A Species Action Plan for the Homosassa Shrew
Sorex longirostris eionis

September 26, 2018

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The 2018 revision of this plan built upon the significant work of the authors and contributors of the original plan, published in 2013. These individuals include:

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Cover photograph by Justin C. Davis

Recommended citation:
Florida Fish and Wildlife Conservation Commission. 2018. A species action plan for the Homosassa shrew. Tallahassee, Florida.

EXECUTIVE SUMMARY

The Florida Fish and Wildlife Conservation Commission (FWC) developed this plan as a component of Florida's Imperiled Species Management Plan (FWC 2016). In 2017, the FWC convened a biological review group (BRG) to reassess the status of the Homosassa shrew (*Sorex longirostris eionis*) using criteria specified in Rule 68A-27.001, Florida Administrative Code (F.A.C.). The BRG determined that the Homosassa shrew does not meet any listing criteria. The findings are published in the 2017 Biological Status Review report (BSR, FWC 2017). Included in the BSR is the FWC staff recommendation to remove the Homosassa shrew as a Species of Special Concern from Rule 68A-27.005, F.A.C.

Results from recent studies, the BRG, and other literature informed the 2018 revisions to this plan, including an amended goal, modified objectives, and updated conservation actions. The goal of this plan is to maintain or improve the conservation status of the Homosassa shrew so that the species will not again need to be listed on the Florida Endangered and Threatened Species List. The following objectives are included to achieve this goal:

1) Ensure the Homosassa shrew's statewide population is stable or increasing.
2) Confirm the taxonomic validity of the Homosassa shrew.

Recommended actions include determining the taxonomic status of the Homosassa shrew, continue to provide appropriate management recommendations to private and public land managers, and provide public outreach materials relating to the ecological importance of the Homosassa shrew and conservation guidelines through FWC media platforms. Successful management of Homosassa shrews through the implementation of this plan requires the cooperation of local, state, and federal governmental agencies; non-governmental organizations; business and industrial interests; universities and researchers; and the public. The FWC developed this plan in collaboration with stakeholders, and its successful implementation requires cooperation and coordination with other agencies, organizations, private interests, and individuals.

This plan details the actions necessary to maintain the conservation status of the Homosassa shrew. A summary of this plan is included in Florida's Imperiled Species Management Plan (FWC 2016), in satisfaction of the management plan requirements in Chapter 68A-27, F.A.C., Rules Relating to Endangered or Threatened Species. Florida's ISMP addresses comprehensive management needs for Florida's imperiled species and includes an implementation plan; regulatory framework; relevant policies; anticipated economic, ecological, and social impacts; projected costs of implementation; and a revision schedule. Achieving the objectives of the ISMP depends heavily on stakeholder input and partner support.

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GLOSSARY OF TERMS AND ACRONYMS

Area of Occupancy (AOO): The area within its extent of occurrence (see Extent of Occurrence) that 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 the 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-27.001, Florida Administrative Code (F.A.C.), 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 the IUCN criteria and IUCN guidelines, are used to help decide if a species should be added or removed from the Florida Endangered or Threatened Species List. In addition, FWC staff may provide within the report a biologically justified opinion that differs from the criteria-based finding.

Extent of Occurrence (EOO): 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.

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

GIS: Geographic information system

GPS: Global positioning system

Habitat: The area used for any part of the life cycle of a species (including foraging, breeding, and sheltering).

ISMP: Florida's Imperiled Species Management Plan

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

Pelage: The hair, fur, wool, or other soft covering of a mammal.

Population: The total number of individuals of the taxon. Population numbers are expressed as numbers of mature individuals only (as defined by IUCN).

Predation: (Depredation, predated) To be killed or destroyed by a predator.

Scientific Collecting Permit: A permit issued for activities that include salvage, voucher, bird banding, wildlife possession, or special purpose. Applications must demonstrate a scientific or educational benefit for the species, and must identify the purpose, scope, objective, methodology, location, and duration of the project.

Species of Special Concern. Protected under Chapter 68A-27, F.A.C., which declares that "no person shall take, possess, transport, or sell any species of special concern included in this subsection or parts thereof or their nests or eggs except as authorized by permit from the executive director, permits being issued upon reasonable conclusion that the permitted activity will not be detrimental to the survival potential of the species. For purposes of this section, the definition of the word take in Rule 68A-1004, F.A.C., applies."

Take: As defined in Rule 68A-1.004, F.A.C. (General Prohibitions): "Taking, attempting to take, pursuing, hunting, molesting, capturing, or killing any wildlife or freshwater fish, or their nests or eggs by any means whether or not such actions result in obtaining possession of such wildlife or freshwater fish or their nests or eggs."

INTRODUCTION

Biological Background

Taxonomy

The Homosassa shrew (*Sorex longirostris eionis)* is 1 of 2 subspecies recognized in Florida; the other is the southeastern shrew (*S. l. longirostris*). The original Homosassa shrew subspecies taxonomic description was based on physical features including differences in pelage, skull size, and tail length from specimens collected in Citrus County (Davis 1957).

Life history

Little is known about the life history, behavior, and biology of the Homosassa shrew. As such, we provide summary information for the southeastern shrew species as a whole, *Sorex longirostris*. For more information on this species, see French (1980*a*, 1980*b*).

Shrews are secretive, living and foraging under leaf or pine straw litter and other debris, and using mole runs; these traits make shrews difficult to study. Shrews tend to be solitary, using echolocation for orientation, and only occupy the same tunnel systems with other individuals during the breeding season, typically March to October (French 1980*b*). Homosassa shrews occur in very low densities and are difficult to capture. Recent survey efforts in parts of the presumed range captured shrews in most areas surveyed, although capture rates were low (Smith et al. 2015, Teets and Doonan 2015). Results of recent surveys confirm the presence of Homosassa shrews within the presumed range, but do not provide data on population size or trends (Smith et al. 2015, Teets and Doonan 2015). Average density for all *Sorex* species is 14 shrews per ha (roughly 5.6 per ac) according to Smallwood and Smith (2001), but have been calculated at 44 shrews per ha (roughly 17 per ac) by French (1980*a*). However, French (1980*a*) indicated that the plot design and location used to create the latter estimate may overestimate density. Few authors have captured 10 or more shrews in 1 locality (French 1980*a*; see summary in French 1980*b*).

Pregnant females have been found from March through October and reported litter size range from 1 to 6 offspring (French 1980*a*). Females can have between 1-3 litters per year (French 1980*a*). Young remain in the nest until nearly full grown. Southeastern shrews (*S. l. longirostris*) typically build nests under logs or other woody debris, and they line the nest with leaves (Whitaker and Hamilton 1998). Most individuals do not breed during the first summer, and they typically survive only 1 winter (French 1980*b*). Average generation time is estimated at approximately 9 months (French 1980*b*; Trani et al. 2007). Young shrews are found as early as May in Georgia and Alabama, and increase in abundance throughout the breeding season. French (1980*a*) reports increased observations of adult shrew death in November and December. Southeastern shrews consume a wide range of invertebrates, including spiders, butterfly and moth larvae, and both adult and larval beetles (French 1984, Whitaker and Hamilton 1998, Davis et al. 2010), and are likely to exploit a variety of prey items according to seasonal availability (Barnard and Brown 1981).

Homosassa shrews have been found in multiple habitat types including, palmetto thickets, longleaf pine sandhills, cypress swamps, bay swamps, slash pine and longleaf pine flatwoods,

hydric hammocks, xeric hammocks, sand pine scrub, and clear-cuttings (Jones et al. 1991). Teets and Doonan (2015) captured *S. longirostris* in upland mixed woodland, sandhill, dome swamp and mesic flatwoods. Smith et al. (2015) collected *S. longirostris* in mixed pine-hardwood forest, mixed wetland forest and pine flatwoods.

Description

Sorex shrews have long tails (>30 mm [>1.2 in]) compared to other shrews (Figure 1). Differentiating between *Sorex* species usually requires examining tooth characteristics and measuring total length and tail length. The southeastern shrew has a fourth unicuspid often larger than the third, with total length usually <90 mm (<3.5 in), and tail length <36 mm (<1.4 in). Compared to other southeastern shrew subspecies, the Homosassa shrew has a darker and more chestnut colored pelage, a larger skull, and shorter tail (Jones et al. 1991).

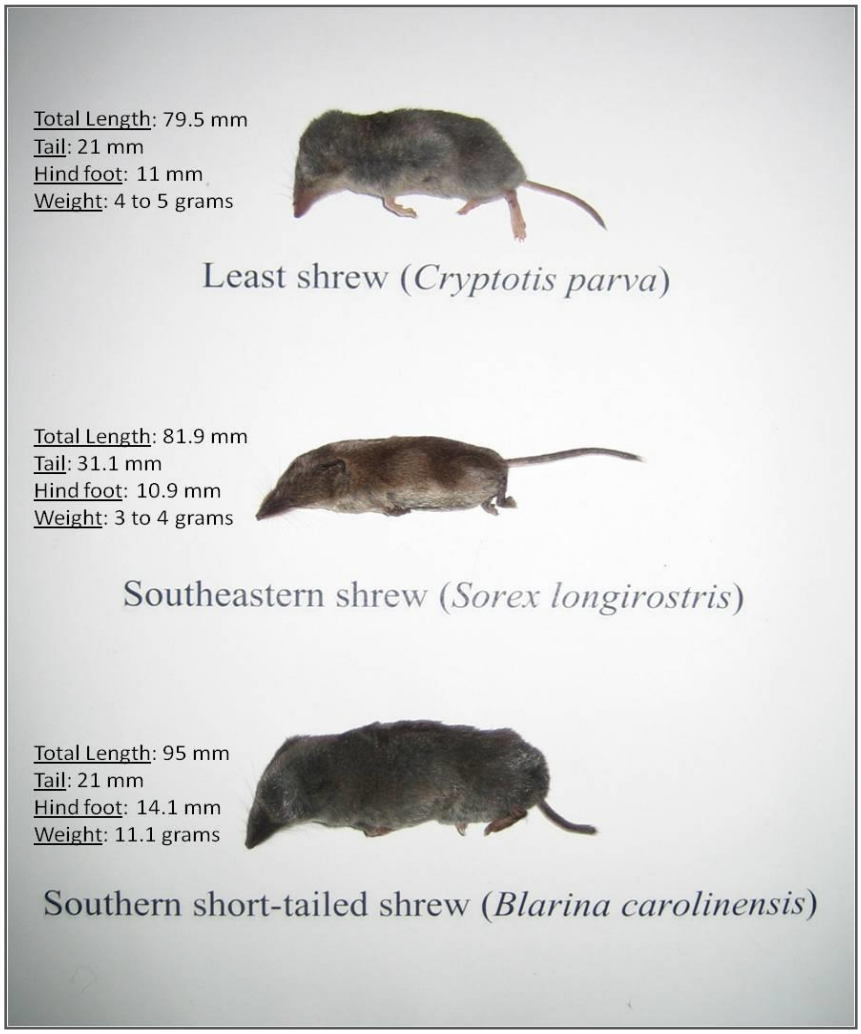

Figure 1. Comparison of shrew species in Florida. Information summarized from Whitaker and Hamilton (1998).

Geographic range and distribution

The Homosassa shrew was originally described as being restricted to only the type locality (see Y in Figure 2), in mesic habitats associated with Homosassa Springs in Citrus County, Florida (Davis 1957). A morphometric analysis of *Sorex longirostris* in Florida has suggested that the Homosassa shrew has a much larger distribution (Figure 2) and the accepted extent of occurrence (EOO; range) encompasses 38 counties in the northern 2/3 of peninsular Florida, with the Suwannee River valley as the current dividing line between the subspecies (Jones et al. 1991, Teets and Doonan 2015). Surveys found *S. longirostris* within its presumed range in Marion, Clay, Putnam, Gilchrist, Lafayette, and Hamilton counties (Smith et al. 2015, Teets and Doonan 2015). Homosassa shrews have been identified in multiple habitat types including, Xeric Uplands (Sandhill, Sand Pine Scrub, and Xeric Oak Scrub), Mixed Hardwood-Pine Forests, Hardwood Hammocks and Forests, Pinelands, Cabbage Palm-Live Oak Hammock, Bay Swamp, Cypress Swamp, Cypress/Pine/Cabbage Palm, Mixed Wetland Forest, and Hydric Hammocks.

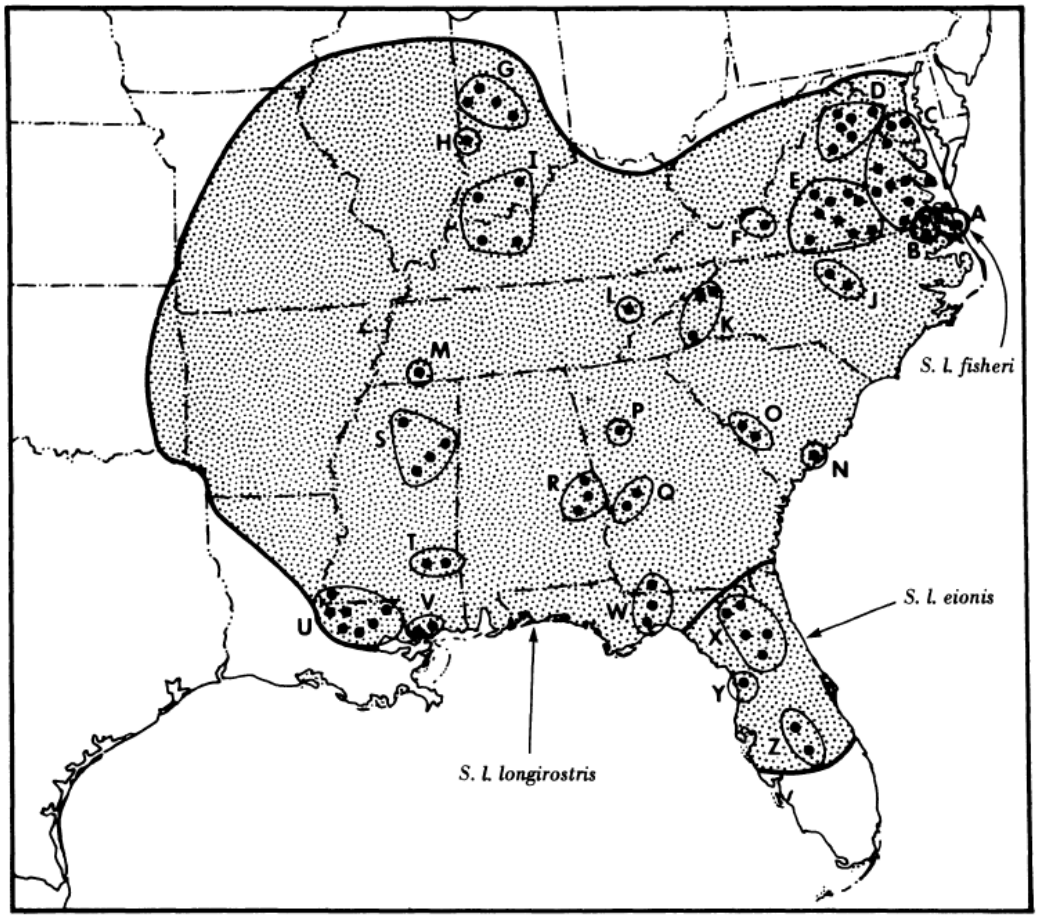

Figure 2. Geographic distribution of the *Sorex longirostris* complex in the United States. From Jones et al. 1991; samples X, Y, and Z represent the Homosassa shrew (*Sorex longirostris eionis*). Sample Y (marked with a red arrow) represents the type locality for the Homosassa shrew.

Additional sampling and genetic analysis of Homosassa shrew is necessary throughout its range to confirm subspecies status, provide a better estimate of distribution, and further clarify the zone

of intergradation with *S. l. longirostris*, which is thought to occur along the Suwannee River (Jones et al. 1991).

Conservation History

The Homosassa shrew was originally described by Davis (1957), and thought to occur only in Citrus and Hernando counties in coastal woodlands (see sample Y in Figure 2). In 1985, the Florida Game and Fresh Water Fish Commission [predecessor to the Florida Fish and Wildlife Conservation Commission (FWC)] listed the Homosassa shrew as a Species of Special Concern based on the belief that the subspecies had a very restricted range.

Jones et al. (1991) examined the physical features of the southeastern shrew, and determined that the Homosassa shrew subspecies was not restricted to Citrus and Hernando counties (Figure 2). They concluded this was a separate subspecies (*Sorex longirostris eionis*) and expanded the range of the Homosassa shrew to include most of peninsular Florida, from the Suwannee River valley south to Lake Okeechobee. However, Jones et al. (1991) reported that the population samples were not sufficient to determine the exact range of the Homosassa shrew or the zone of intergradation with *S. l. longirostris*.

Cox and Kautz (2000) developed a habitat model for the Homosassa shrew based on the original range limited to Citrus and Hernando counties (Davis 1957) that included only hardwood hammock and hardwood swamp habitat cover. In their assessment, Cox and Kautz (2000) concluded that 62% of the Homosassa shrew's potential habitat occurred on managed lands and that the subspecies was secure on existing conservation lands, even within this limited range and number of occupied habitat types. While no surveys were conducted to determine if shrews were present on these existing conservation lands, and no targeted conservation actions were undertaken for the subspecies, habitat management activities occurring on public and private lands likely maintained shrew habitat within that range.

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 Homosassa shrew. In 2010, FWC convened a Biological Review Group (BRG) to assess the status of the Homosassa shrew using listing criteria established by FWC in Chapter 68A-27 of the Florida Administrative Code. The BRG concluded from the 2010 biological assessment that the Homosassa shrew did not meet any listing criteria (FWC 2011). However, peer reviewers expressed concern that the primary data available for making this evaluation were not sufficient for the assessment. In 2010, with consideration of the peer review, staff recommended maintaining the Homosassa shrew as a Species of Special Concern until more current data on EOO, AOO, and population size could be collected and used to more completely evaluate the Homosassa shrew status against the listing criteria (FWC 2011).

In 2013, FWC published the original Species Action Plan for the Homosassa shrew. Actions within the plan guided research efforts to determine current distribution and taxonomic validity of the Homosassa shrew population in Florida. The State Wildlife Grants program funded a study to fill priority data gaps for the Homosassa shrew (Teets and Doonan et al. 2015), through coordination among partners within and outside of the agency. As part of the study, Teets and

Doonan (2015) developed reliable drift fence protocols for surveying and confirmed habitat associations as reported by Jones et al. (1991), concluding that the shrew is a habitat generalist. Teets and Doonan (2015) conducted surveys to determine the abundance and occurrence of Homosassa shrews within their known range using pitfall traps, reports of incidental captures, museum records, and dissection of owl pellets for shrew skulls. Twelve Homosassa shrews were detected in 5 of the 9 habitats surveyed within their range (Teets and Doonan 2015). An additional study by Smith et al. (2015) reported 18 Homosassa shrew captures along roadways adjacent to conservation lands in central Florida. Due to low detections rates, abundance could not be reliably estimated.

Based on this additional information, FWC convened another BRG in 2017 to reevaluate the status of the Homosassa shrew using state listing criteria. Due to the Homosassa shrew's low detectability, the BRG used the most conservative density information available, along with the available habitat within the accepted Florida range, to infer potential population size (FWC 2017). A geographic information system (GIS) analysis by Barrett (2017) calculated suitable Homosassa shrew habitat based on Jones et al. (1991), and found 36% of suitable Homosassa shrew habitat on conservation lands and 64% on private lands (Figure 3) across the known range. Using cooperative land cover data layers, combined with projected future development data from Zwick and Carr (2006), analysis indicated a 5.1% decline in available habitat by 2020, 7.2% loss by 2040, and 8.0% loss by 2060. However, the Homosassa shrew did not meet listing criteria related to EOO or AOO. Further, the BRG used the most conservative estimate of 1 shrew per km^2 (equivalent to 1 shrew per 100 hectares or 0.39 mi^2) to calculate the potential population size, and found that Homosassa shrew exceeded the minimum population size to meet the listing criteria (FWC 2017).

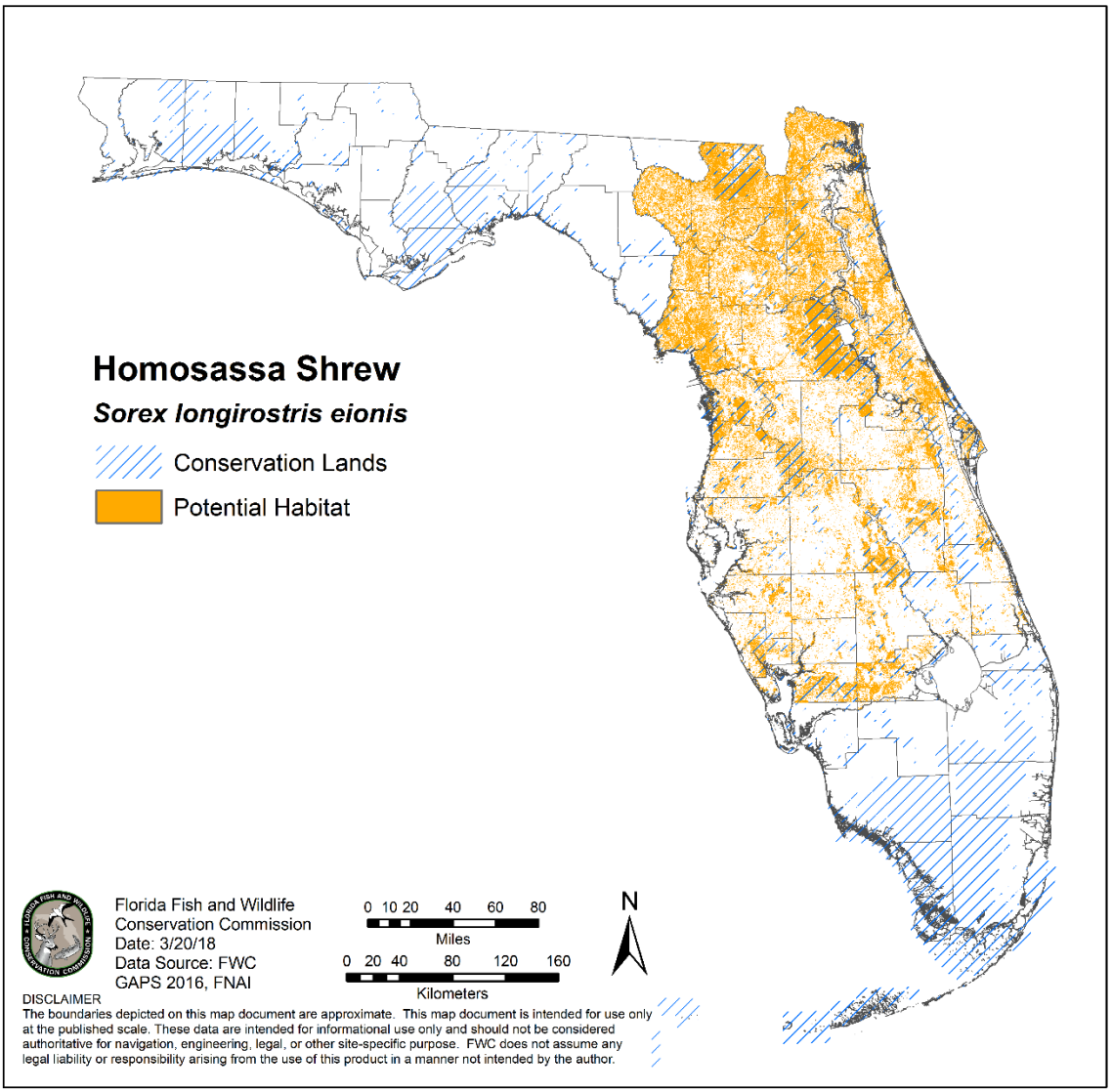

Figure 3. The Homosassa shrew range mapped by potential habitat available for the species (FWC 2017). This map incorporates all potential habitat types as described in Jones et al. (1991), overlaid with existing conservation lands selected from the Cooperative Land Cover (CLC) v3.2, updated in 2016.

Threats and Recommended Listing Status

Threats

Habitat loss and degradation due to increased urbanization and agricultural practices is considered the greatest threat to Homosassa shrews (FWC 2017). It is projected that the Homosassa shrew's native habitat will continue to be lost and degraded as the human population in Florida continues to grow and expand (Barrett 2017, Zwick and Carr 2006). Although Cox and Kautz (2000) report that 62% of the Homosassa shrew's potential habitat is on managed lands, their study used a restricted geographic range and limited set of habitat types for *S. l. eionis* that included only Citrus and Hernando Counties. A more comprehensive analysis of Homosassa shrew distribution showed approximately 35% of potential habitat is on conservation

lands (Barrett 2017). While less than that estimated by Cox and Kautz (2000), the total potential habitat in conservation lands still exceeds the original range that was limited to Citrus and Hernando counties.

Although land acquisition programs in Florida (Preservation 2000, Florida Forever) have dramatically increased the amount of public land managed for conservation (which should benefit the Homosassa shrew), the variety of habitats used by the shrew and its presence in early successional sites (e.g., clearcuts) make management of these lands an important component of successful conservation. Additionally, private lands containing shrew habitat are managed for a variety of activities, including agricultural and silvicultural activities.

Layne (1992) and Loss et al. (2013) identified free-ranging cats as a source of mortality, and anecdotal observations suggest that human-influenced incidental mortalities may also occur from swimming pools and lawn-maintenance activities. However, more data are needed to accurately assess potential impacts from these sources.

Recommended Listing Status

The Homosassa shrew is listed as a species of Least Concern (LC) by the by the International Union for Conservation of Nature (IUCN) because the southeastern shrew (including all subspecies) is considered widespread, abundant, and not subject to major threats (Cassola 2016). In 2017 the FWC convened a biological review group (BRG) of experts on the Homosassa shrew to assess the biological status of the subspecies using criteria specified in Rule 68A-27.001, Florida Administrative Code (F.A.C.). This rule includes a requirement for BRGs to follow 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). The 2017 BRG concluded from the biological assessment that the Homosassa shrew does not meet criteria to warrant listing on the Florida Endangered and Threatened Species List. FWC staff recommended that the Homosassa shrew be removed as a Species of Special Concern from Rule 68A-27.005, F.A.C (FWC 2017).

CONSERVATION GOAL AND OBJECTIVES

Goal

The conservation status of the Homosassa shrew is maintained or improved so that the species will not again need to be listed on the Florida Endangered and Threatened Species List.

Objective

I. Ensure the Homosassa shrew's statewide population is stable or increasing.

Rationale

Because of difficulty detecting the species, the Biological Review Group used density information in combination with available habitat within the accepted Florida range to inform the assessment (FWC 2017). The BSR reports that 64% of Homosassa shrew habitat occurs on private lands; the other 36% on public conservation lands (FWC 2017). However, the amount of suitable habitat on private lands is expected to decline by 20% over the next 40 years due to urbanization (Barrett 2017). To achieve this objective, it is important to manage and conserve public and private lands across the Homosassa shrew range to avoid or minimize further isolation and maintain or increase the statewide population.

II. Confirm the taxonomic validity of the Homosassa shrew.

Rationale

Homosassa shrew taxonomy is based on the work of Jones et al. (1991), using 7 morphological characters to distinguish the subspecies *S. longirostris eionis* from the species as a whole. Genetic analysis provides a more direct and reliable measure of genetic isolation and time since divergence; this is necessary to confirm the taxonomic status of subspecies designation.

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 Within the range of the Homosassa shrew, apply management that accommodates the needs of this subspecies and considers microhabitat where appropriate.

This action is precautionary to ensure conservation lands are managed in a fashion compatible with the needs of the Homosassa shrew, and public and private land managers are provided with information to reduce potential impacts to the Homosassa shrew habitat on the properties they manage. Suitable shrew habitat includes a variety of natural, disturbed, transitional, and agricultural landcovers. Regardless of the lack of specific habitat association data, this plan acknowledges (based on the biology and physiology of the species) that land management activities such as roller chopping or development can negatively influence shrew habitat. Activities that reduce the amount of coarse, woody debris on the ground or that lead to reduced moisture-holding capability of soils may decrease the suitability of that habitat for shrews (Layne 1992, Davis et al. 2010). Further, due to the fossorial nature of the species, activities that cause excessive soil compaction or removal of the uppermost soil layers (i.e., humus and topsoil) are considered detrimental to Homosassa shrew habitat.

Land management and restoration intended to enhance natural communities may require the use of heavy equipment and prescribed fire which could negatively impact shrew habitat. However, these short-term impacts are expected to produce long-term benefits to the habitat.

The following recommendations are designed to maintain or enhance the quality of shrew habitat on lands within the range of the Homosassa shrew. These recommendations should be implemented on lands containing potential habitat (Figure 3).

- Maintain downed, coarse, woody debris during timber-removal operations (including logging slash created from limbing gates and timber operations, and even spreading throughout a stand, if possible), and limit fuelwood harvests that would remove coarse, woody debris or existing stumps and logs.
- Leave snags standing when safety is not compromised; sites with snags may support more *Sorex* than other sites.
- Limit use of heavy equipment in undisturbed habitats, particularly in riparian areas or hardwood hammocks to avoid soil compaction and disturbance to the uppermost soil layers (i.e., hummus and topsoil).

Population Management

No population management actions are currently recommended. Basic population dynamics and density estimates for the Homosassa shrew are currently unknown, but can be coarsely estimated based on the similar subspecies *Sorex longirostris longirostris.* Due to the low capture rates of

the Homosassa shrew in Florida, it is not feasible to implement population surveys to estimate abundance.

Monitoring and Research

The range limits and genetic uniqueness of the Homosassa shrew need to be determined. The extent of occurrence used in the status assessment was based on a species distribution established by a single study using morphometric data of a limited sample size (FWC 2017, Jones et al. 1991). The BRG peer reviewers provided input on specific areas of concern related to lack of understanding of habitat associations and the accepted range of the species based on its subspecies status. To address these concerns and achieve the conservation goal and objective, actions have been identified for monitoring and research. These actions focus on answering basic questions about habitat associations and taxonomic status of the Homosassa shrew in Florida.

Action 2 Conduct genetic analysis to determine the validity of the Homosassa shrew subspecies designation and to determine the current extent of occurrence for the Homosassa shrew.

Genetic analysis of *Sorex* in Florida is necessary to determine the extent of the *S. l. eionis* subspecies. This is especially important considering the accepted distribution of the Homosassa shrew is based solely on the morphometric findings of Jones et al. (1991). Morphological differences may be an adaptation to environmental variation, and not necessarily a definitive means to assess species and subspecies delineation.

Genetic analysis is necessary to calculate a more accurate area of occupancy and extent of occurrence. Some specimens from outside the accepted range, particularly in western Florida and southern Georgia, should be included in the analysis. Further, Webster et al. (2009) found morphometric clustering of *S. l. eionis* which suggests the subspecies' range extends to the Apalachicola River and into southeastern Georgia, which exceeds the currently accepted range for the Homosassa shrew.

Due to the secretive nature of the species and relative trapping difficulty, it may take several years for enough specimens to be captured and submitted for genetic testing to definitively confirm or refute the taxonomic status. To reduce the amount of time necessary to capture specimens for genetic testing, specimens should be requested from investigators conducting projects with methods having the potential to collect Homosassa shrews. In addition, it may be useful to consult with taxonomists and geneticists to target specific sites for collecting specimens that would likely be important for measuring genetic diversity.

Variability in genetic techniques can yield differing results, so we recommend that analysis include both microsatellite and mitochondrial analyses. An academic institution, with coordination between field collection and lab-based analysis, should perform this action. Ongoing coordination with research institutions studying will address conservation concerns during project design (see Action 8). The FWC's Mammal Conservation Coordinator and Protected Species Permitting office can work with institutions to develop scientific collecting permit conditions (Action 5), and enhance compliance with these conditions, including the reporting of data collected.

Action 3 Collect all *Sorex* shrews captured during any monitoring activities to obtain samples for genetic analysis and to aid in determining distribution and habitat associations of the Homosassa shrew.

Because there is a high mortality rate among shrews captured using most techniques, incidental captures could provide additional specimens for genetic testing (Action 2). All permits issued by FWC's permitting staff that have the potential to collect *Sorex* shrews include a condition that all dead *Sorex* shrews be retained and provided to the FWC along with pertinent data related to the mortality. That includes shrews collected during drift fence surveys targeting reptiles and amphibians (Action 5). Land managers and researchers, including FWC staff, often conduct small-mammal and herpetofauna inventories on conservation lands, including Wildlife Management Areas. These types of inventories can potentially capture shrews. Data collected often contain information regarding location, habitat type, and seasonality. Existing incidental capture data could be gathered and analyzed to better understand current Homosassa shrew habitat associations within different parts of their range. Use of existing data may be limited by the level to which the subspecies is identified, but future herpetofauna and small-mammal trapping efforts could include further attempts at specific identification. Use of future incidental-capture data could supplement targeted data-collecting efforts without the need for additional resources.

Action 4 Develop a monitoring strategy that implements range-wide surveys at regular intervals to confirm the presence and distribution of the Homosassa shrew.

Homosassa shrews are considered rare where found and are difficult to detect, even when using drift fence trapping protocols, which are recognized as the most effective method (for example the protocol included in Davis et al. 2010) (Teets and Doonan 2015). Incidental captures on Wildlife Management Areas or other conservation lands can provide supplemental information about the Homosassa shrew distribution and presence across the range (Action 3). However, incidental monitoring alone is not sufficient to adequately monitor the status of Homosassa shrews and meet the goals set for this subspecies. When feasible, multiple potential habitat types should be trapped to assess habitat use without introducing temporal or seasonal variation. If simultaneous trapping is not possible because of a lack of resource availability, seasonality and temporal differences should be accounted for during analysis. A 5-year interval may be appropriate for monitoring, but adaptive management should be applied as information is collected. Additionally, data from incidental captures identified in Action 3 should be used in assessing presence and abundance.

Rule and Permitting Intent

This section identifies the current regulations addressing conservation of the Homosassa shrew and discusses some of the potential issues with protections and applicable Species Conservation Measures and Permitting Guidelines.

Current Protections and Regulations

Because they can be locally rare, viability may be threatened by loss of individuals in some parts of the Homosassa shrew's range. Upon removal from listing under Rule 68A 27.005(2)(d), F.A.C., (Designation of Species of Special Concern; Prohibitions; Permits), the Homosassa

shrew retains protections specified in Rule 68A-4.001, F.A.C. (General Prohibitions). Rule 68A-1.004, F.A.C. states that "no wildlife or freshwater fish or their nests, eggs, young, homes or dens shall be taken, transported, stored, served, bought, sold, or possessed in any manner or quantity at any time except as specifically permitted by these rules nor shall anyone take, poison, store, buy, sell, possess or wantonly or willfully waste the same except as specifically permitted by these rules." Permits are issued through Rule 68A-9.002, F.A.C. for "scientific, educational, exhibition, propagation, management or other justifiable purposes."

Protections and Permitting Considerations

The BRG found that the Homosassa shrew does not meet any criteria for listing and staff recommended removal from the Florida Endangered and Threatened Species List. However, the Homosassa shrew still faces threats from habitat loss, habitat degradation, and fragmentation. To meet the goal of this plan and prevent the need for future listing, some protections are still needed. Land management activities intended to enhance natural communities may lead to incidental take of shrews, but exemptions should be created when these activities support long-term improvements to habitat quality and are conducted with appropriate consideration of wildlife. Because research indicates this subspecies occurs in a wide variety of habitats across a range larger than originally thought, the intent is to limit direct or intentional take and recommend non-regulatory methods to minimize activities that might cause incidental take.

Action 5 Improve conditions included in scientific collecting permits to include that relevant data on capture location, mortality data, and other information are submitted to FWC.

The FWC may issue permits authorizing take of the Homosassa shrew, including for the purpose of scientific collecting. Permit conditions can be improved by clarifying the need for the permittee to report specific information including date, location (including global positioning system [GPS] coordinates if possible), and habitat-type information to FWC. Permit conditions also could require that if incidental mortality occurs, specimens are provided for genetic studies and eventual deposit in the Florida Museum of Natural History. This would allow FWC to gather additional data on distribution and habitat use. Scientific collecting permits also may be issued for activities that produce educational benefits to better inform the public and thus benefit the conservation of the species.

Law Enforcement

No law enforcement actions currently are proposed for the Homosassa shrew.

Incentives and Influencing

This plan provides recommendations for methods for increased involvement of partners and stakeholders in management activities that maximize conservation benefits for this species. Implementation of this plan will require the cooperation of many agencies and partners outside of FWC.

Action 6 Develop or enhance existing incentive programs that encourage management of known potential habitat for the Homosassa shrew.

More than 60% of potential Homosassa shrew habitat is on private lands (FWC 2017). The Homosassa shrew may benefit from management actions on these lands resulting in a mosaic of upland and wetland habitat; preservation, restoration, or enhancement of riparian habitat; and maintaining undisturbed cover such as leaf litter and downed woody debris. These activities may contribute to maintaining shrew habitat and population status on private lands without the need for further targeted efforts. Encouraging appropriate habitat management on these lands through technical assistance and financial support will help ensure the long-term survival of this species. FWC's Landowner Assistance Program and other state and federal programs provide technical and financial assistance to private landowners who conduct wildlife management practices on their lands.

Education and Outreach

Education and outreach to public agencies and the private sector are important for maintaining or improving the conservation status of the Homosassa shrew. Citizens who are well informed regarding needs of and potential benefits of wildlife species and their habitats are more likely to support these efforts.

Action 7 Maintain and update information for the Homosassa shrew in FWC's online species profile, social media posts, and educational materials.

The following are some key themes that would benefit the Homosassa shrew if FWC can include them in ongoing education and outreach efforts or as part of Action 5 and Action 6:

- Shrews eat insects – almost 90% of their weight each day – and can be beneficial in yard and agricultural settings.
- Most people will not see a shrew in their lifetime because shrews live under leaves and detritus, and rarely move across the surface of the land.
- When people do find shrews, it is usually as a result of drowning in swimming pools or as a consequence of lawn-maintenance activities.
- Free-ranging cats can kill shrews (and other small mammals, lizards, small snakes, and birds).
- Limiting pesticide use, maintaining leaf litter and downed woody debris, keeping cats indoors, and covering pools when not in use can benefit shrews.

Coordination with Other Entities

Action 8 Coordinate with internal division partners, university, research institutes, non-governmental organizations, and other agencies to achieve actions relating to genetic analysis and to habitat conservation and management, and to further education and outreach efforts related to the Homosassa shrew.

To complete the actions identified in Habitat Conservation and Management, Monitoring and Research, and Education and Outreach, we will need to work with public landowners, non-governmental organizations, and educational entities that manage conservation lands, can assist in data collection efforts, or have particular expertise required by the actions, such as genetic analysis (Action 2). Further, many public and private land managers initiate monitoring efforts designed to identify species lists for the lands they manage (Action 3). As such, coordination

with these managers could result in the collection of occurrence information and, possibly, shrew specimens collected during herp surveys or small-mammal surveys.

Table 1. Homosassa shrew conservation action table.

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

Objective(s) Addressed	Team Assigned Priority Level	Action Number	Action	Conservation Action Category	Status	Implementation leads: FWC divisions or sections	External partners	Likely Effectiveness	Feasibility	Urgency: Is the action immediately critical to the species' survival?
1	1	1	Apply management that accommodates the needs of the Homosassa shrew and considers microhabitat where appropriate.	Habitat Conservation & Mgmt	ONGOING	WHM, CPS, SCP	TNC, FFS, FPS, WMDs	High; Management of shrew habitat and reduction of impacts to microhabitats is expected to produce the greatest conservation benefits.	This action is highly feasible as FWC coordinates with staff and the public to provide recommendations for habitat management or BMPs.	No - no evidence of dire threats to Homosassa shrew populations
1	1	2	Conduct genetic analysis to determine the validity of the Homosassa shrew subspecies designation and to determine the current extent of occurrence for the Homosassa shrew.	Monitoring & Research	NEW	FWRI, SCP	UF/ other universities, Unknown	High; validation of taxonomic status will affect conservation and management decisions and will improve accuracy of the EOO and AOO.	Highly feasible if funding is available to contract genetic work on shrew specimens, and if shrew specimens are adequately captured.	No - no evidence of dire threats to Homosassa shrew populations
2	2	3	Collect all *Sorex* shrews captured during any monitoring activities to obtain samples for genetic analysis and to aid in determining distribution and habitat associations of the Homosassa shrew.	Monitoring & Research	NEW	FWRI, HSC, SCP	TNC, UF/other universities, WMD, private landowners	High; Coordination among internal and external partners through communication and permitting guidelines, facilitates the collection of shrew specimens and ancillary information to inform distribution, habitat associations, and provide samples for further genetic analysis. Existing partnerships with the FL Natural History Museum will facilitate housing of shrew specimens.	Highly feasible through coordination with other agencies. Information about the species may be acquired more efficiently if pulled from existing data.	No - no evidence of dire threats to Homosassa shrew populations
2	3	4	Develop a monitoring strategy that implements range-wide surveys at regular intervals to confirm the presence and distribution of the Homosassa shrew.	Monitoring & Research	NEW	HSC, FWRI, SCP	UF or other research institutions	Moderate; Due to the difficulty in detecting HOSH, establishing a monitoring strategy at regular intervals will help to inform the status and distribution of the species. However, will likely not provide robust information to make population inferences.	Moderately feasible. Establishing a regular monitoring schedule to assess the HOSH will depend on interest and cooperation from FWC staff biologists and partners. Because this is a nonchromatic species and highly difficult to detect, there is likely limited interest in trapping for the HOSH.	No - no evidence of dire threats to Homosassa shrew populations

Table 1. Homosassa shrew conservation action table.

Objective(s) Addressed	Team Assigned Priority Level	Action Number	Action	Conservation Action Category	Status	Implementation leads: FWC divisions or sections	External partners	Likely Effectiveness	Feasibility	Urgency: Is the action immediately critical to the species' survival?
2	2	5	Improve conditions included in scientific collecting permits to include that relevant data on capture location, mortality data, and other information are submitted to FWC.	Protections & Permitting	EXPANDED	SCP	Unknown	High; collecting range and habitat association data, as well as specimens for genetic testing can provide additional information.	Moderately feasibility. Partnerships exist that can facilitate storage of dead shrews collected from research activities. The development and maintenance of a shrew database to record locations will depend on interest and	No - no evidence of dire threats to Homosassa shrew populations
1	4	6	Develop or enhance existing incentive programs that encourage management of known potential habitat for the Homosassa shrew.	Incentives & Influencing	NEW	HSC, SCP	Unknown	Medium/Low; because the HS is small and non-charismatic, it may not receive a tremendous amount of attention relative to more recognizable species. However, encouraging habitat management that benefits multiple species may improve the success of conserving the HOSH.	Feasible. Coordination with LAP and other state and federal partners can provide assistance and recommendations to private landowners.	No - no evidence of dire threats to Homosassa shrew populations
1	3	7	Coordinate with internal division partners, university, research institutes, non-governmental organizations, and other agencies to achieve actions relating to genetic analysis and to habitat conservation and management, and to further education and outreach efforts related to the Homosassa shrew.	Education & Outreach	EXPANDED	SCP, CPS, CR	IFAS	Medium/Low; because the HS is small and non-charismatic, it will likely not receive a tremendous amount of attention relative to more recognizable species.	Feasible for FWC staff to coordinate.	No - no evidence of dire threats to Homosassa shrew populations
1	3	8	Coordinate with internal division partners, universities, research institutes, non-governmental organizations, and other agencies to achieve actions relating to genetic analysis and habitat conservation and management, and to further education and outreach efforts related to the Homosassa shrew.	Coordination with Other Entities	ONGOING	SCP, WHM, FWRI, CPS	UF or other research institutions, TNC, FPS, WMD, FFS, IFAS, DEP, NGOs, local governments	High; FWC alone will not be able to conduct all aspects of this plan, so participation of other agencies to gather data and implement conservation strategies will be critical to the success of this plan.	Feasible, but requires multiple agencies to devote resources to this work and additional funding sources may be needed. FWC currently coordinates with partner agencies, universities, private landowners and other interests; inclusion of Homosassa shrew in these efforts is an attainable extension.	Yes - funding for this effort will likely be limited, so cooperation of all agencies must take place in order to collect sufficient data on this poorly known species while conserving it to the best of our knowledge in the interim.
1		Complete	Provide land managers guidance for estimating Homosassa shrew densities and determining population status on their lands.	Population Mgmt	COMPLETE	CPS, SCP	TNC, FFS, FPS, WMDs	Medium; depends on receptiveness and ability of partners to collect data; but if implemented will provide valuable info on status.	Feasible, though may take some initial research to gather information for providing this guidance.	No - no evidence of dire threats to Homosassa shrew populations

Table 1. Homosassa shrew conservation action table.

Objective(s) Addressed	Team Assigned Priority Level	Action Number	Action	Conservation Action Category	Status	Implementation leads: FWC divisions or sections	External partners	Likely Effectiveness	Feasibility	Urgency: Is the action immediately critical to the species' survival?
1		Complete	Test a variety of trapping techniques to determine which is most appropriate. Trapping techniques may need to be habitat specific.	Monitoring & Research	COMPLETE	FWRI, SCP	TNC, FFS, FPS, WMDs, research institutions	High.	Feasible depending on which agencies are willing to put time and money resources into determining most effective trapping techniques.	No - no evidence of dire threats to Homosassa shrew populations
1		Complete	Retain the Homosassa shrew on the list of species of special concern in rule 68A-27.005, F.A.C., until data collected from implementation of this action plan are sufficient to determine if listing is warranted.	Protections & Permitting	COMPLETE	SCP, Legal	Public and stakeholders	High.	High feasibility.	No - no evidence of dire threats to Homosassa shrew populations

Acronyms used in this table:

CPS:	Conservation Planning Services, a Section of the Florida Fish and Wildlife Conservation Commission's Division of Habitat and Species Conservation
DEP:	Florida Department of Environmental Protection
FFS:	Florida Forest Service
FPS:	Florida Park Service
FWC:	Florida Fish and Wildlife Conservation Commission
FWCG:	Florida Wildlife Conservation Guide
FWRI:	Fish and Wildlife Research Institute, the research branch of the Florida Fish and Wildlife Conservation Commission
IFAS:	Institute of Food and Agricultural Sciences, a program administered by the University of Florida
HS:	Homosassa Shrew
LAP:	FWC's Landowner Assistance Program
NGO:	Non-governmental organization(s)
SCP:	Species Conservation Planning, a Section of the Florida Fish and Wildlife Conservation Commission's Division of Habitat and Species Conservation
TNC:	The Nature Conservancy
UF:	University of Florida
WHM:	Wildlife and Habitat Management, a Section of the Florida Fish and Wildlife Conservation Commission's Division of Habitat and Species Conservation
WMD:	Water Management District(s)

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