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THE PRESENT AND FUTURE OF THE CAPE SABLE SEASIDE SPARROW

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Abstract.—Seaside Sparrows (*Ammodramus maritimus*) breeding in the Everglades region belong to a morphologically distinct subspecies (the Cape Sable Seaside Sparrow, *A. m. mirabilis*). This population is isolated from the other races of the Seaside Sparrow, the closest of which, the Scott's Seaside Sparrow (*A. m. peninsulae*), is found 300 km north. Other than appearance, the only significant difference between the Everglades subspecies and its relatives is in habitat use. Unlike other Seaside Sparrows, most of which live in salt marshes, the Cape Sable Seaside Sparrow now appears to be confined to freshwater sites.

The history of the Cape Sable Seaside Sparrow is fragmentary. Populations have frequently disappeared, and the same or other populations have been rediscovered in widely separated areas, often many years later. These long-range shifts in distribution, if real, appear to have been in response to the fluctuations that characterize the temporally unpredictable environment of the Everglades. Disturbances such as fire and hurricanes have caused shifts in population distributions, and also long-term modifications of sparrow habitats.

Since the research of Harold Werner, initiated in 1970, several studies have been conducted in an attempt to determine the number of sparrows remaining, and to gather information about their demography. Werner estimated that 2,000-3,000 birds remained in 1974-1975. In 1981 the population was again surveyed, and it was estimated that 3,300 male sparrows remained. In 1991 the survey was resumed. Although referred to as the "extensive" survey, it has not completely covered all potential habitats of the species, nor even the original 1981 census points.

Data collected from a limited number of birds indicate that the Cape Sable Seaside Sparrow has high reproductive potential: females can produce up to nine fledglings per year. Survival rates are high: on average, at least 60% of adults survive from year to year. Preliminary radiotelemetry studies indicate that juvenile sparrows can disperse long distances from their natal sites.

Based on the results of the extensive surveys, claims have been made that the subspecies is decreasing. These results do not fit a population model that incorporates high fecundity and survivorship, as well as extensive juvenile dispersal. This contradiction

may be clarified when valid survey data are available, and after more detailed demographic information has been gathered.

The main Cape Sable Seaside Sparrow population now appears to live in muhly (*Muhlenbergii filipes*) prairie east of Shark River Slough. Although the recovery plan states that muhly prairie is the "preferred" habitat of the subspecies, information about nesting habitats that the birds have used in the past suggests that muhly prairie is simply the habitat into which the sparrow has moved most recently. Management decisions to enhance the recovery of the Cape Sable subspecies are based on the results of the extensive surveys, and on the corollary assumption that muhly is the optimum habitat for the subspecies. For the most part, recovery efforts since 1975 have focused on controlling one environmental factor (water level) that affects sparrow distribution in this one habitat type. If the prediction of the government research, that the subspecies may become extinct within 20 years is true, then immediate intervention is warranted. Strategies such as relocation, captive-rearing, localized flood control, and predator control are recommended. Federal agencies responsible for the recovery of the sparrow have been unwilling to take such actions in its behalf.

The Seaside Sparrow (*Ammodramus maritimus*) occurs in small, localized populations along the Atlantic and Gulf coasts of the United States, from southern Maine to Texas (Werner and Woolfenden 1983, Post and Greenlaw 1994, Brinker 1997). Most breeding birds are confined to tidal marshes. Some have moved farther inland, to colonize freshwater marshes, as, for example, on the Hudson River in New York (Bull 1964), the St. Johns River in central Florida (Nicholson 1929), Taylor Slough of the Everglades region (Ogden 1972). Despite their use of freshwater habitats, the biology of the inland populations appears to differ little from that of birds living in tidal marshes, where the species is believed to have evolved (Beecher 1955).

Largely because of the alteration of coastal wetlands by humans, the Seaside Sparrow has disappeared from many parts of its range (Kale 1983, Greenlaw 1992). The highly distinct Dusky Seaside Sparrow has recently become extinct, and other subspecies distributed along the Gulf of Mexico are classified as threatened or of special concern by conservation agencies. The Cape Sable Seaside Sparrow is the most isolated of the five subspecies that occur in Florida. The distance between this race and the Scott's Seaside Sparrow (*A. m. peninsulae*) is 300 km.

Like the inland population of the Dusky Seaside Sparrow (*A. m. nigrescens*), the Cape Sable Seaside Sparrow occupies inland freshwater marshes. Decreases in the Cape Sable subspecies have been caused by wide-scale alterations of its habitat, including introductions of exotic plants, unnatural water regimes, and large-scale fires. The interactions of these factors make the conservation and management of the Cape Sable Seaside Sparrow difficult (Kushlan et al. 1982). The subspecies was listed as endangered in 1967. It has been the object of much recent research.

The purpose of this paper is to review the biology of the Cape Sable Seaside, and to discuss its management in light of what is known about

the species as a whole. Such a review is necessary at this time because recent publications and reports (Curnutt et al. 1998; Nott et al. 1998; Pimm 1995, 1996, 1997, 1998, 1999) do not consider previous research findings on the species as a whole, nor research on the Cape Sable Seaside Sparrow itself (Kushlan et al. 1982, Kushlan and Bass 1983, Werner 1975, Werner and Woolfenden 1983). This failure has led to misinterpretations of the subspecies' biology, and, consequently, to management failures.

ARE THE "EXTENSIVE" SURVEYS EXTENSIVE?

The Cape Sable subspecies is limited to the southern tip of Florida (Collier, Monroe and Dade Counties) in a roughly rectangular 700 km-sq area. Historical information shows that it was widespread and occupied several habitat types, although it took many years for ornithologists to discover new populations in the difficult terrain occupied by the sparrows. Once found, breeding groups ("colonies") were difficult to relocate. The disappearing breeding groups either had been extirpated or had moved to new areas. Population shifts may have been gradual, in response to successional changes, or abrupt, as a result of catastrophic habitat changes. Several widely-spaced populations have been found existing at the same time, and specific localities may hold sparrows for a few years, the birds then disappear, and the same or another group reappears elsewhere.

At the time of its discovery the Cape Sable Seaside Sparrow was thought to be restricted to brackish marshes in the Cape Sable area. It is possible that it also occupied other areas and habitats in extreme southern Florida. Since 1928 the subspecies has been documented as occurring regularly in three other areas of the Everglades region: Southern Big Cypress (Nicholson 1928), Ochopee (Anderson 1942), and Taylor Slough and the eastern side of Shark River Slough (Ogden 1972). Since 1992, surveys have been conducted over some parts of the subspecies' range, but details of the current status of the various populations have not yet been published.

Based on surveys conducted in 1974-1975, Werner (1978) attempted the first estimate of the entire population. Extrapolating to the area of known occurrence from densities that he found on measured plots on Taylor Slough, he estimated the total population to be 2,000 to 3,000 birds. This estimate assumed that the Taylor Slough birds made up 95% of the subspecies' numbers.

Kushlan and Bass (1983) conducted an extensive survey in 1981, using fixed-radius point-counts (Hutto et al. 1986). The original extensive survey (Kushlan and Bass 1983) did not cover all potential breeding areas although they assumed that the sparrows were uniformly distributed, and that the population density of each survey point accu-

rately reflected that which prevailed in 1 km^2. They thus assumed that each male represented a group of 16 pairs. They estimated the total population to be 6,600 birds. They speculated that the estimate represented a high point in a fluctuating population cycle, which was related primarily to the occurrence of fires.

In 1992, after a 10-year hiatus, the surveys were resumed in the same areas as the 1981 surveys (Curnutt et al. 1998), but coverage has been incomplete every year (mean percentage of 1981 points covered during 1992-1998 = 63%, range 22-93; Table 1). The historical range of the subspecies has not yet been completely surveyed. It is frequently stated that the surveyors periodically check other potential breeding areas outside the traditional survey area but no documentation of such spot checks has been published. Given the history of the sparrow's unexpected appearances in far-flung areas of the Everglades, it is advisable to conduct surveys over a wider area, because it cannot be safely assumed that the subspecies is confined to marl prairie, and that it does not disperse from unsuitable habitats.

The logistical difficulty of the Everglades environment has been cited as the reason the surveys have been incomplete. The survey is certainly a difficult endeavor, but perhaps it should take priority over less critical data-gathering, most of which, other than the results of radio-tracking, has produced little new information about the subspecies. Determination of the actual population size and distribution of the Cape Sable Seaside Sparrow is the most critical need at this time.

ARE THE POPULATION ESTIMATES RELIABLE?

It is difficult to provide a definitive estimate of total population size because the surveys did not cover all potential breeding habitat. How-

Table 1. Number of male Cape Sable Seaside Sparrows recorded in 1981 and succeeding years on the same plots. Sample plots that were invaded by trees (n = 30) were excluded for all years. Data from Kushlan and Bass (1983) and Pimm (1995, 1996, 1997, 1998).

Year	No. of points	Percentage of 1981 points	No. of males
1981	813	100	387
1992	757	93	368
1993	618	76	189
1994	181	22	survey incomplete
1995	505	62	159
1996	497	61	no data available
1997	486	60	225
1998	553	68	160

ever, annual reports submitted to Everglades National Park provide a rough index of total population numbers. These population estimates, based on extrapolations from the point counts (Table 1), show wide fluctuations between years within the different areas. The overall male population size was said to have remained stable between 1981 and 1992. Between 1992 and 1993, the population estimate fell by 50%. In 1993, surveyors counted 207 males (extrapolated to 3,312; Table 2) a reduction of 50% from the previous year. Many areas were not surveyed in 1993, however (Table 1; Curnutt and Pimm 1993). During 1994-1995, the overall population estimate remained about the same: 2,416-2,720 males. Between 1996 and 1997, the population increased, and then decreased the next year. By 1998, the estimate had fallen to 3,056 males, at about which level it has remained through 1999 (Pimm 1999).

Most of the population fluctuations have been due to variation in the size of the large group of birds north of the Ingraham Highway (Population "B"), which decreased by 11% (1995-1996), increased by 50% (1996-1997), and then decreased by 36%. The wide fluctuations in the estimated size of population "B" were likely caused by either sampling error or movements of males.

Although crude estimates of population size may have heuristic value on a year-to-year basis, it is not possible to make conclusive comparisons of population numbers between years, based on inferential statistics. This is because the point counts upon which the estimates are based are not independent of each other, in either space or time. Comparisons between years based on the samples are examples of "pseudoreplication" (Hurlbert 1984). The methodology used to estimate total population size is based on invalid assumptions, and therefore the results cannot be used to model population dynamics for the following reasons.

Table 2. Population estimates of male Cape Sable Seaside Sparrows in the Everglades region, 1981-1998 for each geographical area. Estimate obtained by multiplying number of males seen by factor of 16. Based on data provided by the U.S. Army Corps of Engineers (1998). Data for 1999 and 2000 not available.

Area	1981	1992	1993	1994	1995	1996	1997	1998
A	2,688	2,608	432	80 + *	240	272	272	192
B	2,352	3,184	2,464	2,224	2,128	1,888	2,832	1,808
C	432	3	0	**	0	48	48	80
D	400	7	96	**	0	80	48	48
E	672	37	320	112	352	208	832	912
F	112	2	0	**	0	16	16	16
Total	6,656	6,576	3,312	2,416 + *	2,720	2,512	4,048	3,056

*Survey incomplete.
**No survey.

Assumption 1. All males are recorded. The sampling procedure does not account for seasonal or diurnal variation in males' behavior. For example, male Seaside Sparrows may spend up to 32% of their time singing before the arrival of a female on territory. When young are in the nest, singing time decreases to 4% of the daylight period (Post 1974). The Cape Sable Seaside Sparrow has an extended breeding period (February-August; Werner and Woolfenden 1983). Most surveys have been conducted from late April to early June. This leaves unsampled two five-to-six week periods at the beginning and end of the breeding period. Until the summer of 1999 each plot was visited only once per year. It is possible that any bird remaining on its activity space during a flood that occurs early in the breeding season will wait until waters recede, and then nest, or move to higher ground, or build its nest higher (Tomkins 1941). Seaside Sparrow nests in tidal areas are frequently flooded, often several times in a season. Pairs whose nests are flooded immediately resume retesting (Greenlaw 1983, 1992).

Assumption 2. The surveys assume that males are distributed randomly, and therefore the probability of encountering a bird is the same at each of the census points. However, previous studies have demonstrated that territorial male Seaside Sparrows are often clustered. Large areas of suitable habitat are unoccupied, while in nearby areas sparrows occur at high population densities (Post 1974). Extrapolation from point counts underestimates population sizes in areas where sparrows are clumped (Curnutt et al. 1998).

Assumption 3. Sparrow activity spaces do not overlap. When feeding, Seaside Sparrows range widely outside their territories and may make foraging flights of over 1 km. This results in a pattern of overlapping activity spaces, which has been reported for Seaside Sparrows occupying tidal (Tomkins 1941) and non-tidal areas (Sykes 1980).

Assumption 4. Each male is mated. But, the proportion of unmated male Seaside Sparrows varies widely between breeding groups (23-60%; Greenlaw and Post 1985). At Taylor Slough in 1974, 12% of males remained unmated through the breeding season; 11% in 1975 (Werner and Woolfenden 1983). The variation in incidence of unmated males between populations appears to be related to habitat suitability (Greenlaw and Post 1985).

Assumption 5. Only areas that are surveyed have Seaside Sparrow breeding populations. The history of the intermittent disappearance and rediscovery of Cape Sable Seaside Sparrows in different areas of southern Florida (Kushlan and Bass 1983, Werner and Woolfenden 1983) argues against the validity of this assumption, however. The subspecies also displays an opportunistic response to the geographical-habitat array (Curnutt 1996), and may abandon and later recolonize

specific areas, depending on water levels (Werner 1975, Werner and Woolfenden 1983, Lockwood et al. 1996). This assumption can be tested only by increasing the area of coverage of the surveys.

A final problem comes from the manner in which the population estimates are presented (Anonymous 1997). Each year an estimate of total population size is provided, without any indication of the precision of the results. Using just the count of birds detected per unit effort as an index of abundance is neither scientifically sound nor reliable (Burnham 1981). Readers cannot make independent evaluations of the data. We would have a better understanding of the estimates if we were provided with confidence intervals. Further, the complete results of the surveys should be published and the assumptions and methodologies specified. Annual reports state that the results are not final (Pimm 1998), but the results are used as the basis for management decisions and government position papers (Anonymous 1997, 1999).

IMPROVING THE SURVEYS

The reliability of estimates made from circular plots depends on how potential sources of variation (e.g., among years, within season, habitat associations, and space use) are treated. When the survey was reinitiated in 1992, the researchers continued to use the preliminary sampling procedures of Kushlan and Bass (1983). It would have been advisable, instead, to design statistically meaningful sampling techniques such as, 1) random placement of point counts among years within regions; 2) within year replications; 3) distance sampling (Buckland et al. 1993); 4) calibration of detectability, according to observer and habitat (Bennetts et al. 1999). Curnutt et al. (1998) tested the reliability of the census technique by comparing the number of birds known to be present on measured census plots with those estimated to be present from point counts of the same areas. Their results indicated that the point counts underestimate actual numbers present by 36%.

The American Ornithologists' Union Cape Sable Seaside Sparrow panel (Walters et al. 1999) stated that because of its shortcomings, the current survey methodology is of limited utility in drawing inferences about population trends. The panel recommended that the census takers determine what proportion of males are actually singing at a given time, and use this information to correct the estimates. It was also recommended that the survey teams determine what proportion of males are actually mated. The panel also urged that the surveys be conducted over a larger area. Despite these recommendations, the surveyors have continued to cover a limited area of the subspecies' potential range, and the annual reports continue to provide uncorrected population estimates (Pimm 1999). As the survey methods were flawed in the past,

and continue to be flawed, they cannot be used to estimate accurately the population size, nor say anything definitive about the long-term population trends of the subspecies.

IS THE CAPE SABLE SEASIDE SPARROW A HABITAT SPECIALIST?

Seaside Sparrows occupy tidal marshes or nearby freshwater marshes (Kale 1983, Robbins 1983), but with a discontinuous, local distribution (Greenlaw 1983, 1992). The physiognomy of vegetation used by the species varies, and reflects opportunism in using available substrates (Greenlaw 1983). Requirements shared by most breeding populations are: first, elevated nest sites that provide protection from periodic tidal and storm flooding; second, nearby openings in vegetation, such as pannes, pools and creek edges, which allow birds to forage on open mud, and at the bases of rooted vegetation. Optimum habitats contain contiguous nesting and feeding sites; otherwise, birds commute between nest-centered territories and distant feeding areas (Woolfenden 1956).

The Cape Sable subspecies was first described as occupying brackish marshes ("salt grass", *Distichlis spicata*), and adjacent, presumably less saline marshes dominated by "switch grass" (*Spartina bakeri*) in the southwestern part of its range (Stimson 1968). The structure of this habitat is similar to that occupied by other subspecies (MacGillivray's, Scott's, and Dusky). After the hurricane of 1935, populations of sparrows were found nesting in similar habitat north of Cape Sable, along the western mangrove fringe, north to Ochopee.

Within the last two decades (Werner and Woolfenden 1983), Cape Sable Seaside Sparrows have been described as living in four distinct habitat types: 1) clumped *Spartina* prairies, 2) unclumped *Spartina* prairies, 3) sparse sawgrass prairies, 4) muhly prairies. In addition to these four habitat types, Kushlan and Bass (1983) describe a "mixed prairie habitat", which appears to correspond to sparse sawgrass prairie.

The majority of the surviving sparrows are now believed to nest in muhly prairie, mainly on marl in areas east of Shark River Slough. Before Ogden's (1972) rediscovery of Seaside Sparrows in the Taylor Slough area, and Werner's (1975) research, muhly was not reported as a nesting substrate, and Davis (1943) did not mention the species as a component of the marl prairies where the sparrow now occurs. It has been claimed that the muhly prairies now existing east of Shark River have been propagated by man-influenced reduction in water levels, coupled with the destruction of shallow organic soils by drought fires (Craighead 1974).

A Department of Interior position paper (Anonymous 1997) and the Cape Sable Seaside Sparrow recovery plan (Anonymous 1999)

state that the preferred habitat of the subspecies is mixed marl prairie. It is incorrect, however, to refer to a habitat as "preferred" on the basis of correlational patterns alone (Wiens 1989). Seaside Sparrow densities vary widely even within the same habitat, and reproductive potential is density-independent (Greenlaw and Post 1985).

It is possible that, because of degradation of the coastal and interior *Spartina* prairies that were once occupied by the sparrows, the subspecies is now breeding in the remaining vegetation that is most similar in structure to *Spartina* (Mayer 1998). It is possible that marl prairie may represent a marginal habitat for the subspecies. Reports that sparrows occupying this habitat in the last decade have low annual survival support this hypothesis (Pimm 1995). Similarly, the prairie marshes on the St. Johns River that were occupied by the Dusky Seaside Sparrow may have been marginal habitat. Unfortunately, although some information was gathered about the Dusky Seaside Sparrows in salt marshes on Merritt Island (Trost 1968, Sykes 1980), little was learned about the prairie-nesting sparrows (Baker 1973, 1978).

DOES THE CAPE SABLE HAVE LOWER SURVIVAL RATES THAN OTHER SEASIDE SPARROWS?

Using an estimation method presumably similar to that of Werner and Kushlan, and data on 18 birds followed over two years, Pimm (1995) estimated a minimum adult male survival rate of 50%. From 1994 to 1996, Pimm (1996) banded 122 sparrows. Only 29% of these were seen or caught by the end of the 1996 research season. He reported that adults that had nested in a given area had an annual survival rate of 100%, while those that did not nest had an annual survival of 38% (Pimm 1996).

In contrast to the low survival estimates provided by Pimm (1995, 1996), Werner (1975) estimated minimum annual survival as 88%. Based on additional information from the same study population, Kushlan et al. (1982) provide an annual adult survival estimate of 90%.

Over two years, Post et al. (1983) studied a color-marked population of Seaside Sparrows nesting at Gulf Hammock, Florida, and estimated annual adult male survival at 86%. Additional annual survival estimates for different cohorts from this population are above 80%. Some individuals have survived for nine years (Post and Greenlaw 1994). The 50% survival rate provided by Pimm is clearly anomalous.

THE CAPE SABLE SEASIDE HAS HIGH REPRODUCTIVE POTENTIAL

The measurement that is used to estimate reproductive potential, the number of young per female per year, is higher for this subspecies

than for other population of the Seaside Sparrow. Two published papers (Werner and Woolfenden 1983, Lockwood et al. 1997), and two unpublished reports include information on the nesting success of the Cape Sable Seaside Sparrow (Werner 1975, Fenn 1997). Based on an average of four data sets (Fenn et al. 1997), total nesting success (percentage of eggs that produce fledglings) was estimated at 64%, which is much higher than that reported for Seaside Sparrows at Gulf Hammock, Florida (3%; Post et al. 1983), and higher than that on Long Island, New York (35%; Post et al. 1983).

The mean clutch size of *mirabilis* is 3.5 (Post and Greenlaw 1994), compared with a clutch size of 3.1 in *peninsulae* (Gulf Hammock, Florida) and 3.1 for *macgillivraii* (southeastern Atlantic coast; Post and Greenlaw 1994). Female Seaside Sparrows may initiate as many as four clutches per season. The core period of the nesting cycle is 25 days: four days for deposition of eggs, 12 days for incubation (incubation may start with the laying of the penultimate egg), and nine days during which young are in the nest (Werner 1975, Post and Greenlaw 1994). Males may feed fledglings alone, and females may initiate a new clutch before the old one has fledged (Marshall and Reinert 1990, Werner and Woolfenden 1983). Nest construction usually requires 3-4 d. Therefore, it is possible that a new cycle can start within 30 d of the completion of the preceding clutch. This agrees with Werner (1975) and Marshall and Reinert (1990). If females are physiologically capable of producing four clutches per season, and if nest mortality rates are low, most pairs should be able to produce at least three broods within a 125-d period.

Length of breeding season in *mirabilis* may exceed 150 d (Werner and Woolfenden 1983). If the first nesting cycle requires 35-40 d, and each succeeding cycle requires 30-35 d, and assuming that reproductive success is 64% for each nesting attempt, it is possible for a successful female to produce nine fledglings per season.

IS FLOODING OR PREDATION THE MAIN CAUSE OF NEST LOSS?

Little is known about the causes of nest loss in the subspecies. Although the sampling schedule of the nest-searching program has not been published, efforts appear to have been concentrated in the study areas north of the Ingraham Highway (area "B") during April-June. In a few cases, Werner (1975), Lockwood et al. (1997) and Fenn et al. (1997) inferred causes of mortality to nest contents. At Taylor Slough, 4 of 55 eggs were depredated (7%), and 9 of 55 (16%) failed to hatch. Predation was confirmed during the nestling stage (seven young lost); Werner listed no other causes of mortality for nestlings. Lockwood et

al. (1997) reported that 2 of 36 eggs with the opportunity to hatch failed to hatch, 2 eggs were flooded, 3 young were flooded, and 1 nestling presumably starved. Overall, 78% of all losses of young and eggs were attributed to predation. Lockwood (1998) reported that predation accounted for 92% of all nest losses in 1998. No nests were lost to floods, and no other sources of mortality were listed.

Based on the assumption that higher water levels lead to lowered reproductive success, Nott et al. (1998) claimed a relationship between water levels and population decline. However, in 1997 birds breeding west of Shark River Slough (the most flooded area) had the highest nest success of any of the populations (75%, versus 66% for the other subpopulations; Pimm 1997).

In contrast to statements (Anonymous 1997) that nesting ceases during flooding, Dean and Morrison (1998) found that clutches were initiated during periods of high water (depth >10 cm). The water depth under some nests with eggs or young was 20 cm. They found evidence of successful nestings near the end of July and into August, during periods of high water. Dean also found a flightless young sparrow in early August, after a period of high water. Although they did not estimate the proportion of nests that were successful, their finding that at least some nests were successful refutes the hypothesis that all nesting ceases when water levels begin to rise (Anonymous 1997).

In 1996-97 Lockwood (1998) found peaks in the seasonal pattern of predation, which were correlated with rises in water level. No such peaks were found in the 1998 nesting season, which was attributed to lack of surface water (Lockwood 1998). The species of predators were not determined, although snakes were mentioned as possibilities. It was not explained how high water led to increased snake activity. It has been shown, however, that rodent movements in the Everglades are affected by fluctuations in water levels (Smith and Vrieze 1979). Nest survival of Seaside Sparrows in other areas of Florida is affected by rice rat (*Oryzomys palustris)* predation (Post 1981). Despite this information, and after nine years of research, no attempt has been made to determine the species or numbers of predators in the Cape Sable Seaside Sparrow nesting areas**.**

IS THE SPARROW SEDENTARY?

Our inability to track dispersal prevents us from understanding population dynamics at the landscape level (Faaborg et al. 1998). As yet we have little information on juvenile dispersal of the Seaside Sparrow. Recent radio telemetry studies demonstrate that at least some juveniles may disperse up to 7 km after the nesting season; movements appear to halt when individuals meet a habitat barrier such as

a hammock (Dean and Morrison 1998). The researchers also found a male that nested in one area, and then moved during the same breeding season to establish a new territory about 3 km away.

The Seaside Sparrow is believed to have evolved in estuarine areas (Beecher 1955, Werner and Woolfenden 1983). Individuals that occupy tidal areas respond to seasonal changes in water levels by moving relatively long distances. It seems reasonable to assume that Cape Sable Seaside Sparrows have retained sufficient behavioral flexibility to respond appropriately to short-term habitat changes, whether predictable ones such as water level changes, or unpredictable ones, such as those caused by hurricanes and fires. Based on their failure to find marked individuals farther than 1 km from their summer territories, Balent et al. (1998) concluded that the Cape Sable Seaside Sparrow was sedentary throughout the year. Their sampling methods were flawed, however, as they did not correct for the attenuation of bird numbers as distance from the capture point increased (Ostrand et al. 1998).

Sharp (*in* Kushlan et al. 1982) pointed out the importance of post-breeding emigration of juvenile Seaside Sparrows as a means of population maintenance in habitats that undergo periodic perturbations. The limited amount of data indicate that Seaside Sparrows nesting in non-tidal areas disperse relatively long distances. Six of 13 Dusky Seaside Sparrows nesting in brackish impoundments on Merritt Island, Florida, moved 1.2 km between years; one moved about 1.6 km within the same nesting season (Sykes 1980). In the non-breeding season, Sykes also found Dusky Seaside Sparrows 8 to 32 km outside their known breeding range; Sharp (*in* Kushlan et al. 1982) felt that such movements were in response to habitat degradation occurring in dried-out prairie. Similarly, Dusky Seaside Sparrows nesting on *Spartina* prairie were reported to move up to 1.6 km from their original banding site (Baker 1978).

Werner (1975) documented movements by juvenile Cape Sable Seaside Sparrows. In 1974, a male established a territory 400 m from the site where he was banded as a fledgling; a female was caught 940 m from its original banding point. Werner stated that post-breeding emigration of fledglings probably provided the principal mechanism of dispersal. Kushlan et al. (1982) cited instances of population densities increasing in unburned areas after a fire, suggesting that the sparrows reoccupied suitable habitat soon after being displaced.

WILL THE CAPE SABLE SEASIDE SPARROW BE EXTINCT IN 20 YEARS?

As recently as 1991, the surveyors reported that as many as 6,000 Cape Sable Seaside Sparrows remained. A population of this size is

large for this species in any part of its range. Other races of the Seaside Sparrow are found in small, widely-separated groups that are distributed along a narrow coastal fringe. It is possible that several subspecies found along the Gulf of Mexico (*A. m. sennetti, A. m. fisheri,* and *A. m. juncicola*), which are not listed as endangered, have less than 6,000 individuals (Kale 1983, McDonald 1988).

Conservation agencies and their consultants have stated that the Cape Sable subspecies will become extinct within 20 years if present trends continue (Anonymous 1997). This claim is based on a population viability analysis model developed by Pimm (1997). Population viability analysis models predict population changes, and estimate the probability of extinction based on projected environmental changes (Shaffer 1990). Accurate demographic data are still lacking for this subspecies, and predictions of population viability based on "estimates" of demographic features must be viewed with considerable skepticism (Caughley 1994). It is misleading to base population viability analysis models on abundance estimates with high confidence intervals (Ludwig 1999), which are the kinds of estimates that are provided by the extensive surveys.

If we accept the hypothesis that the Cape Sable Seaside sparrow will become extinct within 20 years if present trends continue, emergency management procedures should be implemented immediately. The only recent recovery strategy pursued by Everglades National Park has been to request other government agencies to manipulate water levels west of Shark Slough. The requests are based on the assumption that the subspecies will become extinct if the western population is extirpated (Anonymous 1997). Data have not been provided to support this assumption. Theoretical models should not be used as the basis for decisions that will have unknown effects on large areas of the Everglades, including habitats occupied or potentially occupied by other populations of the Cape Sable Seaside Sparrow.

LOCAL INTERVENTION IS NECESSARY

As was the case with the Dusky Seaside Sparrow, the bulk of the Cape Sable Seaside population is confined to federally-owned land. Despite this additional level of protection, the Dusky became extinct, and at least some populations of the Cape Sable continue to decrease. The passive management approach pursued by the responsible federal agencies allowed the decline of both subspecies. To protect the Dusky Seaside Sparrow, the U.S. Fish and Wildlife Service purchased 6,200 acres as a reserve for the St. Johns population; however, once they had bought the land, they failed to plug a drainage ditch that ran through the refuge. This ditch caused abnormal drying of the prairie marshes. The re-

maining breeding population was engulfed by wild fires (Walters 1992). Similarly, Everglades National Park has undertaken little habitat management for the Cape Sable Seaside, such as prescribed burning. The park has pursued a passive, wait-and-see approach to the sparrow's conservation.

Kushlan et al. (1982) assessed the status of the subspecies, and concluded that "the sparrow was probably never abundant but was, apparently, and remains, widespread in southern Florida." Unfortunately, although a preliminary survey protocol was established in 1981, for ten years Cape Sable Seaside Sparrow populations were not monitored. It is not known to what extent Everglades National Park has continued prescribed burning for improving nesting habitat, as recommended by Werner (1975), Taylor (1983), and Kushlan et al. (1982). The recovery plan outlined by Kushlan et al. (1982) listed 17 research goals, none of which appear to have been addressed until 1992.

In the first Cape Sable Seaside Sparrow recovery plan, Kushlan et al. (1982) proposed continued vigilance and some habitat management as a means of maintaining the status of the bird. Post (1983) reviewed the management plan, and concurred in this conclusion, but noted that, in light of its relatively high reproductive potential and high survival rate, the subspecies' supposed decline was paradoxical. It also was pointed out that though the management plan was thorough, it was not innovative. For example, it did not consider the potential of translocation or captive-rearing, although these approaches had been successfully developed during recovery efforts for the Dusky Seaside Sparrow (Post and Antonio 1981). The plan also did not mention field intervention techniques, such as use of predator-baffles to protect nests, which also had been developed as a method to improve the reproductive success of Dusky Seaside Sparrows (Post and Greenlaw 1989). Although predation is a main cause of nest mortality of Seaside Sparrows in Florida (Post 1981), no effort has been made to study the predators of the Cape Sable seaside, let alone to control their effects. If flooding is the cause of nest losses in a limited area, it is feasible to construct small dikes to exclude high water (Richard Bonner, U.S. Army Corps of Engineers, pers. comm.). Seaside Sparrows often occupy extremely small activity spaces (Post and Greenlaw 1994). It would be possible to provide flood protection for 16 breeding pairs by diking only 1 ha.

Despite the recommendations of recent researchers (Curnutt et al. 1998), the multi-species recovery plan (Anonymous 1999) continues to advocate the traditional passive management pursued in the last 20 years, the period in which the sparrow appears to have decreased most rapidly. If indeed the survival of the entire subspecies depends on preserving the few birds remaining west of Shark Slough (population "A";

Anonymous 1997), then these birds should become the focus of the recovery effort. Other than crude population estimates, little is known about the status of the "A" birds. In 1999 the surveyors found only 16 males in the "A" population. It should be a simple matter to protect these few birds from the effects of flooding or predation. The management techniques mentioned above would allow immediate intervention on behalf of this, the most threatened, subpopulation of sparrows. Such intervention would identify specific, attainable goals. The government position paper (Anonymous 1997) and recovery plan (Anonymous 1999) view water level as the single most important factor affecting the survival of the western population, and thus the entire subspecies. This view is leading to a simplistic approach to the recovery of the Cape Sable Seaside Sparrow.

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