RECOVERING SMALL CAPE SABLE SEASIDE SPARROW
(*Ammodramus maritimus mirabilis*) SUBPOPULATIONS:
BREEDING AND DISPERsal OF SPARROWS IN THE EVERGLADES

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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 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 – 2013 Field Season Overview**

During 2013 we continued to focus our field research on intensive nest monitoring in small sparrow subpopulations A and D. These two areas are 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 these areas was needed to help direct water management if necessary. In 2013, however, we also began 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 subpopulations. During 2013 we also continued our long-term mark-recapture study by banding individuals in subpopulations A, B and D, and resighting previously banded individuals in these subpopulations.

Overall, the 2013 sparrow breeding season was another below average year in regards to nest success rates in subpopulation A. Subpopulations B and D fared better reporting above average nest success rates. Overall productivity was extremely low in subpopulation A, and total recruitment into both small subpopulations remains low. Subpopulation B reported high productivity and recruitment in 2013. The only evidence of multi-brooding by breeding pairs was in subpopulation B in 2013. Return rates of previously banded individuals were lowest in
small subpopulations A and D; return rates were better in large subpopulation B but remained moderately below average.

The total number of sparrows in subpopulations A and D remains very low, 15 and 5 birds respectively. Both subpopulations declined considerably in 2013. Subpopulation B remained relatively constant at 27 birds in 2013. The decline in subpopulation A is most alarming because it is the second big population decline reported since 2010; numbers first dropped between 2010 – 2011 largely due to a reduction in females on our study plot, and then numbers dropped again between 2012 – 2013 due to a reduction in males this time. The decline in subpopulation D is of less concern because this subpopulation has remained extremely small (averaging < 10 birds) for some 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 very low nest success and 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 subpopulations A and D 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 ratios and very low recruitment rates observed in small sparrow subpopulations A and D. We are concerned that such a highly-skewed adult sex ratio towards males persisted in both subpopulations A and D again in 2013. The sex ratios did become somewhat more balanced in 2013; however, due to the already small population sizes these subpopulations 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. In our 2012 report we 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. Unfortunately, the low return rate of male sparrows observed subpopulation A in 2013 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 the 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.

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2.0 2013 Field Season Overview

2.1 Overview

During 2013 there was a continuing need to monitor basic information on sparrows breeding in small sparrow subpopulations A and D. These two areas are 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 these areas was needed to help direct water management if necessary. We also initiated intensive monitoring in one study plot in large sparrow subpopulation B during 2013 so that we could compare information between large and small subpopulations. This section of our report begins with a summary of the information provided by our field research within each subpopulation (Sections 2.2 – 2.4). We then present a comparison of important demographic parameters between the small sparrow subpopulations (A and D) and large subpopulation (B) under study in 2013 (Section 2.5).

Sparrows that nested in small subpopulation A had another below average year and there was once again a strongly male-biased sex ratio in this subpopulation in 2013. Thus, overall productivity and recruitment for this subpopulation remains extremely low. Sparrows nested successfully in small subpopulation D for the second consecutive year; however, there was also a strongly male-biased sex ratio in this subpopulation. Overall productivity and recruitment in subpopulation D was also extremely low due to the very small size of this subpopulation. Total productivity in subpopulation B in 2013 was much higher than in the small sparrow subpopulations studied. We observed a more balanced sex ratio, higher nest success rates and evidence of multi-brooding in this large sparrow subpopulation which all contributed towards the much higher productivity.

Cape Sable seaside sparrow research efforts in recent years have shifted from field data collection and basic monitoring towards synthesizing information already collected. Several recent scientific publications have resulted from this effort (see Gilroy et al. 2012a, Gilroy et al. 2012b, Virzi et al. 2012), all of which were included in previous reports and are not duplicated
here. Our efforts at synthesis feed back into the need for continued field research in some areas: for example, there remains a large deficiency of information on the survival and dispersal of juvenile sparrows and there is still a lack of understanding of sex-related dispersal patterns. Thus, during 2013 we surveyed subpopulations A, B and D for previously banded sparrows with a continued focus on trying to resight returning juveniles and to detect between-subpopulation movements of sparrows. We also banded individuals (adults and juveniles) in subpopulations A, B and D in an effort to increase the size of the banded population. The data collected during 2013 will continue to strengthen the long-term database on sparrow demography and provide information for further synthesis.

Dispersal among sparrow subpopulations remains low; we documented no between-subpopulation movements of marked individuals in 2013. Return rates for adult sparrows were low in all subpopulations in 2013, but especially so in small subpopulations A and D. Further, in 2013 the return rate for male sparrows declined considerably in these small subpopulations. The low return rates reported are a major concern since these small subpopulations are already on the brink of extinction. 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 assess the rangewide status of the Cape Sable seaside sparrow.

2.2 Subpopulation A

This subpopulation continues to hold relatively few sparrows (density = 3.0 sparrows per km²). 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 management efforts appear to have resulted in relatively stable sparrow occupancy since 1996, this subpopulation shows little sign of recovering to pre-1990 occupancy
levels (Cassey et al. 2007). Further, this subpopulation appears to be in decline since 2008. However, because intensive nest monitoring was not performed from 2000 – 2008 we cannot compare our current population estimates with that period (Virzi and Davis 2012b; also see Figure 4 in Section 2.5 below). We began our research in subpopulation A in 2008 after a fire burned through the West Camp area, and noted that there were large juvenile flocks in the subpopulation indicating that breeding may have been very successful in that year. We have not observed such juvenile flocks since then, which may be an indication that breeding success has been reduced since this period for unknown reasons (e.g., predation pressure may have increased).

In 2013, we continued the intensive nest searching and monitoring in subpopulation A that we began in 2009. Additionally, we continued banding adult and juvenile sparrows which has been ongoing since 1994 (originally through the work of Dr. Stuart Pimm). Our efforts to monitor nests, band sparrows and resight previously banded sparrows were once again concentrated in the area near our field camp, 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”, which is primarily a large hammock, has not been surveyed with the same intensity as the rest of the study plot. Overall, the total area surveyed in 2013 covered approximately 5 km² and was comparable in size with prior years.

Our research effort in subpopulation A was somewhat lower in 2013 due to limitations resulting from a substantial reduction in available helicopter support to reach the subpopulation. Budget cuts due to the recent federal sequestration led to a reduction in the level of helicopter support ordinarily provided by ENP, thus, we were required to modify our fieldwork schedule accordingly. However, we feel that the imposed reduction in research effort did not affect our ability to collect the field data necessary to make useful comparisons with data from previous years. Fortunately, our use of Thermochrom iButtons in sparrow nests helped us to determine
nest fates and timing of transitions (i.e., time of nest failure or fledging) accurately despite a reduction in the number of nest visitations we were able to make during 2013.

During 2013 we documented only 10 territorial male sparrows and 5 breeding female sparrows (Figure 1; also see Table 1 in Section 2.5 below). This represents a substantial decline in the number of male sparrows observed in our study plot in 2013 compared to previous years; there were 17 and 16 males observed in 2012 and 2011, respectively. The number of female sparrows remains low, consistent with previous years. Territory mapping began on 03-April 2013 and ended on 19-July 2013 (territory maps in Figure 1 reflect an average of 8.4 GPS points per individual tracked).

As seen in past years, most sparrows continued to remain outside of the area in our study plot that burned in 2008 despite the apparent recovery of vegetation in this area. Unmated male sparrows did establish territories in the burned area for the second year in a row; however, only 2 males established territories in this area in 2013 compared to 6 males in 2012. The remaining sparrows were located in the Lower and Upper Meadows, approximately 1.5 km and 3.5 km, respectively, from West Camp. It is possible that the biased sex ratio (see below) and very low dispersal and recruitment rates in subpopulation A are continuing to drive the delay in recolonization of the burned area by female sparrows; recolonization was expected to have occurred sooner based on previous research (La Puma et al. 2007). It is also possible that female sparrows have not moved into the recovered habitat near West Camp due to strong philopatry in the Lower and Upper Meadows, where sparrows have typically been breeding in recent years, or due to the influence of stronger conspecific attraction in those same areas (Virzi et al. 2012).

Similar to last year, we documented nesting by only 6 of the 10 territorial male sparrows observed during 2013. Thus, following the trend observed in recent years in subpopulation A, and in small sparrows subpopulations in general (Boulton et al. In Press), most male sparrows (60%) were unmated during 2013. The proportion of unmated males observed in 2013 is lower than the estimate of 65% reported in 2012 (Virzi and Davis 2012b), but is higher than the
estimate of 56% reported in 2011 (Virzi et al. 2011b). Further the proportion of unmated males in subpopulation A remains substantially higher than the estimate of 24% reported in 2010 (Lockwood et al. 2010). We have observed a strongly male-biased sex ratio in subpopulation A since we began conducting ground surveys for breeding sparrows there in 2008 (see Figure 5 in Section 2.5 below). Further, an unbalanced sex ratio has been observed in all of the sparrow subpopulations studied. This is discussed in greater detail in Section 2.5 below.

We located 7 sparrow nests in subpopulation A in 2013; 5 were early-season nests (i.e., initiated before June 1st) and 2 were late-season nests. The first nest was located on 17-April 2013, and the latest nest on 03-July 2013. The timing of nest initiation by sparrows in subpopulation A was consistent with previous breeding seasons (Boulton et al. 2011). The early nests were located in the Lower Meadow while later nests were located in the area between the Lower and Upper Meadows. In fact, we observed much movement of sparrows across our study area after the onset of rainy season. The latter area was drier later in the breeding season after rains began to flood other areas showing the importance of having alternative sites available across the landscape for sparrows to breed after the onset of rainy season.

We report apparent nest success rates here rather than daily survival probabilities (e.g., using Program MARK) due to the small sample size of nests in subpopulation A in 2013. Only 4 of the 7 nests hatched (hatch rate = 57%); 2 were early-season nests, which are known to have higher success rates (Baiser et al. 2008), and 2 were late-season nests. Only 2 of the hatched nests fledged young (fledge rate = 50%); 1 was an early-season nest and 1 was a late-season nest. Our use of Thermochrom iButtons proved to be very helpful to interpret nest fates in 2013 due to the irregular helicopter schedule this field season. All failed nests were due to apparent rice rat predation. The apparent hatch rate of 57% reported in 2013 was above the rate of 44% reported in 2012 (Virzi and Davis 2012b), but was once again well below the rate of 71% reported in 2011 (Virzi et al. 2011b). The fledge rate was average compared to recent years. The mean clutch size of 3.0 eggs per nest reported during 2013 was well below the mean reported over the previous two years (2012 = 3.8; 2011 = 3.6). Further, the mean number of young fledged per breeding pair of 0.8 reported in 2013 was very low for the second year in a
row (2012 = 0.5; 2011 = 1.9). Finally, we documented no multi-brooding in subpopulation A in 2013 for the second consecutive year.

In all, only 5 nestlings fledged from subpopulation A in 2013. With only 3 nestlings fledging in 2012, the combined productivity over the past two breeding seasons was nearly 60% of the total productivity from 2011 alone. Thus, total recruitment into subpopulation A continues to be alarmingly low due to the small population size, strongly male-biased sex ratio, low apparent nest success rates (especially the hatch rate), and a lack of any multi-brooding in the subpopulation.

During 2013 we newly banded 4 adult sparrows (2 males and 2 females) and 5 juvenile sparrows (2 hatch year birds and 3 nestlings) in subpopulation A. Most adults observed in subpopulation A were previously banded; we resighted 8 males and 2 females during 2013. The return rate for adult sparrows of 48% was extremely low compared to the previous two breeding seasons (2012 = 78%; 2011 = 73%). The return rate for the current year also falls well below the 60% rate expected based on previous survival analyses (Boulton et al. 2009, Gilroy et al. 2012b). The return rate for males (47%) was slightly below the return rate for females (50%) in 2013. The low return rates reported in subpopulation A compared to rates observed in other subpopulations are discussed in more detail in Section 2.5 below.

By the end of the 2013 field season, all 10 male sparrows and 4 of the 5 female sparrows in subpopulation A were color-banded. In 2013, we resighted 1 of the 3 juvenile sparrows (nestlings) banded in 2012 (return rate = 33%); no free-flying juvenile sparrows (hatch year birds) were banded in subpopulation A in 2012. We documented no between-subpopulation dispersal events in 2013.
FIGURE 1: Location of Cape Sable seaside sparrow territories in subpopulation A during the 2013 breeding season. Black circles correspond to Everglades National Park helicopter survey sites. Ten male sparrows were observed singing on apparent territories during 2013. Territories are color-coded by unique color-band combinations for each male sparrow; red tones indicate breeding males and blue-green tones indicate single males. Red circles correspond to locations of sparrow nests monitored during 2013. Hatched area represents boundary of fire that burned near West Camp in 2008.
2.3 Subpopulation B

This subpopulation currently holds the largest number of sparrows (Dogleg Study Plot density = 18.0 sparrows per km$^2$). Subpopulation B is considered part of the core habitat for the sparrow (along with subpopulation E). In recent years unnatural flooding and incendiary fires have had a lower impact on this large subpopulation than on other subpopulations, contributing towards making this subpopulation a stronghold for the Cape Sable seaside sparrow (Curnutt et al. 1998). During 2013, we initiated intensive nest monitoring in subpopulation B similar to our monitoring already being conducted in small subpopulations A and D so that we could begin collecting data in a large, apparently healthy sparrow subpopulation for comparison. We decided to monitor sparrows in the Dogleg Study Plot off Main Park Road since this part of subpopulation B 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 have been banded since 1994 (originally through the work of Dr. Stuart Pimm), and where we conducted less intensive field research in 2012 (Virzi and Davis 2012b). Overall, the total area surveyed in 2013 covered approximately 1.5 km$^2$ and was comparable in size with our study plot in 2012.

A major goal of our research in subpopulation B in 2013 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. Thus, we increased the population of marked individuals in an area where many of the older color-banded individuals had already died since banding had not occurred in this study plot for several years (until re-initiated in 2012). This will aid in future monitoring of this subpopulation if a translocation experiment is implemented at a later time. We also continued to refine our methods to capture free-flying juvenile sparrows, which are the most likely candidates for translocation.

During 2013 we located 27 adult sparrows (16 males and 11 females) in the Dogleg Plot of subpopulation B (Figure 2; also see Table 1 in Section 2.5 below). The number of male and
female sparrows observed in the Dogleg Plot in subpopulation B in 2013 was relatively consistent with numbers observed in 2012 (Virzi and Davis 2012b). Sixteen of the 27 adult sparrows observed in subpopulation B (12 males and 4 females) were resights of previously banded individuals. The remaining 4 adult male sparrows and 5 of the remaining adult female sparrows in subpopulation B were color-banded in 2013. Thus, by the end of the 2013 breeding season all of the adult male sparrows and 9 of the 11 adult female sparrows found in our study plot in subpopulation B were color-banded. Territory mapping began on 20-March 2013 and ended on 15-July 2013 (territory maps in Figure 2 reflect an average of 9.7 GPS points per individual tracked).

We located 14 sparrow nests in subpopulation B in 2013; 7 were early-season nests and 7 were late-season nests. The first nest was located on 15-April 2013, and the latest nest on 08-July 2013. The timing of nest initiation in subpopulation B was consistent with the timing observed in subpopulation A in 2013. Territories were clustered on two sides of the Dogleg Plot, with no birds residing in between (Figure 2). The fortunes of the Dogleg North birds were quite different from those in the Dogleg South area, especially when the water levels rose rapidly in early-May after the onset of heavy rains. Dogleg North pairs remained together and on territory throughout the summer, with a strong late-season breeding effort in July. Dogleg South pairs appeared to dissolve with banded females disappearing and the males clumping together disregarding territorial boundaries. Water levels were extremely high in the Dogleg Plot, approaching knee-deep at times and with 100% coverage the entire summer. It is possible that the difference in vegetation structure between the two ends of the Dogleg Plot is partly responsible for the different outcomes. Dogleg South has thinner, shorter grass so there are few to no nesting opportunities during periods of high water. Dogleg North has very thick, tall sawgrass so the pairs just kept building higher nests as water levels rose. Even so, 3 nests were observed flooded in 2013; in 1 nest the young were old enough to escape and fledged a little early but survived, while the other 2 nests had very small young which perished.

Eleven of the 14 nests found in subpopulation B hatched (hatch rate = 79%); 7 were early-season nests (hatch rate = 100%) and 4 were late-season nests (hatch rate = 57%). Nine of the
hatched nests fledged young (fledge rate = 82%); 6 were early-season nests (fledge rate = 86%) and 3 were late-season nests (fledge rate = 75%). The apparent hatch and fledge rates reported in subpopulation B in 2013 were well above the nest success rates reported in small subpopulation A. The mean clutch size of 3.2 eggs per nest reported during 2013 was slightly higher than the means reported in the small subpopulations under study (mean = 3.0). Further, the mean number of young fledged per breeding pair of 2.5 reported in 2013 was substantially higher than that reported in small subpopulation A (mean = 0.8). Importantly, we documented evidence of multi-brooding in subpopulation B in 2013 (27% of the pairs multi-brooded); we observed no multi-brooding in either of the small subpopulations under study this year. Further, multi-brooding occurred in the Dogleg Plot despite heavy rains that began in early-May and deep water levels that persisted throughout the breeding season in this study plot.

Total productivity was quite high in subpopulation B in 2013. In all, 27 chicks fledged from subpopulation B this year. This is in sharp contrast with the total productivity reported in the small sparrow subpopulations under study. Contributing factors towards the higher productivity in subpopulation B include the larger sparrow population in our study plot, more balanced sex ratio in the subpopulation, higher apparent hatch and fledge rates, larger clutch sizes, and multi-brooding by a large proportion of breeding pairs in the subpopulation.

We observed a slightly male-biased sex ratio in subpopulation B in 2013; however, the male bias was lower than that observed in the small subpopulations studied (A and D). In 2012, we had observed a somewhat higher male-biased sex ratio of 0.64 in subpopulation B, but we hypothesized that this was more likely a function of the lower monitoring effort expended in this subpopulation that year rather than a real biological phenomenon (Virzi and Davis 2012b). In 2013, we increased our research effort in subpopulation B to be more consistent with the effort expended in the small sparrow subpopulations under study and observed a male-biased sex ratio of only 0.59 supporting our hypothesis that the sex ratio reported in 2012 was likely biased high. Thus, this provides evidence that highly-skewed sex ratios may only be occurring in small sparrow subpopulations as predicted.
In 2013 most of the adult sparrows observed in subpopulation B were previously color-banded, with most banded as adults in 2012. The return rate for adult sparrows of 57% was higher than the rates reported in the small subpopulations under study, and was more in line with the rate expected based on previous survival analyses (Boulton et al. 2009, Gilroy et al. 2012b). The return rate for males (67%) was above the return rate for females (50%) in 2013, which was in sharp contrast to our observations in small subpopulation A. In 2013, we resighted 2 of the 8 juvenile sparrows banded in 2012 (return rate = 25%) and none of the 16 nestlings banded in 2012. The juvenile return rate of 25% is in line with expectations; however, the combined return rate for juveniles and nestlings was only 8%, which is much lower than expected. Thus, overall recruitment into subpopulation B was low in 2013. We documented no between-subpopulation dispersal events in 2013.
FIGURE 2: Location of Cape Sable seaside sparrow territories in the Dogleg Study Plot in subpopulation B during the 2013 breeding season. Black circles correspond to Everglades National Park helicopter survey sites. Sixteen male sparrows were observed singing on apparent territories during 2013. 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. Red circles correspond to locations of sparrow nests monitored during 2013.
2.4 Subpopulation D

This subpopulation continues to hold very few sparrows (density = 2.5 sparrows per km$^2$). Subpopulation D experienced a continual decline since its 1981 estimate of 400 sparrows. 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 acting as island refuges for breeding sparrows. These patches of suitable habitat may have increased moderately in recent years, due in part to prolonged drought conditions that prevailed recently in South Florida (Virzi et al. 2011a). 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 operational) will create a mound of ground water in subpopulation D critical sparrow habitat, further increasing hydroperiods and water depths in the areas currently occupied by sparrows.

In 2013, subpopulation D was monitored in conjunction with a research project that was funded by the South Florida Water Monitoring District (Virzi and Davis 2013). Subpopulation D continues to be an ephemeral sparrow population with breeding occurring sporadically between years. During 2013 we documented 3 territorial male sparrows and 2 female sparrows (Figure 3; also see Table 1 in Section 2.5 below). This represents a 50% decline in the number of male sparrows found in our study plot from the previous year; the number of female sparrows was the same. One additional male sparrow was observed in subpopulation D during ENP helicopter surveys; however, this male was located off of our study plot and is thus excluded from our data. Territory mapping began on 27-March 2013 and ended on 31-May 2013 (territory maps in Figure 3 reflect an average of 10.7 GPS points per individual tracked). Our study plot was located primarily east of Aerojet Road and west of the C-111 Canal, outside of the boundary of Everglades National Park. We walked into our study plot from Aerojet Road to Everglades National Park helicopter survey site “rpse-22” along the dirt road created by the South Florida Water Management District to a new water monitoring station that was constructed in 2011. We intensively surveyed the area extending from “rpse-22” east to “rpse-
24”, then south to “rpse-33” and west to “rpse-31”. The total area of our study plot in subpopulation D was approximately 2 km² and was comparable in size with prior years.

We located 2 sparrow nests in subpopulation D in 2013, documenting breeding in this subpopulation for the second consecutive year. Only two female sparrows were observed, therefore, 1 of the 3 male sparrows was unmated in 2013. This resulted in a male-biased sex ratio of 0.60 in 2013, which is below the rates observed in subpopulation D in recent years; during 2012 and 2011 we documented male-biased sex ratios of 0.75 and 0.86, respectively (Virzi and Davis 2012a; Virzi et al. 2011a). Both of the nests found in subpopulation D were early nests. Both nests hatched, and both nests fledged 3 chicks in 2013. Thus, 2013 could be seen as a successful year for those few sparrows that nested in subpopulation D. However, total recruitment into subpopulation D remains extremely low due to the extremely small size of this subpopulation, and a lack of enough females for all of the males present.

One of the breeding males in subpopulation D was a returning individual originally banded there in 2012. A second male banded in 2012 was resighted in subpopulation D, but this male remained unmated in 2013. We did not resight any other sparrows color-banded in previous years in subpopulation D during 2013. Thus, return rates of previously-marked individuals were very low in subpopulation D with only 33% of the adult males returning and none of the females, resulting in a total adult return rate of only 25%. We also did not resight any of the 3 nestlings originally banded in 2012.

We banded the remaining male sparrow and both of the female sparrows observed in subpopulation D in 2013. Thus, by the end of the 2013 breeding season all of the known adult sparrows in our study plot were color-banded (3 males and 2 females). We also banded 5 of the 6 nestlings found in subpopulation D in 2013. We documented no between-subpopulation dispersal events in 2013.
FIGURE 3: Location of Cape Sable seaside sparrow territories in subpopulation D during the 2013 breeding season. Black circles correspond to Everglades National Park helicopter survey sites. Three male sparrows were observed singing on apparent territories during 2013. Territories are color-coded by unique color-band combinations for each male sparrow; red and yellow tones indicate breeding males and blue tone indicate single male. Red and yellow circles correspond to locations of sparrow nests monitored during 2013. Figure provided by Virzi and Davis 2013.
2.5 Comparative Data

During 2013 we conducted intensive nest monitoring in both a large sparrow subpopulation (B) and small subpopulations (A and D) for the first time since 2009, which was the last time intensive nest monitoring was conducted in large subpopulations (B and E) and small subpopulations (A, C and D) simultaneously. This section of our report summarizes and compares data collected in subpopulations A, B and D during the 2013 sparrow breeding season. Table 1 below presents data collected in these subpopulations from 2011 – 2013. For small subpopulations A and D, we present data for the past 3 years in order to show trends in demographic parameters over recent breeding seasons. We monitored these subpopulations with similar effort in each of these years making these data comparable. For large subpopulation B, we present data collected in our Dogleg Study Plot in 2013 and 2012; however, we did not intensively monitor nests in this subpopulation in 2012. The sections below highlight some of the important differences between the large and small subpopulations under study that we observed in our data.

2.5.1 Population Trends

Figure 4 below presents Cape Sable seaside sparrow population trends in small subpopulations A and D compared with more recent trends in our study plot in large subpopulation B. We included population estimates for the small subpopulations since 2009 because these data were available, and because these data are useful to show an apparent decline in sparrow numbers in subpopulation A over recent years. We only show population estimates for subpopulation B since 2012 because we only began intensively surveying the Dogleg Study Plot that year. One trend that is apparent in Figure 4 is that numbers in subpopulations B and D seem to have remained relatively constant, while numbers in subpopulation A have declined since 2010. We hypothesize that several factors working congruently might be leading to the apparent decline in sparrows in subpopulation A over this period, as follows.

First, 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, we did not observe any between-subpopulation dispersal events into subpopulation A from 2009 – 2013. Combined with the low annual productivity and recruitment rates being observed in subpopulation A this would contribute towards a decline in overall numbers as adult birds senesce. However, there are clearly other factors contributing towards the decline in numbers in subpopulation A because this factor alone would not explain the large drop in numbers observed between 2010 and 2011 (49% decline), and then again between 2012 and 2013 (32% decline).

Second, a major contributing factor could be the recent consecutive years with poor breeding seasons in subpopulation A. Looking back to 2009, there have been 2 average and 2 well below average breeding years in subpopulation A. The 2009 breeding season was a very poor year for sparrows throughout their range, and this followed several other below average years (Virzi et al. 2009). The following year was average to below average once again (Lockwood et al. 2010). The 2011 breeding season was one of the better years for sparrows, but still could not be considered a boom year (Virzi et al. 2011b). Finally, 2012 was another below average breeding season (Virzi and Davis 2012b). Thus, we could be seeing the lagging effect of multiple poor breeding seasons combined with very low dispersal rates into the subpopulation. This could lead to the population trends observed since the sparrow is such a short-lived species.

Finally, we should point out that there continues to be a highly skewed sex ratio in favor of males in subpopulation A (see Section 2.5.3 below), and that there was a very low return rate for males in this subpopulation in 2013. The unbalanced sex ratio contributes towards low overall annual productivity in the subpopulation. 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 males observed in subpopulation A in 2013 is alarming and should be monitored closely.
2.5.2 Nest Success

It is difficult to make statistical comparisons of nest success data among the subpopulations due to small sample sizes; however, we note the following observations. First, it is clear that sparrows breeding in small subpopulation D and large subpopulation B were much more successful than sparrows breeding in small subpopulation A during 2013. All demographic parameters presented in Table 1 were much lower in subpopulation A, including: (1) hatch rate, (2) fledge rate, (3) clutch size, and (4) chicks fledged per pair. Since sparrows breeding in small subpopulation D were so successful in 2013 it is unlikely that the problems observed in subpopulation A are entirely density-related. Previous research has shown that Allee effects leading to lower nest survival rates were not present in the Cape Sable seaside sparrow population (Gilroy et al. 2012a). However, this research did find that subpopulation A had moderately lower nest survival rates than other sparrow subpopulations. Our research in 2013 seems to indicate that subpopulation A might have some other factor(s) unique to the subpopulation that are leading to lower nest success. One hypothesis has been that predation pressure, primarily from rice rates, may be higher in this subpopulation; however, this remains untested.

The other important observation in our 2013 data is that no multi-brooding occurred in either of the small subpopulations studied. However, 27% of the sparrows in large subpopulation B were able to successfully raise a second brood. Interestingly, water levels were perhaps highest in subpopulation B throughout most of the breeding season and sparrows were still able to multi-brood despite the high 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 2013 data indicate that low water levels may not be the sole factor necessary for sparrows to multi-brood. It is 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.
2.5.3 Sex Ratio

Our data suggests that there is consistently a more highly-skewed sex ratio in the small sparrow subpopulations than in large subpopulations (Figure 5). Although it is not an uncommon occurrence for there to be a male-biased sex ratio in small populations of threatened species (Donald 2007), the level observed in subpopulation A (and other small Cape Sable seaside sparrow subpopulations) is higher than expected. It is unknown at this time why the sex ratio is so skewed in these small sparrow subpopulations. Possible explanations for such highly-skewed sex ratios 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). This could subsequently lead to a high proportion of unpaired males in a population, and hence a reduced potential for population growth and higher extinction risk (Dale et al. 2001, Bessa-Gomes et al. 2004). Dispersal between subpopulations is known to be limited in the Cape Sable seaside sparrow (Gilroy et al. 2012b, Van Houtan et al. 2010); however, little is known about sex-specific dispersal patterns at this time.

A classic example of the consequence of a severely male-biased adult sex ratio in a small avian population occurred in the now extinct Dusky seaside sparrow (A. m. nigrescens) when surveys from 1977-1979 located 28, 24 and 13 males respectively, while the last female was seen in 1975 (Delany et al. 1981). The current skewed sex ratio in subpopulation A (and other small sparrow subpopulations) is reminiscent of the Dusky extinction. Thus, we are concerned that if more female sparrows do not recruit into subpopulation A we will see a continued and perhaps rapid decline in sparrow numbers in this already very small sparrow subpopulation. In recent years we had suggested that translocation of female sparrows from a larger and more stable subpopulation into small subpopulation A should be considered in order to ensure persistence of this important sparrow subpopulation. However, due to the large decline in male sparrows in subpopulation A in 2013 we suggest that further monitoring and research be conducted in this subpopulation before any attempt to translocate females be conducted.
TABLE 1: Demographic data collected by Rutgers University for Cape Sable seaside sparrows breeding in small subpopulations A and D (2011 - 2013) compared with data from large subpopulation B (2012 - 2013). Sex Ratio = male bias in subpopulation; Chicks Fledged/S.Nest = Chicks Fledged / Nests Fledged; Chicks Fledged/Pair = Chicks Fledged / Breeding Pairs; Banded Adults = total number of banded adults in subpopulation at year end (birds banded current year + resights); Return Rate = Resights / Banded Birds (from prior year, by age class).

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FIGURE 4: Cape Sable seaside sparrow population trends in subpopulations A, D and B. Study plots in small subpopulations A and D were intensively surveyed annually during the 2009 – 2013 breeding seasons (March – July). Study plot in large subpopulation B (Dogleg Plot) was surveyed with similar effort from 2012 – 2013 only. Total area surveyed in study plots located in subpopulations A, D and B was approximately 5.0 km², 2.0 km² and 1.5 km², respectively, each year.
FIGURE 5: Cape Sable seaside sparrow sex ratios observed in small subpopulations A and D during the 2011 – 2013 breeding seasons compared to sex ratios observed in large subpopulation B during the 2012 – 2013 breeding seasons. Ratios greater than 0.50 indicate male-biased sex ratios (black dashed line).
3.0 Literature Cited


