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 represents 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.

Section 2.0 – 2012 Field Season Overview

During 2012 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. The extreme drought conditions prevalent in South Florida prevented detrimental water management actions during the 2011 breeding season, and these conditions continued into the early part of the 2012 breeding season before a more typical wet season finally returned to South Florida. Fortunately, we did not observe any detrimental water management actions after an abrupt start of the 2012 wet season. During 2012 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 2012 sparrow breeding season was a below average year in regards to nest success and an average year in regards to return rates of banded individuals. The total number of sparrows in Subpopulations A and D remains low, 22 and eight birds respectively, but the populations are relatively the same size as we reported in 2011. Two 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 in 2012. Further, we are concerned that the male-bias increased for the second year in a row in Subpopulation A. 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.

We recommend that more attention be paid to the highly-skewed adult sex ratios in small sparrow subpopulations at this time. Future research should continue to document these rates in small subpopulations, but should also 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 Cape Sable seaside sparrow population viability. It is very difficult to assess the effects of skewed sex ratios on the overall sparrow population based solely on the limited sample sizes that can be obtained in the small subpopulations alone. Thus, we recommend that intensive nest monitoring in a large sparrow subpopulation be initiated with similar effort to that being conducted in small subpopulations at present.
Related to the issue of skewed sex ratios, we suggest that it is time to begin discussion of translocating female sparrows from a large sparrow subpopulation to small Subpopulation A in order to ensure persistence of this important subpopulation. Local recruitment and dispersal rates alone will unlikely be enough to maintain this isolated sparrow subpopulation. We suggest that it may be necessary to translocate female sparrows to achieve an adequately-sized breeding population for persistence in Subpopulation A, and that the time to do this is likely becoming critical as the existing male sparrows in this subpopulation continue to age. Our research in 2012 shows that sparrow productivity in Subpopulation B (Dogleg Plot) may be high enough to support removal of juvenile sparrows from this large subpopulation to be used as the individuals for translocation to Subpopulation A. However, we do caution that until we more fully understand the cause for the apparent decline in the sparrow population in our study plot in Subpopulation A over the past several years there is considerable risk associated with the translocation of sparrows at this time.

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2.0 2012 Field Season Overview

2.1 Overview

During 2012 there was a continuing need to monitor basic information on sparrows breeding in 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 summarize the information provided by our field research in this section, by subpopulation, below. Sparrows that nested in Subpopulation A had a below average year, and there was once again a strongly male-biased sex ratio in this subpopulation in 2012 thus overall productivity and recruitment for this subpopulation was extremely low. Sparrows nested in Subpopulation D for the first time since 2010; 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 coupled with the skewed sex ratio.

Understanding the effects of this male-biased sex ratio on small sparrow subpopulations is critical in assessing the rangewide status of the Cape Sable seaside sparrow.

Much of our efforts in recent years have shifted from field data collection 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. 2012a), 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 we still need additional
information on the survival and dispersal of juvenile sparrows. Thus, during 2012 we surveyed Subpopulations A, B and D for previously banded sparrows with a continued focus on trying to resight returning juveniles. We also banded individuals in Subpopulations A, B and D in an effort to increase the size of the banded population. The data collected during 2012 will continue to strengthen our long-term database on sparrow demography and provide information for further synthesis. We documented a single between-subpopulation dispersal event in 2012; a female sparrow dispersed from Subpopulation D to Subpopulation B after a failed breeding attempt. Return rates for both adult and juvenile sparrows were within the ranges expected based on our previous research. Continued research in this area is still needed to better understand juvenile survival and dispersal.

2.2 Subpopulation A

This subpopulation continues to hold relatively few sparrows. 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 between 2000 – 2008 we cannot compare our current population estimates with that
period. 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 an unknown reason (e.g., predation pressure may have increased).

In 2012, 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). Intensive ground surveys for breeding sparrows were generally 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 (Fig. 1). The far southeastern corner of the study area near “shark-108”, which is primarily a large hammock, was not surveyed.

During 2012 we documented 17 territorial male sparrows (Fig. 1), but only five breeding females. This is one more male sparrow and one less female sparrow than we documented in our study area during the previous year. Territory mapping began on 12-April 2012 and ended on 28-June 2012 (territory maps in Fig. 1 reflect an average of 18.0 GPS points per individual tracked). Monitoring in Subpopulation A was discontinued somewhat earlier than in previous years as available helicopter support was depleted by the end of June. 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; however, six unmated male sparrows did establish territories in the burned area 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. The presence of male sparrows in the burned area provides evidence supporting hypothesized recolonization rates of sparrows in habitat recovering from fire (La Puma et al. 2007). It is possible that the biased sex ratio (see below) and very low dispersal and recruitment rates in Subpopulation A are driving the delay in recolonization of the burned area by female sparrows. 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, or due to the influence of stronger conspecific attraction in those areas (Virzi et al. 2012a).

We documented nesting by only six of the 17 territorial male sparrows observed during 2012 which is one less than in the previous year, and similar to 2011 one female nested with two different males. 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 (65%) were unmated during 2012. The proportion of unmated males observed in 2012 is alarming since it again increased over the estimate in 2011 of 56% (Virzi et al. 2011a), and is substantially higher than the estimate of 24% reported in 2010 (Lockwood et al. 2010). We have observed a male-biased sex ratio in Subpopulation A since we began conducting ground surveys for breeding sparrows there in 2008 (Fig. 2).

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. 2012, 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. We suggest that translocation of female sparrows from a larger and more stable subpopulation into small Subpopulation A should be considered at this time in order to ensure persistence of this important sparrow subpopulation.

We located nine sparrow nests (one brood was already fledged when found) in Subpopulation A in 2012, five were early-season nests (i.e. initiated before June 1st) and four
were late-season nests. The first nest was located on 12-April 2012, and the latest nest on 18-June 2012. Only four of the eight nests hatched (44%); all were early-season nests, which are known to have higher success rates (Baiser et al. 2008). Only two of the hatched nests fledged young (22%). 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 2012. The apparent hatch rate was well below the rate of 71% reported in 2011 (Lockwood et al. 2011). The mean clutch size for all nests was 3.8 (consistent with 2011; mean = 3.6); however, the mean number of young fledged per successful nest was only 1.5 (considerably below the rates observed in 2011 and 2010; mean = 2.6 and 3.3, respectively). Once again, we documented no multi-brooding in Subpopulation A in 2012. The small sample size of breeding pairs in Subpopulation A make comparisons between years difficult, but in any event total recruitment into the subpopulation is very low and apparently declining.

Nests were difficult to find in 2012, and the behavior of the pairs suggested that they were breeding but nests were failing early in incubation before we could locate them. Five of seven failed nests had evidence of rodent (possibly rice rat) depredation, the majority during incubation. Two females relocated distances > 300 m during the breeding season; one female moved with her mate to a drier area nearly 700 m away after at least one unsuccessful nesting attempt in the Lower Meadow; the other female turned up with a new male slightly south of the Lower Meadow cluster following an unsuccessful first attempt, and her original male was never seen again. While anecdotal, these observations could be evidence of high predation pressure in Subpopulation A.
During 2012 we newly banded seven adult sparrows (six males and one female) and three juvenile sparrows in Subpopulation A. Most adults in Subpopulation A were previously banded; we resighted 11 males and three females during 2012. The return rate for males (73%) was similar to that reported in previous years. The return rate for females was 100% in 2012, although this is based on a very small sample size of banded females. By the end of the 2012 field season, all 17 male sparrows and four of the five female sparrows in Subpopulation A were color-banded. We also banded three juvenile sparrows in Subpopulation A in 2012; these were the only juvenile sparrows observed in this subpopulation. In 2012, we resighted four of the 11 juvenile sparrows banded in 2011 (36% resight rate). The return rates for adult and juvenile sparrows are in line with expectations based on previous survival analyses (Boulton et al. 2009, Gilroy et al. 2012). We documented no between-subpopulation dispersal events in 2012.
FIGURE 1. Location of Cape Sable seaside sparrow territories in Subpopulation A during the 2012 breeding season. Black circles correspond to Everglades National Park helicopter survey sites. Seventeen male sparrows were observed singing on apparent territories during 2012. 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 2012. Black ‘x’s indicate additional locations of sparrow activity (unidentified sparrows). Hatched area represents boundary of fire that burned near West Camp in 2008.
FIGURE 2. Trend in Cape Sable seaside sparrow sex ratios observed in Subpopulation A from 2008 to 2012. Ratios greater than 0.50 indicate male-biased sex ratios. Sex ratio reported for 2008 may be inflated to some degree due to lower research effort in Subpopulation A in that year (i.e., all females in the subpopulation may not have been detected).
2.3 Subpopulation B

This subpopulation currently holds the largest number of sparrows. 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 2012, we had not originally planned to monitor sparrows in Subpopulation B. However, since helicopter support needed to access Subpopulation A was limited in 2012 we had additional time and resources to monitor sparrows in this subpopulation. Thus, we decided to monitor sparrows in the Dogleg Plot off Main Park Road since this part of the subpopulation was easily accessible by car/foot. This allowed us to continue to collect mark-recapture data in this core sparrow subpopulation, where sparrows have been banded since 1994 (originally through the work of Dr. Stuart Pimm). Our efforts in 2012 focused on attempting to estimate the number of sparrows breeding in this study plot, resighting previously banded individuals and banding additional sparrows. We did not conduct intensive nest monitoring in Subpopulation B in 2012; however, some nests were located incidentally (see below). We also conducted several opportunistic surveys in the Old Ingraham Highway Plot in Subpopulation B to resight previously banded individuals.

A major goal of our research in Subpopulation B in 2012 was to gain information about sparrows breeding in a large subpopulation that might be useful in the future if conservation managers decide to translocate female sparrows from a large sparrow subpopulation into small Subpopulation A (see previous section). 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. This will aid in future monitoring of this subpopulation if a translocation experiment is implemented, or if conservation managers decide to initiate intensive nest monitoring in a large subpopulation, which we recommend. We also refined our methods to capture free-flying juvenile sparrows, which are the likely candidates for translocation. Another goal of our research in this study plot was to record songs of known individuals to aid in analysis of song data collected as part of an acoustic monitoring experiment that was conducted in Subpopulation D in 2012 with funding from the South Florida Water Management District. These data are not presented in this report (see Virzi et al. 2012b).

During 2012 we located 28 adult sparrows (18 males, eight females and two of uncertain sex) in the Dogleg Plot of Subpopulation B (Fig. 3). Five of these sparrows (two males and three females) were resights of previously banded individuals. The remaining 23 sparrows were color-banded in 2012. Since we did not conduct intensive nest monitoring with effort consistent to that in Subpopulations A and D in 2012, it is possible that additional sparrows were breeding in this study plot but went undetected. Thus, the estimated population size in the Dogleg Plot is likely a low estimate. Even based on this conservative estimate of the number of males breeding in this study plot, the density of male sparrows in the Dogleg Plot (9 males/km²) is substantially higher than the densities observed in our study plots in small Subpopulations A (2 males/km²) and D (3 males/km²).

With only eight female sparrows banded in the Dogleg Plot there is an apparent male-biased sex ratio of 0.75, which is similar to the skewed sex ratio observed in small Subpopulations A and D. However, due to the difficulty in detecting and capturing female sparrows we did not band all of the females in the Dogleg Plot, and in fact most males appeared
to be mated in this subpopulation. Thus, the sex ratio reported is likely not an indication of a biological phenomenon in this subpopulation; rather, it is likely a function of the limited amount of effort spent in Subpopulation B during 2012 combined with the lower detection probability of females. Still, this is an area that warrants additional research since understanding the adult sex ratio in all Cape Sable seaside sparrow subpopulations could be critically important for viability of the subspecies.

While we did not conduct intensive nest monitoring in Subpopulation B during 2012, late-season research in the Dogleg Plot (which continued until 02-August) provided some interesting anecdotal data about sparrows breeding in this apparently healthy subpopulation. First, we observed that most males appeared paired with females in the Dogleg Plot, which is in sharp contrast to our observations in small sparrow Subpopulations A and D. Second, we incidentally located nine nests while banding adults in Subpopulation B (seven of which were late-season nests) and documented that at least two nests fledged young. Third, we banded 24 juvenile sparrows in Subpopulation B (16 nestlings and eight hatch-year birds), which provides evidence of a considerably higher recruitment rate into this subpopulation compared to the smaller sparrow subpopulations monitored in 2012. These observations indicate that successful nesting occurred in Subpopulation B in 2012, and given that breeding continued into late-July this may also be an indication that sparrows in this subpopulation were able to multi-brood. Finally, we made several interesting behavioral observations, including: (1) small juvenile flocks began to appear in mid-June, (2) juvenile males were observed practicing song at this time, (3) most singing by male sparrows stopped by late-July, (4) territory abandonment began at this time, and (5) molting also began in late-July. This is valuable behavioral information that
could inform conservation managers in any attempts to translocate sparrows between subpopulations.

We also documented the only between-subpopulation dispersal event in 2012 while conducting our research in Subpopulation B. A female banded in Subpopulation D in 2012 was resighted in Subpopulation B on 13-June in the Old Ingraham Highway study site, which was visited opportunistically several times in 2012 (i.e., not part of our regular sparrow monitoring) to resight banded individuals. She appeared to be wandering around the study plot rather than paired with a Subpopulation B male. We have suspected that Subpopulation B was a source of Subpopulation D birds, but this is the first direct documentation of a bird moving between the sites, albeit in the opposite direction than expected.
FIGURE 3. Location of Cape Sable seaside sparrow activity in the Dogleg Plot in large sparrow Subpopulation B during the 2012 breeding season. Black circles correspond to Everglades National Park helicopter survey sites. Banding locations of sparrows indicated by red-triangles (males), yellow triangles (females) and grey triangles (juveniles). Territories were not mapped in Subpopulation B in 2012; however, all field observations of sparrows are indicated by a black ‘x’ on the map in order to show the relative spatial distribution of sparrows across the study plot.
2.4 Subpopulation D

This subpopulation continues to hold very few sparrows. 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. 2011b). 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 in the areas currently occupied by sparrows.

Subpopulation D continues to be an ephemeral sparrow population with breeding occurring sporadically between years. During 2012 we documented six territorial male sparrows (Fig. 4), and two female sparrows which is one more female than in 2011. Territory mapping began on 12-March 2012 and ended on 28-May 2012 (territory maps in Fig. 4 reflect an average of 15.7 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”. This
study plot was monitored in 2012 in conjunction with an acoustic monitoring experiment that was funded by the South Florida Water Monitoring District in Subpopulation D (Virzi et al. 2012b).

We located three sparrow nests in Subpopulation D in 2012, documenting breeding in this subpopulation for the first time since 2010. Only two female sparrows were observed, therefore, four of the six male sparrows were unmated in 2012. This resulted in a male-biased sex ratio of 0.75 in 2012, which is similar to the rates observed in Subpopulation D regularly over recent years; during 2011 and 2010 we documented male-biased sex ratios of 0.86 and 0.78, respectively (Virzi et al. 2011a, Lockwood et al. 2010). All three of the nests found in Subpopulation D were early nests. Only two nests hatched, and one nest possibly fledged a single chick in 2012. Thus, recruitment into Subpopulation D remains extremely low. Both of the failed nests were due to unknown predation.

Both of the breeding males in Subpopulation D were returning individuals originally banded there in 2011. We did not resight any other sparrows color-banded in previous years in Subpopulation D during 2012. We banded all four of the remaining male sparrows and both of the female sparrows observed in Subpopulation D in 2012. All of the newly-banded males wandered somewhat during the spring, which is typical of unmated male sparrows. Two of these males disappeared shortly after banding, to be replaced by new males occupying similar areas. The only between-subpopulation movement documented in 2012 was one of the banded females from Subpopulation D that moved to Subpopulation B in late-May. This female was still on her territory in late-May, but appeared in Subpopulation B on 13-June (see above). The other female sparrow observed in Subpopulation D had disappeared from our study plot by early-May.
FIGURE 4. Location of Cape Sable seaside sparrow territories in Subpopulation D during the 2012 breeding season. Black circles correspond to Everglades National Park helicopter survey sites. Six male sparrows were observed singing on apparent territories during 2012. Territories are color-coded by unique color-band combinations for each male sparrow; red tones indicate breeding males and blue tones indicate single males. Red circles correspond to locations of sparrow nests monitored during 2012. Black ‘x’ s indicate additional locations of sparrow activity (unidentified sparrows). One of the males (GRBL_ORAL) wandered widely across the subpopulation over the course of the breeding season.
3.0 LITERATURE CITED


Dale, S. 2001. Female-biased dispersal, low female recruitment, unpaired males, and the 
extinction of small and isolated populations. Oikos 92:344-356.


Gilroy, J. J., T. Virzi, R. J. Boulton, and J. L. Lockwood. 2012a. A new approach to the
“apparent survival” problem: estimating true survival rates from mark-recapture studies.
Ecology 93:1509-1516.

Gilroy, J. J., T. Virzi, R. J. Boulton, and J. L. Lockwood. 2012b (In Press). Too few data and not
enough time: approaches to detecting Allee effects in threatened species. Conservation
Letters.

Gruebler, M. U., H. Schuler, M. Muller, R. Spaar, P. Horch, and B. Neaf-Daenzer. Female
biased mortality caused by anthropogenic nest loss contributes to population decline and

La Puma, D. A., J. L. Lockwood, and M. J. Davis. 2007. Endangered species management
requires a new look at the benefit of fire: The Cape Sable seaside sparrow in the

populations of birds. Evolution 59:890-897.

2010. Recovering small Cape Sable seaside sparrow (Ammodramus maritimus mirabilis)
subpopulations: breeding and dispersal of sparrows in the Everglades, Report to US Fish
and Wildlife Service and National Park Service, Homestead, Florida, USA.


