

# Emergency Management Action Plan for the endangered Cape Sable Seaside Sparrow *Ammodramus maritimus mirabilis*



Federal Status	Endangered (March 11, 1967)
Florida Status	Endangered
Range	Endemic to Florida Everglades
Population Estimate	~ 2,000 to 3,500 birds
Current Population Trend	Stable
Habitat	Marl prairie
Major Threats	Habitat loss and degradation, altered hydrology and fire regimes
Recovery Plan Objective	Down listing from 'Endangered' to 'Threatened'
<b>EMAP Goal</b>	Develop a decision framework to help rapidly guide sparrow emergency management actions
<b>EMAP Objective</b>	Identify the situations or events that would trigger an emergency management action and provide the details for each action.

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## EXECUTIVE SUMMARY

The following plan outlines emergency actions necessary after an event causes a significant decline in the endangered Cape Sable seaside sparrow (*Ammodramus maritimus mirabilis*) population. The objective of the emergency management plan is to provide guidance during the threatening situation, avoiding delays in executing actions, and reducing the risk of extirpation of subpopulations or the entire taxon. The need for this plan highlights a failure in fully implementing the species recovery plan and thus a failure to remove the risk of extinction. While the sparrow population has remained stable since the massive decline it experienced in the 1990s, the population has shown no signs of recovery and we see little of the habitat restoration deemed necessary for their recovery. Therefore, we must emphasize that, without amending the conditions that led to the birds' initial decline, any implementation of emergency actions are prone to failure.

A large population of sparrows once existed west of Shark River Slough (identified as subpopulation 'A'), and along with this subpopulation the sparrows were distributed across a further five subpopulations (B-F). Now 90-97% of the remaining sparrows are concentrated within two subpopulations (B and E). This restricted distribution makes the sparrow particularly vulnerable to stochastic events. Thus, our emergency action criteria only encompass a significant (75%) reduction in area, occupancy or sparrow numbers in any of 3 subpopulations (B, E and A). The conditions that caused subpopulations C, D and F to decline have not been resolved, and only after significant recovery would we advise their inclusion in the emergency criteria developed here. While we cannot overemphasize the need to recover ALL subpopulations, the objective of this plan is to help managers in an emergency event, not to outline how to recover the species. However, we recognize that without full population recovery the sparrow will always be at risk and in a state of emergency, therefore we reiterate water and fire management requirements for each sparrow subpopulation. We also identify increased availability of suitable habitat as a positive emergency event to instigate actions to take full advantage of restored habitat.

We identify fire and mismanaged water flows as the most threatening events to the sparrow's persistence, both capable of causing short and long-term impacts on the sparrow's breeding habitat. The other emergency triggers are disease, increased predation

and skewed adult sex ratio. Unlike fire and flood, these events would not directly damage sparrow habitat. Reduced survival and reproductive output caused by skewed sex ratios would be unlikely to cause a major population decline alone, but rather be a consequence of small population sizes.

For each of these emergency events, we outline a course of emergency actions (e.g., habitat restoration, conspecific attraction, reintroduction, captive breeding) that managers should follow when emergency criteria are triggered. For each emergency action, we describe protocols and methods, provide a cost estimate, outline monitoring requirements, and detail the federal policies and IUCN guidelines associated with the action. For most actions, we lack adequate information on the effectiveness and/or the feasibility of the actions to stem a decline or extirpation in a Cape Sable seaside sparrow subpopulation. Consequently, major information gaps and research needs are included in this document and summarized in a stand-alone companion document. Finally, decision-tree flow charts provide a graphical schematic of the steps managers need to take in order to remedy emergency situations.

This plan relies on the best scientific information available, but where information gaps exist, authors used expert opinion, including their long-term experience studying the sparrow and working in the Everglades. We envision this plan as a working document, requiring revisions every 5-10 years as new information emerges through additional research and management.

# 1. INTRODUCTION

The Cape Sable seaside sparrow (*Ammodramus maritimus mirabilis*) was first discovered by Howell (1919) on the southern tip of the Florida mainland, Cape Sable. The 1935 Great Labor Day hurricane severely altered the landscape of Cape Sable and the sparrow was never reliably sighted there again. By this time the sparrow had only been recorded at one other location, near Pinecrest Collier County in 1928 and 1932 (Nicholson 1928;1934). The sparrow was believed to be extinct until 1942, when Anderson (1942) rediscovered sparrows “in a little savannah next to the Big Cypress” in Collier County. Stimson (1944, 1948, 1956) set out to find the limits of the species’ range and surprisingly located several groups of sparrows within freshwater marshes of the Everglades interior. Until the remains of two sparrows were located near Long Pine Key in Everglades National Park (ENP; Ogden 1972), the sparrows range was thought to be limited to the prairies west of Shark River Slough. This discovery spurred another extensive search, this time east of Shark River Slough where the core of the sparrow population currently exists (Werner and Woolfenden 1983).

The sparrow’s limited distribution and the persistent threats to its habitat posed by large-scale conversion of land to agriculture led the U.S. Fish and Wildlife Service (USFWS) to list the sparrow as endangered in 1967. Extensive range-wide surveys in 1981 and 1992 yielded a population estimate of approximately 6,500 birds (Pimm et al. 2002). Curnutt et al. (1998) divided the sparrow population into six subpopulations (A-F) based on the location of sparrows during these surveys. Between 1993 and 1996, the sparrow underwent a 50% decline in numbers, especially in the western part of their range (Curnutt et al. 1998, Nott et al. 1998). The decline was attributed to the water management actions of the US Army Corp of Engineers and the South Florida Water Management District that allowed high water levels to persist well into the sparrows’ breeding season (Nott et al. 1998). This action led to legal and management responses that remain controversial to this day (Walters et al. 2000). Recent surveys indicate the sparrow population numbers around 3,000 individuals, with the sparrow essentially restricted to two subpopulations (Pimm et al. 2007b). With such a limited distribution and small population size, the sparrow remains extremely susceptible to extinction.

We divide this document into 4 sections. The first section outlines the Objectives of the emergency management plan. The second section, Emergency Criteria and Events, describes the baseline conditions upon which we evaluate emergencies and explains the criteria used to determine if an event reaches the category of an emergency. This section also summarizes those emergency events believed to pose the most significant threat to the Cape Sable seaside sparrow. The third section, Emergency Actions, describes the emergency management actions recommended for each Emergency Event, while section four contains a series of decision trees outlining the specific management steps, in flow chart form, to follow in the event of an emergency. We also summarized the list of information gaps and research needs included under the Emergency Action section and placed them in a companion document to guide research in the following years. This plan relies on the best scientific information available, but where information gaps exist, authors relied on expert opinion, including their long-term experience working in the Everglades. We envision this plan as a working document that will require revision every 5-10 years as new information emerges from additional research and management.



## **2. OBJECTIVES**

The threat of extirpation of local sparrow subpopulations or the entire taxon prompted the USFWS to request the development of a Cape Sable seaside sparrow emergency management action plan. The goal of this plan is to help guide federal agencies in the event of an impact (or impacts) that threaten the persistence of the sparrow. In the absence of an emergency management plan, agencies responsible for the recovery and protection of the sparrow may be severely hindered by a lack of information and potential remedies. This plan provides step-by-step guidelines in preparation for the eventuality of having to intervene with emergency management actions, improving the efficacy of such actions by reducing the time required to implement appropriate actions.

Specific objectives of this plan include:

- 1) Identify situations or events that would trigger proposed emergency management actions;
- 2) Develop specific management actions for each situation identified in Objective 1;
- 3) Develop a decision framework tree to help guide rapid determination of actions;
- 4) Synthesize information gaps and future research needs.

### **3. EMERGENCY CRITERIA AND EVENTS**

As a first step in this management plan, we describe the baseline conditions for each subpopulation from which managers should evaluate all potential emergencies. In 1981, Kushlan and Bass (1983) conducted the first extensive sparrow survey, systematically searching potential sparrow habitat throughout ENP and Big Cypress National Preserve. This first ‘range-wide’ survey yielded a sparrow population estimate of 6,600 individuals, with most of the birds located in two core areas (subpopulations A and B). Following the survey, Kushlan et al. (1982) produced a management plan with the objective “...to determine and maintain the present distribution of the Cape Sable sparrow and to prevent it from becoming in danger of extinction” (p. 19). The next range-wide survey was not undertaken until 1992, a decade after the original census, and was expanded into many wetter areas to determine if the sparrow’s distribution was wider than expected. It was not, and the population estimate was similar to the 1981 survey. Between 1992 and 1996, the sparrow population drastically declined due to breeding failure associated with high water levels in subpopulation A during the breeding season (Curnutt et al. 1998, Nott et al. 1998, Cassey et al. 2007). Recent sparrow population estimates are between 2,700 and 3,500 birds (survey years 2002-2007: Pimm et al. 2007b). In 2008, the largest subpopulations were B and E, which contained 90-97% of the estimated sparrow population.

We believe that baseline values for each subpopulation should reflect those abundance and distribution levels found at their historic peak (i.e., primarily the 1981 survey). Likewise, the goal of managers should be to increase the abundance and distribution of sparrows to those levels. Achieving historic numbers may be uncertain, but securing a minimum of three healthy subpopulations is needed to ensure that not only are sparrows maintained over as wide an area as possible, but that within that distribution there are functional subpopulations capable of serving as a hedge against a catastrophe in any other subpopulation. This is not a new idea, but it is critical that we provide a baseline from which we gauge potential emergencies. Below, we discuss the baseline conditions for each subpopulation.

### 3.1 Subpopulations

Historically the two largest areas of sparrow habitat and numbers were in subpopulations A and B and these were identified as core areas (DOI 1997). However, the decline in sparrow numbers during the 1990s led to a change in the way we perceive the subpopulations; the vast majority of birds now occur in subpopulations B and E and subpopulations A, C, D, and F support very few birds. We believe that emergency management, and consequently emergency actions, should consider the sparrow population as comprised of rather different subpopulations, each with different emergency criteria. We considered subpopulations B, E, and A as “core” subpopulations and subpopulations C, D, F as “periphery” subpopulations. This separation of subpopulations into groups is a means to prioritize emergency efforts, and, of course, group association may change over time and periphery subpopulations have the potential to be core subpopulations.

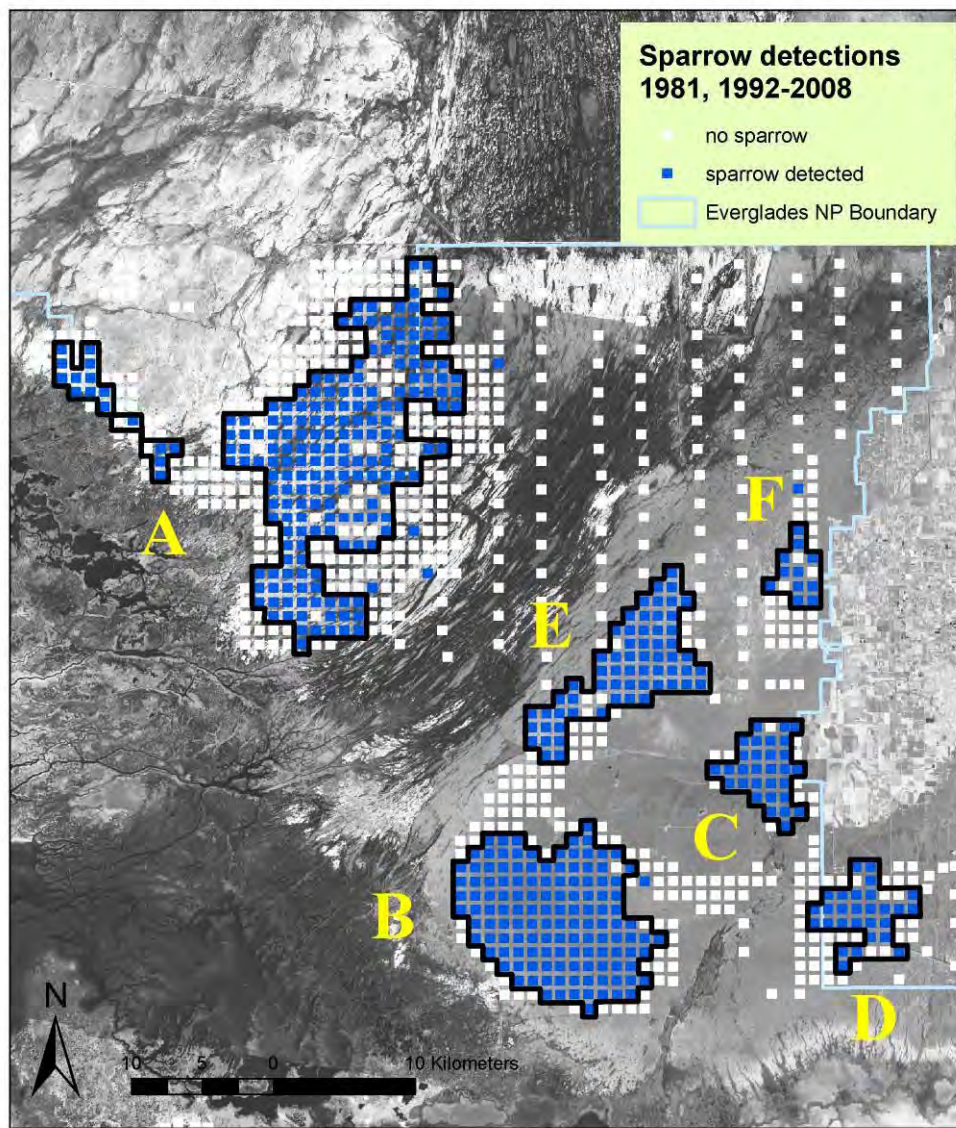
Subpopulation boundaries were determined using the presence-absence data from the range-wide survey points across all survey periods (1981 and 1992-2008; [Figure 1, 2](#)), and we estimated the area of each subpopulation from the subpopulation boundaries. In general, we included all survey points that have ever held a sparrow to create the subpopulation boundaries. Many points have only detected sparrows 1-2 times during the course of the survey period ([Figure 2](#)), often only during the 1981 and 1992 surveys when the sparrow population was at its peak in numbers and distribution. While sparrows are currently absent from many of these original survey points, we believe management goals should be to return sparrows to these previously occupied sites. Thus, subpopulations should represent currently suitable habitat that is either occupied or unoccupied and all potential sparrow habitat (e.g., at some point in recent history it was suitable and occupied).

There are several reasons to categorize the subpopulations as core and periphery areas. First, each core subpopulation has (or had in the case of subpopulation A) the potential to support a large number of birds (>1,000). This criterion is critical as we recognize the relationship between population size and persistence. Secondly, these three core subpopulations (A, B and E) provide the spatial distribution that is important in maintaining the species across its range. Equally important is that each core

subpopulation is somewhat isolated from each other by natural barriers (e.g., Shark River Slough, pine rockland) that would protect sparrows in one subpopulation from a large-scale fire or hydrological event that occurred in a neighboring subpopulation. Finally, subpopulations are biologically separated to a small extent as these same natural barriers also dissuade dispersal to some unknown extent, and thus dispersal within each subpopulation is likely more frequent than between these subpopulations.

In contrast to the core subpopulations, we consider C, D and F as periphery subpopulations for a number of reasons. First, these subpopulations have apparently smaller amounts of habitat than the core subpopulations and they have not supported a significant number of individuals since the 1981 survey (<450) ([Figure 3](#)). Secondly, and most importantly, habitat in these areas appears substantially degraded, requiring significant habitat restoration before the areas will support significant numbers of birds again. However, these periphery subpopulations are important for future sparrow persistence, as they provide another refuge area in the case of a catastrophic event in the core subpopulations. If we could restore 1981 numbers, they represent another significant sparrow area that could serve as a core subpopulation. In essence, these subpopulations have already crossed the threshold of an emergency. Without a significant change in hydrological management (i.e., restoration of historic water flows to the northeastern Shark River Slough) and the removal of invasive woody species (in the case of subpopulation F) to create suitable habitat, emergency actions would be futile.

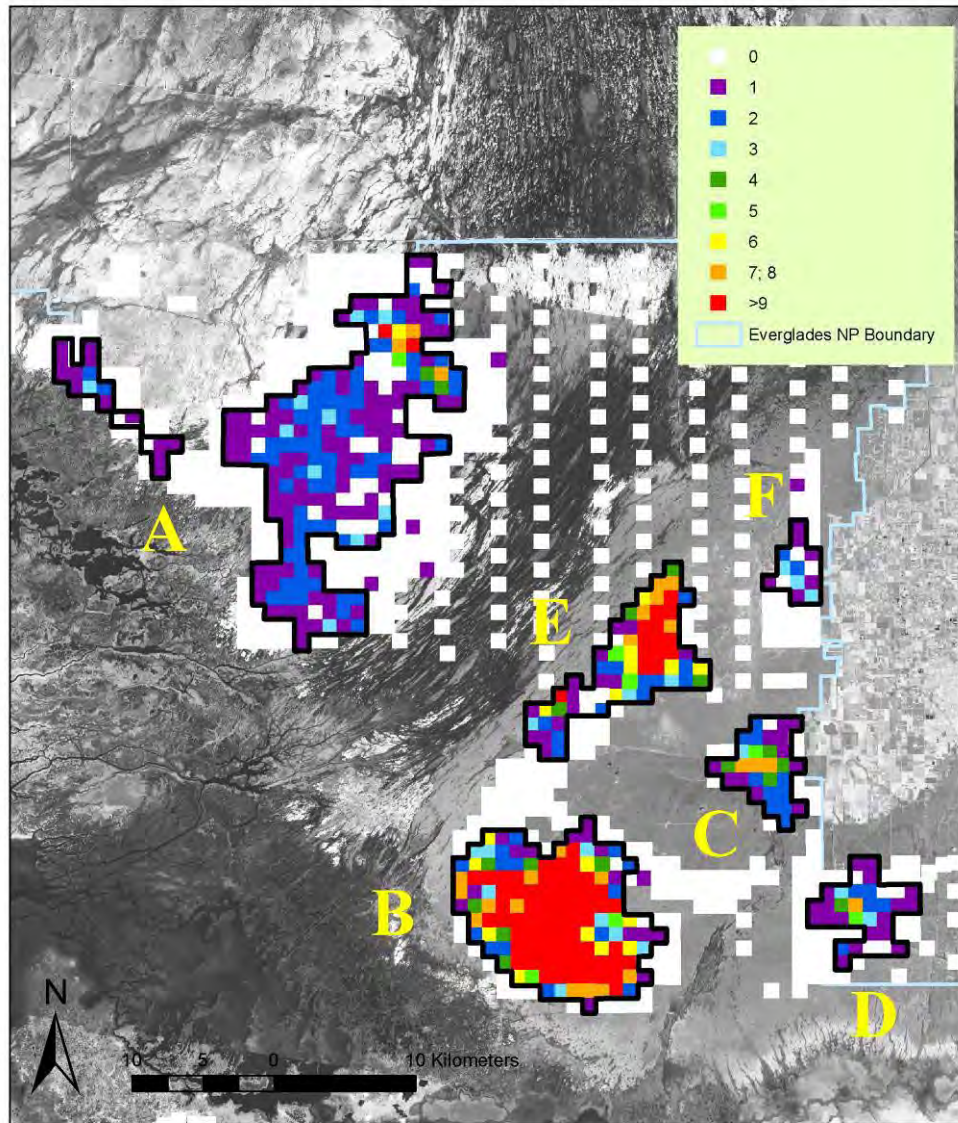
## Cape Sable seaside sparrow subpopulations



**Figure 1.** Map of the six Cape Sable seaside sparrow subpopulations A-F. The core subpopulations are A, B, and E and the periphery subpopulations comprise C, D, and F. The points represent the results from the range-wide sparrow surveys conducted from 1981 and 1992-2008. The survey point data has been converted to illustrate sparrow presence (blue) or absence (white) to help delineate all suitable sparrow habitat for each subpopulation.

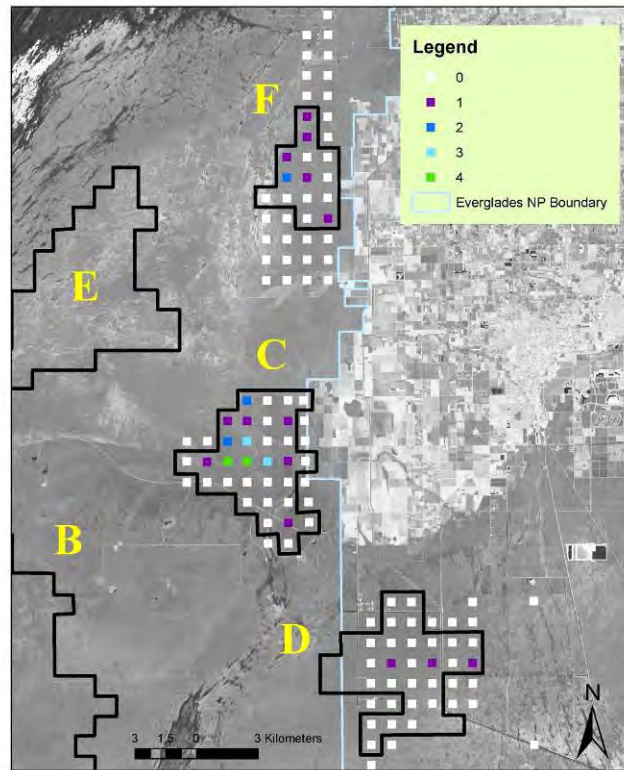


Cape Sable seaside sparrow subpopulations:  
Number of detections 1981, 1992-2008



**Figure 2.** Map of six Cape Sable seaside sparrow subpopulations and the results from the range-wide sparrow surveys conducted from 1981 and 1992-2008. The survey point data is color-coded to illustrate the number of times a sparrow has been detected at each point across all the surveys within the six subpopulations.

Periphery Cape Sable seaside sparrow subpopulations:  
sparrow detections 2003-2008



**Figure 3.** The results from the range-wide sparrow surveys conducted from 2003-2008 in the periphery subpopulations C, D and F. Each survey point is color-coded to illustrate the number of times a sparrow has been detected across the six-year period.

The core subpopulations include:

- (1) **Subpopulation A** is the only sparrow subpopulation situated west of Shark River Slough. This area contains the largest amount of potential sparrow habitat, with approximately 230 km<sup>2</sup> of marl prairie, including an area of mixed cordgrass marsh in the Stairsteps region. In 1981, subpopulation A was the largest subpopulation with an estimated 2,688 individuals. Estimated population size in recent years has hovered around 16 to 112 birds (Pimm et al. 2007b).
- (2) **Subpopulation B** consists of one large (approximately 132 km<sup>2</sup>), contiguous expanse of marl prairie bounded by Shark River Slough to the west, Taylor Slough to the east and the pine rocklands to the north. Subpopulation B has been a stronghold for the sparrows since the original 1981 survey with an estimated 2,352 birds; with similar numbers recorded in recent years.
- (3) **Subpopulation E** encompasses approximately 66 km<sup>2</sup> along the eastern edge of Shark River Slough and is separated from the other eastern subpopulations by the Rocky Glades. The original 1981 survey estimated 672 birds, but recent surveys estimate 368 to 704 birds.

The periphery subpopulations include:

- (1) **Subpopulation C** lies along the ENP eastern boundary near Taylor Slough and contains approximately 31 km<sup>2</sup> of sparrow habitat. The 1981 survey estimated 432 birds in this area, with recent estimates from 48 to 160 birds. The subpopulation has suffered from both irregular seasonal water inundation and frequent fires, but it is the only subpopulation that has shown any sign of recent recovery (Cassey et al. 2007).
- (2) **Subpopulation D** lies mostly outside the ENP boundary within the Southern Glades Wildlife and Environmental Area, managed jointly by the Florida Fish and Wildlife Conservation Commission (FFWCC) and the South Florida Water Management District. It encompasses approximate 33 km<sup>2</sup> of sparrow habitat. The 1981 survey estimated 400 birds, but high water levels since 2000 have resulted in the most recent surveys detecting few or no sparrows.



- (3) **Subpopulation F** is the northernmost and smallest area of sparrow habitat (approximately 14 km<sup>2</sup>), bounded to the east by agricultural and residential development and the ENP boundary. The 1981 survey estimated 112 birds in this area but frequent human-induced fires and exotic tree invasion caused by reduced water flows under the Central and South Florida Project has resulted in the most recent surveys detecting few or no sparrows.

## 3.2 Emergency action criteria

Under optimal conditions, we would determine if we should implement an emergency action from annual measures of the size and demographics for each subpopulation. For an elusive and cryptic species whose habitat is relatively inaccessible, such detailed information is not available. Perhaps in time extinction probability estimates for each subpopulation using a dynamic population model will serve as the most useful arbiter of an emergency event. However, for now we use our expert biological opinion to identify a series of trigger criteria (area, occupancy, population size and demography) that can be evaluated using current monitoring techniques (e.g., habitat assessment, range-wide helicopter survey) to determine when an emergency action should be initiated. Given the status of the endangered sparrow, we use a series of trigger criteria to ensure that we adequately and quickly detect a major population decline.

### 3.2.1 Core subpopulations

#### (i) Area criterion

At the simplest level, we recommend an area criterion, such that if a certain amount of habitat were impacted within a subpopulation an emergency action would be triggered. For each core subpopulation, we estimated the approximate amount of available suitable habitat as a baseline. We recommend a criterion of >75% reduction in available sparrow habitat within a core subpopulation as a trigger for emergency management ([Table 1](#)). This criterion will only be effective for events that visually destroy or alter the sparrow habitat, such as in the case of fire or flood.

The three plausible scenarios are:

- Large-scale event decreases sparrow habitat by >75% in one core subpopulation (equivalent to losing 17,250 ha in subpopulation A or 9,900 ha in subpopulation B or 4,950 ha in subpopulation E; [Table 1](#)).
- Large-scale event decreases sparrow habitat by >75% in two core subpopulations.
- Large-scale event decreases sparrow habitat by >75% in all three core subpopulations.

This criterion provides a quick mechanism to initiate an emergency action following a habitat assessment. However, it would be inadequate for identifying those instances where sparrow numbers in the subpopulations have declined dramatically, but the amount of available habitat is high. For example, if a disease or predator caused substantial sparrow mortality or flooding excluded breeding for a single season (without permanently altering habitat).

**Table 1. Baseline values (1981) and emergency trigger thresholds for the area, occupancy, and population size criteria for each of the three core Cape Sable seaside sparrow subpopulations.**

	Area criterion		Occupancy criterion <sup>a</sup>		Subpopulation size criterion <sup>a</sup>	
Core Subpopulation	Baseline Area (ha)	75% decline in area	Baseline occupancy <sup>b</sup>	75% decline in occupancy <sup>b</sup>	Baseline subpopulation size	75% decline in subpopulation size
A	23,000	17,250	199	49	2,688	672
B	13,200	9,900	130	32	2,352	588
E	6,600	4,950	63	15	672	168

<sup>a</sup> Under full range-wide survey

<sup>b</sup> Number of survey sites occupied

## (ii) **Occupancy criterion**

Kushlan and Bass (1983) designed the range-wide helicopter survey to identify all areas where Cape Sable seaside sparrows were present. This survey information is by far the most comprehensive monitoring effort for this species and as long as the survey (or some portion of it) continues in future years, it offers a more robust means of evaluating an emergency than our area criterion. Cassey et al. (2007) used presence-absence

information from the survey to extract detailed information on changes in sparrow habitat occupancy and site usage. Our use of the presence-absence data is simpler in that we propose to use the percentage of a subpopulation occupied as our occupancy criterion (i.e., the threshold to initiate an emergency action).

We use the same percentage of declining occupancy from the baseline condition, >75%, as for the area criterion. The baseline condition for this criterion is the total number of occupied survey sites within our subpopulation boundaries over the course of all surveys conducted to date ([Table 1](#)). For example, in subpopulation B, sparrows have been present at 130 of the 132 survey points, thus for an emergency action to be triggered, the range-wide survey would have to find sparrows at fewer than 33 (75% of 130) points ([Table 1](#)). [Table 2](#) and [Figures 4 and 5](#) provide a brief history of occupancy in each core subpopulation. It should be noted that column *a*, representing the total subpopulation, has between 86-99% occupancy across the whole survey period. Interpretation of the data within [Table 2](#) is complicated by the fact that the number of survey sites visited during the breeding season often changed through time, usually in response to logistical or resource constraints. For example, we have seen a reduction in the number of sites visited in subpopulation A since 2007, as managers decided that continuing to survey sites with no recent history of sparrows or suitable habitat was an inefficient use of resources. Sites that are not surveyed in a given year because an expert decision has been made that they likely do not have sparrows should be considered absences in the calculation of occupancy.

The three plausible scenarios are:

- >75% unoccupied sparrow habitat in one core subpopulation ([Figure 5](#) indicates that this is the current scenario)
- >75% unoccupied sparrow habitat in two core subpopulations
- >75% unoccupied sparrow habitat across all three core subpopulations

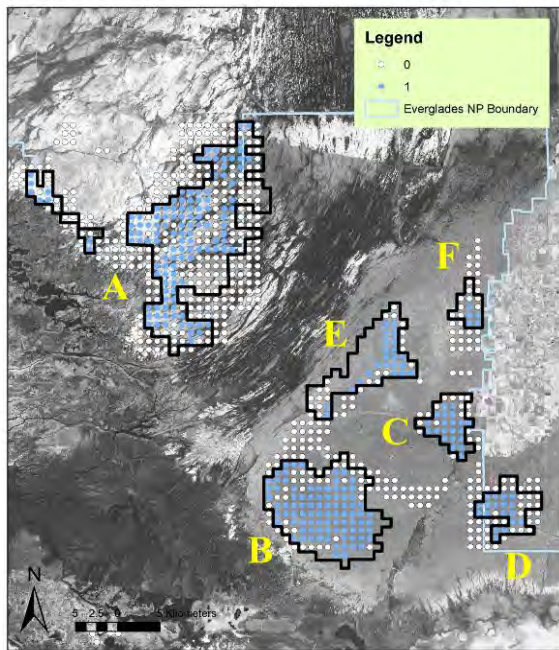
The application of these data as an emergency criterion succeeds only when a large portion of each subpopulation is surveyed each year and surveys are not biased toward presumably occupied sites. For example, if time or resource constraints allowed only

10% of E or B to be surveyed and surveyors concentrated in high occupancy areas, then this would reveal 100% occupancy. However, if sparrows were absent in the other 90% then the true occupancy level would be approximately 10%, clearly triggering an emergency action. In the event of a possible emergency, we recommend a full survey of a core subpopulation, particularly in E and B because it is extremely important to detect a decline in these subpopulations as they hold the majority of the sparrows. Overall, we do not expect this to be a frequent problem as the full range-wide survey is expected to be conducted every three years (S. Bass, personal communication), and we expect a full range-wide survey would be conducted if an emergency event, such as extensive flooding occurred.

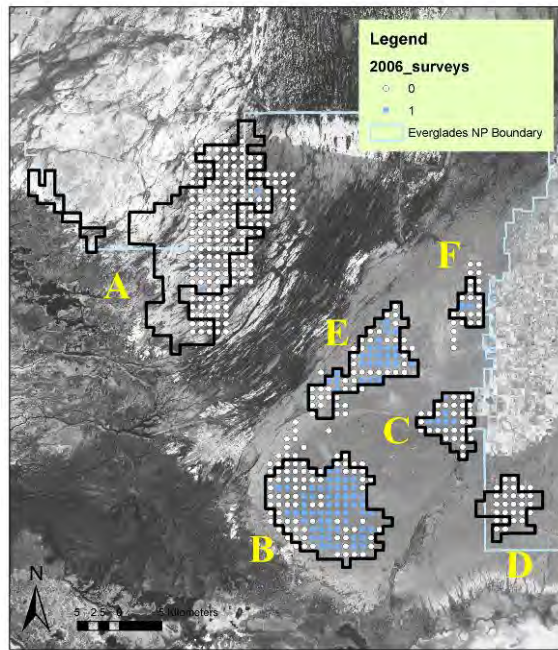
**Table 2.** The size (ha) of the three core sparrow subpopulations and the number of range-wide survey points sampled across the different survey periods. The number in parenthesis represents the percentage of the survey points that recorded a sparrow. (a) Total number of different survey points within each subpopulation across all survey periods (1981, 1992-2008), (b) 1981 the first range-wide sparrow survey, (c) 1996 the first range-wide sparrow survey after the early 1990 population declines, and (d) 2006 the last extensive range-wide sparrow survey and the percentage of total subpopulation surveyed. See [Figure 4](#) for 1981 & 2006 results.

Core Subpopulation	Area (ha)	# points surveyed during survey period [% occupied during survey period]				% Subpop. Surveyed in 2006
		1981, 1992-08 <sup>a</sup>	1981 <sup>b</sup>	1996 <sup>c</sup>	2006 <sup>d</sup>	
A	23,000	230 [86]	226 [54]	95 [12]	122 [2]	53%
B	13,200	132 [99]	121 [73]	119 [43]	121 [47]	92%
E	6,600	66 [96]	41 [56]	41 [17]	60 [43]	91%

1981 range-wide survey



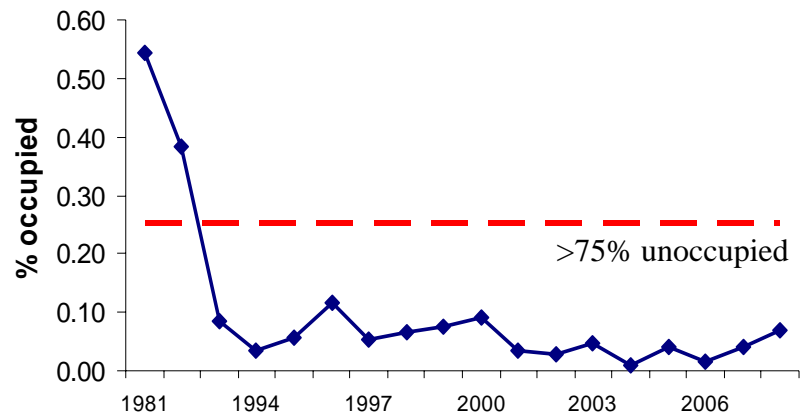
2006 range-wide survey



**Figure 4.** The results from the first range-wide sparrow survey conducted during 1981 and the 2006 survey. The survey point data has been converted to illustrate sparrow presence (blue) or absence (white) within the four management units.

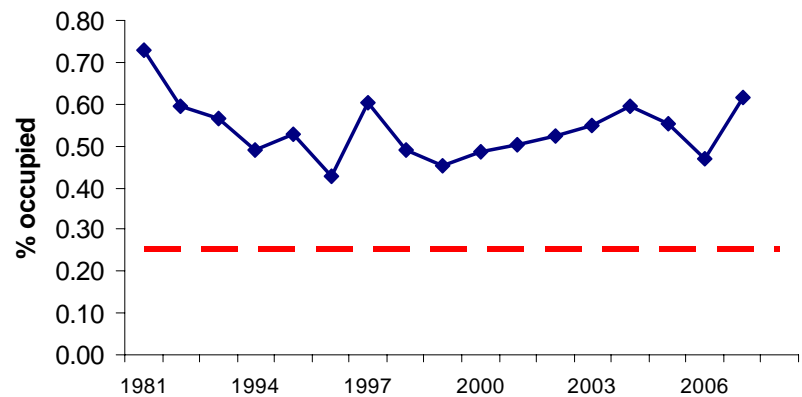
### Subpopulation A

Since 1993, the subpopulation has been below the trigger level.



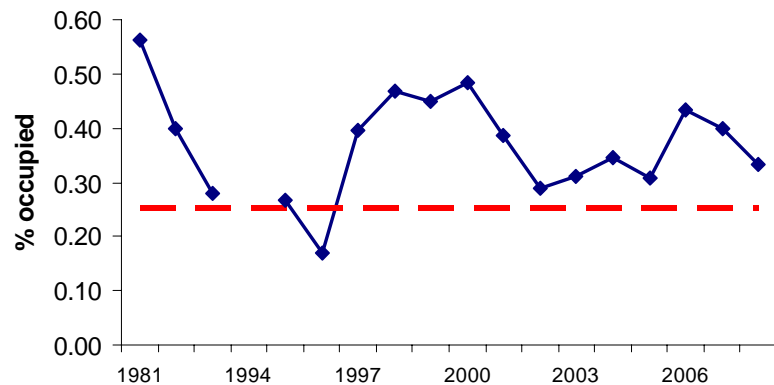
### Subpopulation B

The most stable core subpopulation; above the trigger level since 1981.



### Subpopulation E

Dipped below the trigger level in 1996, recovered and is again showing signs of a decline in recent years.



**Figure 5.** Graphs indicating the annual percent of occupied survey sites within the three core subpopulation boundaries with respect to the baseline conditions in 1981. The red dashed line indicates the occupancy criterion threshold.

### (iii) **Population size criterion**

In addition to the occupancy criteria, we recommend a population size criterion as a second way to use the range wide survey data to identify an emergency. Given the possible limitations of both the occupancy and population size criteria, we feel the best approach is to use both methods. Each year managers estimate the sparrow population size using the number of sparrows counted during the range-wide survey. A correction factor of 16 is used to translate each sparrow detection, based on the distance a sparrow can be heard and the average territory size (Pimm et al. 2002). Presently, sparrow detection probability at different population sizes and in different habitats is unknown. This lack of information may pose problems for estimating true population size, but as another measure to detect large population declines, we believe use of these data as a primary emergency criterion is warranted.

Like the previous criteria, we use a  $>75\%$  decline in population size as our criterion to identify an emergency event. The baseline condition for this criterion is the population size derived from the 1981 survey ([Table 1](#)). Because the range-wide survey generally covers all high occupancy and core areas, the 1981 estimate should be comparable to recent surveys even though the number of sites surveyed may differ among years. Although this criterion could also evaluate the sparrow population size as a whole, we believe it is extremely important to detect population declines in each of the subpopulations separately. For example, a population estimate of 3,000 birds all confined to subpopulation B poses a much higher risk of extirpation than if the 3,000 birds were distributed between subpopulations B and E.

If the population size in any of the core populations decreases by  $>75\%$  then an emergency action is triggered. For example, in subpopulation B, sparrow population size in the 1981 survey was 2,352. Thus, for an emergency action to be triggered, the range-wide survey would have to count fewer than 37 individuals (a population size estimate of 592 with the 16x correction factor; [Table 1](#)). [Figure 6](#) shows the pattern of population size estimates over the course of the range-wide survey, and clearly shows that subpopulation A is currently in emergency status.

The three plausible scenarios are:

- >75% decline in population size in one core subpopulation
- >75% decline in population size in two core subpopulations
- >75% decline in population size across all three core subpopulations

However, like the occupancy criterion, the application of these data is only valid if managers conduct some portion of the survey each year. If a partial survey is conducted, then we recommend that only those points that are surveyed be compared to the same points in the baseline condition to determine if a 75% decline in occupancy has occurred.

#### **(iv) Demographic criteria**

Demographic information, in the form of adult survival, is presently collected in all of the core subpopulations whereas nest survival data is only collected in subpopulation E. How much (and where) monitoring will continue in the core subpopulations is unknown. Given these uncertainties, it is difficult to use demographic information as a primary criterion. However, when available this additional information could provide invaluable insight and it may be useful for initiating an emergency assessment. For example, if nest monitoring revealed wide-scale nest failure during a breeding season, a more detailed range-wide survey should be undertaken the following year.

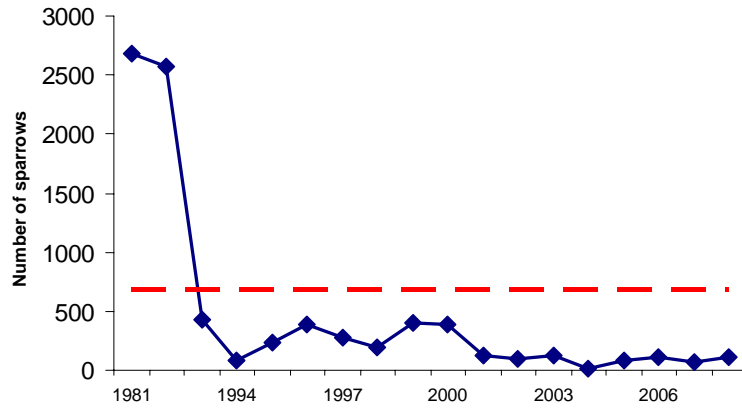
#### **3.2.2 Periphery subpopulations**

If we applied the area, occupancy or population size criterion to the periphery subpopulations, we would consider each to be in emergency states ([Table 3](#), [Figure 7](#)). Indeed, most of the restoration actions proposed under Everglades Restoration are considered emergency management actions for the sparrow (DOI 1997). Until habitat recovers in these subpopulations, it is futile to undertake additional management actions other than those already proposed through Everglades Restoration ([Section 4.1 Habitat management](#)). Here, we recommend that emergency actions should not be considered



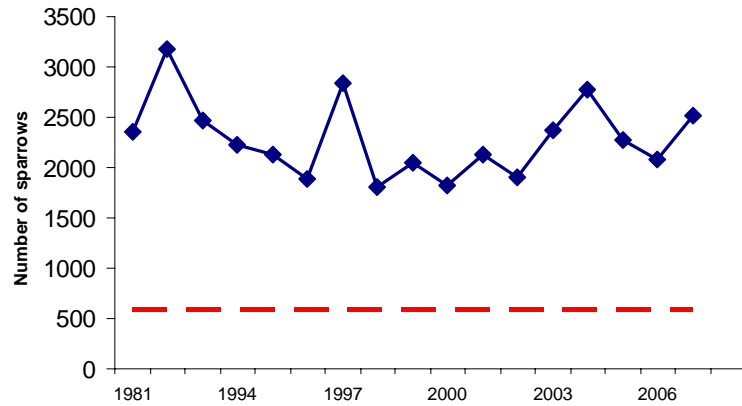
### Subpopulation A

Since 1993 has been below the threshold level.



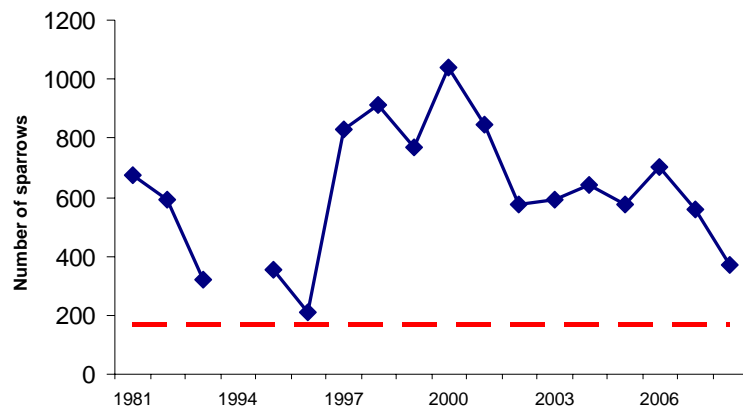
### Subpopulation B

Above the threshold level



### Subpopulation E

Above the threshold level



**Figure 6.** Graphs of population size in the three core subpopulations since the original 1981 survey and the 75% emergency threshold level.

until the population size of two periphery subpopulations have recovered to >50% of their 1981 population estimates, indicating once more the suitability of the habitat (Table 3). Recovery of two areas would constitute a significant population size and permit initiation of emergency actions identical to core subpopulations. Once recovery to this level has been achieved we recommend emergency action triggers if a significant decline (>75% of 1981 numbers) is observed (i.e., they would be treated with the same criteria as the core populations). We propose the use of the population size criteria when assessing periphery subpopulation recovery because the small number of survey sites will cause proportional data (occupancy criteria) to perform poorly.

However, we do not detail the likely scenarios or resulting actions for the periphery subpopulations in this emergency management action plan because such a substantial recovery is likely to take >10 years due to delays in many Comprehensive Everglades Restoration Plan (CERP) projects directly related to improving habitat in these areas.

During this restoration period, we do not recommend ignoring the periphery subpopulations, and in fact, their value cannot be over-emphasized. They offer the opportunity to study small population dynamics that will improve our understanding of the possible implications of large declines in the core subpopulations. Detailed research in the small subpopulations from 2006-2008 have been fruitful and indicate that small populations evince low recruitment, low adult returns, biased sex ratios, and an apparent high rate of long-distance dispersal, but normal nest survival (Lockwood et al. 2006, 2007). We still know very little about the dynamics and importance of these subpopulations for the sparrow's overall persistence. Information obtained now could help answer questions related to how sparrows select breeding habitat when present at very low densities and whether dispersing individuals can rescue declining local populations. Answers to these types of questions will also help us understand which emergency actions are more likely to succeed.

The comparatively easy access to the periphery subpopulations makes them suitable for experimental trials in respect to emergency management actions. The degraded habitat offers safer areas to investigate the use of habitat management tools, such as prescribed fire, to restore suitable habitat. As the habitat recovers, particularly in

the centrally located subpopulation C, preliminary studies of some of the other emergency actions could be undertaken there (e.g. ease and success of hard vs. soft reintroductions).

**Table 3.** The size (ha) of the three periphery sparrow subpopulations and the number of range-wide survey points sampled across the different survey periods. The number in parenthesis represents the number of sparrows recorded x 16. (a) Total number of different survey points within each subpopulation across all survey periods (1981, 1992-2008), (b) 1981 the first range-wide sparrow survey, (c) 1996 the first range-wide sparrow survey after the early 1990 population declines, and (d) 2008 the last range-wide sparrow survey. The last column represents the population size required for a 50% recovery.

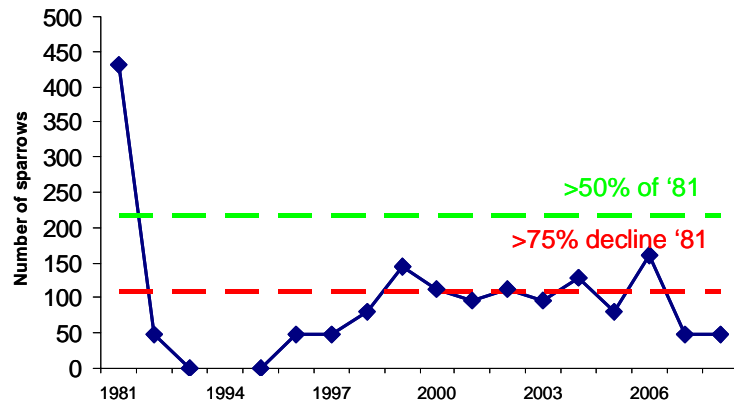
		# points surveyed during survey period [sparrow numbers during survey period]				Population size needed for 50% recovery
		1981, 1992-08 <sup>a</sup>	1981 <sup>b</sup>	1996 <sup>c</sup>	2008 <sup>d</sup>	
C	3,100 ha	31	30 [432]	30 [48]	22 [48]	216
D	3,300 ha	33	33 [400]	29 [80]	16 [16]	200
F	1,400 ha	14	14 [112]	8 [16]	10 [0]	56

### 3.2.3 Emergency assessment

After any trigger event such as a fire, flood, or severe hurricane, an immediate population assessment should be undertaken. Unfortunately, because we can only reliably detect sparrows during the breeding season (April-June), this evaluation may not be immediately executable. At a minimum, managers should evaluate the amount of sparrow habitat impacted, enabling the area criteria to be enacted. Managers should fully implement the range-wide helicopter survey the year following a trigger event in the impacted area to determine sparrow occupancy and population size. After this assessment, we recommend an “emergency working group” of scientists and managers from ENP to assemble to make final decisions about actions in the event of an emergency.

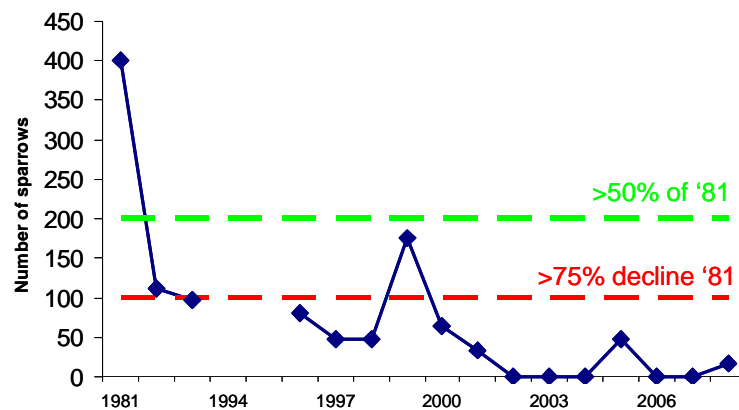
### Subpopulation C

Most likely to recover, declined after 2006 due to a fire burning half of the occupied territories early in 2007.



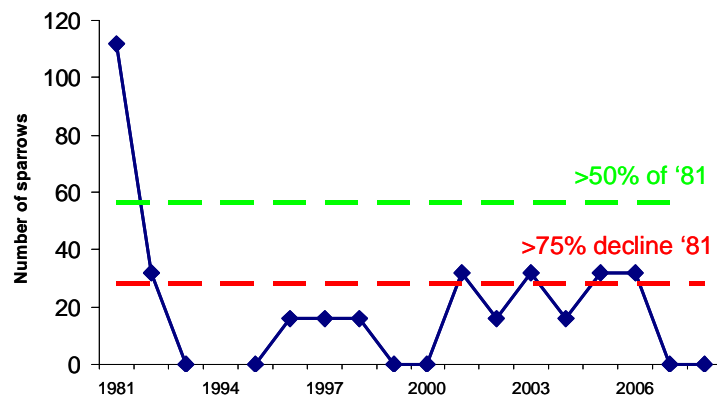
### Subpopulation D

In 2008, only five single males were located.



### Subpopulation F

The entire subpopulation was burnt during the Mustang Corner Fire 2008.



**Figure 7.** Graphs of population size for the three periphery subpopulations, including the levels of 50% and 75% declines from the original 1981 survey. Two of the periphery subpopulations would need population size to rise above the 50% level in order for them to be treated with the same emergency management criteria as core subpopulations.

### 3.3 Emergency events

Understanding the different situations that might lead to an emergency action is critical for the successful implementation of the sparrow emergency management plan. Here, we identify and outline each event/circumstance and how it may trigger a proposed emergency action summarized in [Section 4 EMERGENCY ACTIONS](#). For each event, where appropriate, we summarize its scientific basis as an emergency event, any known impact on sparrow population dynamics, the likelihood of such an event occurring, and an emergency decision framework tree ([see Section 5](#)). We use the best available data and science to determine these emergency events but acknowledge that all views and recommendations are of the authors.

#### 3.3.1 Fire

Anthropogenic actions have undeniably changed the natural hydrology of the Everglades, and while Everglades restoration focuses on “getting the water right”, it largely ignores another fundamental driver of the ecosystem – fire. Like hydrology, anthropogenic actions have altered natural fire regimes; for example, unnatural ignition sources affect fire frequency, size and intensity differently than natural ignition sources (i.e., lightning; Slocum et al. 2007). Incendiary fires (arson or accidental) occur at the end of the dry season, burning larger areas and more intensively than lightning-ignited fires that tend to occur after the first rains of the wet season. Prescribed fires that occur late in the wet season burn patchily and less intensely, often unable to achieve restoration goals. Fire is a natural phenomenon in marl prairies, and the interaction between fire and flooding can have profound effects on vegetation changes and consequently sparrow habitat. For example, evidence indicates that severe flooding directly after fire in sparrow habitat may not only delay the vegetation recovery process, but change the species composition to the extent that it may no longer support sparrows (Sah et al. 2008).

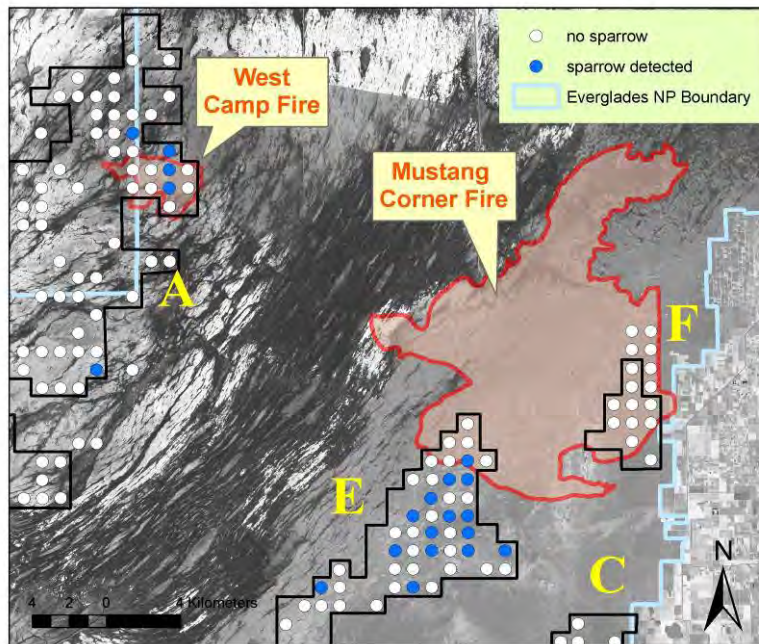
Fire consumes vegetation, making habitat unsuitable for Cape Sable seaside sparrows from two to four years (Werner 1975, Taylor 1985). Much of our detailed understanding of fire and sparrow demography comes from a long-term study plot (2002-2005) in subpopulation E. In 2001, the Lopez Fire burned 3,410 ha, and although human-

ignited, it occurred early in the wet season, typical of a lightning-ignited fire. Sparrows in the burned area either perished or moved far from the area, while the habitat remained unoccupied because the vegetation structure necessary for sparrow breeding was apparently not present. After two years, vegetation structure and composition had returned to pre-burn conditions and local individuals colonized the burn area. Subsequent sparrow density and nest survival did not differ between the burned habitat and the surrounding unburned habitat (La Puma et al. 2007). While a short-term (2-yr) decline in demography occurred, there were no long-term impacts of the fire on the study plot. This is not surprising as the subpopulation was large, allowing for rapid re-colonization by dispersing offspring.

However, changes to the natural fire regimes and the current spatial extent of sparrow subpopulations make the sparrow extremely vulnerable to fire. The risk of subpopulation extinction, and therefore reduced re-colonization success, due to a single fire event has recently been highlighted with medium-scale fires ( $\geq 1,000$ ha) in 2007 and 2008 ([Figure 8](#)) burning half of the occupied sparrow habitat in subpopulation C and A (Lockwood et al. 2007, Boulton et al. 2008). Under different wind conditions, the massive Mustang Corner Fire could have completely burned subpopulation E, C, and F ([Figure 8](#)).

**[FIRE decision framework tree – Page 84; Figure A](#)**

### Everglades Fire and sparrow detections 2008



**Figure 8.** Everglades National Park fires during 2008 that burnt sparrow habitat after the 2008 range-wide surveys. The arson lit Mustang Corner fire burnt 16,000 ha (14-May-08) including most of subpopulation F and the top northern corner of E. The lightning ignited West Camp fire burned 1,000 ha (21-June-08) including occupied sparrow habitat in subpopulation A.

### 3.3.2 Flood

Flooding and the sparrow have a long and often controversial history. Flooding has a number of effects on sparrows and their habitat, not all of which are negative as the sparrows life-history evolution is closely linked to the Everglades – a dynamic freshwater wetland. That said, sparrows are more abundant in areas of shorter hydroperiods where graminoids such as muhly (*Muhlenbergia filipes*), *Rhynchospora* spp., and Florida little bluestem (*Schizachyrium rhizomatum*) dominate the vegetation community. These species disappear in wet prairies with longer hydroperiods, replaced by large patches of sawgrass (*Cladium jamaicense*), which sparrows avoid.

It is clear that prolonged flooding of the sparrows' breeding habitat is detrimental to the sparrow, as evidenced by the precipitous decline in subpopulation A during the 1990s (Pimm et al. 2002). The floods of 1993, 1994, and 1995 in subpopulation A stemmed from the inability of water managers to move large quantities of water into

northeast Shark River Slough after high rainfalls. Water levels were so high in this region from 1993 to 1996 that most sparrows likely did not nest, causing the massive population collapse (Nott et al. 1998). The unforeseen long-term consequence of flooding in this region was a shift in vegetation from wet-prairie habitat, suitable for sparrows, to vegetation dominated by sawgrass, a characteristic of longer hydroperiods. The sparrow population has not recovered (Jenkins et al. 2003a).

We poorly understand vegetation changes in marl prairie in response to hydrological alterations. However, it does appear that prolonged high water can cause a rapid shift in vegetation from a diverse *Muhlenbergia* dominated community to a less diverse sawgrass community (Armentano et al. 2006), like that observed in areas of subpopulation A and D (Nott et al. 1998). A similarly rapid conversion back to a diverse *Muhlenbergia* community and more suitable sparrow habitat has not been recorded, but may require the process of fire (Sah et al. 2008).

In addition to physically flooding nests, it appears that high water levels have a subtle and complex relationship with sparrow nesting survival (Lockwood et al. 1997, Baiser et al. 2008). Sparrow population growth appears driven by successful second and third breeding attempts (Lockwood et al. 2001). However, nests initiated during the onset of the wet season, which are typically second or third attempts, have considerably reduced survival, suggesting a seasonal effect due to a change in predator abundance or activity (Baiser et al. 2008). How water levels are tied to these seasonal effects is not fully understood, and with such altered hydrological conditions, it is extremely difficult to fully predict how such subtle effects might influence the sparrow population.

Although some stakeholders of the CERP argue that water management based on sparrow needs hinders restoration efforts and negatively affects other species, it seems agreed that all agencies and groups wish to see reduced flows to the western areas and increased flows to the eastern Everglades (SEI 2007). Many see the only long-term solution to the problems faced by the sparrow as the success of the Everglades restoration, undeniably an exceptional challenge and one that thus far seems unattainable. CISRERP (2008) concluded that CERP is bogged down in budgeting, planning, and procedural matters and is making scant progress toward achieving restoration goals. While some of the most critical CERP projects for achieving overall restoration goals are



still being designed or planned, some key CERP related projects that will improve water flow to the natural areas are now being implemented ([see Section 4.1.2 \(i\) Hydrological regimes](#)). Positive ecosystem changes may take years or decades to occur once restoration activities are enacted (CISRERP 2008), and sparrows are likely to be impacted during the transition of restoration, making it imperative to have emergency management actions in place.

We outline two scenarios where flooding would create an emergency event, but the emergency management response differs. In one scenario, short term flooding could result in large population declines with sparrow habitat remaining suitable.

#### **[SHORT-TERM FLOODING decision framework tree – page 85; Figure B](#)**

The second scenario describes the situation that occurred in subpopulation A, where high water levels resulted in a large population decline and habitat changed.

#### **[LONG-TERM FLOODING decision framework tree – page 86; Figure C](#)**

### **3.3.3 Disease**

Infectious diseases influence wildlife population dynamics, life-history traits and the community composition. Along with directly affecting the health and survival of individuals, there are concerns about the role disease may play in future biodiversity decline and loss. Most biologists list infectious diseases as one of the major threats to species extinction in the United States (Wilcove et al. 1998). Yet, there is little evidence that disease has contributed significantly to global species loss (Smith et al. 2006). There is emerging evidence of unusually high rates of infectious diseases notably caused by anthropogenic process that alter the dynamics between host and vector populations. Therefore, endangered species may be particularly susceptible to the ill-effects of disease and it is not surprising that conservation biologists are becoming increasingly aware of the possible impact of disease when managing imperilled species.

One fundamental principle of epidemiology is that intensity and prevalence of infectious diseases tend to increase with host population density (Arneberg et al. 1998).

This principle would imply that endangered species at low population densities would be less susceptible to a host-specific infectious disease agent and thus disease management is less important. Then why are conservation biologists so concerned with infectious disease? An endangered population can be vulnerable to disease because of inbreeding and environmental or physiological stress. These factors increase as the endangered population declines, with stress levels being particularly high if the population directly suffers from human actions (e.g. hunting, trapping, habitat loss). Thus, infectious diseases should only drive species extinct under specific circumstances such as when pre-epidemic population size is small, reservoir hosts are available, and when the infectious agent can survive in the abiotic environment (de Castro and Bolker 2005).

We have no evidence that disease has played any role in the decline of the Cape Sable seaside sparrow population, but like most endangered species, there is insufficient baseline data on population health to make a firm declaration of ‘no effect’ (Deem et al. 2001). Generally, the greatest risk of disease in wildlife conservation programs involves animal movement, such as translocation, transportation to captive breeding facilities, movement between facilities and reintroductions. Disease risk in the wild sparrow population is probably low but researchers should be vigilant for any signs of sickness or risk of infection. If disease issues become apparent within reintroduction or captive breeding programs for sparrows, the usefulness of these techniques as emergency actions should be re-assessed, perhaps leading to increased reliance on less manipulative emergency actions (e.g., habitat restoration, conspecific attraction) or more cautious threshold levels (e.g., declines of 50% instead of 75%).

#### **DISEASE decision framework tree – page 87; Figure D**

#### **3.3.4 Increased predation**

The threat of a large sparrow population decline due to increased predation by an exotic or native predator is unknown. We know very little about predation on either juvenile or adult sparrows except that cottonmouth (*Agkistrodon piscivorus*) will take adult sparrows (Dean and Morrison 1998). However, with overall nest survival of only 18% (95% CI 14-23%) and nearly all nest failures attributable to predators, nest predation

is an important factor influencing sparrow demography and population viability (Baiser et al. 2008). Large increases in the incidence of nest predation would likely be detrimental to the sparrow.

Presently we only know that rice rats (*Oryzomys palustris*) are regular predators at sparrow nests, but other native predators likely include the hispid cotton rat (*Sigmodon hispidus*), red-shouldered hawk (*Buteo lineatus*), and American crow (*Corvus brachyrhynchos*). There is no reason why predation rates by native species should increase unless the biological mechanism behind the seasonal effect of nest failure became exacerbated (Baiser et al. 2008). It appears that predator abundance or activity may increase later in the breeding season during the onset of the wet season, thus if managers released water earlier into the sparrow's breeding habitat an increase in predation may occur.

Non-native predators also have the potential to affect sparrows. The Everglades are home to a large number of exotic species, but the recent establishment of Burmese pythons (*Python molurus bivittatus*) in ENP is of great concern for many of the park's species. The python's diet includes most terrestrial vertebrates, ranging in size from house wrens (*Troglodytes aedon*) to bobcats (*Felis rufus*) and alligators (*Alligator mississippiensis*) (Snow et al. 2007). How this species might affect the sparrow in the future is unknown, although clearly it does eat birds as small as sparrows and is a generalist predator. These traits indicate that the python may be a predator of adult or young sparrows.

#### **INCREASED PREDATION decision framework tree – page 88; Figure E**

##### **3.3.5 Skewed adult sex ratio**

One important, but often overlooked, aspect of monitoring and conserving endangered species is the presence of non-breeding, floater males. These birds can cause a significant male biased sex ratio, a phenomena prevalent in globally threatened avian taxa (Donald 2007). A skewed sex ratio may be the major factor limiting population growth, particularly in small, isolated populations (Steifetten and Dale 2006), justifying the use of demographic uncertainty in the sex ratio in population viability analysis (Brook

et al. 2000). A high proportion of non-breeding males may be a good indicator that a population is in trouble and at high risk of extinction. This situation was strikingly obvious with the Dusky seaside sparrow (*Ammodramus maritimus nigrescens*) when the last six known individuals were all males. Surveys during 1977, 1978 and 1979 located 28, 24 and 13 males respectively while the last female was seen in 1975 (Delany et al. 1981).

While the subject of sparrow floater-males and the possibility of their presence overestimating population estimates has been mentioned by Walters et al. (2000), little information to date has been gathered. However, recent work in the periphery subpopulations has revealed a number of non-breeding males associated with each breeding pair (Lockwood et al. 2006, 2007). This situation was extreme in 2008 with four breeding pairs in subpopulation C plus six non-breeding males and only five single males in subpopulation D (Boulton RL pers. comm.). Subpopulations D and F were functionally extinct in one or two years of the three-year study, with only non-breeding males being present in the (limited) suitable habitat in these areas. While some non-breeding males are present in larger subpopulations (B and E), there is no evidence this floater component is very large suggesting this pattern may only be a problem in smaller subpopulations.

There are a number of non-independent possibilities for why we might see skewed adult sex ratios in threatened avian populations (Donald 2007). The two likely possibilities for the sparrow are higher female mortality and sex-biased natal dispersal. Female sparrows may suffer 14-19% higher mortality than males (Boulton et al. In press). Whether this is due to higher mortality during dispersal, costly parental care (females build nests, incubate and brood alone), predation during the nesting period, competition for resources, or some other factor is unknown. In general, natal dispersal is female biased in avian species (Greenwood and Harvey 1982). Whether this is true for Cape Sable seaside sparrows is unknown, as we have only witnessed three long-distance natal dispersal events (1 male, 1 female, 1 unknown sex). Of 78 nestling sparrows banded in the periphery subpopulations during 2006 and 2007, we have resighted three males only, all were within 500m of their natal territory (Boulton RL pers. comm.).

If natal dispersing females have limited ability to search for mates, they may be lost to the breeding pool by settling in unsuitable or unoccupied habitat, leading to a male-biased population within suitable habitat. This scenario can have a profound effect on small and/or isolated populations as female emigration outweighs immigration, further reducing the reproductive output of the population (Dale 2001, Steifetten and Dale 2006), and making it more susceptible to stochastic events and extinction. This mechanism may be seen as an Allee effect as it involves behavioral malfunction at low population densities (Stephens and Sutherland 1999). It therefore seems likely that biased sex ratios will only be a problem in small subpopulations. Before implementing any management action to mediate the skewed adult sex ratio (e.g. release females to balance sex ratio), we need to fully understand why the sex ratio might be skewed and what consequences this might have for population viability.

#### **[SKEWED SEX RATIO decision framework tree – page 89; Figure F](#)**

##### **3.3.6 Population decline of >75%**

It is unlikely that a major sparrow population decline would occur without some evidence of the process involved. However, there may be some situations where we observe a >75% decline in occupancy or sparrow numbers and are uncertain what caused the population decline. If such an event occurred, the only option may be to capture a sample of individuals and move them into captivity until the threat is identified and remedies prescribed, especially if the decline is evident among all core subpopulations.

##### **3.3.7 Availability of suitable habitat**

The success of any management action that deals with the fate of the Cape Sable seaside sparrow relies on the availability of suitable habitat. Restoration of historic water flows through the Everglades is generally conceded as the only long-term solution to the problems faced by the sparrow. Increasing water flows into northeast Shark River Slough and reducing flows into western Shark River Slough have long been regarded as central restoration objectives; however, significant delays to restoration efforts have resulted in there being little or no change. How resilient the sparrow will be during the transition

from current conditions to full restoration is unknown, with perhaps the more difficult questions being how long restoration might take and will marl prairie benefit (SEI 2007).

Although most events that result in an emergency trigger and subsequent initiation of a management action involve negative impacts on sparrow populations, these events need not be negative. Restoration efforts that successfully create sparrow habitat could initiate emergency management actions to take advantage of this available habitat. This action would assume that the sparrow's dispersal capabilities were inadequate to rapidly locate and occupy newly available habitat or that intervention may produce immediate population growth. Newly created sparrow habitat may arise via (a) changed water and fire regimes in poorly managed areas, (b) transition from current conditions to full restoration results in shifts in location of suitable habitat, and (c) reclaimed marl prairie due to removal of exotic trees ([Section 4.1 Habitat Management](#)).

**[INCREASED SUITABLE HABITAT decision framework tree – page 90; Figure G](#)**

## 4. EMERGENCY ACTIONS

In this section, we detail emergency actions aimed at reducing the risk of sparrow extirpation under the specific circumstances identified in [Section 3.3 Emergency events](#). We outline specific information related to each emergency action including suitability, objectives, methods and required monitoring, cost, and duration needed to carry out each action. We also include key information gaps or uncertainties that need addressing prior to implementation of such measures. We use the best available science to determine these actions but acknowledge that without experimental trials the success of the following protocols is uncertain. It is extremely important to treat each management action as a research experiment with a clear experimental design and adequate monitoring to determine the outcome of each action and its ability to recover sparrow populations. As researchers fill information gaps, we expect managers to revise and improve this plan, as more effective or efficient means to accomplish management goals are developed.

### 4.1 Habitat management

The Cape Sable seaside sparrow is restricted to short-hydroperiod (< 7 months standing water) freshwater marl prairies, dominated by muhly grass, sawgrass, *Rhynchospora* spp. and Florida little bluestem in the southern Everglades ecosystem (Pimm et al. 2002). In this ecosystem, humans manage water flow through a series of levees, canals, and pumping stations. Overall, managers have failed to mimic natural hydrological patterns, and consequently, altered hydroperiods (the duration of flooding events) have had adverse effects on the sparrow and the habitat it depends upon within the marl prairie (Nott et al. 1998, Lockwood et al. 2003, Armentano et al. 2006, Slocum et al. 2007). Reduced water flows through eastern Shark River Slough have shortened hydroperiods, increasing drought and fire severity in the eastern sparrow habitats, while unseasonable pulses of water to the west have extended hydroperiods and reversed natural drying patterns in the western sparrow habitat (Pimm et al. 2002, Davis et al. 2005). Sparrows in these degraded areas suffered major declines and the remaining individuals are now restricted to one central area of habitat. This restricted geographic

distribution puts the sparrow in a precarious position and highlights the urgent need to restore the marl prairie.

#### **4.1.1 Objectives**

The primary goal of habitat management is to restore previously inhabited Cape Sable seaside sparrow habitat to a state suitable for sparrow re-colonization. The specific objective of this action is to increase the amount of suitable breeding habitat following an emergency or previous mismanagement using fire, hydrology, or exotic tree removal as management tools.

Success criteria:

- Sparrows re-colonize previously degraded habitat after;
  - Appropriate hydrological conditions are re-established
  - Prescribed fires successfully convert marsh vegetation back into historically present mixed prairie
  - Exotic tree removal

#### **4.1.2 Protocol and methods**

##### **(i) Hydrological regimes**

While specific restoration objectives are beyond the scope of this emergency management plan, we provide a brief summary of the major projects that directly influence the sparrow subpopulations and their likely impact. We then reiterate water management requirements for each sparrow subpopulation.

The nearly \$11 billion (2004 estimate) CERP is vast and complex and has suffered major delays (CISRERP 2008). One major delay has been the WCA 3 Decompartmentalization and Sheet Flow Enhancement Project (Decomp), a project cited as the “heart of the restoration effort” (USACE and SFWMD 2002). It aims to improve sheet flow, hydropatterns, and hydroperiods within WCA 3 and ENP, promoting natural hydrologic recession rates throughout the ridge and slough, marl prairie, and rocky glades landscapes. CERP projects build upon ongoing activities of the state and federal government, many of which are essential to its success. These include Modified Water Deliveries to ENP (Mod Waters) and modification of the C-111 canal, both projects that



will alter hydrologic patterns to resemble pre-drainage conditions. ModWaters is a precursor for Decomp and has been delayed so long that some of its elements, most importantly raising a portion of the Tamiami Trail, have been moved to Decomp. The ultimate effectiveness of Decomp and restoration of flow to northeast Shark River Slough is in question and it seems conditions for the sparrow are unlikely to improve for another 15 years at least, and then only if Decomp is fully implemented.

*Subpopulation A*; water managers released large quantities of water into western Shark River Slough after record high rainfalls from 1993 to 1995. Managers' inability to move water to northeast Shark River Slough because of the flood-control constraints (essentially the protection of the partially developed 8.5-square-mile-area) meant subpopulation A suffered a dramatic population decline and destruction of habitat, with sparrows unable to nest during this period (Curnutt et al. 1998, Nott et al. 1998, Jenkins et al. 2003a). Following these events, emergency water management measures were implemented to avoid further jeopardy conditions, first in the form of an Interim Structural and Operational Plan (ISOP) and subsequently an Interim Operational Plan (IOP). ISOP and IOP were specifically designed to protect subpopulation A by restricting flow from WCA-3A through the S-343, S-344, and S-12 structures into the marl prairies of western Shark River Slough during the breeding season. IOP is to be succeeded by the Combined Structural and Operational Plan (CSOP) when ModWaters and C-111 projects are completed, as the latter are conceived as eliminating the conditions that necessitated emergency management by enabling greater flows to northeastern Shark River Slough (CISRERP 2006).

However, recent evidence reveals that ISOP/IOP conditions have only been met near the NP205 water monitoring station, not near P34 to the southwest where water levels remain high and sparrows have largely disappeared (Pimm et al. 2007a, Pimm et al. 2007b). The best explanation a recent scientific panel heard for this unanticipated pattern was that high water levels in WCA-3A caused water to flow west into Big Cypress through gaps in the L-28 levee (SEI 2007), and this Water subsequently funneled south into the western and southern portions of the prairies of subpopulation A. Only by moving larger volumes of water northeast into Shark River Slough, will the continued threat to sparrow habitat in subpopulation A cease.

*Subpopulation B*; is the largest and most stable sparrow subpopulation, likely due to its position downstream of the elevated pine rocklands, where it is relatively protected from managed water releases. Water managers should attempt to maintain current hydrological conditions within this area.

*Subpopulation E*; the present hydrological conditions in this region appear to be sufficient to maintain suitable sparrow habitat. However, the close proximity to Shark River Slough makes this area, particularly the lower western section, vulnerable to extended hydroperiods. Sparrows in this section declined after 1992, presumably due to flooding (Pimm et al. 2002). Under a fully implemented CERP, the western section is likely to become further inundated and unsuitable for sparrows. However, increased water flows ought to offset this impact by reducing the risk of fire to the drought-prone eastern sections where large scale human-ignited fires along the ENP boundary in both 2001 and 2008 threatened to completely burn the subpopulation.

*Subpopulation C*; holds relatively few sparrows even though it is the only subpopulation to have shown any signs of recent recovery (Cassey et al. 2007). Habitat within this area has suffered in the past from both irregular seasonal water inundation and frequent fires (Pimm et al. 2002). This complex problem arose due to the construction of the S-332 pumping station at the boundary of ENP and Taylor Slough in 1980. Vegetation communities below the structure rapidly changed to resemble long hydroperiod marshes (Armentano et al. 2006), while areas to the north are over-drained, which led to increased risk of fire. Modification to the C-111 canal intends to improve hydrologic conditions in Taylor Slough and the eastern rocky glades in ENP and increase freshwater flows to northeast Florida Bay. How this will affect sparrow habitat in subpopulation C is currently unknown.

*Subpopulation D*; experienced a continual decline since its 1981 estimate of 400 sparrows. With on the ground surveys detecting one breeding pair in 2006, 2007, and 5 males in 2008, it is most likely functionally extirpated (Lockwood et al. 2007, R.L. Boulton, pers obs). Habitat in this area appears to have suffered from high water levels since 2000. Consequently, sawgrass dominates the area with only small drier patches of muhly grass. The C-111 canal basin essentially encloses this area, which results in altered hydrologic conditions and causes extended hydroperiods during wet periods. Restoration

models predict the first phase of the C-111 spreader canal (currently taking place) will create a mound of ground water in subpopulation D critical sparrow habitat, further increasing hydroperiods and water depths. Any further increase in water levels in this area will eliminate over 3,300 ha of once suitable sparrow habitat and any likelihood of subpopulation recovery. We cannot make this counsel any clearer.

*Subpopulation F*; the most easterly sparrow subpopulation situated at the ENP boundary and close to agricultural and residential development. Over-drainage and reduced water flow result from this close proximity to development. Drier conditions and proximity to development have allowed exotic tree invasion (see below) and frequent human-induced fires (Lockwood et al. 2003). Ultimately, this area requires increased water flows to alleviate drought-like conditions.

#### Recommendations

- Determine reasons for increased water flows to western portions of subpopulation A under ISOP/IOP and adjust accordingly.
- Increase water flows to northeastern Shark River Slough via either ModWaters or Decomp.
- Assess ‘benefits’ of C-111 spreader canal to subpopulation C and D.

#### (ii) **Fire regimes**

Fire has the potential to change the composition and structure of the marl prairie, which means that it could be a useful management tool for restoring sparrow habitat. A ‘natural’ fire will cause relatively little change in marl prairie composition and likely control the slow encroachment of woody plants. Whether a similar recovery occurs after a large incendiary fire such as the Mustang Corner Fire is unknown. Flooding soon after fire can cause rapid and enduring changes in the vegetation composition and structure and is responsible for much of the heterogeneity of the marl prairie (Sah et al. 2007, Sah et al. 2008).

Prescribed fires are a powerful ecosystem management tool to reduce fuel and fire hazards, compensating for disruptions to the natural fire regime. Everglades’ fire specialists are now in a position to understand the specific conditions required in the marl

prairie to achieve management objectives and prevent unnatural fires. Most prescribed burns are performed in the wet or transition season in order to mimic historical fire regimes.

(a) *Habitat protection*: Since 1998, Everglades Fire Management has used prescribed fires to burn buffer strips along the eastern ENP boundary in an effort to reduce the likelihood of fire in subpopulation F. Unfortunately, it appears the management is ineffective at times (i.e., drought), as the arson lit Mustang Corner Fire burned the entire area of subpopulation F during drought-like conditions ([Figure 8](#)). Prescribed burns by Everglades Fire Management are also necessary along the eastern edge of subpopulation C. We make this recommendation due to the prescribed fire by the Florida Fish and Wildlife Commission on 8-Mar-2007 adjacent to this subpopulation. The fire (Frog Pond Fire) jumped the boundary canal, and before being extinguished, burnt 183 ha of sparrow habitat and a key breeding site for the sparrows during 2006 (Lockwood et al. 2006). Although the fire was lit during ‘suitable conditions’ (i.e., low risk of escape), it was <1 km from known sparrow nesting sites, and conducted during extremely dry conditions in the dry season – an unseasonal burn. These types of fires are particularly dangerous to small sparrow subpopulations and highlight the extensive knowledge fire managers require to conduct safely prescribed fires near sparrow habitat.

(b) *Habitat improvement*: High water flows in the past, particularly in areas of subpopulation A and D, converted areas of mixed marl prairie into marsh dominant vegetation. Recent work indicates that in subpopulation A marsh-dominant vegetation occurs even in areas where the hydroperiod is typical of mixed prairies (Ross MS & Sah JP pers comm.). There is little evidence that fire promotes the dominance of *muhly*/*Schizachyrium* over sawgrass, but fire frequency and intensity are likely important and might help ‘push’ marsh vegetation back into suitable sparrow habitat. (Sah et al. 2008). Fire burned over 50 long-term vegetation plots in sparrow habitat during 2008 including areas of subpopulation A. Continued research into the response of marl prairie vegetation to fire interval and season and the interaction between fire and flooding may provide information to improve the use of fire as a management tool.

### (iii) Exotic tree invasion

Anthropogenic development and shortened hydroperiods have allowed the encroachment of exotic trees in the eastern marl prairie, damaging potential sparrow habitat. Aggressive management by ENP has successfully killed most exotic trees (*Melaleuca* [*Melaleuca quinquenervia*], Brazilian pepper [*Schinus terebinthifolius*], and Australian pine [*Casuarina equisetifolia*]) near the sparrow subpopulation F. However, this habitat remains unsuitable for sparrow occupancy because dead trees, mainly *Casuarina*, remain as either snags (perches for avian predators) or ground cover (obstructing sparrow nest placement). Ground surveys within subpopulation F indicate this is suitable habitat except for the standing or downed dead exotic trees (Lockwood JL, pers obs). Removal of these dead trees could render the habitat suitable for sparrows. Cutting the dead trees down, although helpful, does not remove them from the habitat. We suggest removing these trees by mulching or using a stump decay product. Managers should take vegetation measurements of structure and composition before exotic tree removal in both the control and treatment plots and for each year following the management action. Although the Mustang Fire burned some of these areas in 2008, it is not yet known what the effect of the fire was on the dead trees.

#### 4.1.3 Estimate of cost

Emergency action	Task description	Estimated cost (\$000s)	Comment
Restore disturbed potential sparrow habitat, creating opportunities for re-colonization of former habitat	<ul style="list-style-type: none"> <li>Implement appropriate hydrologic regimes necessary to support CSSS habitat</li> </ul>		Cost difficult to determine because task involves extensive cooperation and cost sharing among a number of agencies
	<ul style="list-style-type: none"> <li>Use prescribed fire to convert marsh vegetation back into mixed prairie</li> </ul>	2/ha <sup>a</sup>	Total cost depends on area managed
	<ul style="list-style-type: none"> <li>Kill exotic trees in CSSS habitat</li> </ul>	1-3/ha <sup>b</sup>	Total cost depends on area, density and exotic species
	<ul style="list-style-type: none"> <li>Remove dead exotic trees from sparrow habitat</li> </ul>	6/ha <sup>a</sup>	Total cost depends on area managed and methodology

<sup>a</sup>Estimate from the implementation schedule for the South Florida multi-species recovery plan (US Fish and Wildlife Service 2006).

<sup>b</sup>Estimate from H. Cooley (ENP Botanist). Note this task is likely complete, with only follow-up work necessary.

#### 4.1.4 Monitoring requirements

Prescribed burns should be undertaken in relatively large contiguous areas (approximately 2km x 1km) of effected habitat near enough (2-3 km) to currently occupied habitat so that the site has a reasonable chance of being re-colonized but not so close it risks burning the occupied habitat. Vegetation measurements of structure and composition should be taken before the prescribed fire in both the control (occupied or recently occupied) and treatment plots and for each year following the management action. Such a systematic and experimental approach in sawgrass-dominated areas could yield compelling results.

Monitoring in areas where prescribed fire or exotic tree removal is conducted should be undertaken for 3-4 years post-management action based on prior results related to fire effects (La Puma et al. 2007, Sah et al. 2008). Managers should replicate occupancy surveys over the same period in both control and treatment areas to determine when and to what extent sparrows re-colonize the restored habitat. Researchers

monitoring any newly occupied areas should band all individuals. They should also monitor all nests found in newly occupied areas to determine nest success rates, and compare these rates to nesting data from the long-term study plot in subpopulation E (Lockwood JL, pers obs) to determine if productivity reaches similar levels after restoration.

During the expected construction of CERP projects set to commence, there is an enormous opportunity to monitor the demographic response of sparrows to these management actions. Therefore, we recommend that adult and nest survival data across the subpopulations and the range-wide helicopter survey continue, as they will provide valuable information related to the birds' responses to these management actions.

#### **4.1.5 Identification of key information gaps and uncertainties**

##### Hydrology

- Continue long-term research into the response of marl prairies to different hydrological conditions.
- Investigate how and where additional marl prairie might be restored as projects within CERP are implemented.

##### Fire

- Continue long-term research into the response of marl prairies to fire.
- Investigate the effectiveness of prescribed fire to convert marsh into wet prairie habitat in marl prairies.
- Continue to monitor the response of sparrows to fire, particularly the rate they re-colonize burnt habitat in different areas and/or fire intensity.

##### Exotic tree removal

- Investigate methodology and feasibility of exotic tree removal for restoration of sparrow habitat.

## **4.2 Reintroduction**

The principal goal of reintroduction is to re-establish a self-sustaining population of a species, subspecies, or race that is extinct or extirpated in the wild (IUCN 1995).

Reintroduction can augment (termed “reinforcement” or “supplementation” by IUCN 1995) populations that are small and at risk of extirpation. Although an increasingly popular conservation tool, reintroductions should only occur within a species’ natural range where habitat is sufficient to support a viable population, and where protection from the factors that caused the species disappearance are rectified and long-term management is expected to be minimal (IUCN 1995).

Despite the widespread use of reintroductions to re-establish populations of native species (Tear et al. 1993, Wolf et al. 1996), rigorous, well-documented assessments of post-reintroduction demography remain scarce (Fischer and Lindenmayer 2000, but see Armstrong and Ewen 2002, Armstrong et al. 2006). The failure to monitor the demography of reintroduced populations has hindered the identification of factors associated with reintroduction success and retarded progress in improving the success rate of species reintroductions (Scott and Carpenter 1987, Sarrazin and Barbault 1996, Fischer and Lindenmayer 2000, Seddon et al. 2007). Consequently, numerous reintroduction techniques are available to conservation practitioners, but we know little about which techniques work best, and this is the case for the Cape Sable seaside sparrow. A recent workshop has suggested the trial reintroduction of sparrows (SEI 2007). Translocation of wild animals from other parts of their range or through the release of captive individuals (either wild-or captive born) is one of the first decisions of a reintroduction. In this section, we focus on the use of translocation of wild animals from other parts of their range and leave comments regarding captive breeding to their own section ([see Section 4.6 Captive breeding](#)).

Comparative analyses indicate several factors may be associated with reintroduction success (Griffith et al. 1989, Wolf et al. 1996). The most important variables are location of release area (core versus periphery or outside species’ current range), number of animals released, habitat quality, status of species (threatened versus game), and taxonomic class. Only the first three directly apply to a release of the sparrow, and these were given significant consideration in a protocol for translocating sparrows developed by Jenkins and Pimm (1999). That protocol followed IUCN guidelines developed to introduce rigor into the concepts, design, feasibility and implementation of reintroductions, despite the wide diversity of species and conditions involved.



In the following section, we outline a proposed methodological approach to conducting reintroductions of Cape Sable seaside sparrows in the event of an emergency. Although, we believe our methods outline the best chance for reintroduction success, it is clear that preliminary pilot studies to investigate reintroduction approaches would be highly beneficial prior to the implementation of a full reintroduction program. It is also important that any reintroduction effort be designed to address *a priori* questions to improve future reintroduction success (Armstrong and Seddon 2008). Given the lack of knowledge regarding sparrow reintroductions, any reintroduction program will need to incorporate the principles of adaptive management.

#### **4.2.1 Objectives**

The primary goal of reintroduction is to re-establish or augment sparrow populations where they have declined below the thresholds identified as triggers for emergency action ([see Section 3.2 Emergency action criterion](#)). The specific objective of this technique is to increase population size in subpopulations as rapidly as possible following an emergency, as a hedge against risks of extinction. Before implementing a reintroduction action, several assumptions need to be met. First, there must be suitable, but unoccupied habitat available for colonization by sparrows, and this area should be large enough to support a self-sustaining population. Second, a sufficient source of birds to conduct a translocation must be available from a donor population large enough to withstand removals. Finally, protection and management assurances need to be in place at the reintroduction site such that these habitats will remain suitable for sparrows in the future.

Success criteria:

- Establish a self-sustaining population in the release area. However, the term ‘self-sustaining’ is ambiguous without a defined temporal framework and without taking into account various dynamic scenarios, including unexpected catastrophic events. Managers must state these aspects prior to the initiation of the reintroduction effort.

- Evaluating reintroduction success is a critical step, and best approached using both short and long-term criteria (Sarrazin and Barbault 1996).

Short-term or year-to-year success measures

- Reintroduced birds establish territories and reproduce successfully.
- The population size increases in successive years.

Long-term success measures

- We suggest using a comparison of demographic rates of reproduction and survival between the reintroduced population and the source population during the period that translocations are occurring. The primary assumption here is that the long-term growth rate of the source population (i.e., high quality reference site) is  $> 1.0$  and thus provides a suitable measure against which to judge success of the reintroduced population.
- Ultimately, when enough data are available, it will be critical to evaluate the long-term demography of the reintroduced population through a population viability analyses to estimate extinction probability, population size, growth rate, and growth rate variance estimates under various sets of environmental conditions. Russell and Jenkins (pers. comm.) have developed a demographic model for the Cape Sable seaside sparrow and it may be possible to adapt that model for this step to be completed.

#### **4.2.2 Protocol and methods**

Managers have never attempted to reintroduce sparrows to unoccupied sites, although Jenkins and Pimm (1999) drafted a detailed reintroduction protocol for the sparrow. This protocol explicitly describes the step-by-step guidelines, as outlined by the Reintroduction Specialist Group of the IUCN's Species Survival Commission (IUCN 1995), necessary to conduct a reintroduction of the sparrow. The guidelines include sections on pre-project planning activities, socio-economic factors, release strategies, and post-monitoring activities. In this section, we focus on the specific decisions related to release strategies, outlining several methods for reintroducing sparrows, other aspects such as socio-economic benefits and are not repeated here. Our reintroduction strategies vary with respect to timing and logistical constraints, and we propose a preferred

alternative that we believe would provide the best opportunity of success given the information currently available. However, other strategies have significant potential of success and it is clear that researchers need to investigate various reintroduction approaches to identify the most efficient and productive reintroduction methods prior to the implementation of a full reintroduction.

**(i) Source of birds (wild vs. captive-bred)**

The use of wild birds is clearly associated with improved success in reintroduction efforts for numerous reasons (see [Section 4.6](#)) (Wolf et al. 1998). Releases of wild birds have been successful in re-establishing extirpated land birds in many parts of the world (Komdeur 1994, Armstrong and Ewen 2002), including pine forest habitat in the Everglades (Slater 2001). The improved success of reintroductions with wild birds reinforces the need for this management action to happen while birds exist in the wild in sufficient numbers (Jenkins and Pimm 1999). Waiting until birds breed in captivity greatly reduces the chance of success of any reintroduction effort.

**(ii) How many birds to release and over what time period?**

The decision of how many birds to release into the reintroduction site is based on how many individuals one believes is necessary to avoid the extinction risks associated with small populations (demographic stochasticity, allee effects, inbreeding and loss of genetic diversity). No magic number insures success, but other reintroductions provide guidance. A comparative analysis indicated that success of mammal and bird reintroductions were correlated with the number of individuals released, although the correlation was asymptotic, with releases of more than 80-120 individuals not influencing success (Griffith et al. 1989, Wolf et al. 1998). However, populations have also been established with a small number of founder birds (<15) (Taylor et al. 2005). The number of founder individuals necessary to establish a population will likely depend on the circumstances of the reintroduction and the characteristics of the release site and species (Taylor et al. 2005). For example, in New Zealand, reintroduced populations of saddlebacks (*Philesturnus carunculatus*) and robins (*Petroica australis*) were established with a small number of founders in closed systems (i.e., islands) where habitat was favorable and species' sedentary behavior favored high pairing success. In the

Everglades, Slater (2001) successfully established nuthatch and bluebird populations to pine forests with fewer than 50 individuals.

Information on the probability of a released individual sparrow becoming successfully established (i.e., establish a territory and breed successfully) to the release area would assist in decision-making of the number of birds that should be released. Thus, we strongly suggest pilot studies to look at this question prior to a full reintroduction. Reintroductions of Cape Sable seaside sparrows could potentially be successful with relatively small numbers of individuals ( $< 80$ ), as some features of the habitat and the species' behavior is similar to those found in New Zealand. The apparent lack of suitable habitat between subpopulations mimics the situation for true islands, and consistent with this comparison, dispersal by the relatively sedentary sparrow among subpopulations is rare (Pimm et al. 2002). These conditions are similar to those in New Zealand where high pairing success promoted high initial population growth rates. Another condition to consider is that vital rates in a small, reintroduced population might be higher than a fully saturated population due to the absence of density dependent factors, which also would produce high initial population growth rates.

However, until there is more information on the probability that a released sparrow will settle in the reintroduced habitat, we suggest a relatively conservative approach in determining the number of released birds necessary to insure successful establishment. Incorporating an adaptive management framework is necessary as the project progresses. At this time, we believe releasing a minimum of 80 individuals to a reintroduction site is necessary for successful establishment.

### **(iii) Length of reintroduction effort**

The amount of time needed to reintroduce a minimum of 80 birds will likely be 3-5 years, as availability of birds from source populations and logistical considerations will constrain the effort. The removal of 20-40 birds, equally divided among sex, from a donor population, would represent a net annual loss of ~5% of a population of 700 individuals. The only areas likely to serve as source populations at the time of writing (2008) are subpopulation B and E, both of which have had  $>700$  individuals in recent years. In south Florida, Slater (2001) removed approximately 3% of breeding adult bluebird and nuthatches from a donor population each year over a four-year period.

Under that situation, pairs reoccupied all removal sites prior to the following breeding season.

**(iv) Timing of captures, sex and age of individuals**

Timing of reintroduction is an important consideration. Notably, timing is dependent on when researchers can successfully catch individuals for translocation. However, it is also necessary to consider maximizing the proportion of released birds alive at the start of the subsequent breeding season, when a reintroduced population can begin to grow. Previously, researchers have caught adult sparrows throughout the breeding season and juveniles towards the end of the breeding season (June-July) when they form small inquisitive flocks. Thus, there are two reasonable times to attempt a sparrow reintroduction (1) prior to the breeding season, and (2) towards the end of the breeding season. The benefit of capturing individuals prior to breeding, is that, once released they have the potential to breed immediately. Whereas releasing individuals post-breeding can reduce the number of individuals available at the start of the next breeding season due to annual mortality.

Capturing equal numbers of male and female sparrows prior to breeding may be logistically challenging, as adults are easier to catch when breeding and females are notoriously difficult to capture. Adult males respond aggressively to song playback on their territories but females are more wary. Capturing females requires first locating the female, setting up a mistnet nearby, and then attempting to flush her into the net. In contrast, capturing juveniles late in the fall is relatively easy and will likely provide near equal numbers of males and females. Sexing juvenile sparrows has proven successful, with slightly larger wing and tarsus measurements for males (Davis MJ pers. comm. and unpublished data).

Research comparing these two periods would be valuable to identify the most appropriate time to capture individuals. However, until we have more information on the best time to release sparrows, we recommended catching individuals in the easiest manner, which is towards the end of the breeding season when juveniles begin to form small flocks. It is important that personnel involved in the capture procedure are familiar with Cape Sable seaside sparrows to help increase rapid capture and chances of success (Baker-Gabb 2008). After a relatively successful breeding season, we estimate that two

experienced researchers could catch 10-15 juveniles in a single morning. A number of adult sparrows can accompany juvenile flocks during this period, but they are clearly identifiable due to molt. We suggest releasing known adults immediately and only using juveniles for the translocation; sexing individuals would be attempted using morphometrics. Juveniles disperse further than adult sparrows, presumably to find vacant territories. This propensity to disperse may predispose them to be better settlers, should they encounter vacant habitat. However, sparrows will have time to scatter widely and may not find mates the following breeding season. Whether released juvenile sparrows suffer low nesting success due to the lack of breeding experience is unknown, but there is no evidence to suggest nesting success increases with sparrow age.

**(v) Transport**

Methodologies to transport birds are well established to minimize stress and risk of disease (Bocetti 1994, Slater 2001). After capture, we would initially hold all individuals in opaque cloth bags. Once banded, we would introduce these individuals to small, standard pet birdcages for transport to the release site. These cages, which can usually hold  $> 2$  individuals, should offer perches and food (i.e., live mealworms). Spreading mealworms on the bottom of the cage maximizes the visual stimulus of the food. In nuthatch and bluebird (both eastern and western) reintroductions, individuals typically ate within 30 minutes (Slater, pers. obs). Water dishes pose a risk to caged birds during transport. If feathers become saturated an individual's ability to thermoregulate is reduced, increasing stress to an already stressful situation. Therefore, water is probably unnecessary if transportation to the reintroduction site is less than a couple hours. Covering cages with cotton cloth during transportation reduces light but allows air circulation into the cage. Maintaining minimum interaction between pairs is required if transporting multiple cages and pairs prior to the breeding season, as individuals can get overly agitated in adjacent cages, increasing stress. Given the location of sparrow habitat within the Everglades, transport to the release site will likely be with a helicopter.

Sterilizing bird bags and cages between captures is necessary to reduce the risk of disease transmission.

**(vi) Hard vs. soft release strategy**

Little information is available to determine the best release strategy for Cape Sable seaside sparrows. Evidence from previous bird translocations indicates no difference in success using hard vs. soft release strategies (Griffith et al. 1989, Clarke et al. 2002). Given the absence of information on sparrow reintroductions, we suggest employing a hard release strategy first, especially if releasing juveniles in the fall. These individuals are likely to disperse and investigate the release site anyway, so holding them to become acquainted with the area may only increase logistical challenges.

However, there may be some benefits in considering a soft release, particularly during translocations prior to the breeding season. This technique, used in the Everglades with brown-headed nuthatches and eastern bluebirds, resulted in approximately 65% of the released pairs establishing territories and breeding together. Recent work in the San Juan Islands with western bluebirds also found that if translocated pairs were allowed to begin nest-building in the aviary (which usually occurred <14 days) and then released, pairs remained at the release site and immediately nested. Such a strategy has significant benefits, as fewer individuals are required from the source area and released birds can begin mating almost immediately. These soft-release reintroductions used mobile 8 ft x 8 ft x 8 ft aviaries, constructed of plywood and hardware clothe, at the release site. Researchers easily moved these aviaries to new areas for subsequent reintroduction events.

**(vii) Additional method considerations**

We suggest investigation into the use of conspecific attraction techniques to improve reintroduction success.

**(viii) Summary of release strategies and preferred alternative**

We critically need research to evaluate the many decisions involved in developing an effective and efficient reintroduction strategy for the Cape Sable seaside sparrow. Below, we list several strategies that we favor and identify a preferred reintroduction program based on our knowledge and experience of reintroduction techniques and efforts, and on the information available concerning the life history traits of Cape Sable seaside sparrows. At this time, it seems wise to follow the most logistically simple, yet scientifically sound, reintroduction method. However, for any reintroduction,

implementing the principles of adaptive management as we acquire additional information from reintroduction activities will improve the probability of successfully establishing individuals.

- **Preferred Strategy: Capture 20-40 young of the year in the fall when sparrows are easier to catch. Transport individuals to release site and conduct hard release. Conduct over 3-5 years.**
- Alternative Strategy 1: Capture 20-40 young of the year *and adults* in the fall when sparrows are easier to catch. Transport individuals to release site and conduct hard release. Conduct over 3-5 years.
- Alternative Strategy 2: Implement the Preferred Strategy or Alternative Strategy 1 using soft-release techniques.
- Alternative Strategy 3: Capture 5-10 breeding pairs prior to the breeding season and transport to the release site. Conduct soft release, holding individuals from 1-7 days. Conduct over 3-5 years.
- Alternative Strategy 4: Capture 5-10 breeding pairs prior to the breeding season and transport to the release site. Conduct soft release, holding individuals in aviaries until breeding behavior (e.g., singing, nest-building) is observed. Conduct over 3-5 years.

**(ix) Genetic considerations**

Several genetic issues deserve consideration in the evaluation of a sparrow reintroduction program, including taxonomic status, distinctiveness of various populations, and genetic variation within populations. The Cape Sable seaside sparrow is considered a subspecies of the widely distributed seaside sparrow (Post and Greenlaw 1994). A study of mitochondrial DNA (mtDNA) in six geographical subspecies of seaside sparrow identified two highly distinct matriarchal clades, the ‘Gulf’ and ‘Atlantic’ (Avice and Nelson 1989). Like the extinct dusky seaside sparrow, the Cape Sable subspecies belongs to the ‘Atlantic’ matriarchal clade of seaside sparrows and is highly divergent from its nearest relatives along the Gulf of Mexico (Nelson et al. 2000). Inhabiting the marl prairies of southern Florida, the Cape Sable subspecies is geographically isolated and morphologically and ecologically distinct from other seaside sparrows. Consequently, there is no reason to consider the use of other subspecies as a



source of birds for any reintroduction of the Cape Sable seaside sparrow. This distinction is actually unnecessary as The Endangered Species Act of 1973 protects geographically distinct sub-species, races, and populations.

There is no available information that leads the authors to believe that subpopulations of the Cape Sable seaside sparrow are genetically distinct. Historically, the subpopulations in southern Florida were substantially larger and closer in distance to each other than today's situation, suggesting movement likely occurred between regions of their range. Even today, with limited data on dispersal, there are records of movement among the subpopulations, several of which are long distances (~ 12-31 km, unpublished data). Consequently, we believe that it is unnecessary to consider subpopulation distinctiveness in the reintroduction of the species.

The final genetic issue of concern is genetic variation (e.g., heterozygosity, allelic diversity) within a potential source population. We lack genetic information on the level of variation within any one subpopulation. However, given the relatively large size of likely source subpopulations (> 500 numbers; currently subpopulations B and E), there is no reason to suspect that the reintroduced population is likely to suffer from low genetic variation that might result in decreased population growth rate or depressed reproduction or survival (see [Section 4.2.2 \(xi\) Donor and release sites](#)).

**(x) Disease control and consideration**

The importance of disease to the population dynamics of the Cape Sable seaside sparrow is unknown, and there is no evidence that disease has played a role in the range-wide decline of the sparrow, or any of the sparrow subpopulations. There are also no known diseases specific to the Cape Sable seaside sparrow. Yet, the risk of disease is an issue of consideration in reintroduction efforts because placing individuals in stressful situations may make them more susceptible to disease. In addition, the risk of exposure to disease increases during the reintroduction process due to direct contact with other sources (e.g., bird bags, cages, etc) that may have contained individuals with disease.

For the first issue, minimizing stress is the key. Upon capture, we would examine all individuals for ectoparasite loads and lesions, and any other signs of sickness or infection that would preclude them as a candidate for reintroduction. We do not recommend an involved screening, including blood pathology, etc, because it would take

too long and impose additional stress on the captured individual. Assuming the individual looks healthy, the reintroduction should proceed.

In order to minimize exposure of disease to translocated individuals, it is critical to keep bird bags, transport cages, and aviaries clean and sterilized using a sterilizing solution of water and chlorine.

It is critical to monitor the health of all individuals held in captivity for long periods, such as in the case of a soft-release. We suggest removing any individuals that show signs of stress, reduced vigor, or infection and attempt to diagnose the cause of the illness.

**(xi) Donor and release sites**

The donor site must be large enough to support the removal of individuals for translocation without endangering the source population. Harvest models may provide guidelines for the number of individuals that can be safely removed (Dimond and Armstrong 2007). In general, one expects that animals removed from a population at carrying capacity are compensated for by increases in fecundity and survival as density dependent factors are reduced. In reintroductions of nuthatches and bluebirds (both eastern and western), the removal of 3-5% of breeding individuals from donor population had no effect on the source population (i.e., all territories were reoccupied the following breeding season; Slater 2001). Using juveniles captured in the fall, a sparrow reintroduction project could likely exceed a 3-5% removal, as approximately 50% of those individuals are expected to die anyway based on juvenile mortality rates under saturated conditions.

Reintroduction sites should contain high quality habitat large enough to support a viable, self-sustaining population. As a rule-of-thumb, any site should have sufficient habitat to support at least 100 pairs of birds prior to reintroduction. Prior to a reintroduction, suitable release sites should be evaluated through habitat modeling, previous and current sparrow occupancy, and extensive ground surveys. Reintroductions to reestablish sparrow populations after large declines or extirpation are likely only after managers establish appropriate hydrology and fire regimes. Clearly, before any reintroduction site (occupied or unoccupied) is approved, the original reason for the sparrow's decline or extirpation must be identified and eliminated. Finally, we need

assurance that these release sites will remain protected and suitable for sparrows in the future.

#### **4.2.3 Federal policy and IUCN guidelines**

The proposed actions in this section are regulated by Federal policy and thus appropriate permission would be required prior to the implementation of translocation protocols. All aspects of bird research and scientific collecting at the federal level are described under the U.S. Code of Federal Regulations 50 – Wildlife and Fisheries. For the actions described in this section, the important Parts of this regulation are 10 (General provisions), 13 (Permit procedures), 17 (Endangered wildlife and plants), and 21 (Migratory bird permits). Necessary permits for conducting a reintroduction include a migratory bird permit from USFWS and a permit to band individuals from USGS (Bird Banding Lab). An additional permit would also be required from ENP for work within the Park. For all of the permits, the most critical concern for a reintroduction project involving the endangered Cape Sable seaside sparrow would relate to whether the action would improve rather than jeopardize the persistence of the sparrow. Actions described in this section should not cause harm to the sparrow, given that the aim is to restore the species.

Jenkins and Pimm (1999) developed a reintroduction protocol for the Cape Sable seaside sparrow following IUCN guidelines. The actions described here incorporate those guidelines.

#### **4.2.4 Estimate of costs**

Reintroductions are inherently expensive, especially when long-term monitoring and management costs are included. Reintroductions are also long-term commitments and, although the reintroduction itself may be completed in a five year period, post reintroduction monitoring in both donor and reintroduction sites is critical to evaluate success and is likely to require another five years of effort. The budget for a Cape Sable seaside sparrow reintroduction will also depend on where the reintroduction occurs. Efforts in isolated areas, such as subpopulation A, may require more funding for travel costs, which will need to be by helicopter. For the Everglades nuthatch and bluebird

reintroduction effort and associated monitoring ten years ago, annual costs approached \$85,000.

Estimated annual cost for a Cape Sable seaside sparrow reintroduction project.			
<b>Personnel</b>			
<i>Description</i>	<i>Unit</i>	<i>Rate</i>	<i>Cost</i>
Principal Investigator	0.50 FTE	(GS-12)	\$55,500
Technicians (2)	0.50 FTE	(GS-5)	\$45,000
<i>Sub-total Personnel</i>			<i>\$100,000</i>
<b>Direct Expenses</b>			
<i>TRAVEL</i>			
<i>Description</i>	<i>Unit</i>		<i>Cost</i>
<b>For remote subpopulation</b>			
Helicopter time <sup>a</sup> (for capture and transport of birds)	6 hours	\$800/hr <sup>b</sup>	\$4,800
Helicopter time <sup>c</sup> (for transport of field personnel for breeding season monitoring)	6 hours	\$800/hr	\$4,800
<b>For subpopulation accessible by vehicle</b>			
Vehicle	2,000 miles	\$0.58	\$1,160
<i>SUPPLIES</i>			
<i>Description</i>	<i>Unit</i>		<i>Cost</i>
Aviary supplies cages, food, etc			\$250
Aviaries <sup>c</sup> (for soft release)	3	\$500	\$1,500
<b>TOTAL ANNUAL COST</b>		<b>\$101,410 – \$112,510</b>	

<sup>a</sup> Assumption: 1 hour of travel time per day for 6 trap days.

<sup>b</sup> Rate as of 2008

<sup>c</sup> Assumption: 1 hour of time to transport field technicians to remote site 6 times for monitoring (e.g., subpopulation A). Technicians would stay on site for 10 days at a time.

#### 4.2.5 Monitoring requirements

Documentation should be made of the complete history of each released individual. Pre-release documentation should include individual capture and handling

history, habitat and environmental conditions at the capture site, and transportation procedures (cages, helicopter or truck, time). Release documentation should include the conditions under which the individual was prepared for release (e.g., just captured and moved, held in aviary for conditioning to new environment, etc.), the condition of the release habitat and environmental conditions at the time (weather, time of day, people present, etc.). Upon release, it is critical to follow the reproduction and fate of reintroduced individuals and their offspring. We recommend intense nest monitoring and banding of all individuals (adults and young) during translocation years and at least five years post-translocation. Nest-monitoring and banding protocols should follow those employed by S. Pimm and J. Lockwood in their intensively monitored plots.

In addition to monitoring at the reintroduction site, it is also critical to employ the same monitoring effort at the donor site to evaluate the effect of the removals.

#### **4.2.6 Identification of key information gaps and uncertainties**

- Development and effectiveness of reintroduction techniques (e.g., time of removals, age, soft vs. hard release)
- Population and habitat modeling to provide guidance for
  - How much habitat is necessary (i.e., how many individuals the area can support) to initiate a reintroduction
  - The size of the donor population and the number of individuals that can be safely removed from the donor population

### **4.3 Conspecific attraction**

Theoretical and empirical studies examining habitat selection of birds tend to assume individuals select breeding territories based solely on the availability and quality of suitable habitat (Fretwell and Lucas 1970). Under this view, individuals that manage to find optimal habitat will establish a breeding territory there and any surplus individuals will not breed at all. This idea was modified by Pulliam and Danielson (1991) who suggested that density dependence could force behaviorally non-dominant individuals into marginal habitats to breed even though these individuals may not form a self-sustaining population there. If Cape Sable seaside sparrows follow these standard models,

then we would expect them to settle in all habitat suitable for breeding regardless of the number of other sparrows present up until the carrying capacity of that habitat is surpassed. At this point, any individuals that failed to secure a breeding territory would either not breed or move into nearby less-dense habitat(s) and establish a breeding territory. However, these dispersing individuals would likely experience reduced fecundity or survivorship in these more marginal (or ‘sink’) habitats, and thus these habitats may not support self-sustaining populations.

Despite the widespread acceptance of these models of population distribution, we still poorly understand the cues birds use to select breeding territories when they are present in low population densities. The few studies that have tracked habitat selection among birds within very low population situations have shown that the presence of conspecifics (i.e., other individuals of the same species) may offer a reliable cue for habitat selection. One common explanation for why we see aggregations of territories in some bird species is that conspecifics are used as a source of information about the habitat quality (Stamps 1988). Dispersing birds, especially juveniles, may gain reliable information about a habitat’s quality by using the behavior or the presence of other individuals of the same species when selecting a breeding area. Individuals may also gain increased breeding opportunities, group vigilance, and predator dilution.

Although the history of conspecific attraction has largely been anecdotal, a number of studies have recently emerged documenting its existence in open-cup nesting territorial species ranging from shrubland to grassland to forest habitats. Perhaps the best example as a management tool for endangered species has been with the black-capped vireo (*Vireo atricapilla*). Ward and Schlossberg (2004) attracted vireos to sites where brood parasites were controlled, increasing the species’ reproductive output.

If Cape Sable seaside sparrows were to demonstrate a preference to settle near conspecifics, this has significant implications for their management. Managers could use the appropriate cues to attract birds to high quality but unoccupied habitat or recently restored areas and thus increase overall population size. Obviously, suitable but unoccupied habitat would need to be available. Attracting sparrows to unoccupied habitat would offer no benefits if the habitats’ limiting factors had not been addressed.

Sparrows may partially select habitat based on the presence of conspecifics, as they appear to have a clustered spatial breeding distribution. Extensive territory mapping in the smaller subpopulations C, D and F during the 2006-2008 breeding seasons revealed areas of clustering, even though suitable habitat appeared to be available nearby (Lockwood et al. 2006, 2007). Two dispersal events in 2006 were in the opposite direction predicted by source-sink or similar habitat selection models. That is, two unmated adult males moved from very low-density situations into a subpopulation that held relatively more sparrows (Lockwood et al. 2006).

Habitat models frequently predict species will be present in certain areas, when they are not. Likewise, species occur in some areas where habitat models do not predict. Recently, Campomizzi et al. (2008) suggested that conspecific attraction may help explain these discrepancies and is a missing component in habitat modeling. The companion paper to Jenkins et al. (2003a) gives a number of explanations for the error in their model predicting suitable sparrow habitat from satellite imagery (Jenkins et al. 2003b). They concluded that bird errors are larger than the model errors, with two types of bird error (1) *Commission errors*: some suitable habitat does not contain sparrows due to limited dispersal, and (2) *Omission errors*: some birds remain in unsuitable habitat that was formerly suitable due to very high site fidelity. Conspecific attraction may explain 'sparrow error' with commission errors the result of insufficient cues for dispersing birds to assess and subsequently settle unoccupied habitat. Omission errors may result from 'false' location cues provided by the site-faithful birds. Assuming unoccupied habitat patches are unsuitable habitat or of poorer quality may be erroneous for endangered species living at low population levels that are using social cues to select breeding habitats.

#### **4.3.1 Objectives**

The primary goal of conspecific attraction is to reestablish Cape Sable seaside sparrow populations in formerly occupied breeding habitat where they have disappeared due to an emergency event. The specific objective of this technique is to increase the number of areas supporting sparrow populations as rapidly as possible following an emergency using conspecific vocalizations.

Success criteria:

- Male and female sparrows respond to conspecific attraction and establish breeding territories in proximity to playback systems.
- Annual demographic characteristics (nest success rates, fecundity and mating status) of sparrow populations established through conspecific attraction are similar to naturally occurring subpopulations.
- The population established via conspecific attraction becomes self-sustaining and sparrows remain in the area after playback systems removal.

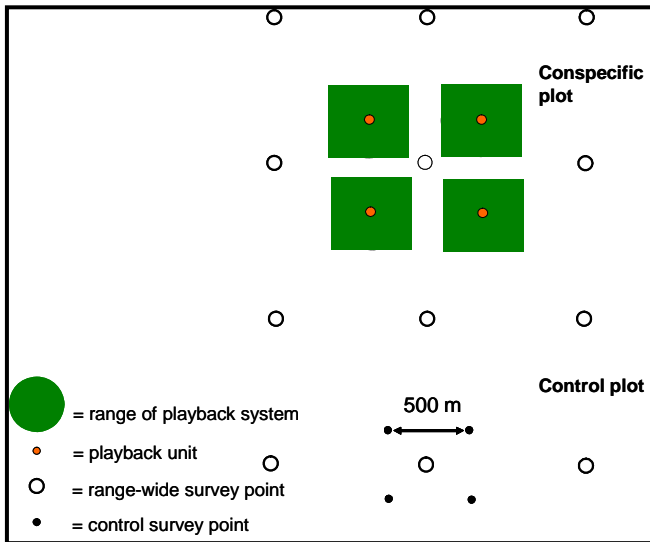
#### **4.3.2 Protocol and methods**

Conspecific attraction will be implemented in suitable habitat where breeding has not occurred in a number of years due to (1) poor management practices (e.g. changed flooding or fire regimes) making the habitat unsuitable or (2) newly available habitat through recent restoration efforts. Restoration may create suitable sparrow habitat in unpredictable and previously unoccupied areas. Confirmation that both the original negative process making the habitat unsuitable has been mediated and that indeed the habitat is of high quality, will be required. Hydrologists and botanists will provide some information about the habitat quality and future water management of selected conspecific plots but ultimately researchers familiar with sparrow breeding habitat in healthy subpopulations should carry out the final evaluation. Each conspecific plot will require an adjacent control plot of similar unoccupied habitat with no conspecific cues to test the success of the emergency action at attracting sparrows.

Each conspecific plot will consist of a number of playback units. The number and configuration of these units will depend on the amount of suitable habitat available and the number of territories specified by management objectives. For example, four playback units in a 1 km<sup>2</sup> configuration may be used to broadcast over an area capable (if high habitat quality) of supporting 20-50 pairs (average territory size 2ha, Pimm et al. 2002) ([Figure 9](#)). Pre-recorded sparrow vocalizations would broadcast daily from early to mid-morning (06:00 to 09:30), which is the period when sparrows are actively singing. After successful breeding has been recorded on conspecific plots, playbacks would be stopped. Currently, we do not know if sparrows prospect for suitable breeding habitat



before the breeding season commences or after. Therefore, we recommend conspecific broadcasts during two periods: February-March and June-August for at least two years.



**Figure 9.** Example of the Cape Sable seaside sparrow conspecific broadcast setup and control plot configuration.

#### 4.3.3 Estimate of cost

The number and location of each conspecific setup will depend on the size of the treatment area, but playbacks were clearly audible 250 m away using the prototype constructed in July 2008 (Kittel, C; Boulton RL; and Lockwood, JL). The Everglades environment (hot, wet, and humid) and the isolation of the sparrow's habitat require systems to be very rugged and relatively self-reliant. Playback setups would be maintained via helicopter access, therefore it would be preferential if systems were solar powered (eliminates need to replace battery) and all electronics completely waterproof (to help eliminate faulty equipment). While this initially makes each system expensive, it reduces the need of regular visits to maintain equipment and ultimately reduces costs.

**An example of the approximate cost to construct one conspecific setup using the equipment list based on the prototype constructed by Kittel C, Boulton RL and Lockwood JL during 2008.**

	<b>EQUIPMENT</b>	<b>Cost</b>
<b>Sound</b>	Playback player	150
	Amplifier	80
	Cigarette plug adapter	20
	Y-plug adaptor	15
	Speakers	80
<b>Power</b>	Solar panel	185
	Charge controller	50
	Battery	90
	Programmable Timer	85
<b>Construction</b>	Wire	10
	Wiring blocks	20
	Fuses	10
	Waterproof box (e.g. Pelican case)	110
	Mounting equipment in field	50
		<b>TOTAL ~ \$955 per unit</b>

#### **4.3.4 Monitoring requirements**

Area searches of both conspecific and control plots should be conducted before playback initiation and then every 2-3 weeks throughout the treatment period to determine the number of breeding individuals on each plot. Researchers should band all sparrows that establish territories within the plots to monitor individual-based breeding activity. These data will be used to assess demographic differences between sparrow populations established through conspecific attraction and naturally occurring subpopulations. Demographic data would most likely come from the long-term demographic study in subpopulation E (Lockwood JL). If sparrows use the presence of conspecifics to determine where they will breed, we expect sparrows to breed in the conspecific plots and not in the control plots. The number of breeding sparrows in conspecific plots should increase through time, compared with detecting no sparrows breeding in control plots. We also expect the number of breeding sparrows to increase more rapidly on conspecific plots than natural control subpopulations. If sparrows are not using conspecifics in settlement decisions, we expect there to be no increase in the

number of breeding sparrows in conspecific plots through time and for these plots to mirror the population dynamics of the natural control subpopulations.

#### **4.3.5 Identification of key information gaps and uncertainties**

The primary information gap for this emergency management action is whether sparrows will respond to conspecific vocalization. Ideally, researchers would carry out an experimental trial before implementing the emergency action. The success of conspecific attraction depends on our ability to accurately assess and predict suitable sparrow habitat and the dispersal capabilities of both male and female sparrows to find this habitat. The following information would facilitate our understanding and chances of success:

- Experimental phase that tested the layout and density of speakers necessary to attract sparrows, and the duration of playback vocalizations needed to maintain sparrows on the site. Currently we do not know if sparrows prospect for suitable breeding habitat before the breeding season commences or after. Therefore, two periods should be trialed (February-March and June-August) to determine what time of year playback is more successful at attracting sparrows.
- Update sparrow habitat models to identify suitable sparrow habitat necessary to undertake conspecific attraction. Currently managers/researchers refer to areas within the subpopulations that are no longer suitable due to vegetation changes but there are no accurate maps of these areas.
- A more detailed understanding on how sparrows choose specific breeding territories and measures of habitat quality are required.
- We currently have no information on whether there are differences between the sexes in their dispersal capabilities.

#### **4.4 Disease risk assessment**

Managing the wild Cape Sable seaside sparrow population for a disease outbreak is impracticable, but managers should be aware of the risk. The best safeguard against disease is maintaining large sparrow populations and relying on the sparrow's ability to evolve resistant traits in its natural environment, as attempting to exclude pathogens from the sparrow's environment is impossible. An assessment of sparrow health including

complete blood count, serum biochemistry profiles, vitamin and mineral levels, and evidence of exposure to infectious agents (antibodies, microbes or chemicals) would help establish a 'normal' baseline dataset. However, testing healthy individuals is not informative as all individuals will have some form of parasites (e.g. mites and coccidia), and often these parasites will be chronic and asymptomatic.

#### **4.4.1 Objectives**

The primary goal of a disease risk assessment for the Cape Sable seaside sparrow is to provide guidelines given the detection of an infectious disease in Florida within related taxa, or within the sparrow population itself. The specific objective of the risk assessment is to identify the sparrows' likelihood of obtaining an infectious disease, to establish the range of potential diseases and their likely impact, to establish baseline sparrow health, and to guide management during an infectious disease outbreak.

Success criteria:

- Obtain essential information concerning basic sparrow health
- Prevention of any major disease outbreak in the wild Cape Sable seaside sparrow populations
- All captive bred individuals remain disease-free

#### **4.4.2 Protocol and methods**

##### **(i) Risk of disease in Cape Sable seaside sparrows**

*Exposure* – Introducing novel pathogens into a naive system can lead to disastrous declines in animal abundance. Perhaps the best-known avian examples involve blood born parasites with insect vectors (commonly mosquitoes). Any species with restricted geographic range or small population size in regions of high mosquito abundance could be at risk (e.g., avian malaria and poxvirus introduced to the Hawaiian avifauna). Certainly, these criteria put the sparrow in the danger zone for an infectious disease event. A prime candidate is West Nile Virus (WNV). WNV is usually asymptomatic in Old World bird species; however, since its arrival in New York in 1999, it has spread across the United States, resulting in declines of numerous avian species. Exposure to

WNV in the Cape Sable seaside sparrow is unknown, but the virus reached the Florida Keys by the summer of 2001 (Pollock 2008).

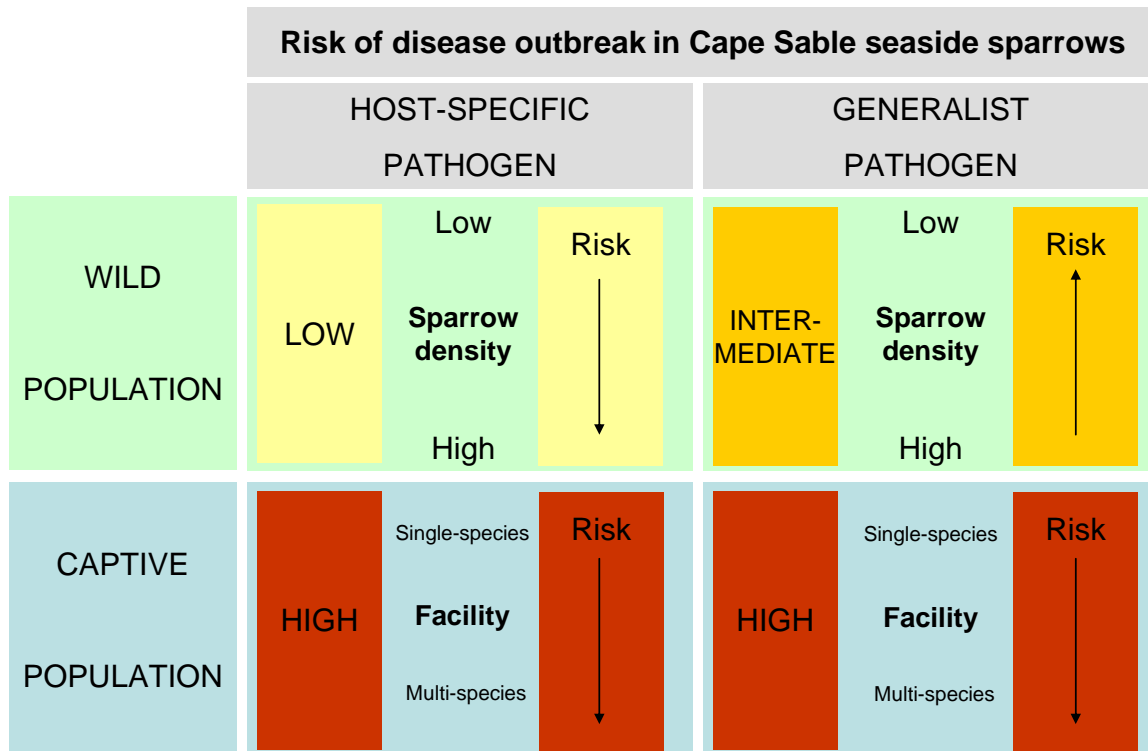
*Genetic constraints* – There is some evidence that endangered species are more susceptible to pathogens because of reduced genetic diversity. Inbred populations may show limited ability to respond evolutionarily to new pathogens because of the loss of allelic diversity or reduced heterozygosity (Altizer et al. 2003). A similar risk exists for individuals bred in captivity, as resistant traits from the wild population may be lost in the absence of the pathogen, making reintroduced individuals more susceptible. Currently we do not know if the sparrow suffers from inbreeding or an accumulation of detrimental mutations, as information on genetic diversity in the sparrow is lacking.

*Biotic and abiotic reservoirs* – An infectious disease that utilizes reservoir hosts and is able to survive in the abiotic environment poses a much greater risk to the sparrow ([Figure 10](#)). The semi-tropical Everglades environment poses some risk, particularly for mosquito-transmitted diseases, without severe winters to kill pathogens or insect vectors. Drought conditions may facilitate exposure risk (to mosquitoes and other birds) as sparrows preferentially forage around wet solution holes. How important host and environmental reservoirs will be to disease outbreak will be pathogen specific. To date, WNV would be the greatest concern to the sparrow, as Florida is yet to have a major WNV epidemic. Results indicate that widespread drought in the spring followed by wetting during summer could greatly increase the probability of a WNV epidemic in southern Florida (Shaman et al. 2005). An outbreak of WNV in an American alligator (*Alligator mississippiensis*) farm in central Florida, suggests that alligators may serve as a vertebrate amplifying host for WNV.

*Captive breeding* – Probably the biggest risk of disease to the sparrow is moving individuals outside their historic range into captive breeding facilities where their naive immune systems would be exposed to an array of exotic pathogens. Birds in captive breeding facilities have increased exposure risk due to high population densities, contaminated food, and cross-species contact. While captive breeding and reintroductions intend to conserve species, there has been a high frequency of disease outbreaks in captive populations (Snyder et al. 1996); although this frequency has been reduced through captive-breeding programs developing comprehensive disease management plans

(see [Section 4.6 Captive breeding](#)). However, there is always the risk that release programs will inadvertently introduce an exotic pathogen into the wild population. The greatest risk is to individuals in open, multi-species facilities outside the species' historic range thus highlighting the need for rigorous disease screening pre-release ([Figure 10](#)). This safeguard assumes that pathogens can be reliably detected (e.g. latent, slow-acting diseases).

*Contaminants (Mercury)* – For years, fish consumption advisories have been issued throughout the Everglades due to elevated levels of mercury. In addition, high levels of mercury appear to have had deleterious health effects on wading birds, alligators and the Florida panther (Roelke et al. 1991, Spalding et al. 1994, Sepulveda et al. 1995). While the sparrow is not an aquatic species or a higher-level predator, the possibility of mercury accumulation and contamination is possible. Cristol et al. (2008) recently showed that terrestrial-feeding bird species preying on predatory invertebrates such as spiders, showed mercury levels similar to, or higher than, aquatic-feeding species. The sparrow's diet consists largely of Odonata, Lepidoptera and Orthoptera (Pimm et al. 2002), but they have been observed eating small fish and tadpoles (RL Boulton pers. comm.). Whether Cape Sable seaside sparrows suffer any negative effects from high mercury levels is unknown, but further investigation is underway (USGS).



**Figure 10.** A flow diagram representing the risk of a disease outbreak in wild and captive Cape Sable seaside sparrow populations by a host-specific or generalist pathogen.

**(ii) Basic health evaluation**

Researchers routinely capture Cape Sable seaside sparrows during the breeding season to mark each bird with a unique color band combination. Researchers could integrate a simple physical examination and collection of tissues into this procedure to allow for a thorough analysis of sparrow health. In a 10-minute examination, researchers could measure an individual sparrow, visually search feathers and skin for the presence of ecto-parasites, and collect blood and blood smear samples. Blood samples (~100µl) taken through brachial venipuncture would test for the prevalence of blood-borne parasites such as the genera *Plasmodium*, *Haemoproteus* and *Leucocytozoon*. Any fecal material defecated during handling or before release (within the bird-holding bags) should be sampled to look for pathogens such as Coccidia. Infertile egg contents, blood, and feather samples should be tested for total mercury concentrations (Cristol et al. 2008). Blood mercury reflects recent dietary intake, whereas feathers and eggs indicate cumulative exposure as mercury can only enter feathers and eggs while they are growing and connected to the bloody supply.

### **(iii) Disease outbreak and management response**

If during fieldwork, a sparrow was observed with signs of lethargy, ruffled feathers, unusual posture, lack of motor control, and ataxia an immediate attempt should be made to capture the individual to collect a biological sample. A post-mortem should be carried out on all dead sparrows located. If an external risk was identified (e.g., a large bird die-off within Florida), a sample of sparrows across the subpopulations should be tested for the presence of the likely disease agent(s). However, sampling other resident species known to be susceptible (e.g., WNV in Corvids) or principle vectors (e.g., mosquitoes) of the disease may be more useful because capturing a large enough sample of sparrows for such an assessment would be unlikely. Once the infectious disease has been identified, a formal risk assessment should be undertaken (e.g., disease virulence and likely mortality, risk of spread, chances of subpopulation extinction).

Taking a small number of uninfected individuals into captivity would only be advisable if exposure to a pathogen risked almost complete mortality of any individual exposed, thus translating into an extremely high extinction risk for the species. Sparrows left in the wild to evolve resistant traits would be a better safeguard against disease. Moving individuals known or suspected of carrying a disease into captivity risks the health of all other species held at the breeding facility. Individuals would need to be held in quarantine for an extended period, causing further stress and potential exposure to other exotic pathogens. This procedure would only be an option for a treatable pathogen.

Such intervention as vaccination against a particular disease would be extremely costly and impractical in wild sparrow populations. Sparrows are difficult to catch, particularly when population densities are low, therefore it seems that vaccination and medical treatment would only be useful for individuals in captivity (assuming a treatment existed).

The National Wildlife Health Center (NWHC) provides information, technical assistance, and research on national and international wildlife health issues. The Field Manual of Wildlife Diseases: *General Field Procedures and Diseases of Birds* can be downloaded from their webpage. This document provides extremely useful information about specimen collection and preservation, how to ship samples, and other field related procedures:



[http://www.nwhc.usgs.gov/publications/field\\_manual/](http://www.nwhc.usgs.gov/publications/field_manual/)

USGS and a network of partners across the United States work on documenting wildlife mortality events in order to provide timely and accurate information on locations, species and causes of death. The webpage below offers a reliable and updated source of disease outbreaks and should be routinely consulted:

[http://www.nwhc.usgs.gov/mortality\\_events/ongoing.jsp](http://www.nwhc.usgs.gov/mortality_events/ongoing.jsp)

#### 4.4.3 Estimate of costs

Emergency action	Task description	Estimated cost per sample	Comment
Disease vigilance	• Basic health evaluation	\$15-100 <sup>a</sup>	Total cost depends on the number of samples
	• Example of disease screening – avian malaria using nested PCR and DNA sequencing	\$15 <sup>b</sup>	
	• Methylmercury analysis for sparrow eggs and feathers	\$160	

<sup>a</sup> Will depend on tests.

<sup>b</sup> Estimate from JG Ewen (Institute of Zoology London). Note this does not include personal time.

#### 4.4.4 Monitoring requirements

There are no specific monitoring requirements for disease beyond the routine sparrow range-wide surveys and the vigilance of field researchers for any signs of sick or dying individuals while observing and handling sparrows in the field. If researchers confirmed a disease outbreak, a full range-wide disease survey would be necessary (during the breeding season) to determine the extent of the infection. We recommend sending personnel to known sparrow locations throughout the subpopulations to observe individuals for signs of infection.

#### 4.4.5 Identification of key information gaps and uncertainties

Sparrow health

- Undertake basic health evaluation and determine the prevalence and identity of pathogens that healthy sparrows carry.

- Test whether sparrows have mercury concentrations at levels high enough to cause mortality, reproductive failure or other health issues.
- Necropsies should be performed on any dead sparrow to gather information on health.

## **4.5 Predator control and nest protection**

There are two reasons why predator control or nest protection would be employed in the sparrow populations: (1) increased predation was responsible for significant population declines or, (2) managers wished to augment small population numbers. Nest predation is an important component of sparrow population dynamics because of the high loss of second and third clutches. Sparrow populations appear to remain stable when there is a high success of early clutches, but if we wish to see population size increases then late-season clutches must experience higher survival rates. Conservation projects can be extremely successful in increasing nest survival by directly manipulating predator numbers or protecting nest sites (e.g. Innes et al. 1999, Murphy et al. 2003). However, it is very important to fully understand the predator-prey dynamics of the system if these management options are to benefit species survival (Keedwell et al. 2002).

### **4.5.1 Objectives**

The primary goal of predator control and nest protection is to increase Cape Sable seaside numbers in breeding habitat where they have declined due to increased predation or another emergency trigger event. The specific objective of this technique is to increase adult and nest survival in areas supporting small sparrow populations as rapidly as possible following an emergency by effectively controlling predator numbers or protecting individual sparrow nests.

Success criteria:

- The sparrow population increases in size due to successful control of predators or protection of their nests.

#### 4.5.2 Protocol and methods

The effectiveness of manipulating predator numbers and protecting sparrow nest sites is somewhat limited because of key information gaps with respect to the sparrows' predator-prey dynamics (see [Section 4.5.5](#)). We currently do not know which predators cause significant sparrow nest loss or anything about predator density, abundance or activity in relation to the sparrow's habitat. Without this information, it is extremely difficult to devise specific management actions. Obviously, the first task would be to identify the key predator(s).

The recent Avian Ecology Workshop (SEI 2007) suggested that predator barriers, like those used by Post and Greenlaw (1989) on *Ammodramus maritimus* nests, may improve Cape Sable seaside sparrow nest survival. Unfortunately, trials during the 2008 breeding season revealed that female sparrows were unwilling to accept such structures around their nests and the trial was abandoned (1/6 accepted barrier, Boulton RL pers. comm.). Therefore, protecting nest sites will need to be on a larger-scale (e.g., fencing whole territories or study plots) or using non-intrusive methods (i.e., non-lethal chemical/sound repellants), and their effectiveness will depend on the major predator type (avian, mammalian or reptilian). Poisoning and trapping predators, although effective in some situations, will not be practical in the Everglades environment unless it was essential for sparrow nest survival and there was little risk to other species. Constant re-invasion from outside control areas would make this an expensive and time-consuming management action.

#### 4.5.3 Estimate of costs

Emergency action	Task description	Estimated cost (\$000s)	Comment
Increase sparrow numbers by predator control or nest protection	<ul style="list-style-type: none"><li>Identify key nest predators using nest cameras</li></ul>	\$1-4 per setup	Cost depends on the type of camera, power supply and number of cameras used
	<ul style="list-style-type: none"><li>Monitor predator density, activity, and abundance throughout sparrow habitat</li></ul>	\$60 per annum <sup>a</sup>	Total cost will depend on the number of agencies/universities involved in the research and the scale predator control/nest protection is implemented
	<ul style="list-style-type: none"><li>Protect sparrow nests</li></ul>		
	<ul style="list-style-type: none"><li>Control predators, particularly invasive species</li></ul>		

<sup>a</sup>Estimate from the implementation schedule for the South Florida multi-species recovery plan (US Fish and Wildlife Service 2006).

#### 4.5.4 Monitoring requirements

It is extremely important to implement appropriate monitoring protocols in conjunction with predator control or nest protection measures to determine the success of the management action. An appropriate experimental design with both control and treatment sites would be necessary to confirm whether the action has a measurable impact on sparrow nest, adult or juvenile survival rates. Obviously, it is necessary to monitor parental sparrow's acceptance of any protective structure erected around their active nest. Alternating different control procedures through time and measuring the resulting changes in sparrow survival would identify the level of predator control necessary for protection.

#### 4.5.5 Identification of key information gaps and uncertainties

The primary information gap for this emergency management action is whether predator control or nest protection is truly feasible to make this an effective technique to increase sparrow numbers. Ideally, we would carry out an experimental trial before implementing the emergency action. The following information would facilitate our understanding and chances of success:

Predator identification

- Identify the key nest predators at sparrow nests using nest cameras.
- Determine which predators are responsible for the increase in nest failure late in the breeding season.

#### Predator-prey dynamics

- Quantify predator density, abundance and activity across the breeding season and during the transition into the wet season throughout the sparrow's habitat.
- Determine whether predator activity influences the location of sparrow nest sites.

#### Predator control

- Establish a clear experimental design with adequate monitoring to test the strengths of alternative methods for predator protection and/or control to increase sparrow reproductive success and survival.

## 4.6 Captive breeding

The use of captive breeding as a conservation strategy for an endangered species is a last-ditch effort typically initiated when all other conservation actions aimed at maintaining wild, self-sustaining populations have failed. Captive breeding of Cape Sable seaside sparrows has never been attempted and should only be considered under the most severe emergency event. Even as a last recourse, captive breeding is not a long-term solution nor should it stand alone as a management action; rather, it must inherently be coupled with other recovery actions (Snyder et al. 1996). Faced with the risk of extinction, a sparrow captive breeding project is pointless without remedies for the ultimate cause of its population declines.

The numerous limitations and risks associated with captive breeding make it a last recourse for managers (Snyder et al. 1996, McDougall et al. 2005). The first and perhaps the most obvious problem for captive programs are achieving self-sustaining captive populations. Unfortunately, attaining sufficient reproduction does not end the problems associated with this technique. The dynamic and uncertain nature of evolutionary forces in small, captive populations can lead to behavioral problems and rapid domestication, even with careful genetic procedures in place. Both concerns probably play significant roles in the relatively poor performance record of reintroducing captive-bred animals to

the wild (Wolf et al. 1996, Griffith et al. 1989). Increased exposure to exotic pathogens in zoos and conservation facilities predispose captive species to disease outbreaks. Without stringent disease screening prior to release programs, captive bred individuals risk exposing wild populations to exotic pathogens. Captive breeding programs are inherently expensive and maintaining administrative continuity over the course of the effort is difficult because most programs are lengthy. In general, *in situ* conservation strategies are more cost effective because they are likely to benefit the ecosystem as a whole and the multiple species dependent upon it. Unfortunately, captive breeding can often divert attention from the real problem and become a technological fix, prolonging the problem as opposed to fixing it.

Captive breeding has been the difference between survival and extinction for some bird species including the Guam rail (*Gallirallus owstoni*), California condor (*Gymnogyps californianus*), Mauritius kestrel (*Falco punctatus*), and others. Given the indecision by government agencies regarding the use of captive breeding for the dusky seaside sparrow and its ultimate extinction, it is clear that the development of a captive breeding plan for the Cape Sable seaside sparrow prior to an emergency event would be beneficial. However, a comprehensive and detailed plan is dependent on having sufficient information to develop Standard Operating Procedures (SOPs) for various aspects of a captive breeding program. General rules of thumb can be acquired through other captive breeding programs, but pilot studies using the sparrow would be beneficial to develop specific husbandry SOPs for capture, breeding, feeding, social and genetic management, etc, prior to an emergency event. Below we outline a framework for a captive breeding program for Cape Sable seaside sparrows, recognizing that specific details will require additional information not currently available. Where possible, we diagram the choices and outline the specific information needs of a captive breeding program.

#### **4.6.1 Objectives**

The primary goal of a captive breeding program is to produce a self-sustaining population of captive bred Cape Sable seaside sparrows. The specific objective of this management technique is to provide demographic and genetic support for wild populations of sparrows through the supply of individuals for reintroduction to establish

new populations and augment existing wild populations facing extinction. Maintaining a captive population prevents the extinction of the sparrow during large-scale emergencies. However, there is no substitute for habitat restoration, and there is no sense maintaining birds in captivity if there is no likelihood of eventual releases.

Success criteria:

- Husbandry protocols maintain healthy individuals with all birds maintaining normal weight, behavior, and remaining disease-free.
- Individuals successfully breed, producing young to independence and sexual maturity (1 yr).
- Captive productivity exceeds mortality and captive-reared individuals are released in the wild (reestablish population or augmentation).
- Captive-reared individuals survive and successfully breed in the wild.
- Studies comparing demographic rates of captive-released individuals and their offspring with non-captive birds are comparable.

#### **4.6.2 Protocol and methods**

Steve Shurter, Director of Conservation at the White Oak Conservation Center (WOCC) in northern Florida assisted in drafting the following methodological considerations. WOCC is a wildlife breeding, research, and training facility, providing conservation options for threatened species by maintaining genetically diverse populations in natural facilities. With their complex of research, husbandry, education and conference facilities, WOCC leads professional efforts to improve veterinary care, develop holistic animal management techniques, and better understand the biology of critically endangered species. WOCC is a member of the Conservation Centers for Species Survival and has worked with government agencies on endangered species issues in south Florida including the recovery of the Florida Panther (*Puma concolor coryi*).

There has been no effort to breed Cape Sable seaside sparrows in captivity, but two subspecies of seaside sparrow have bred very successfully in captivity (Post and Antonio 1981, Webber and Post 1983) and husbandry protocols for the dusky seaside sparrow are available to provide guidelines. However, over the last two decades, captive

breeding program management has advanced considerably, making these prior efforts relatively obsolete.

**(i) Captive population guidelines**

Important management decisions involving captive breeding programs are not restricted to captive husbandry. In fact, before managers consider captive propagation they should address a number of key questions to optimize decisions, such as when to capture wild individuals or release captive-bred individuals into the wild. Managers should consider developing these types of decisions in a stochastic model framework (e.g., Tenhumberg et al. 2004).

*(a) At what wild population size should managers start breeding Cape Sable seaside sparrows in captivity?* Breeding programs are often initiated when the wild population has dwindled to a very few individuals, resulting in limited founder availability for the breeding program. Therefore, we strongly suggest initiating a captive breeding program before the wild population is reduced to a few individuals. This allows managers time to solve husbandry problems and secure the genetic and demographic foundation for the captive population, while also minimizing the adverse effects on the wild source population. This was not the case for the dusky seaside sparrow. When the Florida Game and Freshwater Fish Commission moved the entire wild population of dusky seaside sparrows into captivity (1979 and 1980) it was obviously too late, as only five males remained alive (Webber and Post 1983). We would only recommend capturing the entire sparrow population if it fell below a threshold size of 20 females, assuming sparrow populations increase faster in captivity than in the wild (Tenhumberg et al. 2004). Counting males in this situation is extremely dangerous given the severe sex ratio bias observed in the dusky seaside sparrow and small Cape Sable seaside sparrow subpopulations.

If sparrow population estimates fell below a threshold size of 1,400 individuals (based on a 75% decline in 1981 numbers), the current emergency criterion recommends moving a number of sparrows into captivity as a safeguard against further declines. Although this threshold size appears relatively large, it allows time for trial studies into captive husbandry techniques.



*(b) How many individuals should we take from the wild population and from where?* The goal of a small population program is to maintain the genetic diversity of the origin (*in situ*) population so that the captive population continues to represent the traits of its founders throughout the time period set for the program (Ralls and Ballou 1992). Small population management rule of thumb minimally includes 20 initial founders (10 males; 10 females) with all founders contributing to the future population. With less than 20 founders, inbreeding can become a problem in captive populations after several generations.

Removal of wild individuals should occur across as wide an area of their range as possible, to reduce relatedness and increase genetic diversity among founders. Where managers remove these individuals from will depend on the specific situation that instigated the full implementation of the captive breeding program. For example, in an extreme emergency event, individuals may only be available from one subpopulation. We recommend extreme care when selecting the number/location of wild individuals for captivity breeding purposes if other emergencies actions (i.e. translocation) are co-occurring.

If the wild population could support the removal of small numbers of individuals, another strategy would be to occasionally infuse additional founders to the conservation breeding program (e.g., one effective founder added every 3-5 generations) to help reduce inbreeding and maintain diversity of the program and population. It is likely that non-breeding males would be readily available, particularly in small subpopulations. We consider such an alternative with the sparrow as a follow-up to an initial trial initiated with 20 individuals.

*(c) How many individuals should we release into the wild population, where and how?* The ultimate success of a captive breeding program is the successful release and establishment of captive-bred individuals in the wild. Unfortunately, reintroductions involving captive-bred individuals are notoriously unsuccessful, which is why it is necessary to carefully design release strategies. We recommend trial releases of captive-bred individuals once the captive population is close to its carrying capacity. Considerations include release method (soft or hard), individual's age and breeding experience, predator avoidance training, timing, and release numbers. We suggest initial

trial releases of no fewer than 20 individuals (10 male; 10 female) into temporary aviaries at the release site 2-4 weeks before the breeding season commences. Another alternative is to wait for birds to initiate breeding attempts within the aviaries before release.

Release sites should contain high quality habitat large enough to support a viable, self-sustaining population. Whether managers decide to use captive-bred individuals to augment or reestablish a sparrow population will depend on sparrow population dynamics at release time. Releases should occur in areas where population expansion can occur quickly. Clearly, before selecting any release site, we need to identify and eliminate the original reason for the sparrow's decline or extirpation and assure future habitat protection. We suggest evaluating suitable release sites through habitat modeling, previous and current sparrow occupancy, and extensive ground surveys by experienced sparrow researchers.

**(ii) Captive husbandry**

*(a) Housing facilities: capacity, climate, security.* Although specific housing facilities would need to be determined, a basic framework for a founder population of 10 pairs would require secure housing for the founders and two subsequent generations (200 - 250 birds). This design could be accomplished with 4 – 20 ft by 25 ft roofed and cement slab facilities, each including 10 – 5 ft x 10 ft x 8 ft flight cages built with wood or steel frames and covered with metal mesh netting. A secondary fence of vinyl wire (½ inch x 2 inch) that surrounds the facility would be required for security purposes.

In general, the facilities required to initiate a breeding program for the Cape Sable seaside sparrow could be quite simple. Based on historical information, managers should house individuals to approximate natural social behaviors. To maximize founder representation, individual identification of all founding sparrows (and all offspring) is necessary for housing as breeding pairs. Facilities could maintain social flock contact through open, side-by-side wire mesh (Zoomesh) caging systems, and/or through seasonal manipulation of birds, assuring separation of desired pairs during the breeding season. Developing artificial incubation facilities, although time consuming and challenging with small passerines, may optimize chick production

Some features would depend on the location of the facility. For example, facilities in northern Florida would require supplemental heat or indoor enclosures; southern Florida facilities may not need heated areas. All facilities would require roofed or shaded areas. Additional security measures would be required to withstand storm events, prevent theft or tampering, maintain health management, and keep snakes and predators out of the flight cages.

*(b) Health requirements: social needs, disease considerations, nutrition.*

Husbandry protocols would aim to approximate the natural behaviors and social needs of the sparrow including flying, flocking, foraging/feeding, breeding, nesting and chick rearing. Developing these protocols would benefit from a pilot study. The captive diet of the sparrow would mimic the species' natural diet to the extent possible. Even though the sparrow has adapted to the unique habitats found only in the marl prairies of southern Florida, we assume that captive diets fed to similar sparrow species would suffice. However, the best diet may take experimentation and coordination with the field biologists studying this species.

A significant challenge of captive passerine management is disease control. Avian influenzas, avian malaria, ecto and endoparasites, and encephalitis-based viruses can be devastating. Veterinary animal health protocols for sparrows would need to be developed and would include quarantines, surveillance, necropsy and pathology, and possibly vaccination and treatment protocols. Close surveillance by veterinarians may identify unknown sparrow-specific diseases. The scientific team at the institution managing the captive population could design specific disease SOPs through a pilot study.

*(c) Management: expertise, records, coordination/communications.* Significant resources are required when committing to a sustainable long-term conservation breeding program. Passerine captive management requires unique animal care, management, and veterinary expertise to provide for the daily needs of the animals and to react and meet the challenges associated with such programs. Depending upon the size of the colony/flock it could minimally require one full-time animal keeper (per facility) to maintain such a program. Veterinarian care, program management and coordination, and communications would not be full-time but would require substantial block of times weekly, or seasonally, again depending on the size of the program. Records management,

budget management, and reporting would also be essential components of the program's success, with daily, weekly, monthly, and annual applications of time.

(d) *Genetic considerations.* The goal of endangered species captive breeding programs is the maintenance of the genetic diversity present in the wild individuals from whom the captive program is descended (Ralls and Ballou 1992). The size of the captive breeding program will be a function of the founders represented (i.e., taxonomic status, population distinctness), and often this is a complication for conservation breeding programs. There is no reason to consider the use of other subspecies as a source of birds for the Cape Sable seaside sparrow captive breeding program if managers attempt to capture founding individuals before wild populations reach critical levels.

Another genetic consideration within a captive breeding program is maintaining population structure, if present. There is no reason to believe that subpopulations of sparrows are distinct or that other population structure exists and needs to be considered in genetic management. Historically, the subpopulations in southern Florida were substantially larger and closer in distance than today's situation, suggesting movement likely occurred between regions of their range. Even today, where subpopulations are more divided and farther apart, the limited data available on dispersal indicates that some movement occurs among the subpopulations.

*Genetic monitoring:* Genetic management of a captive breeding population will require the maintenance of a studbook computer database, detailing information on all animals in the captive population, including dates of births and deaths, gender, parentage, locations, and local identification numbers of animals. Analyses of these data would provide critical information necessary for evaluating temporal changes taking place in a captive population, including age-specific reproductive and survival rates, age structure, numbers of founders, degree of inbreeding and loss of genetic diversity. These data are also the basis for making management recommendations designed to enhance the demographic and genetic security of the captive population.

(e) *Timeframe* Because of the simplicity of the construction and materials required for such a facility, it is estimated that once the project was approved and funding available, the captive breeding project could be implemented within six months (if conducted at WOCC). Understandably, this would depend on the scope and duration of

the project. Additional facilities and partnerships may require different resources and timelines. For example, this timeframe does not include research pertaining to the founder selection process (size and location), *in situ* genetic or disease screening before founder removal, or monitoring post-removal at all capture sites.

The length of the program time (in generations) will also affect the program capacity. Nevertheless, even a short time-frame reintroduction program would likely reach 20 years.

### **(iii) In situ augmentation**

One way of avoiding some of the problems associated with captive breeding is to consider conservation-breeding programs *in situ* or that do not necessarily rely on birds reproducing in captivity. There are excellent examples of field-based conservation projects being complemented by captive methods (e.g., Seychelles magpie-robin *Copsychus sechellarum* and kākī *Himantopus novaezelandiae* (Digney et al. 2001, van Heezik et al. 2005). Although the Everglades environment (e.g., hurricanes) does not appear appropriate for conservation breeding on-site, we propose one method that would not involve ‘off-site’ breeding facilities as an alternative strategy.

We know from detailed nest survival analysis that clutches laid late (June-July) in the breeding season have a very small chance of survival (1-12% Baiser et al. 2008). For example, in June-July 2007 18 nests were located with 70 eggs and/or nestlings and only 3 nests fledged young. By incubating eggs artificially, rearing nestlings in captivity and then releasing them as juveniles we would bypass one of the highest periods of mortality. The period of care would be relatively short as incubation is approximately 10-12 days, nestling period 9-10 and fledglings probably only need direct care for 7-14 days. Cross fostering would be time consuming and difficult and is probably not necessary. Once young were capable of feeding themselves they could be moved to temporary aviaries on release sites for one week. Carrying out predator avoidance trials or incorporating a small number of adult sparrows into the aviaries may help habituate the young birds.

Captive breeding facilities generally do not consider the selective pressure wild individuals experience. After a number of generations in captivity without these natural selective pressures, individuals may lose important morphological, physiological and behavior traits necessary to survival in the wild. One of the major advantages of *in situ*

augmentation is the short-time frame birds are held (egg to independence, ~ 40 days), reducing the chance of domestication.

The success of the method briefly outlined here would depend on the growth and survival during captivity, the level of domestication, and the fate of captive-reared juveniles following release as compared to non-captive reared individuals.

#### **4.6.3 Federal policy and IUCN guidelines**

The Department of the Interior, USFWS captive breeding regulations regulates interstate movement of birds and captive breeding of endangered species. The Code of Federal Regulations (CFR) 50 lists specific regulations. These actions require permits from USFWS, and include reporting requirement and fees.

The U.S. Department of Agriculture (USDA) Animal and Plant Health Services regulates captive breeding facilities in the United States that buy or sell wildlife. These regulations govern animal care and species-specific activities at these sites and include annual inspections and reporting requirements. Historically, USDA has not regulated bird care but future implementation is likely.

The Florida Game and Fish Commission regulate wildlife in the State of Florida. They have established species-specific regulations for endangered species and species of special concern in Florida. They have also established regulations for captive wildlife including caging and care standards, which are enforced with permits and inspections processes.

The IUCN Reintroduction Specialist Group has created comprehensive guidelines for reintroduction of species through captive breeding.

#### 4.6.4 Estimate of costs

Approximate costs for Year one of Captive Breeding Program.			
Staffing/Professional Services			
<i>Description</i>	<i>Unit</i>	<i>Cost</i>	
1- full time avian keeper, salary and benefits	Annual	\$37,800	
Vet care – staff, lab costs, consumables	Annual	\$18,000	
Administration, records keeping, reporting	Annual	\$2,500	
Direct Expenses			
<i>Description</i>	<i>Unit</i>	<i>Cost</i>	
Bird housing facility (20 ft X 25 ft; 4 @ \$21,000)	One-time	\$84,000	
Utilities	Annual	\$250	
Feed costs	Annual	\$1,800	
TOTAL FIRST YEAR COST		\$144,350	
TOTAL SUBSEQUENT ANNUAL COSTS		\$60,350	

#### 4.6.5 Monitoring requirements

Details from the dusky seaside sparrow husbandry efforts are available for review and use. WOCC and all organization that are part of the Conservation Centers for Species Survival group use standardized daily record-keeping practices for their animal collections. Participation with USFWS species recovery programs includes regular reporting requirements to the recovery team. Scientific documentation or research projects would be shared with field biologists and recovery teams, providing a mechanism for evaluating the captive breeding effort.

Researchers should closely monitor the impact of removing individuals from the founding captive population (e.g., productivity, survival, and numbers). After releasing captive-bred individuals into the wild, it is critical to follow their reproduction and fate. We recommend intense nest monitoring and banding of all individuals (adults and their young) during release years and at least 5 years post-release.

#### **4.6.6 Identification of key information gaps and uncertainties**

##### Before captive breeding program initiation

- Undertake a cost/benefit analysis to establish whether captive breeding is in fact necessary/practical in the Cape Sable seaside sparrow's situation and the impact of removing individuals from the wild population.
- Model more precisely the wild population size threshold below which managers should capture founder individuals.
- Determine whether the genetic variability between subpopulations is high enough to warrant consideration when selecting founder individuals from the wild.
- Undertake basic disease screening in the wild population.

##### Captive husbandry

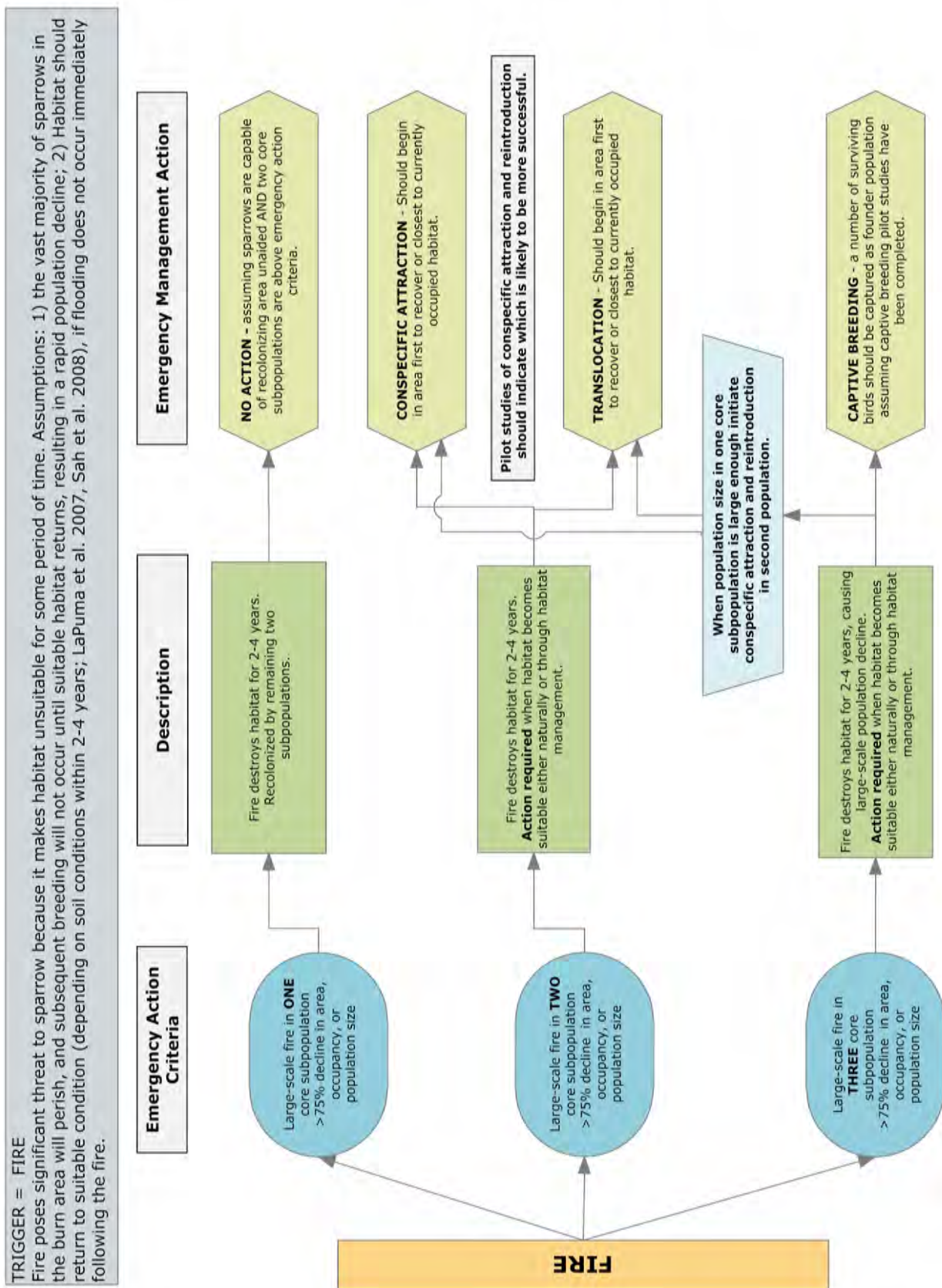
- Develop effective husbandry protocols for captive breeding of Cape Sable seaside sparrows
  - Size and type of enclosure
  - Necessary diet
  - Disease surveillance and prevention

##### Release considerations

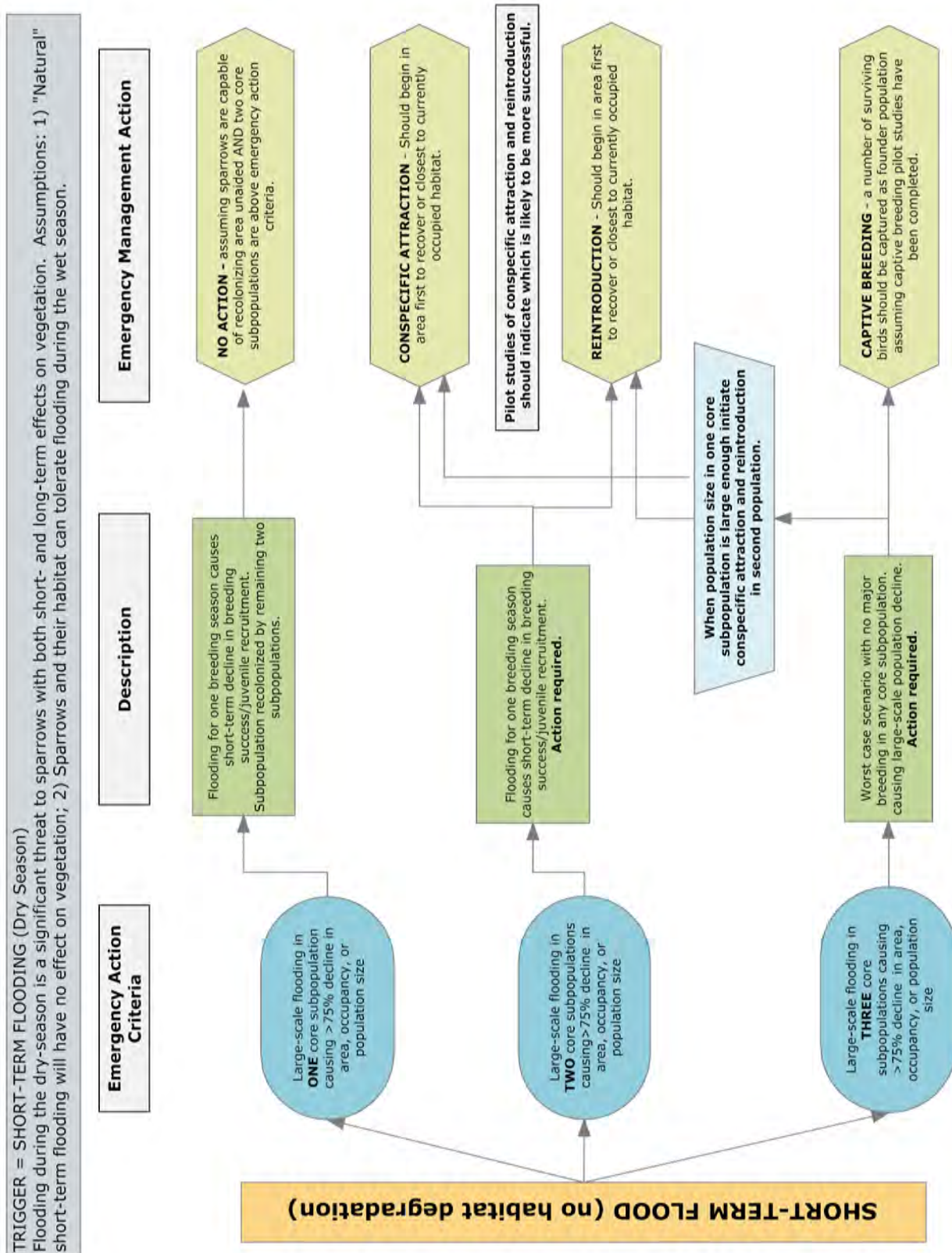
- Population and habitat modeling to provide guidance for
  - How much habitat is necessary (i.e., how many individuals the area can support) to initiate a release program
  - Locating areas of high quality habitat
- Effectiveness of captive-bred sparrows as a source population in a reintroduction program
  - Determining whether captive-bred individuals should augment or reestablish a sparrow population
  - The maximum number of individuals we could safely remove from the captive population
  - Development and effectiveness of release strategies (e.g. soft vs. hard, juveniles vs. adults, feasibility of predator avoidance training and time of release)



## **5. DECISION FRAMEWORK TREES**

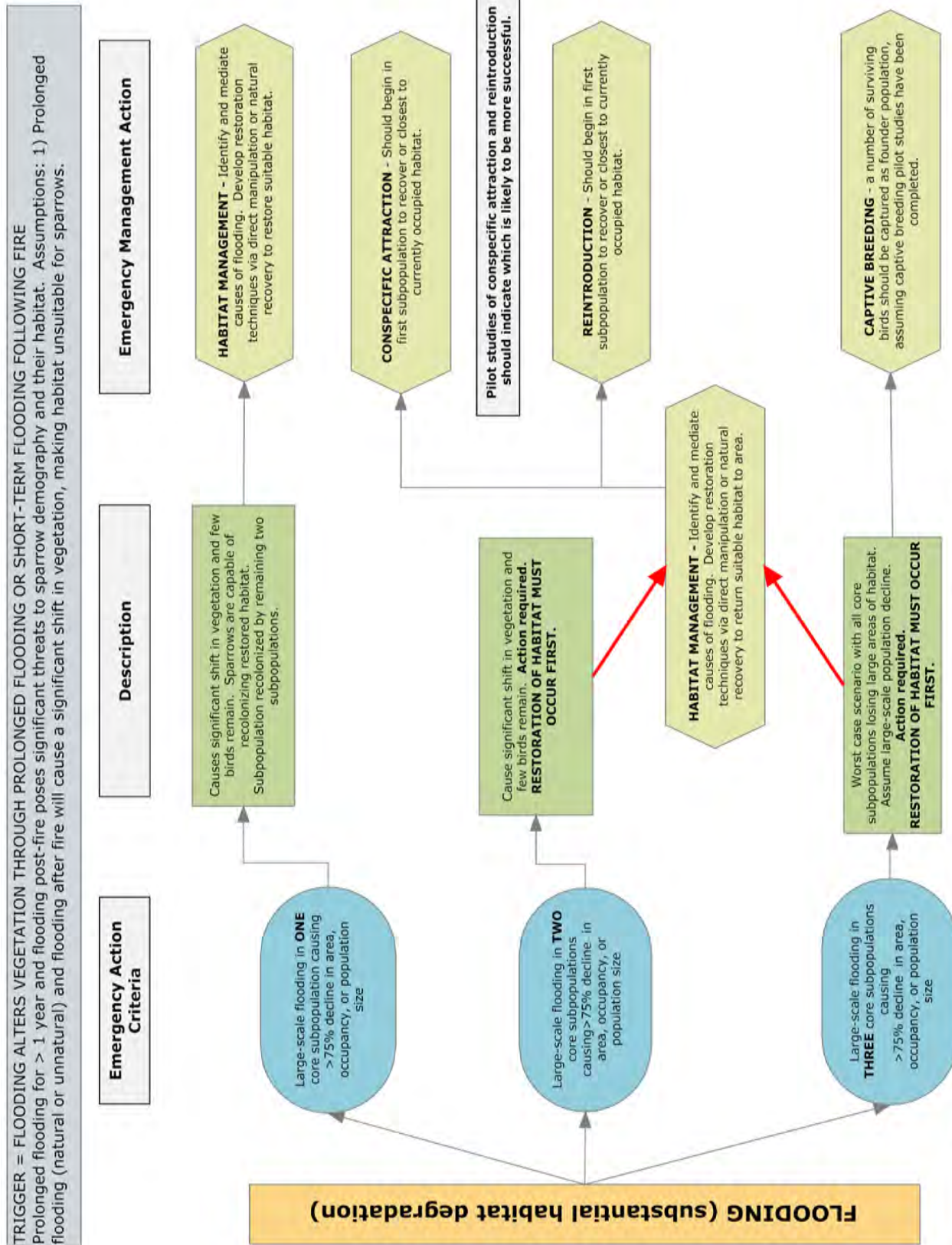


**Figure A.** Decision framework tree for the wild Cape Sable seaside sparrow population in response to the threat of fire.

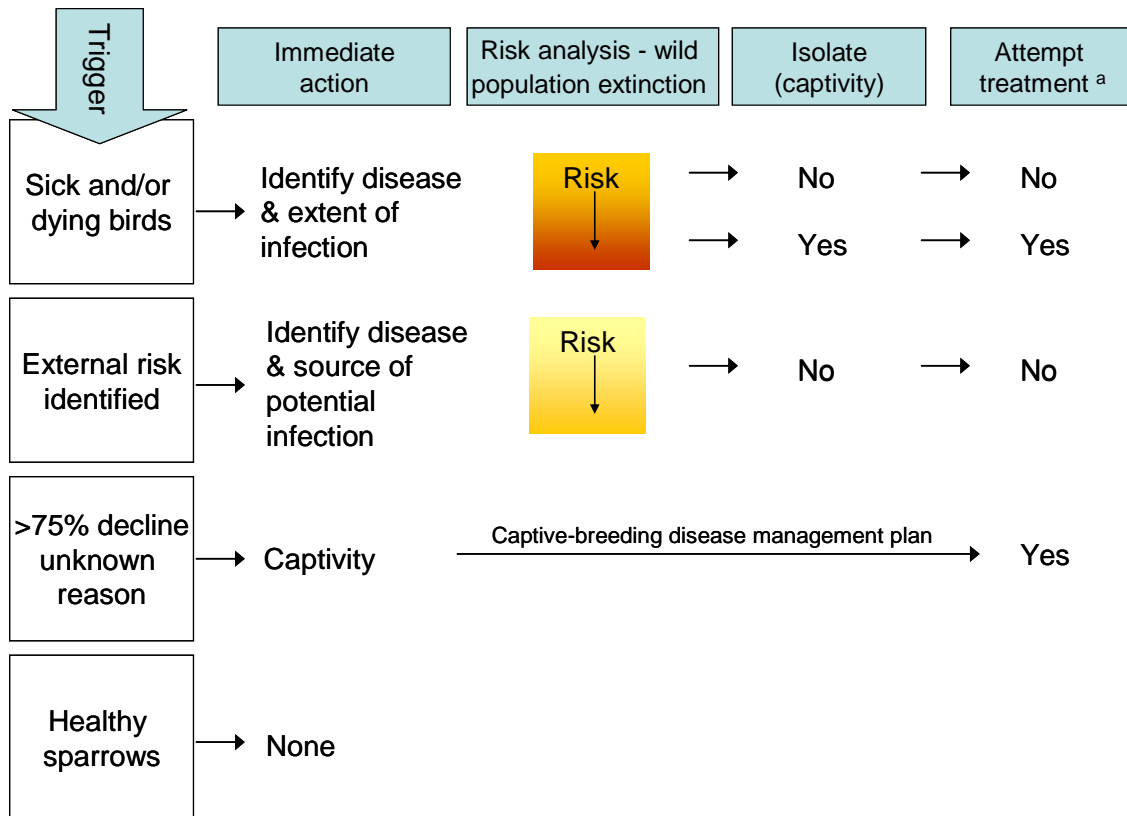


**Figure B.** Example of a decision framework tree for the wild Cape Sable seaside sparrow population in response to the threat of short-term flooding.



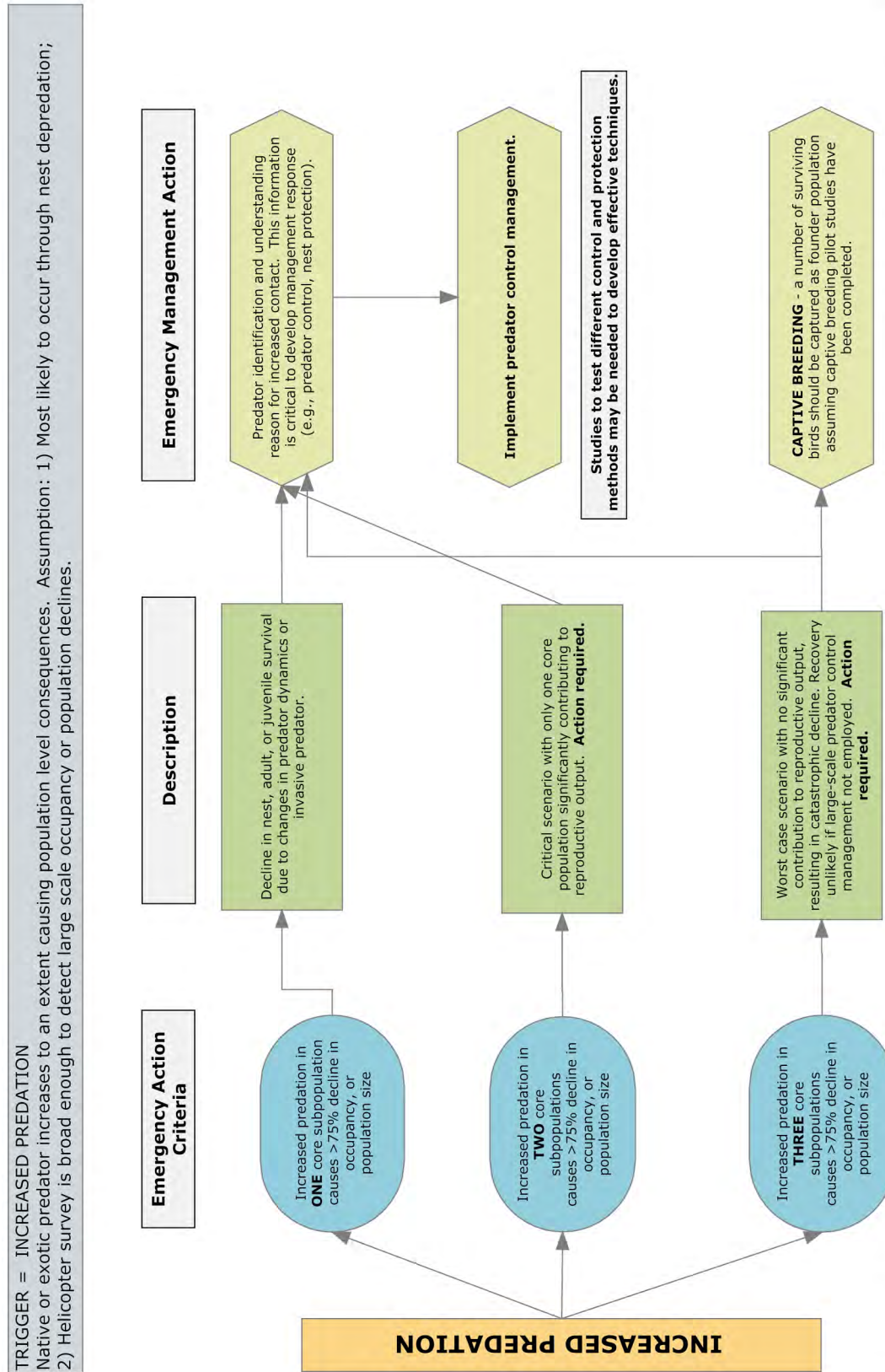


**Figure C.** Example of a decision framework tree for the wild Cape Sable seaside sparrow population in response to the threat of long-term flooding.



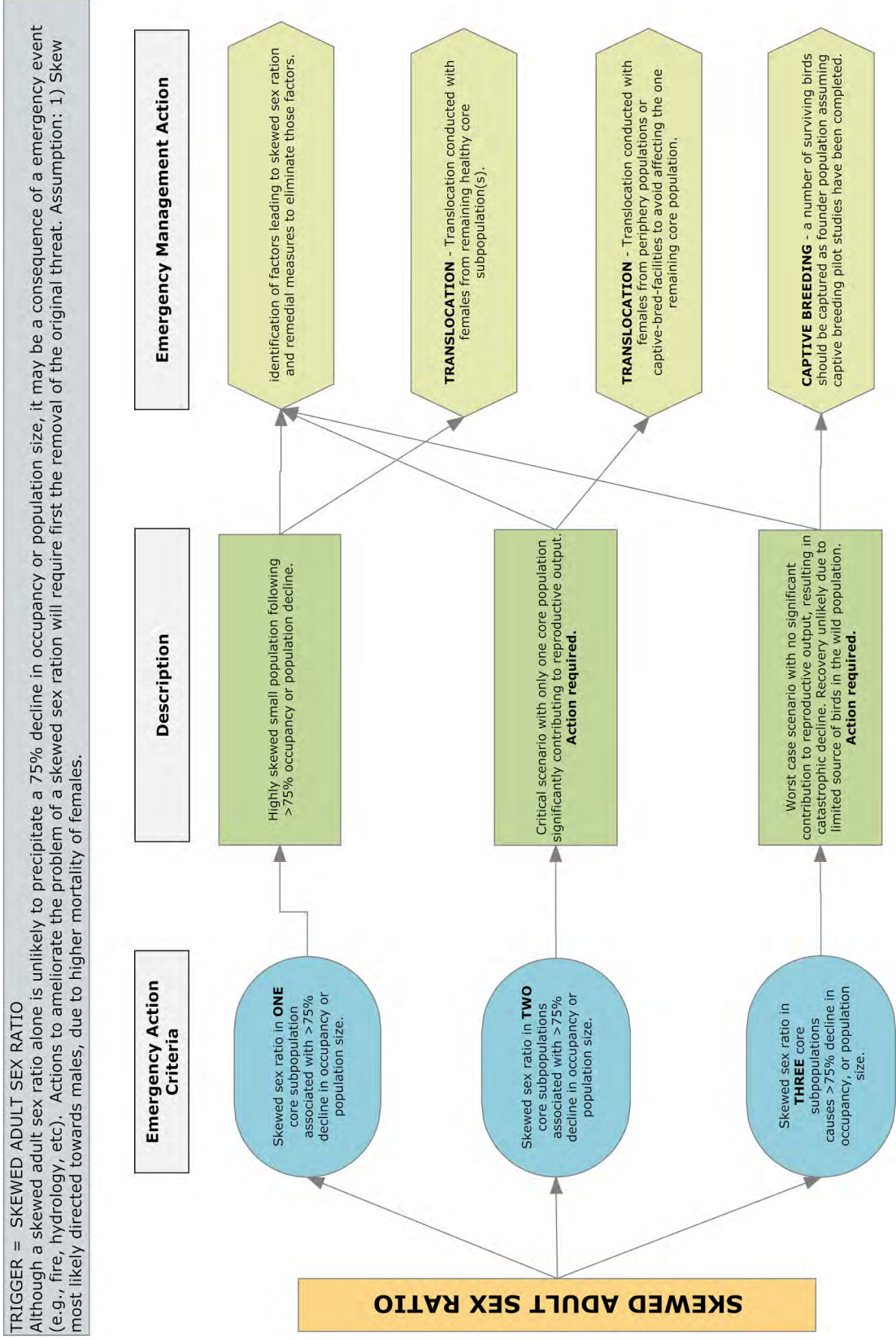
<sup>a</sup> assumes a safe and effective treatment is available.

**Figure D.** Decision framework tree for the wild Cape Sable seaside sparrow population in response to the threat of a disease outbreak.

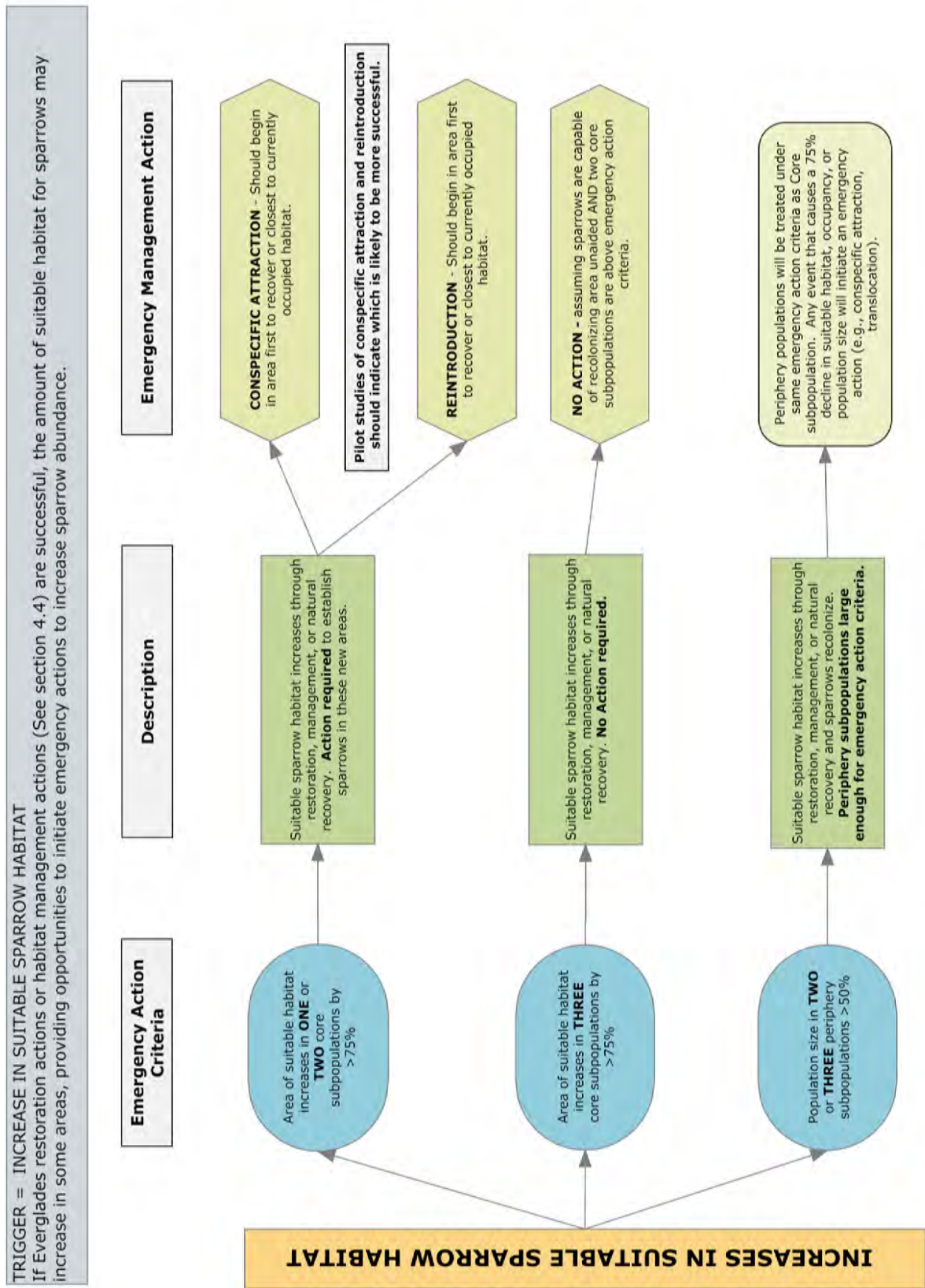


**Figure E.** Example of a decision framework tree for the wild Cape Sable seaside sparrow population in response to the threat of predation.





**Figure F.** Example of a decision framework tree for the wild Cape Sable seaside sparrow population in response to the threat of skewed adult sex ratio.



**Figure G.** Example of a decision framework tree for the wild Cape Sable seaside sparrow population in response to an increase in suitable habitat.



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I Subpopulation delineation and survey points

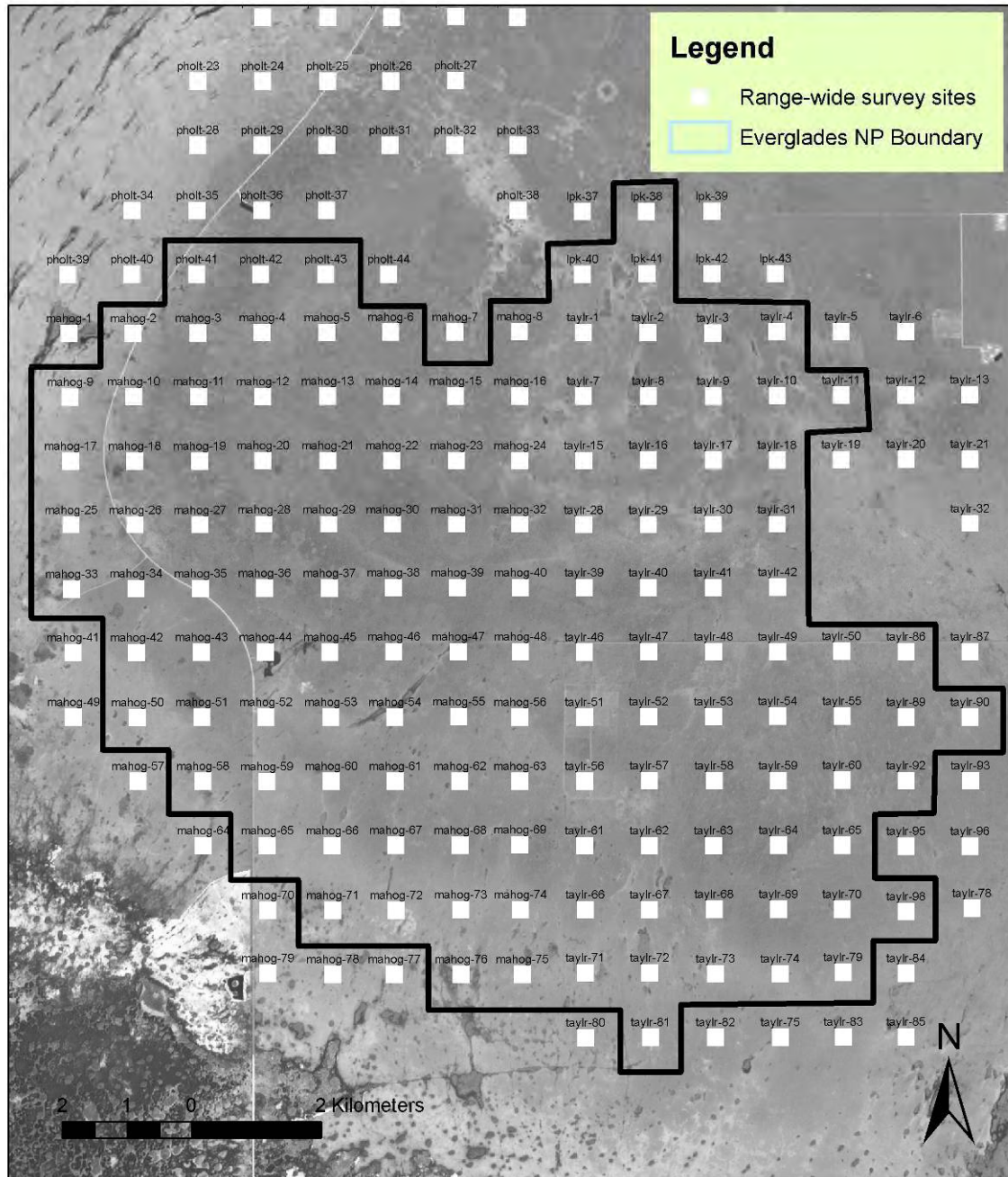
Subpopulation A survey sites





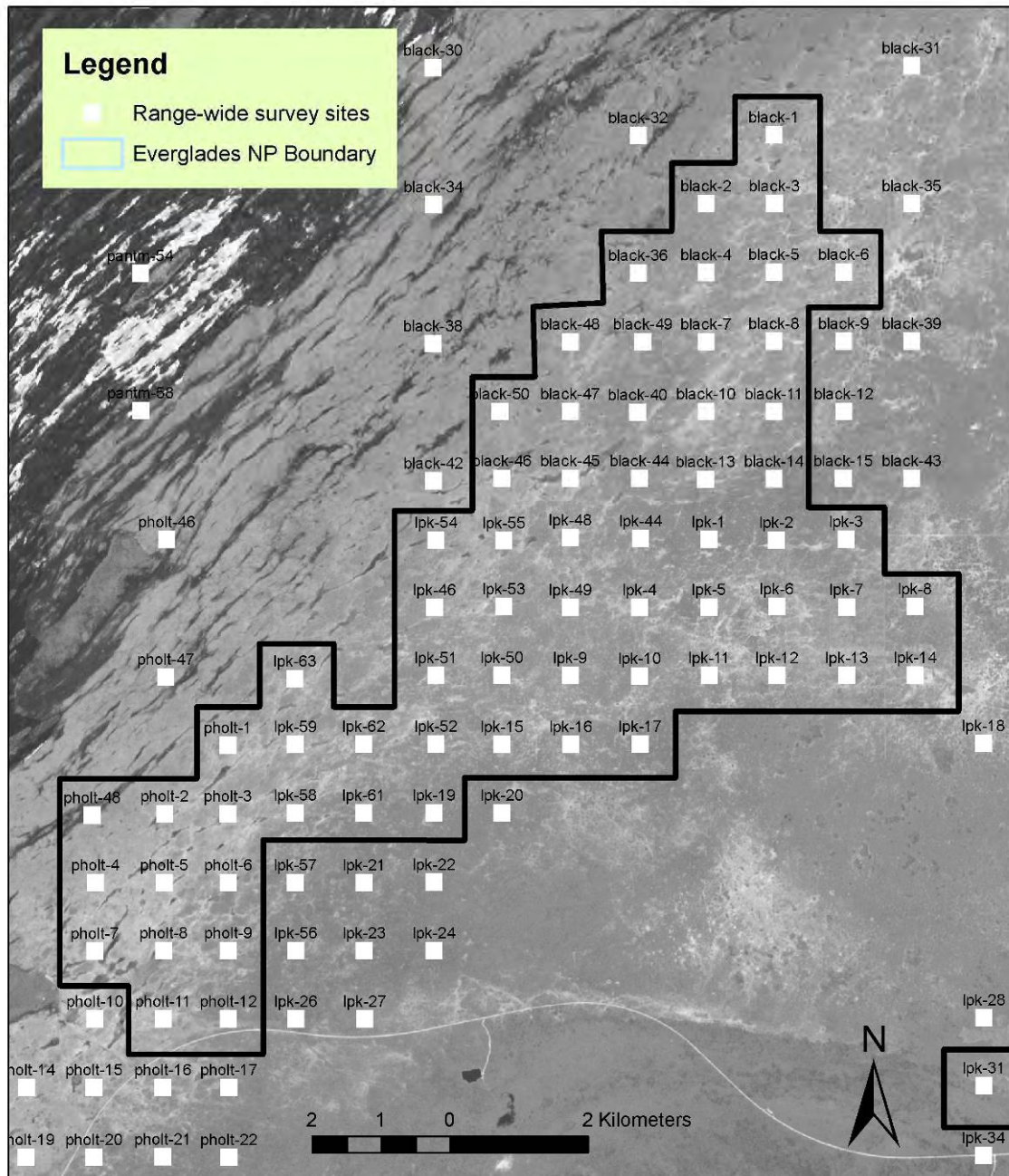
# Appendix I

## Subpopulation B survey sites



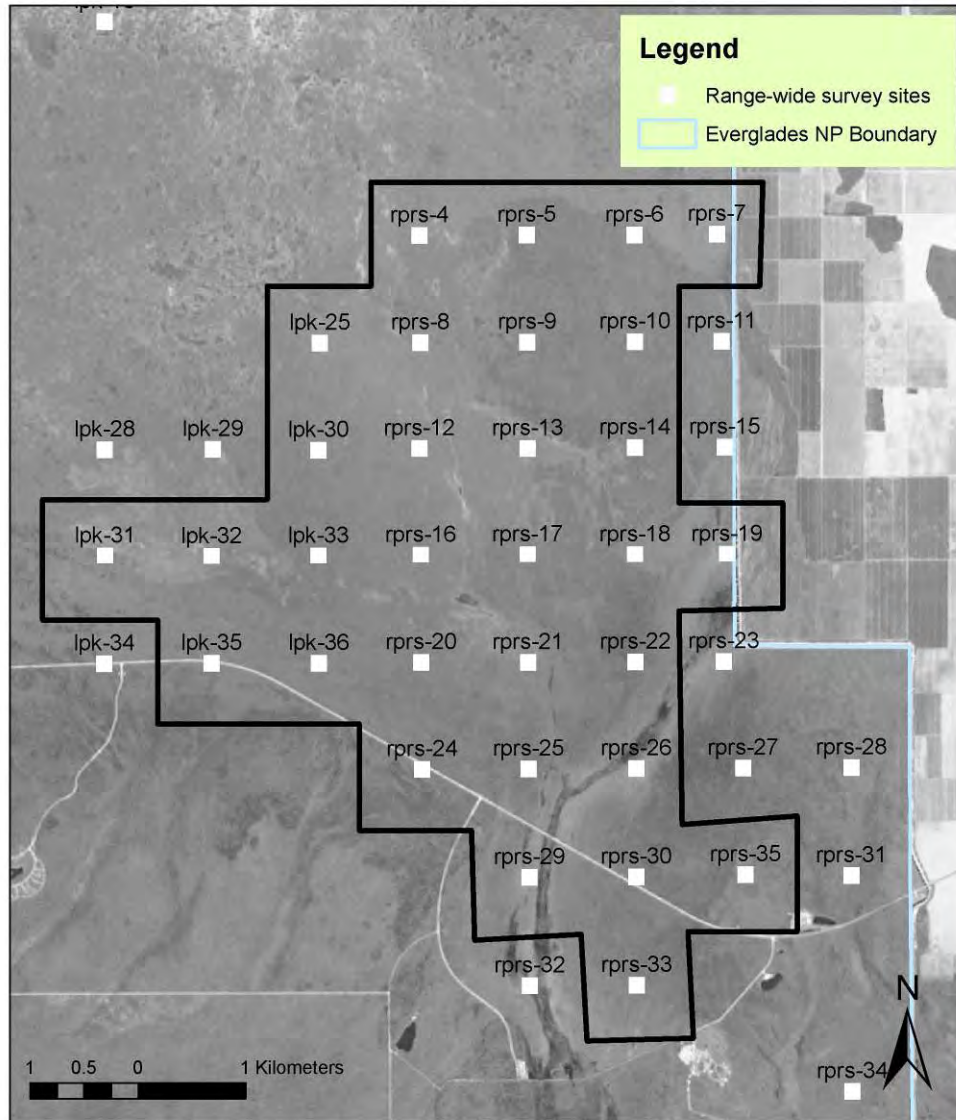
# Appendix I

## Subpopulation E survey sites



## Appendix I

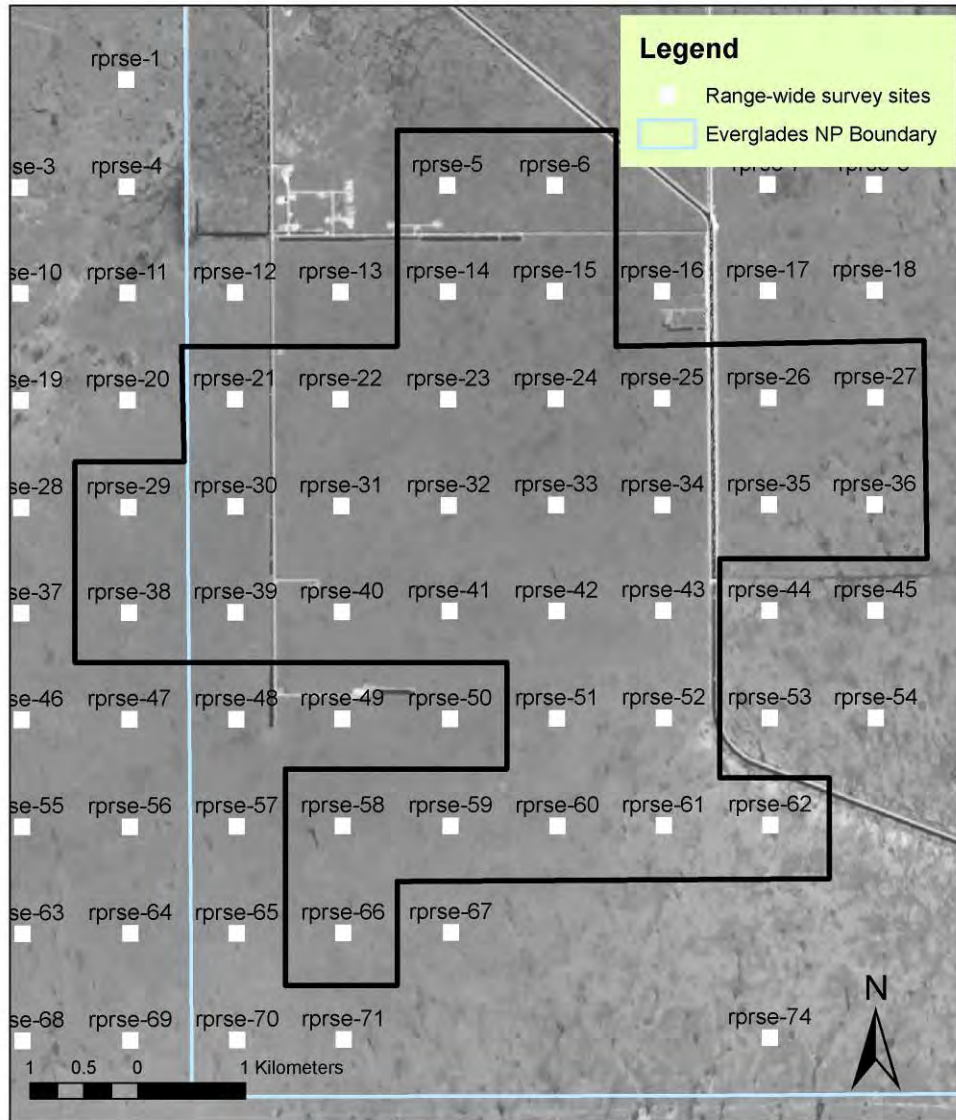
### Subpopulation C survey sites





## Appendix I

### Subpopulation D survey sites



## Appendix I

### Subpopulation F survey sites

