

**RECOVERY OF THE ENDANGERED CAPE SABLE SEASIDE SPARROW  
IN EVERGLADES NATIONAL PARK: MONITORING AND SETTING PRIORITIES**



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DECEMBER 2014

FINAL REPORT TO THE UNITED STATES NATIONAL PARK SERVICE  
(EVERGLADES NATIONAL PARK, HOMESTEAD FL)



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## **1.0 EXECUTIVE SUMMARY**

The following report presents research on the Cape Sable seaside sparrow (*Ammodramus maritimus mirabilis*) conducted under a grant from the Critical Ecosystems Science Initiative (CESI) of Everglades National Park (“Recovering small populations of the Cape Sable seaside sparrow”). Original funding for this research came from a grant from the United States Fish and Wildlife Service (USFWS; “Detailed study of Cape Sable seaside sparrow nest success and causes of nest failure”), with continuing funding from CESI serving to expand our efforts into new areas and augment the questions we could address. Funding for sparrow research also was provided by the South Florida Water Management District. This report represents our final report for research conducted under the CESI grant since funding for this project has been discontinued.

### **Section 2.0 – 2014 Field Season Overview**

During 2014 we continued to focus field research on intensive nest monitoring in small sparrow subpopulation A. This area has seen a decline in sparrow numbers in recent years and is subject to current management changes, or proposed changes, and thus near real-time information on where sparrows were nesting and the status of individuals in this area was needed to help direct water management if necessary. In 2014 we also continued intensive nest monitoring in a study plot in subpopulation B so that we could collect data from a large sparrow subpopulation for comparison with data collected from the small subpopulation. During 2014 we also continued a long-term mark-recapture study by banding individuals in subpopulations A and B, and resighting previously banded individuals in these subpopulations.

Overall, the 2014 sparrow breeding season was an average year in regards to overall nest success rates in subpopulations A and B. However, the mean hatch rate observed in subpopulation A was substantially lower than the rate in subpopulation B. Overall productivity was low in subpopulation A, and total recruitment into this small subpopulation remains low. Subpopulation B reported high overall productivity and recruitment in 2014. The only evidence of multi-brooding by breeding pairs was in subpopulation B in 2014. Return rates of previously

banded individuals were very low in small subpopulation A; return rates were substantially higher in large subpopulation B.

The total number of sparrows in subpopulation A remains very low, with 14 birds detected. Subpopulation B slightly increased with 30 adult birds in 2014. The continued decline in subpopulation A is a major concern; numbers first dropped from 2010-2011 largely due to a reduction in females on our study plot, and numbers dropped again from 2012-2014 due to a reduction in males this time. We are concerned that subpopulation A could be approaching a minimum threshold necessary to promote settlement of breeding sparrows, perhaps due to a lack of enough conspecific cues. The past low nest success rates and current low return rates in subpopulation A raise alarm that this subpopulation may face continued declines unless the causes of the lower demographic rates here can be identified and managed. We suggest that monitoring should continue to be conducted in a large sparrow subpopulation in conjunction with monitoring in small subpopulation A for comparative purposes in order to quickly recognize potential Allee effects in the small subpopulations that could lead to rapid population declines.

Two other areas of major concern remain the highly-skewed adult sex ratio and very low recruitment rates observed in small sparrow subpopulation A. The sex ratio did become more balanced in 2014; however, due to the already small population sizes this subpopulation should be monitored closely for future changes. Highly skewed adult sex ratios increase a species' risk of extinction (Dale et al. 2001). This process was observed during the extinction of a closely-related species, the Dusky seaside sparrow (*A. m. nigrescens*), when ultimately all of the remaining sparrows in the wild were males (Delany et al. 1981). Thus it is critical that the skewed sex ratio in small sparrow subpopulations be monitored closely to assess the rangewide status of the Cape Sable seaside sparrow in the future. Future research should continue to document sex ratios in small subpopulations, but should also continue to examine sex ratios in a large sparrow subpopulation for comparison to potentially capture early warning signs of a rangewide pattern that could be very detrimental to overall Cape Sable seaside sparrow population viability.

With such low nest success and limited dispersal in subpopulation A, we are concerned that this important sparrow subpopulation may be subject to continued declines in the near term. Local recruitment and dispersal rates alone will unlikely be enough to enable this isolated sparrow subpopulation to persist. It has previously been suggested that conservation managers should consider translocation of female sparrows into subpopulation A to achieve an adequately-sized breeding population for its persistence, and that the time to do this was likely becoming critical as the existing male sparrows in this subpopulation continued to age (Virzi and Davis, 2012). Unfortunately, the low return rate of male sparrows observed in subpopulation A in 2014 could be an indication that our hypothesis was correct, and it is possible that we may already be very close to the critical mass necessary for this subpopulation to persist. While translocation of birds may seem like a viable management option for this subpopulation at this time, we caution that until we more fully understand the mechanisms causing reduced demographic rates and recent population declines in our study plot in subpopulation A there is considerable risk associated with the translocation of sparrows. We suggest that sparrows breeding in subpopulation A should be monitored closely to determine if the population continues to decline, and that the best method to monitor the subpopulation is to conduct intensive ground surveys and nest monitoring with similar effort to that conducted in recent years.

## **Acknowledgements**

We thank Everglades Air Safety, Fire Cache and Dispatch for ensuring our safety every time we go into the field. We thank the many individuals in various departments at Everglades National Park that have helped us along the way, especially Tylan Dean, Alicia LoGalbo and Mario Alvarado. We thank Sandra Sneckenberger, Kevin Palmer and Rick Fike at the United States Fish and Wildlife Service for all of their support and valuable input into our research. We also would like to thank Martha Nungesser and Pamela Lehr at the South Florida Water Management District. Finally, we thank Dr. Richard Lathrop, Jim Trimble and John Bognar from the Grant F. Walton Center for Remote Sensing and Spatial Analysis at Rutgers University for help with geographic information systems and data management.

## **2.0 Demographic monitoring in subpopulations A and B in 2014**

### **2.1 Introduction**

In 2014, we continued recent demographic monitoring efforts in subpopulations A and B that had been ongoing since 2009 in A and 2012 in B. Subpopulation A continues to be one of the most important subpopulations to track because historically it was one of the two largest subpopulations before significant population declines in the 1990s. Therefore, it holds the potential for significant recovery, even as it remains extremely vulnerable due to its small population size and its downstream position west of Shark River Slough, which exposes it to freshwater management decisions during the breeding season. Monitoring is needed in this area because it is subject to current water management actions, and thus near real-time information on where sparrows are nesting and the status of individuals in this area is needed to help direct water management, if necessary.

In contrast, subpopulation B contains the largest number of sparrows, has maintained relatively stable population trends since the early 2000s, and apparently supports demographic rates that produce an annual population growth rate  $> 1.0$ . As such, it serves as a high-quality reference population for comparison with subpopulation A.

Monitoring is also needed to maintain continuity with previous research and monitoring, and to evaluate and consider new opportunities for recovery as new restoration actions are being proposed. The Central Everglades Planning Project (CEPP) is the next generation of proposed projects to be implemented under the Comprehensive Everglades Restoration Plan. One goal of CEPP is to identify and plan for projects on land already in public ownership to allow more water to be directed south to the central Everglades, Everglades National Park (ENP), and Florida Bay. Although this project is expected to produce large-scale hydrological benefits to the ecosystem, there is also concern about its potential impact on endangered species, including the Cape Sable seaside sparrow, whose range is extremely limited and population very small.

In this document, we report on demographic monitoring in subpopulations A and B following methods established in 2012 and 2013 (Virzi and Davis 2013, 2012). We conducted intensive nest searching on plots and we continued banding adult and juvenile sparrows, which has been ongoing since 1994 (Pimm et al. 2002).

## **2.2 Subpopulation A**

At one time considered part of the 'core' habitat for the sparrow (along with subpopulation B), subpopulation A experienced a very noticeable, and consequently controversial, decline between 1992 and 1995 (Curnutt et al. 1998). Persistent unnatural flooding during consecutive breeding seasons caused this subpopulation to decline substantially in occupancy and numbers, leading to legal actions requiring a change in water management so that less water was delivered into subpopulation A during the peak of the sparrow's breeding season (Pimm et al. 2002). While these water management efforts appear to have resulted in relatively stable sparrow occupancy since 1996, at least until recently based on ENP rangewide survey data, this subpopulation shows little sign of recovering to pre-1990 occupancy levels (Cassey et al. 2007) and has apparently declined in numbers since 2008. Demographic monitoring began in subpopulation A in 2008 after a fire burned through the West Camp area. Observations of several large juvenile flocks indicated that breeding may have been very successful in that year. More intensive demographic monitoring has been ongoing since 2009, although observations of large juvenile flocks, as seen in 2008, have not been seen again. The goal of our research in subpopulation A is to better understand why the subpopulation shows no sign of recovery. Two specific objectives include: 1) to keep water managers abreast of current nesting conditions, and 2) to continue collecting basic demographic information.

### **2.2.1 Study plot**

Intensive nest searching was concentrated in the area near West Camp (within 4 km). Since 2009, intensive ground surveys for breeding sparrows have generally been conducted in a square study area between the following Everglades National Park helicopter survey sites: shark-40 (near West Camp), shark-28 to the north, shark-105 to the east, and shark-108 to the

south (**Figure 1**). The area directly to the east of West Camp, towards the southeastern corner of the study area near shark-108, is mostly covered by a large hammock and has not been surveyed with the same intensity as the rest of the study plot. Overall, the total area surveyed in 2014 covered approximately 5 km<sup>2</sup> and was comparable in size with prior years. However, most of our effort was concentrated in the area between shark-32, shark-36, shark-69, and shark-82, known as the Lower Meadow.

In 2014, monitoring did not begin until late April, almost a month later than in previous years, because of delays in funding. Funding levels were also lower, which reduced the number of person-days dedicated to monitoring. One outcome of this change in effort was a greater focus in the Lower Meadow portion of the study plot, particularly after visits to the Upper Meadow yielded no detections of sparrows. Despite a reduction in the number of nest visitations, the use of ThermoChrom iButtons helped us to determine nest fates and timing of transitions (i.e., time of nest failure or fledging).

### **2.2.2 Number of sparrows on study plot**

Territory mapping began on 15-Apr 2014 and ended on 01-Aug 2014. We documented 7 territorial male sparrows, 6 breeding female sparrows, and 1 wandering male (**Figure 1, Table 1**). The number of breeding pairs (6) in 2014 was nearly identical to the previous three years. However, the number of males was lower compared to previous years (2013 = 10; 2012 = 17; 2011 = 16). The number of female sparrows was consistent with previous years. Due to the decrease in males, the sex ratio crept closer to 1:1 in 2014 (0.57; **Figure 2, Table 1**). Male-biased sex ratios have been observed in all the sparrow subpopulations studied, although ratios have historically been the most extreme in subpopulation A. Territory maps in **Figure 1** reflect an average of 12.3 GPS points per individual tracked. The density of sparrow on this plot was 2.8 sparrows per km<sup>2</sup>.

As seen in past years, most sparrows continued to remain outside of the area in the study plot that burned in 2008, despite the apparent recovery of vegetation in this area. One unpaired male established a territory in the burned area this season; this compares with 2 males in 2013



and with 6 males in 2012. The bird was never banded, and was not seen at this location later in the summer. However, we observed another wandering unbanded male in the Lower Meadow area later in the summer, thus the unpaired male from the burn area may have departed his original territory to explore the occupied areas further north in the Lower Meadow. All remaining sparrows were located only in the Lower Meadow, approximately 1.5 km northeast from West Camp. During 2014, no sparrows were observed in the Upper Meadow.

### **2.2.3 Reproduction**

We located and monitored the fate of 7 sparrow nests: 5 were early-season nests (i.e., initiated before June 1<sup>st</sup>) and 2 were late-season nests. The first nest was located on 15-Apr 2014, and the last nest was found on 19-Jun 2014. The timing of nest initiation by sparrows in subpopulation A was consistent with previous breeding seasons (Boulton et al. 2011), although there were earlier nests as evidenced by an independent juvenile seen in the Lower Meadow on 24-Apr. All monitored nests were located in the Lower Meadow. No birds or nests were found in the Upper Meadow, although effort consisted of only 3-4 visits.

Pairs in 2014 tended to stay on the same territory for the entire season, unlike during 2013 when sparrows moved across the study area to re-nest in drier areas after the onset of rainy season (Virzi and Davis 2013). This may have been due to the delayed onset of water level rise and overall reduced water levels in 2014 compared to 2013. However, no nests were found in late-June and throughout July even though birds still appeared to be showing signs of breeding behavior.

Mean clutch size was 3.3 eggs/nest, similar to estimates in previous years (**Table 1**). Three of the 7 nests (43%) survived to hatching (i.e., 13 days), all from early-season nests, which have higher success rates (Baiser et al. 2008). This success rate was lower than the rate of 57% reported in 2013 (Virzi and Davis 2013), but was similar to the rate of 44% reported in 2012 (Virzi and Davis 2012). These rates are well below the rate of 71% reported in 2011 (Virzi et al. 2011).

Overall nest success (% nests that produced  $\geq 1$  young) was 43%, although this is apparent success and we expect real success was lower since it does not take into account nests that failed prior to being located. We did find evidence that at least two unlocated nests successfully fledged young. In one case, we found an independent juvenile early in the breeding season and in the second case a pair was found feeding fledglings. Our use of ThermoChrom iButtons proved to be very helpful to interpret nest fates in 2014, particularly as nest visits were irregular due to the helicopter schedule. All failed nests were due to apparent depredation, with a rodent implicated in one event based on evidence observed at the nest (e.g., empty nest with eggshells on the ground, iButton found outside the nest with tooth marks on it, and time of nest loss based on iButton data = 23:50). Additionally, iButton data suggests that 2 of the 3 fledged nests may have been attacked by predators, causing early fledging of survivors (e.g., nests found empty and disheveled, iButtons moved, and iButton data shows young left nests at night). It is unknown how many (if any) nestlings were lost during these attacks, but adults were confirmed feeding the survivors at a later time confirming successful fledging of the nests.

In all, 9 nestlings fledged from monitored nests in subpopulation A in 2014. Thus, more young fledged in 2014 than in the previous two breeding seasons combined (2013 = 5; 2012 = 3) without including the additional young fledging from 2 unfound nests. The mean number of young fledged/pair and young fledged/successful nest were 1.5 and 3.0, respectively. With such small sample sizes it is hard to interpret these estimates, but they are generally similar to previous years (**Table 1**). Finally, we documented no multi-brooding in subpopulation A in 2014 for the third consecutive year.

#### **2.2.4 Survival**

During 2014, we newly banded 7 adult sparrows (3 males and 4 females) and 3 nestling sparrows. Of the 14 banded adults in subpopulation A in 2013, we resighted 4 males and 2 females yielding an adult return rate of 43%. This rate is similar to that observed in 2013 (48%), but substantially lower than rates observed in 2012 (78%) and 2011 (73%). The return rate in

2014 is lower than the apparent adult survival range estimated by Boulton et al. (2009) from 2002-2009 (mean = 0.60; range = 0.44-0.75).

In 2014, we resighted none of the 3 nestling sparrows banded in 2013, but both birds banded as free-flying juveniles in 2013 returned to hold territories in 2014 (return rate = 100%). Both of these birds were paired males, and settled within 100 to 400 meters of their original banding locations. We documented no between-subpopulation dispersal events involving subpopulation A in 2014.

## **2.3 Subpopulation B**

This subpopulation currently holds the largest number of sparrows. Subpopulation B is currently considered part of the core habitat for the sparrow (along with subpopulation E). It is generally protected from flooding and incendiary fires by Long Pine Key, contributing towards making this subpopulation a stronghold for the Cape Sable seaside sparrow (Curnutt et al. 1998). During 2014, we continued intensive nest monitoring in subpopulation B, which was initiated in 2013, so that demographic rates could be compared between subpopulations, with subpopulation B considered a high-quality reference site.

Another object of the research in subpopulation B in 2014 was to gain information about sparrows breeding in a large subpopulation that might be useful in the future if conservation managers decide to translocate sparrows from a large sparrow subpopulation into small subpopulation A. We also continued to refine our methods to capture free-flying juvenile sparrows, which are potential candidates for translocation.

### **2.3.1 Study Area**

Monitoring was conducted in the Dogleg Study Plot off Main Park Road, a small part of subpopulation B that is easily accessible by car/foot. This also allowed us to continue to collect mark-recapture data in this core sparrow subpopulation, which is an area where sparrows were banded from 1994 to 2008 (through the work of Dr. Stuart Pimm) and since 2012 (Virzi and

Davis 2012). Overall, the total area surveyed in 2014 covered approximately 1.5 km<sup>2</sup> and was comparable in size with the study plot monitored in 2012-2013.

### **2.3.2 Number of sparrows on study plot**

During 2014 we located 30 adult sparrows (17 males and 13 females; **Figure 3, Table 1**). The numbers of male and female sparrows were similar to numbers observed in 2012 and 2013 (Virzi and Davis 2013). Territory mapping began on 14-Apr 2014 and ended on 05-Aug 2014 (territory maps in **Figure 3** reflect an average of 11.2 GPS points per individual tracked). The density of sparrows on the Dogleg Study Plot was 20.0 sparrows per km<sup>2</sup>. We observed a slightly male-biased sex ratio (0.57; **Figure 2**).

### **2.3.3 Reproduction**

We located 26 sparrow nests, of which 11 were early-season nests and 15 were late-season nests. The earliest nest was located on 14-Apr 2014, and the latest nest was found on 28-Jul 2014. Territories were relatively evenly distributed across the Dogleg Plot, with a slightly greater density of birds in the north end (**Figure 3**). Eleven of the pairs remained on stable territories and continued to breed throughout the season, while one new male appeared later and paired with a new female. Another returning male moved in at the end of the summer replacing a male that had disappeared earlier, taking over the territory and making overtures to the female. An additional male had an unknown status, and the last two males were unpaired all summer. These two unpaired males both had marginal territories; one to the south nearest the pond, and one to the north close to the pine rockland habitat.

Mean clutch size was 3.2 eggs per nest. Twenty of the 26 nests (77%) found in subpopulation B survived to hatching; 8 were early-season nests (73%) and 12 were late-season nests (80%). Twelve of the 20 hatched nests (60%) survived to fledge young; 7 were early-season nests (88%) and 5 were late-season nests (42%). Overall nest success was 46% (12 of 26 nests were successful). The mean number of young fledged/breeding pair and young fledged/successful nest were 2.5 and 3.0, respectively. Importantly, we documented evidence of multi-brooding in

subpopulation B in 2014 (15% of the pairs multi-brooded). Overall, 33 young fledged from monitored nests in subpopulation B in 2014.

#### **2.3.4 Survival**

In 2014, we newly banded 2 adult males and 4 adult female sparrows. We needed to band few adults because of the extremely high number of returning adults from 2013. Of the 25 banded adults in subpopulation B in 2013, 23 (92%) were resighted in 2014. This return rate was much higher than apparent adult survival estimates generated by Boulton et al. (2009) from 2002-2009 (mean = 0.60; range = 0.44-0.75). The return rate for males (94%) was slightly higher than for females (89%). By the end of the 2014 breeding season all of the adult male sparrows and 12 of the 13 adult female sparrows found in the study plot in subpopulation B were color-banded.

In 2014, we resighted 3 of the 5 juvenile sparrows banded in 2013 (return rate = 60%) and 3 of the 17 nestlings banded in 2013 (return rate = 18%). The combined return rate for juveniles and nestlings was 27%, which was much better than the combined return rate observed in 2013 (8%; Virzi and Davis 2013).

We documented one between-subpopulation dispersal event in 2014. A single territorial male originally banded as a nestling at the Dogleg Plot in 2012 was recaptured in subpopulation D, a movement of over 26 kilometers through mostly prairie habitat. This bird was not observed in 2013.

#### **2.4 Comparative Data**

This section of our report summarizes and compares data collected in subpopulations A and B during the 2014 sparrow breeding season. **Table 1** presents data collected in these subpopulations from 2011-2014. For small subpopulation A, we present data for the past 4 years from our study plot near West Camp in order to show trends in demographic parameters over recent breeding seasons. We monitored subpopulation A with similar effort in each of these years making these data comparable, albeit with somewhat reduced effort in 2014 –

especially in the Upper Meadow area of our study plot. For large subpopulation B, we present data collected in our Dogleg Study Plot off Main Park Road from 2012-2014. Survey effort was similar in all years and nest monitoring effort was similar in 2013-2014; however, we did not intensively monitor nests in this subpopulation in 2012. The objective of this section is to highlight some of the important differences we observed in the data between a large and a small subpopulation.

#### **2.4.1 Number of sparrows on study plots**

**Figure 4** shows trends in abundance of Cape Sable seaside sparrows on our study plots in small subpopulation A and large subpopulation B. We included abundance estimates for subpopulation A for the period since 2009 because these data were available, and because these data are useful to show an apparent decline over recent years. We only show abundance estimates for the Dogleg Study Plot in subpopulation B since 2012 because this is when intensive ground surveys were reinitiated in this area. One apparent pattern observed is that the number of birds on our study plot in subpopulation B has remained relatively constant, while the numbers on our study plot in subpopulation A have declined since 2010. From 2010-2011 there was a substantial decline in the number of male (from 24 to 16) and female (from 19 to 6) sparrows in our study plot in subpopulation A. Since 2011 the number of breeding pairs in the subpopulation A plot has remained somewhat constant (range = 5 to 6); the continued decline in total numbers is due to a decline in single males only.

While the plot in Subpopulation B has been near-saturated with breeding territories, the density of breeding territories in A has been low, even though large areas of apparently suitable habitat exist. The inability of the sparrow population in A to reverse population declines when apparently suitable habitat is available has been a major question to land managers.

Unfortunately because the population size is small, our sample sizes for estimating demographic rates are also small, making it difficult to make strong inferences about limiting factors. It seems likely that several factors are working congruently to stem population recovery. One pattern that appears when looking at the data is that the demographic rates

that drive population growth – reproduction, survival, and recruitment (juvenile survival) rates – have been generally lower in subpopulation A compared to B. However, we have little information on the habitat factors (e.g., vegetation, predators, food availability) that influence these demographic rates in subpopulation A, and thus no way to develop strategies aimed at improving vital rates. An expanded demographic monitoring effort could help answer these questions and should be considered for future research.

One area on our study plot in subpopulation A where sparrows were expected to recolonize is the area that burned in the southern portion of the Lower Meadow in 2009. This area supported numerous breeding territories prior to the burn based on previous research (La Puma et al. 2007); sparrows can reoccupy burned patches two to three years post-fire. Prairie vegetation in this area has recovered and appears suitable for sparrows. However, if population growth rates within the study plot and the subpopulation remain  $< 1.0$ , there may be no surplus birds capable of immigrating into this area. It is also possible that sparrows have not moved into the recovered habitat near West Camp due to strong philopatry to the Lower Meadow, where sparrows have been breeding in recent years, or due to the influence of stronger conspecific attraction in those same areas (Virzi et al. 2012).

The subpopulation is not likely to see an increase in number through immigration from other subpopulations. Subpopulation A is certainly the most isolated sparrow subpopulation being the only subpopulation located west of the Shark River Slough. Sparrow dispersal probability declines greatly over longer distances and thus the likelihood of sparrows from other subpopulations dispersing into subpopulation A is low (Gilroy et al. 2012b; Van Houtan et al. 2010). In fact, no between-subpopulation dispersal events have been observed into the study plot in subpopulation A from 2009-2014.

#### **2.4.2 Sex Ratio**

Our data suggests that there is consistently a more highly-skewed sex ratio in the small sparrow subpopulations than in large subpopulations. In 2014 the sex ratio in subpopulation A (0.57) was the same as that observed in subpopulation B for the first time since this demographic

parameter has been measured in both subpopulations (**Figure 2**). While on the surface this seems like a good development, the more moderately skewed sex ratio was achieved through a reduction in the number of male sparrows detected in subpopulation A rather than an increase in females (**Table 1**). We do not have an explanation for this shift, although we suspect it is temporary based on previous data that shows small populations of Cape Sable seaside sparrows, and other threatened species (Donald 2007), tend to have a male-biased sex ratio.

Possible explanations for male-biased sex ratios in sparrows are the effects of inbreeding (Liker and Szekely 2005), lower female survival rates (Gruebler et al. 2008) or sex-specific dispersal patterns (Steifetten and Dale 2005). Small, isolated populations may be particularly vulnerable to skewed sex ratios because natal dispersal is usually female-biased (Dale et al. 2001). Adult female survival is slightly lower than adult male survival in Cape Sable seaside sparrows, although not dramatically (Boulton et al. 2009). It is unknown at this time why the sex ratio is so skewed in these small sparrow subpopulations, but the consequences can be severe, as was the case with the now extinct Dusky seaside sparrow (*A. m. nigrescens*). More research is needed to understand the factors that drive the sex-ratio bias in the Cape Sable seaside sparrow. In addition, conservation techniques to address this problem, such as translocating female sparrows from a larger and more stable subpopulation should be considered. It is important to recognize the inherent risk of moving birds, however, translocation should be considered if for no other reason than to ensure the short-term persistence of this important sparrow subpopulation. However, due to the current dearth of information regarding factors affecting demographic rates in subpopulation A we suggest that further monitoring and research be conducted in this subpopulation before any attempt to translocate female sparrows be conducted.

Finally, we should point out that there recently has been a sharp decline in the number of male sparrows in subpopulation A, and very low return rates for both sexes in this subpopulation over the previous two years (see **Section 2.4.4** below). Although the sex ratio has come closer to a 1:1 ratio in subpopulation A, it is due to a reduction in the number of male sparrows rather than an increase in the number of females. The continuing unbalanced sex ratio contributes



towards low overall annual productivity in subpopulation A. The small population size and unbalanced sex ratio could also lead to lower recruitment rates due to a lack of enough conspecific cues in the subpopulation to encourage settlement by sparrows. It is possible that subpopulation A could be dropping below a critical threshold necessary to attract settling males. Regardless of the cause, the low return rate for adult sparrows observed in subpopulation A since 2013 is alarming and should be monitored closely.

### **2.4.3 Reproduction**

It is difficult to make statistical comparisons of nest success data between the subpopulations due to small sample sizes; however, we note the following observations. First, it is clear that sparrows breeding in large subpopulation B have generally been more successful than sparrows breeding in small subpopulation A. However, in 2014, sparrows in subpopulation A had greater overall nesting success and produced more juveniles than in previous years. One troubling pattern seen in the nesting data is that the proportion of nests that survive to hatching has been much lower in subpopulation A than B. Predation is thought to be the primary cause of nest failure. One hypothesis for increased predation in A is a greater abundance of predators, such as rice rats, in the region. However, this remains untested.

Overall productivity remains low in small subpopulation A compared to large subpopulation B, partially explained by the continued low density of breeding pairs in subpopulation A. During 2014, mean clutch size and overall nest success rates were comparable between the subpopulations. However, as mentioned previously the hatch rate remained substantially lower in subpopulation A. Further, the total number of nestlings fledged per breeding pair continued to be substantially lower in subpopulation A (1.5) compared to B (2.5). Thus, overall productivity and recruitment for subpopulation A remains extremely low.

The other important observation in our 2014 data is that no multi-brooding occurred in small subpopulation A; however, 15% of the sparrows in large subpopulation B were able to successfully raise a second brood. Interestingly, water levels were higher in subpopulation B breeding areas compared to subpopulation A throughout most of the breeding season and

sparrows were still able to multi-brood despite the higher water levels. Since multi-brooding is predicted to be critical for the population viability of the Cape Sable seaside sparrow it is vitally important to identify the factors that lead to successful multi-brooding. Our 2014 data indicate that low water levels may not be the sole factor necessary for sparrows to multi-brood.

Although Gilroy et al. (2012a) previously found no Allee effects associated with nest success rates among Cape Sable seaside sparrow subpopulations, it is still possible that there could be an unrecognized Allee effect in small sparrow subpopulations leading to a lack of multi-brooding, again perhaps due to a lack of sufficient conspecific cues in the small subpopulations as one hypothesis. We suggest that this is an area of research that deserves much more attention.

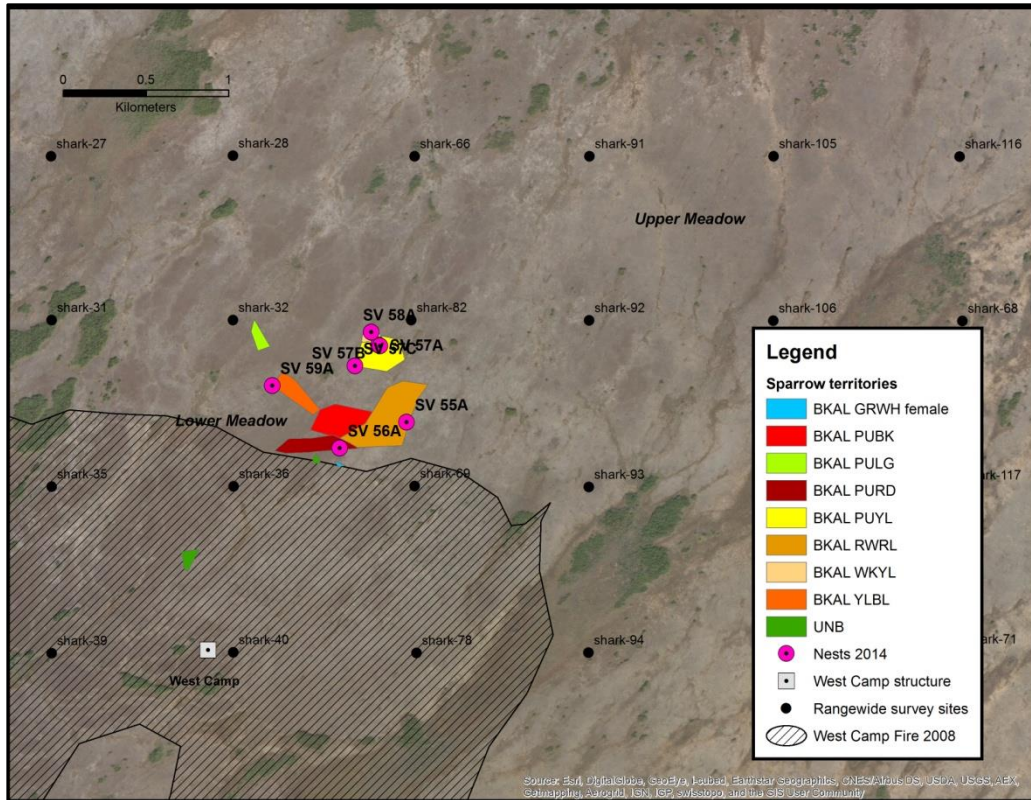
#### **2.4.4 Survival**

Return rates for adult sparrows were quite high in subpopulation B in 2014 (males = 0.94; females = 0.89), but were substantially lower in small subpopulation A (males = 0.40; females = 0.50). Importantly, in 2014 the return rate for male sparrows declined for the third year in a row in subpopulation A. The low return rates reported in subpopulation A are a major concern since this small subpopulation is already on the brink of extinction. The low return rates observed in subpopulation A could be the result of lower survival rates or the dispersal of individuals to areas off our study plot. Long-distance dispersal is rare for the Cape Sable seaside sparrow so this is unlikely to be the cause for the low return rates; however, we cannot rule out that short-distance dispersal is going undetected due to the small size of our study plot. We suggest that further research is needed to better understand the cause for the low return rates observed in subpopulation A, perhaps intensifying surveys to include areas off-study plot to detect dispersing individuals. Dispersal patterns and potential causes for the male-biased sex ratios seen in small sparrow subpopulations remain critical factors that need more understanding in order to better assess the rangewide status of the Cape Sable seaside sparrow.

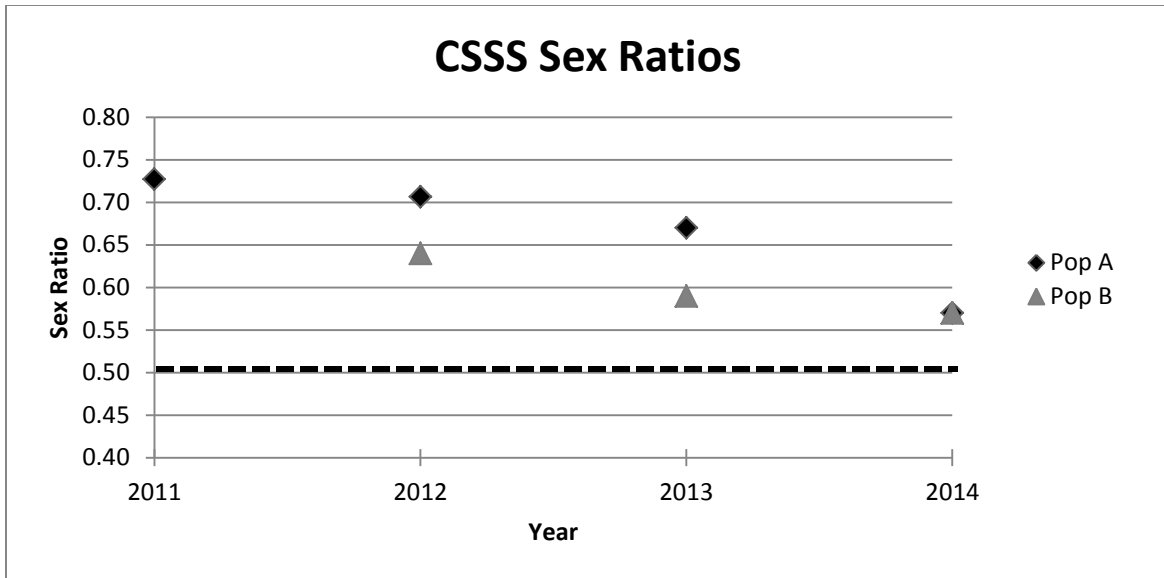
## 2.5 Tables and Figures

**TABLE 1:** Demographic data collected by Rutgers University (2011-2013) and by Ecostudies Institute (2014) for Cape Sable seaside sparrows breeding in small subpopulation A compared with data from large subpopulation B. Sex Ratio = male bias in subpopulation; Chicks Fledged/S.Nest = Chicks Fledged / Nests Fledged; Chicks Fledged/Pair = Chicks Fledged / Breeding Pairs; Banded Individuals = total number of banded sparrows (by sex and age class) in subpopulation at year-end; Return Rate = Resights / Banded Adults (from prior year, by sex).

Data	Pop A				Pop B			
	2011	2012	2013	2014	2011	2012	2013	2014
Total Population	22	22	15	14	na	28	27	30
Breeding Pairs	7	6	6	6	na	8	11	13
Males	16	17	10	8	na	18	16	17
Females	6	5	5	6	na	8	11	13
Sex Ratio	0.73	0.77	0.67	0.57	na	0.64	0.59	0.57
Density (Sparrows/km <sup>2</sup> )	4.4	4.4	3.0	2.8	na	18.7	18.0	20.0
Nests	17	9	7	7	na	9	14	26
Mean Clutch Size	3.6	3.8	3.0	3.3	na	na	3.2	3.2
Nests Hatched	12	4	4	3	na	na	11	20
Hatch Rate	0.71	0.44	0.57	0.43	na	na	0.79	0.77
Nests Fledged	5	2	2	3	na	na	9	12
Fledge Rate/Hatched	0.42	0.50	0.50	1.00	na	na	0.82	0.60
Nest Success (%)	0.29	0.22	0.29	0.43	na	na	0.64	0.46
Chicks Fledged	13	3	5	9	na	na	27	33
Chicks Fledged/S.Nest	2.6	1.5	2.5	3.0	na	na	3.0	3.0
Chicks Fledged/Pair	1.9	0.5	0.8	1.5	na	na	2.5	2.5
Pairs Fledging >1 Brood	1	0	0	0	na	na	3	2
%Fledging >1 Brood	0.14	0.00	0.00	0.00	na	na	0.27	0.15
Banded Individuals								
Adults	18	21	14	13	na	28	25	29
Males	15	17	10	7	na	18	16	17
Females	3	4	4	6	na	8	9	12
Juveniles	3	0	2	0	na	8	5	23
Nestlings	8	3	3	3	na	16	17	37
Resights - Adults	16	14	10	6	na	5	16	23
Resights - Males	13	11	8	4	na	2	12	15
Resights - Females	3	3	2	2	na	3	4	8
Return Rate - Adults	0.73	0.78	0.48	0.43	na	na	0.57	0.92
Return Rate - Males	0.72	0.73	0.47	0.40	na	na	0.67	0.94
Return Rate - Females	0.75	1.00	0.50	0.50	na	na	0.50	0.89

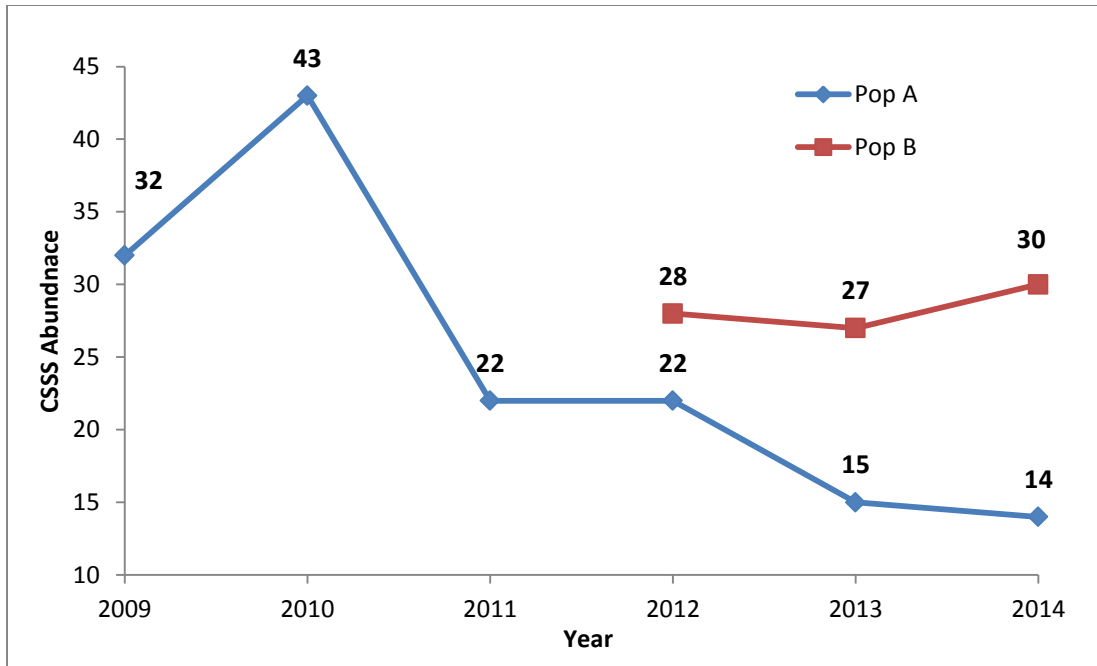


**FIGURE 1:** Location of Cape Sable seaside sparrow territories in subpopulation A during the 2014 breeding season. Black circles correspond to Everglades National Park helicopter survey sites. Eight male sparrows were observed singing on apparent territories during 2014. Territories are color-coded by unique color-band combinations for each male sparrow; red-yellow tones indicate breeding males and blue-green tones indicate single males. Pink circles correspond to locations of sparrow nests monitored during 2014. Hatched area represents boundary of fire that burned near West Camp in 2008.



**FIGURE 2:** Cape Sable seaside sparrow sex ratios observed in small subpopulation A during the 2011-2014 breeding seasons compared to sex ratios observed in large subpopulation B during the 2012-2014 breeding seasons. A ratio > 0.50 indicates a male-biased sex ratio (black dashed line).





**FIGURE 4:** Number of Cape Sable seaside sparrows on the plot in subpopulation A and B. The study plot in small subpopulation A was intensively surveyed annually during the 2009-2014 breeding seasons (March - July). The study plot in large subpopulation B (Dogleg Plot) was surveyed with similar effort from 2012-2014 only. Total area surveyed in study plots located in subpopulations A and B was approximately 5.0 km<sup>2</sup> and 1.5 km<sup>2</sup>, respectively, each year.

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