake habitat in the Lower Keys identified the following sites: Bahia Honda State Park, Great White Heron NWR, Key Deer NWR, Naval Air Station, FKWEA, John J. Pescatello Torchwood Hammock Preserve, Monroe County Managed Areas, and Saddlebunch Key Sanctuary. FWC's FKWEA is the largest estimated public holding of potential Lower Keys brown snake habitat (2 km² [0.8 mi²]). Because of the extremely limited amount of potential habitat available to the Lower Keys population of the Florida brown snake,

the most critical and highest-priority action for the long-term conservation of this population is the acquisition and management of as much suitable habitat as possible within its range. In order to achieve this, coordination with local, state, and federal land managers will be needed to develop lists of priority parcels to be directly acquired and managed that protect the highest quality suitable habitat for the Florida brown snake (Lower Keys population). Reliable and dedicated funding sources must be identified for land acquisition and management, and imperiled species management should be a top concern when evaluating conservation land acquisitions within the range of this species. With the exception of several donated parcels, the entire FKWEA consists of lands purchase by Florida Forever. Prioritization of land acquisition under this program should consider the potential presence of Lower Keys brown snakes on proposed acquisitions within its range. In addition to state-owned Florida Forever lands, the USFWS and Monroe County Land Authority also have acquired significant tracts of land for conservation purposes.

On conservation lands currently in public ownership, as well as on future conservation land acquisitions within the range of the Florida brown snake, the habitat needs of this and other imperiled species should be a high priority during land management planning. Habitat restoration should be considered on potential habitat that has been degraded over time as a result of human activity. In addition, collaboration with private landowners to promote land management for this species could be beneficial. This species shows some tolerance for certain levels of habitat alteration and has been found in suburban developments (FWC 2011). Two of the most important habitat management considerations are continuing removal of non-native species and maintaining freshwater wetlands. Management techniques that minimize effects of roads on snake populations, if employed in the Lower Keys, would benefit all listed snake species in that area. Many of those measures are reviewed by Jochimsen et al. (2004). There are programs that provide technical assistance and funding to landowners interested in managing their lands for imperiled species ([Action 10](#)). Restoration and management of Florida brown snake habitats should follow habitat management recommendations to provide the greatest benefit for the species and reduce the risk of extirpation of the Lower Keys population ([Action 3](#)).

Action 3 Develop habitat management recommendations for land managers and owners.

Habitat management recommendations need to be developed for the Florida brown snake (Lower Keys population) to guide managers of public and private lands on habitat management goals, actions, and techniques required to ensure that high-quality habitat is available for this species. These are not to be confused with other pre-existing best management practices, such as agricultural or water management programs that are administered by other state agencies and fit within various regulatory frameworks. The habitat management recommendations proposed here are a stand-alone tool designed specifically to provide guidance for wildlife habitat management, including avoidance and minimization measures as well as measures designed to promote species recovery through improvements in ecosystem health. Habitat management recommendations also need to consider factors such as control of non-native animals or free-roaming domestic animals that may present a threat to the Florida brown snake (Lower Keys population). Maintaining habitat for Florida brown snakes in the Lower Keys is essential to halt declines in habitat quality and quantity that put this population at risk of extirpation.

Action 4 Continue the removal of non-native species.

Non-native species pose threats to the Florida brown snake (Lower Keys population) and other species native to the Lower Keys. Currently, there are several non-native animals in the Keys targeted for rapid response removal, such as black spiny-tail iguanas (*Ctenosaura similis*), tegus (*Tupinambis* spp.), monitor lizards (*Varanus* spp.), and large-bodied snakes. In addition, numerous non-native invasive plant species are being actively removed from public and private lands in the Keys. These efforts need to be continued and expanded in cases where specific non-native species not targeted for removal are identified as a potential threat to the Florida brown snake (Lower Keys population) or its required habitats.

Population Management

There are no specific population management actions identified for the Lower Keys population of the Florida brown snake at this time. Under the right circumstances, a captive breeding program may be considered, but no such program is currently proposed.

Monitoring and Research

Action 5 Investigate the taxonomy of the Florida brown snake (Lower Keys population).

There is dissent among herpetologists as to the taxonomic status of the Florida brown snake in the Lower Keys. Some herpetologists believe that the Lower Keys population is a distinct species, while others think that it is a subspecies. The taxonomic status could affect the future state listing status of the Florida brown snake (Lower Keys population). A change in taxonomic status requires a consensus from the scientific community. Additional genetic research is needed to confirm taxonomic status and settle dissent among species experts.

Action 6 Conduct surveys of existing habitat (survey habitat and determine quality of habitat). Conduct population surveys using methods to be determined for the Florida brown snake (Lower Keys population).

Because of the relative rarity of the Florida brown snake and its secretive nature, its population status and trends are poorly understood. The relative scarcity of this population will make it extremely difficult to use traditional survey techniques to collect sufficient data to produce a clear picture of its population status. It is likely that, at least in the near term, conclusions on the conservation status of this population will have to be based on indirect observations of existing habitat and less robust survey methodology relying on presence and absence observations. In spite of these difficulties, active pursuit of research into aspects of the life history, habitat needs, and population trends will be critical to providing information necessary to guide management decisions intended to ensure the long-term conservation of this species. The BRG suspected that declines in habitat had occurred and would continue to occur; we agree. The magnitude of these declines is unknown, so data should be collected to determine the urgency of this threat by measuring the magnitude of the declines.

Habitat Surveys

Currently, the extent of suitable habitat found within the range of the Florida brown snake (Lower Keys population) is poorly known. Endries et al. (2009) provided a GIS-based analysis of potential habitat using existing GIS datasets. FWC staff refined this model during the [BSR](#) process to come up with a baseline estimate of potential habitat (18.5 km² [7.1 mi²]). However, these models are based on data that are not current, and little of the identified potential habitat has been verified in the field. The habitat needs of this species are so poorly understood, it is difficult to create a model of potential habitat, and the results of these models must be used with caution. To provide a better assessment of the status of potential Florida brown snake habitat in the Florida Keys, a baseline habitat survey must be conducted to delineate existing potential habitat throughout its range. If areas containing significant population clusters of Florida brown snake (Lower Keys population) occur outside of lands under the management of FWC, partnerships will need to be developed to ensure the long-term viability of populations on these lands ([Action 12](#)).

Population Surveys

As identified in the [BSR](#), virtually no information exists on the population status and trends of the Lower Keys population of the Florida brown snake. The estimates that were made were based on estimates from the mainland population and not the Lower Keys population. The relative rarity of the population in combination with its habitat preferences makes reliably capturing the species extremely difficult using traditional techniques. Regardless of the inherent difficulty in finding these animals, a baseline survey of potential habitat within the range of the species needs to be conducted to determine, at minimum, patterns of presence and absence within existing habitat. An effort should be made to develop a survey protocol robust enough that reliable conclusions on the presence and absence of the species at any particular site can be determined.

Because of the relatively high value of any verifiable observation of a Florida brown snake, a mechanism should be established for reporting sightings of this snake by natural resource professionals and the general public ([Action 8](#)). Such a database and reporting process would be beneficial for other rare Keys wildlife.

Action 7 Develop a long-term monitoring strategy for the Florida brown snake (Lower Keys population).

It is critical to periodically re-assess the status of identified populations of Florida brown snake (Lower Keys population) as well as their habitat to determine if conservation strategies are working to ensure the long-term viability of the population or to inform additional conservation actions needed to mitigate for new or expanding threats. An evaluation of suitable habitat for the population should be conducted on a 10-year timeframe to determine changes in habitat quality or quantity, as well as to determine if changes in land ownership or land use are having a beneficial or detrimental effect on the viability of the species. If additional populations are found, then extent of occurrence and area of occupancy may increase, affecting listing status. While all of the listing criteria attempt to measure the risk of extinction, or in this case extirpation, from the wild, population trends provide a solid indication of a species' status and should be investigated.

Action 8 Establish a program for reporting and tracking sightings of Florida brown snakes (Lower Keys population).

Because Florida brown snakes (Lower Keys population) are highly elusive and difficult to detect using traditional survey methods, incidental observations of these animals are a potentially extremely valuable data source. There is currently no mechanism for sharing incidental observations by members of the conservation community or the general public to conservation agencies or interested organizations, except for contributing voucher sightings to natural history museums or FNAI. A simple, user-friendly mechanism for collecting incidental observations may be an internet database. FWC has several models for such a database, and these allow uploading of voucher photos and georeferencing through graphic mapping interface or smart-phone application. If such a database is developed, training and outreach materials should be distributed among members of the conservation community (partner agencies such as the Florida Department of Environmental Protection's [DEP's] Recreation and Parks, USFWS, non-governmental organizations such as Audubon, the Florida Reptile and Amphibian Working Group, and the North American Center for Snake Conservation) and interested members of the public in the Keys. This training information could include web tutorials on surveying and reporting as well as identification guides designed to be printed out and taken in the field. Partners should be consulted during creation of the website. The reporting system should be publicized through outreach to local conservation groups, hobbyists, and biologists. The database also should be publicized on the FWC website and should be easily accessed through a website search for Florida brown snakes. An easy reporting process and provision of training and education materials should help foster public interest in the conservation of imperiled species in the Keys in addition to increasing our knowledge of the species.

Rule and Permitting Intent

Rule Intent

Listing as a Threatened species provides adequate regulatory protection for the Florida brown snake (Lower Keys population).

Permitting Structure

Although the regulatory structure is sufficient to protect populations from take, as stated above, in practical application permits allow individuals to legally conduct activities prohibited or limited in rule. In recognition of the distinctiveness and limited distribution of the Florida brown snake (Lower Keys population), all permitted activities should be carefully considered to prevent undue stress and resultant declines to this population. In recognition of the poor understanding of the taxonomy of this species, we recommend that tissue samples be taken when researchers encounter the brown snake (Lower Keys population) and that those tissue samples be provided to the FWC. FWC will retain samples until enough are collected for analysis. This is a cost-effective way to collect samples that can be used to understand the taxonomy, demographics, population stability, and fragmentation of Lower Keys populations of Florida brown snakes.

Intentional Take for Conservation or Research Purposes

Having a scientifically informed listing process requires that researchers be able to "take" species when necessary. Even the gentlest methods might be considered harassment when the

animals are handled or their movements are impeded. Rule 68A-27.007, F.A.C., Permits and Authorizations for the Take of Florida Endangered and Threatened Species, provides factors to be considered for the issuance of permits for scientific or conservation purposes. These criteria are sufficient for the issuance for permits to further conservation while mitigating potentially threatening activities. The authors of this plan recommend that these permits be issued for scientific or educational purposes that contribute to the objectives of this plan or the conservation of the Florida brown snake. We recommend that, as a condition of the permit, be permittees report information collected about this species to the FWC, FNAI, and the Florida Museum of Natural History within 1 year of completion of the work.

The following factors should be considered in determining whether there is a scientific or conservation purpose that will benefit the survival potential of the species:

- whether the purpose for which the permit required is adequate to justify removing specimens of the species from the wild
- the probable direct or indirect effect which issuing the permit would have on the wild population of the species sought to be taken
- whether the permit would conflict with any program intended to enhance the survival of the species sought to be taken
- whether the purpose of the permit would likely reduce the threat of extinction for the species sought to be taken
- the opinions or views of subject matter (species) experts concerning the species sought to be taken
- whether the expertise, facilities, or other resources available to the applicant are adequate to successfully accomplish the objective stated in the application

Law Enforcement

Action 9 Provide training opportunities specific to Florida brown snake protections in the Lower Keys for law enforcement officers.

The FWC's Division of Law Enforcement, in conjunction with federal, state, and local partners, is responsible for enforcing Florida's wildlife laws. FWC biologists educate law enforcement officers through the development, circulation, and interpretation of identification tools, distribution maps, and other training materials. These media should be comprehensive to the regional needs encompassing all regulated species in the Lower Keys, not merely focused on Florida brown snakes.

In turn, one of the most important components of the enforcement strategy is ensuring compliance through public education. FWC law enforcement officers understand the importance of explaining wildlife laws to the public to avoid unintentional violations. However, FWC law enforcement officers actively pursue and recommend prosecution for those who intentionally violate wildlife laws. The FWC's Division of Law Enforcement administers the Wildlife Alert program, which receives information via a toll-free number (1-888-404-3922) that is answered 24 hours a day, 7 days a week. Cash rewards are offered to callers who provide information about any illegal activity that results in an arrest. Callers may remain anonymous and are not required to testify in court.

Incentives and Influencing

Action 10 Develop less-than-fee acquisitions on private lands.

Because funding for direct land acquisition and land management is often lacking or the timeframe for acquisition may not be appropriate, less-than-fee acquisitions on private land should be considered as a land-protection strategy. Less-than-fee acquisitions may come in the form of easements or agreements with private landowners who are willing to promote conservation of imperiled species on their lands. These types of acquisitions are often incentive-based to promote participation and to ensure that private landowners receive a benefit from voluntary conservation actions that they might not otherwise perform. Because of the unique nature of habitats within the Florida Keys, many properties within these areas do not fall neatly within the parameters established by currently existing programs. For instance, some of these programs have minimum acreage requirements that will be difficult to meet on properties within the Keys. However, administrators of these programs often have latitude that may allow some of these programs to apply to critical properties in the Keys. FWC biologists can provide technical assistance and advice to landowners interested in participating in these programs. In addition, FWC and other agencies may need to consider new incentives based on less-than-fee programs specifically for the Keys in order to address the unique nature of these areas. Due to the limited amount of habitat available for the Lower Keys population of the Florida brown snake (as well as other potentially occurring imperiled species), this could likely be achieved at a relatively low cost, when compared to similar programs occurring on the mainland.

In general, it is expected that less-than-fee acquisitions in the Florida Keys will likely be a limited opportunity practice due to land use patterns, the relatively small size of parcels available, and the limited amount of suitable potential habitat available on parcels that may be considered for less-than-fee tools. In addition, existing tools are generally not designed for the unique land use patterns found in the Keys. However, less-than-fee acquisitions may still be important even if they are rare. Any protection and suitable management of the extremely limited available potential the Lower Keys population of Florida brown snake habitat may turn out to have an important role in ensuring the long-term viability of this population.

Florida also provides tax incentives including property tax exemptions under [s.196.26, F.S.](#) for landowners who put a perpetual conservation easement on their land. Additional incentives may include exemption from permits for activities that enhance wildlife habitat such as removal of invasive non-native vegetation, as long as it is not a precursor to development.

Education and Outreach

Action 11 Direct outreach to local conservationists and interested members of the public.

There are many local conservationists and recreational herpetologists who could provide sighting information and supplement the monitoring program where funding and resources are lacking. [Action 8](#) calls for an online database where the public could add sightings. There will be outreach to encourage reports of sights from the public through local conservation groups and

partners (e.g., DEP's Division of Recreation and Parks, USFWS, Audubon, the Florida Reptile and Amphibian Working Group, and the North American Center for Snake Conservation).

Coordination with Other Entities

Action 12 Coordinate with and provide technical assistance to local governments on local environmental issues and occurrences of Florida brown snakes.

FWC staff will meet with local government staff to provide technical assistance, share research, range and distribution information, GIS information, and land conservation measures with local planners. Information will be provided to local governments for property owners who potentially have Florida brown snakes on their property. Information could be distributed by counties and local governments with permit information or materials. FWC will help encourage development and enforcement of listed species and habitat protection in local Comprehensive Plans and ordinances. Local governments could also assist in distributing information to businesses receiving occupational licenses such as contractors, landscapers, and golf courses. Coordination with local conservationists is also discussed in [Action 11](#).

Monroe County's Comprehensive Plan addresses land development and protection of native habitats. Local government implementation and enforcement of these laws are vital for the goals outlined in this plan. Regulations address state-listed species in general terms and have provisions for protection of native habitats. In addition to county regulations, the City of Marathon and the City of Key West have comprehensive plans that address protecting native habitats and species. The inclusion of the Florida brown snake in plans affecting the Lower Keys will provide a conservation lift for the species by taking the needs of the species into account during land development activities.

Table 1. Lower Keys Population of the Florida Brown Snake (*Storeria victa*) Conservation Action Table

NOTE: An explanation of acronyms used is below the table.

Objective(s) Addressed	Team Assigned Priority Level	Action Item Number	Action Items	Conservation Action Category	Ongoing, Expanded or New Effort?	Authority	Man Power	Estimated Cost To Implement	Funding Source(s)	Lead for Implementation: FWC Program(s) and/or Section(s)	External partners	Likely. Effectiveness	Feasibility	Urgent?
2	2	1	Apply management that accommodates the needs of the Florida brown snake within its known range.	Habitat Conservation & Mgmt	ONGOING	YES	NO	TBD	Trust fund, legislature, donations, and other	HSC	DEP, State Parks, USFWS, UF, Monroe County, Nature Conservancy	Highly likely.	Yes it can be done, yes it is practical, and relationships exist.	No, this will not reduce the critical threats, but will make this species more secure in its range; that is why this action is giving 2 priority.
2	1	2	Maintain suitable habitat, restore degraded habitat, and acquire or otherwise conserve as much potential habitat as possible for the Florida brown snake in the Lower Keys.	Habitat Conservation & Mgmt	ONGOING	YES	NO	TBD	Trust fund, legislature, donations, and other	HSC	DEP, State Parks, USFWS, UF, Monroe County, Nature Conservancy	Highly likely.	Yes it can be done, yes it is practical, and relationships exist. If programs like Florida Forever are funded this could facilitate the process.	No, this will not reduce the critical threats, but this is one of the most important things to do for this species. There is very limited habitat available to the Lower Keys population. The population will not recover without adequate habitat.
2	2	3	Develop habitat management recommendations for land managers and owners.	Habitat Conservation & Mgmt	NEW	YES	YES	TBD	Existing budget, maybe grant funding	HSC	DEP, State Parks, USFWS, Monroe County, the Nature Conservancy, Local Governments, Private Land Owners	Likely.	Yes it can be done, yes it is practical and relationships exist.	No, this will not reduce the critical threats, but this is given a 2 priority because it will improve habitat.
2	1	4	Continue the removal of non-native species.	Habitat Conservation & Mgmt	EXPANDED	YES	YES	TBD	Grants legislature, existing budget	HSC	DEP, State Parks, USFWS, Monroe County, Local Governments, UF	Likely.	Feasibility and practicality depends on the species, relationships exist.	No, this will not reduce the critical threats, but this is one of the most important things to do for this species. Non-native predators released on islands can quickly reproduce to numbers that could threaten the recovery of this species.
3	3	5	Investigate taxonomy of the Florida brown snake (Lower Keys population).	Monitoring & Research	NEW	YES	YES	\$5,000	Existing budget	FWRI	State Parks, USFWS, FSU	Very likely.	Yes it can be done, yes it is practical and relationships exist.	No, this will not reduce the critical threats, but this could affect future listing status.
1	1	6	Conduct surveys of existing habitat (survey habitat and determine quality of habitat). Conduct population surveys using methods to be determined for Florida brown snakes (Lower Keys population).	Monitoring & Research	NEW	YES	NO	\$50-100k	Grant	HSC and FWRI	State Parks, USFWS, UF, Monroe County	Moderately likely.	Yes, but can't predict level of detail of data collected.	No, surveys will not reduce critical threats to the survival of this species, but this work must be conducted first prior to other conservation actions.
1	2	7	Develop a long-term monitoring strategy for the Florida brown snake (Lower Keys population).	Monitoring & Research	NEW	YES	NO	TBD	Unknown	HSC and FWRI	State Parks, USFWS, UF, Monroe County	Unknown.	Unknown, because it is a data deficient species a certain level of knowledge will need to be obtained before this is known.	No, this will not reduce the critical threats, but this is essential to determining status and recovery.
1	2	8	Establish a program for reporting sightings of Florida brown snakes (Lower Keys population).	Monitoring & Research	NEW	YES	YES	\$10,000	Existing budget	HSC and FWRI	State Parks, USFWS, UF, Monroe County, Center for Snake Conservation	Likely.	Yes it can be done, yes it is practical and some of the relationships exist.	No, this will not reduce the critical threats, but this will greatly aid monitoring.
1	3	9	Provide training opportunities specific to Florida brown snake protections in the Lower Keys for law enforcement officers.	Law Enforcement	ONGOING	YES	YES	TBD	Existing budget	HSC	State Parks, USFWS, Monroe County, Local Governments and National Park Service	Likely.	Yes it can be done, yes it is practical and relationships exist.	No, this will not reduce the critical threats, but this will aid in protecting the species from take.

Table 1. Lower Keys Population of the Florida Brown Snake (*Storeria victa*) Conservation Action Table

Objective(s) Addressed	Team Assigned Priority Level	Action Item Number	Action Items	Conservation Action Category	Ongoing, Expanded or New Effort?	Authority	Man Power	Estimated Cost To Implement	Funding Source(s)	Lead for Implementation: FWC Program(s) and/or Section(s)	External partners	Likely. Effectiveness	Feasibility	Urgent?
2	2	10	Develop less-than-fee acquisitions on private lands.	Incentives & Influencing	EXPANDED	YES	YES	TBD	Unknown	HSC	DEP, USFWS, UF, Monroe County, Local Government	Likely.	Yes it can be done, yes it is practical, and relationships exist. It is more practical on larger parcels and if it is closely located to other conservation land.	No, this will not reduce the critical threats, but this could improve habitat.
1	3	11	Direct outreach to local conservationists and interested members of the public.	Education & Outreach	NEW	YES	YES	\$5,000	Grant/ existing budget	OCR, HSC	State Parks, USFWS, UF, Monroe County	Likely.	Yes it can be done, yes it is practical and some of the relationships exist.	No, this will not reduce the critical threats, but this will aid monitoring.
1	2	12	Coordinate and provide technical assistance to local governments on local environmental issues and occurrences.	Coordination with Other Entities	ONGOING	YES	YES	\$1,500	Existing budget	HSC	State Parks, USFWS, UF, Monroe County	Likely.	Yes it can be done, yes it is practical and relationships exist.	No, this will not reduce the critical threats, but this will aid in protecting this species and its habitat.

Acronyms used in this table:

- CCCA: Candidate Conservation Agreement with Assurances
- DEP: Florida Department of Environmental Protection
- FSU: Florida State University
- FWC: Florida Fish and Wildlife Conservation Commission
- FWRI: Fish and Wildlife Research Institute, the research branch of the Florida Fish and Wildlife Conservation Commission
- HCP: Habitat Conservation Plan
- HSC: Habitat and Species Conservation, a Division of the Florida Fish and Wildlife Conservation Commission
- LE: Law enforcement
- OCR: Office of Community Relations, administered by the Florida Fish and Wildlife Conservation Commission
- TBD: To be determined
- UF: University of Florida
- USFWS: United States Fish and Wildlife Service

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