

**WET SEASON ECOLOGY OF THE CAPE SABLE SEASIDE SPARROW
(AMMODRAMUS MARITIMUS MIRABILIS)**

KARLA L. BALENT^{1*}, KATHERINE H. FENN², AND JULIE L. LOCKWOOD¹

¹ Dept. of Ecology and Evolutionary Biology, Univ. of Tennessee, Knoxville, Tennessee 37996

² South Florida Natural Resource Center, Everglades National Park, 40001 State Road 9336,
Homestead, Florida 33034

*Corresponding author address: Dept. of Biological Sciences, SUNY College at Brockport,
Brockport, New York 14420. E-mail: kb0546@acspr1.acs.brockport.edu

ABSTRACT.— During the wet, or non-breeding, season the Cape Sable Seaside Sparrow (*Ammodramus maritimus mirabilis*) exhibit neither long-distance nor local migration within Everglades National Park. Individuals move an average of 277 m from the previous season's breeding territory. They show a microhabitat shift from open marl prairie to stands of sawgrass (*Cladium jamaicensis*), small tree islands and the edges of large hammocks. As the wet season progresses, observations of birds decrease until early February when males begin to establish breeding territories for the coming spring. Because there is no migration out of its breeding habitat, the Cape Sable Seaside Sparrow depends exclusively on the marl prairies it inhabits year-round.

Through its short history of discovery, alleged disappearance and rediscovery, the Cape Sable Seaside Sparrow (*Ammodramus maritimus mirabilis*) has been considered an elusive bird (Werner and Woolfenden 1983). Only recently have researchers begun to piece together the life history of the Cape Sable Seaside Sparrow and to discover the requirements for its continued persistence (Lockwood et al. 1997, Pimm et al. 1997, Curnutt et al. 1998, Nott et al. 1998). One of the more enigmatic portions of its life history has been its winter, or wet season, habits. Although Lockwood et al. (1997) reported some post-breeding activities of the sparrow, important information on wet season dispersal and habitat requirements are lacking. Data such as this brings full circle the requirements needed to build population models which will be applicable to management schemes. To provide this data, we conducted systematic surveys from June 1996 to March 1997 to determine the wet season distribution and habits of the sparrow.

The Cape Sable Seaside Sparrow is a subspecies of the widespread Seaside sparrow (*A. mirabilis*). However, it is not a 'seaside' sparrow ecologically as it inhabits interior freshwater marshes within the remains of the Everglades ecosystem (Lockwood et al. 1997, Curnutt et al. 1998, Werner 1975, Bass and Kushlan 1982). The nearest subspecific relative is *A. m. peninsulae* which inhabits saltwater coastal marshes 300 km to the north (Curnutt et al. 1998). For these reasons, the taxonomic classification of this subspecies has been controversial and remains to be resolved using modern molecular techniques (Curnutt et al. 1998). However, because the Cape Sable Seaside Sparrow is ecologically and geographically distinct, Curnutt et al. (1998) consider the subspecies evolutionarily independent if not yet a full species.

Information on the wintering habits of most races of Seaside sparrows is sporadic (Quay et al. 1983, Greenlaw 1992, Post and Greenlaw 1994). Northern races are sometimes migratory (Quay et al. 1983, Post and Greenlaw 1994) and southern races are not believed to migrate at all (Post and Greenlaw 1994). The climate of the southern Florida peninsula is sub-tropical alternating between a wet and dry season with little variability in temperature. This climate is not only different from northern regions of the Seaside sparrow range, but also from regions in northern Florida. These climatic effects may or may not produce novel wet season (or over-wintering) adaptations. Cape Sable Seaside Sparrows may remain within freshwater marshes and become so secretive that observations are rare. They may move within their breeding range but outside the boundaries of our study areas. Since early sightings occurred during winter months within salt marshes (Howell 1919, 1932; Stimson 1956), the sparrow may still winter in these areas. For this reason, we did not limit the scope of our surveys and included all areas accessible on foot and by car or boat within Everglades National Park.

First discovered in the coastal prairies of Cape Sable on the west coast of the south Florida peninsula (Fig. 1), the Cape Sable Seaside Sparrow was at that time considered "moderately numerous" (Howell 1919). The hurricane of 1935 apparently devastated the population on the Cape (Stimson 1956) but Werner (1971) found a small group of sparrows there in 1970. By 1979 the sparrow had disappeared from Cape Sable again and has not been found there since (Bass and Kushlan 1982, Pimm et al. 1994, 1995, 1996; this study).

Other populations within Everglades National Park (hereafter referred to as ENP) and Big Cypress National Preserve have similarly declined. Populations in

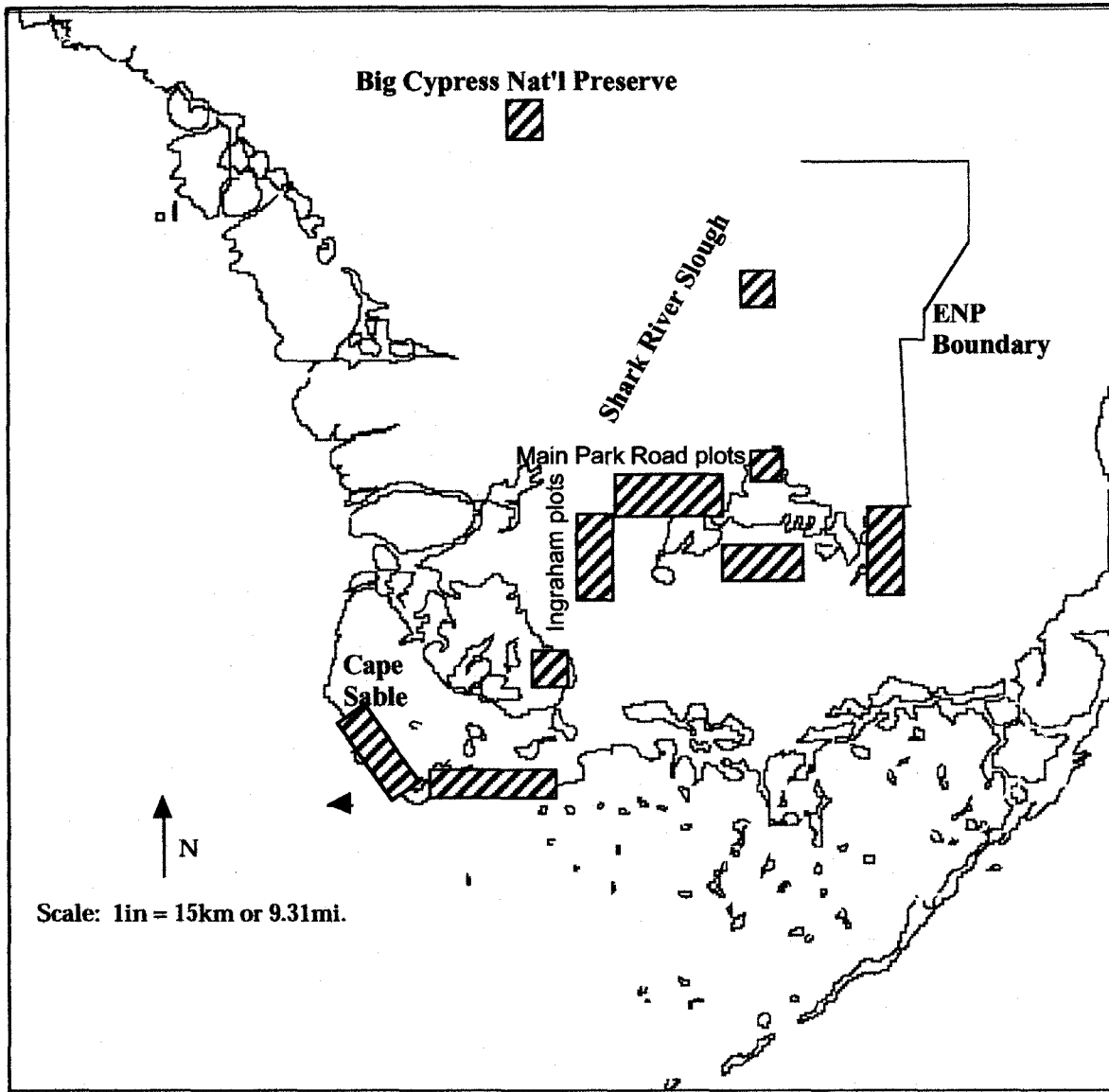


FIG. 1. Areas surveyed for Cape Sable Seaside Sparrows during the wet season of 1996-1997.

Ochopee, near Big Cypress, had disappeared by 1980 (Bass and Kushlan 1982) and populations in Taylor Slough had gone by 1993 (Curnutt and Pimm 1993). The sparrow's low population numbers and numerous disappearances from historic sites helped lead to its listing as endangered on the Federal Register in 1967 (32 Federal Register 4001, 1967).

However, populations in east and west ENP persist, and while the sparrow's overall density remains stable, individual populations within its widespread range are declining sharply (Pimm et al. 1995, 1996, 1996; Curnutt et al. 1998). The current range of the Cape Sable Seaside Sparrow is entirely within the boundaries of ENP and Big Cypress National Preserve.

Studies have shown these declines to be tied to altered hydrological regimes (Nott et al. 1998). This study concentrated on the sparrow sub-population located in eastern ENP. This area currently holds the highest densities of Cape Sable Seaside Sparrows. This sub-population has been the most stable of all the sub-populations not having declined over the past 20 years (Bass and Kushlan 1982).

METHODS

The Cape Sable Seaside Sparrow exclusively breeds in marl prairies (Werner 1975, Bass and Kushlan 1982, Pimm et al. 1996, Lockwood et al. 1997). Marl prairies are dominated by *Mulenbergia filipes* interspersed with sawgrass (*Cladium jamaicensus*) stands and small tree islands. These prairies are flooded during the wet season, usually June through February. Several study plots established in the eastern sub-population have been under observation during the breeding season for the past four years. Within these plots 227 Cape Sable Seaside Sparrows have been color banded since 1994 (Pimm et al. 1997). Initially, we concentrated our efforts on these plots. Observations began immediately after the breeding season ended (mid-June 1996). We visited four of these established plots, each approximately 1000 m², from June 1996 to March 1997. Two plots (Alligator Hammock and Dogleg) were visited an average of three times a week. The remaining two plots (Old Ingraham North and South) were each visited once a month (Fig. 1).

As the wet season progressed we expanded the area of observation to include most of the southeastern portion of ENP, including Cape Sable. In order to determine if the sparrows migrate out of the marl prairies during the wet season, point count surveys were conducted in seven different habitat types found within ENP: marl prairie, coastal prairie, mixed prairie, dry prairie, pineland, dwarf cypress and mangrove (see Gunderson 1994 for detailed descriptions of habitat types). Other subspecies of Seaside sparrows have been found wintering in prairies in ENP, but no Cape Sable Seaside Sparrows have been recorded in areas outside of their breeding habitats (O.L. Bass pers. comm.).

These seven habitat types are representative of ENP as a whole although most censuses were conducted in readily accessible areas (Fig. 1). Since there are no observations of Cape Sable Seaside Sparrows during the wet season beyond that given by Stimson (1954) and Howell (1919), we chose not to narrow the search in any manner. However, we did budget our observations according to the habitat type in which we most often found sparrows (i.e., we spent the majority of observation time within the marl prairie habitat).

Following Gutzwiller (1991), we used an unlimited distance point count to survey each habitat type and identify all birds present. Count points were placed 200 m apart. Each count duration was determined by using the gain rate of species (Hutto et al. 1986) for each habitat, and compensating for the difficulty in detecting Cape Sable Seaside Sparrows. For example, the gain rate for coastal prairie habitat was 5.5 min. Thus, after 5.5 min, 80% of all species eventually detected after 20 min had been counted. The average time to detect a sparrow was determined by recording the duration needed to identify one sparrow on two consecutive mornings during the non-breeding season (8 min.). This time was added to the gain rate resulting in a count duration of 12.5 min for coastal prairie habitats. We conducted all surveys between 0700 hours and 1000 hours, the time during which the sparrows are the most active (Werner 1975). To account for differences in survey effort throughout the wet season, all results are expressed as the number of birds observed per observer per day. This number is calculated by totaling the number of birds observed in each category per month and dividing that total by the number of observers reporting.

Water measurements were taken at fixed points within two marl prairie study plots throughout the season, and during point count surveys in all other habitats.

Using colored flagging tape, we followed changes in sparrow distribution by marking all locations in which birds were found. Each resight of a banded bird was flagged with colors coordinated with its leg band combination. Otherwise, each location in which we sighted a bird was marked with white flagging. We used a Magellan Global Positioning System linked to a Magellan Differential Beacon Receiver (DBR), to record the locations of banded birds in UTM coordinates. The use of the DBR allowed a location to be specified to within 20 m. We used UTM coordinates taken during the 1996 and 1997 breeding season to calculate the distance resighted, banded individuals moved from the 1996 breeding season to the non-breeding location and/or to the 1997 breeding season. We used the CA-CricketGraph III software program to map UTM coordinates on an X,Y graph. By scaling the graph into equal increments on the X,Y axis (i.e., 100 m) we then calculated the distance each banded bird moved from its 1996 breeding territory to each non-breeding resight location, and where possible, to its 1997 breeding territory. This was only possible for banded birds, although positions of unbanded birds were recorded as well.

We also recorded the following data for each individual bird resighted: any behavior observed (e.g., vocalizations, intra-specific interactions); the number of birds in the "flock"; status of tail and wing molt; and the microhabitat type in which the bird was found. Microhabitats were classified into X categories (Table 1) based on verticle structure and species composition.

Fifteen behavioral classifications were established during the 1996 breeding season and we continue their use here (Pimm et al. 1996). For a detailed list of behaviors and vocalizations see Werner (1975). The number of birds observed exhibiting a particular class of behavior was recorded per day. The frequency in which each behavioral class occurred was plotted from March 1996 to February 1997. These graphs allowed us to determine if particular behaviors were associated exclusively with the wet (non-breeding) season and to make better estimates of the beginning and end of the breeding season.

RESULTS

Behavior and Habitat Use.— Fig. 2 shows the frequency in which we observed the various behavioral classes during one full year beginning just before the 1996 breeding season. Using such graphs, we classified each behavior as breeding, non-breeding or undetermined. These graphs indicated that several behaviors could be attributed to only the breeding season. Some of these behaviors were as expected, such as delivering and gathering food. Others, not necessarily expected, included singing while perched in open prairie and chasing another individual over open prairie. Only two behaviors can be attributed solely to the wet season. These are 'seep' calls and quiet chipping while perching in dense vegetation.

In addition, using only behavioral classes that can be clearly defined, we can illustrate when the breeding season ended and later began (Fig. 3). It is clear from Fig. 3 that the 1996 breeding season ended in early June and the 1997 breeding season began in mid-February. This supports observations of early and late nests found during the 1995, 1996 and 1997 breeding seasons (Lockwood et al. 1997, J.L. Lockwood and K.H. Fenn pers. obs.). Based on these graphs, we considered observations as 'wet season' if they occurred between 1 July 1996 and 15 February 1997. All results below reflect this decision.

Similar to the behavior witnessed by Werner (1975), immediately following the end of the breeding season we saw family groups of up to eight birds. Very often these 'flocks' consisted of one or two banded males and several unbanded individuals. We believe these are family groups as the unbanded individuals often gave a sub-song typical of juveniles (see Werner 1975 for description) and lacked the full length tail

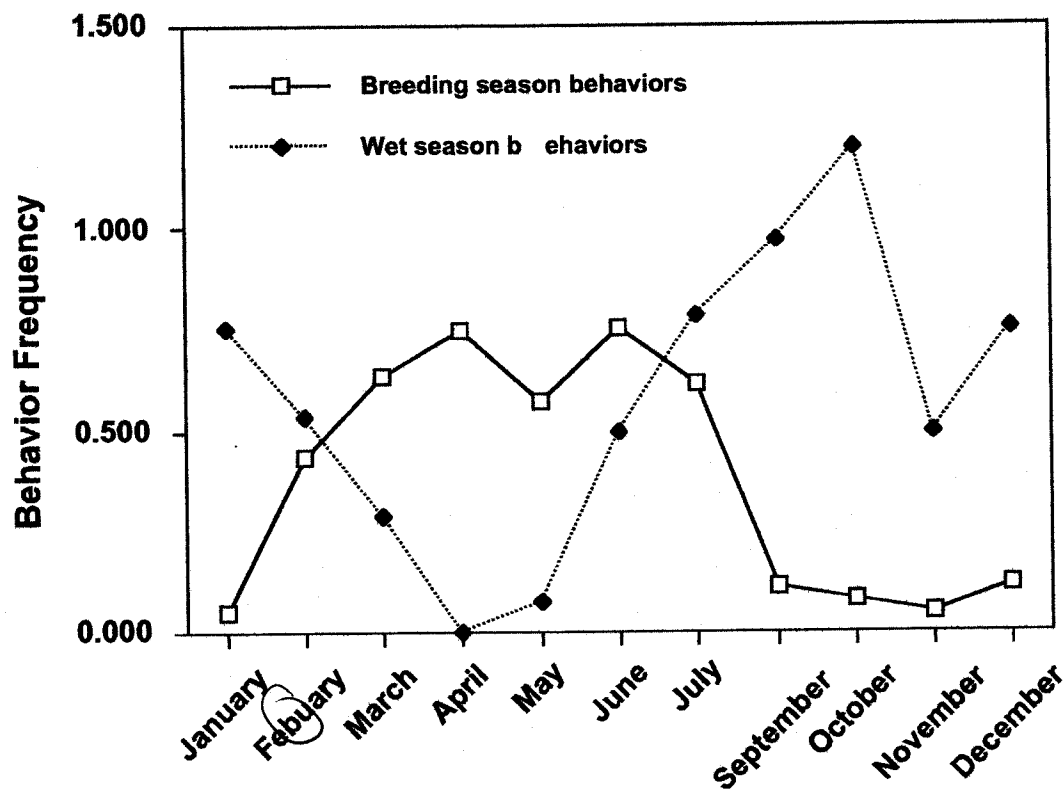


FIG. 2. Observation frequency of various non-breeding and breeding behavioral classes. A decrease in breeding behavior and an increase in wet season behavior approximates the 1996 end (1 June) and 1997 start (15 February) of the breeding season.

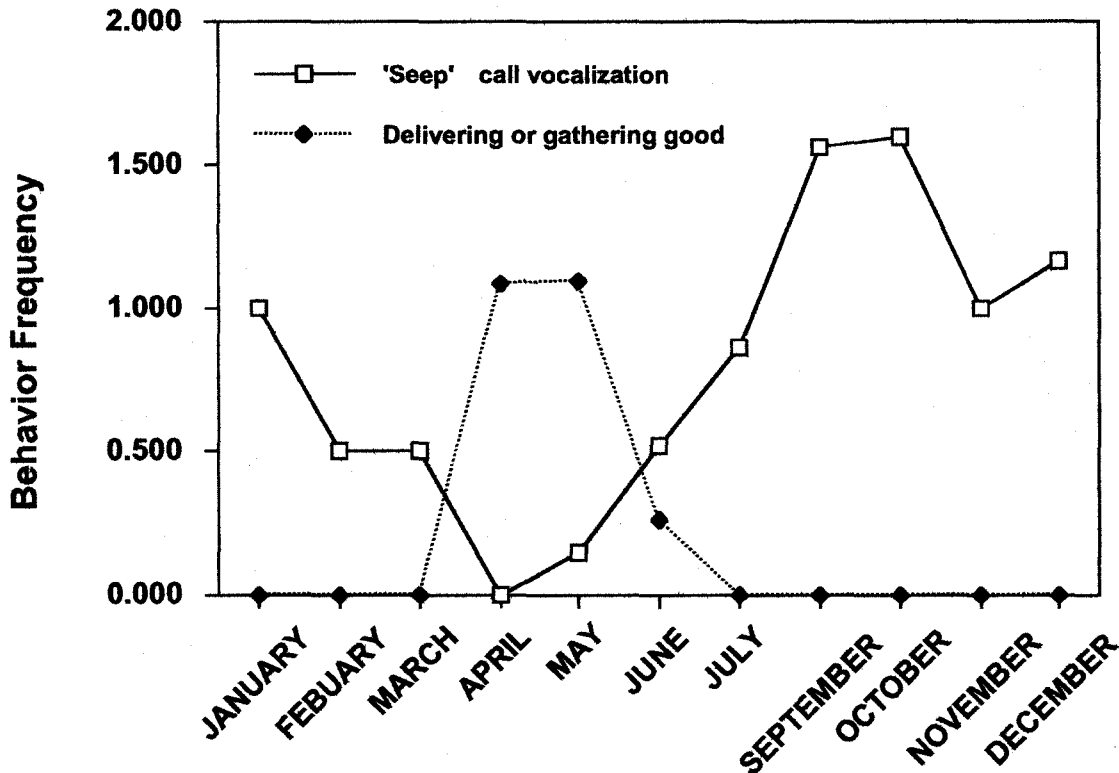


FIG. 3. Examples of behaviors that can be classified as either breeding season or wet season behaviors.

feathers of adults. Males did not sing during the wet season. These family groups broke down by September after which most observations were of two or fewer individuals.

The majority of detections throughout the wet season are of birds in sawgrass sways and sawgrass sways with small trees (80%: Table 1). Occasionally, we found sparrows perched in small trees within hammocks (all within the plot in which they nested), saw palmettos, or road-side vegetation. This behavior is in contrast the breeding season activity when Cape Sable Seaside Sparrows spend all of their time in the open prairie (Pimm et al. 1995, 1996). Through July, August and September some birds showed signs of molt. Molting individuals remained within sawgrass sways presumably for cover.

Wet Season Distribution.— Fig. 4 shows the sum total of birds (total, banded, and unbanded) seen throughout the wet season per observer per day. The total number of Cape Sable Seaside Sparrows detected showed a steady decline beginning at the end of the breeding season in June. Detections reached a low of less than one bird seen per observer per day in November. Thereafter, the number of detections began to increase, until an average of two birds were seen per observer per day by mid-February. At this point, male sparrows were regularly observed singing from high perches within open marl prairie.

However, when banded bird detections are separated from unbanded bird detections, a different pattern emerges. Detections of banded birds decline steadily with no subsequent increase as the wet season progresses. Detections of unbanded

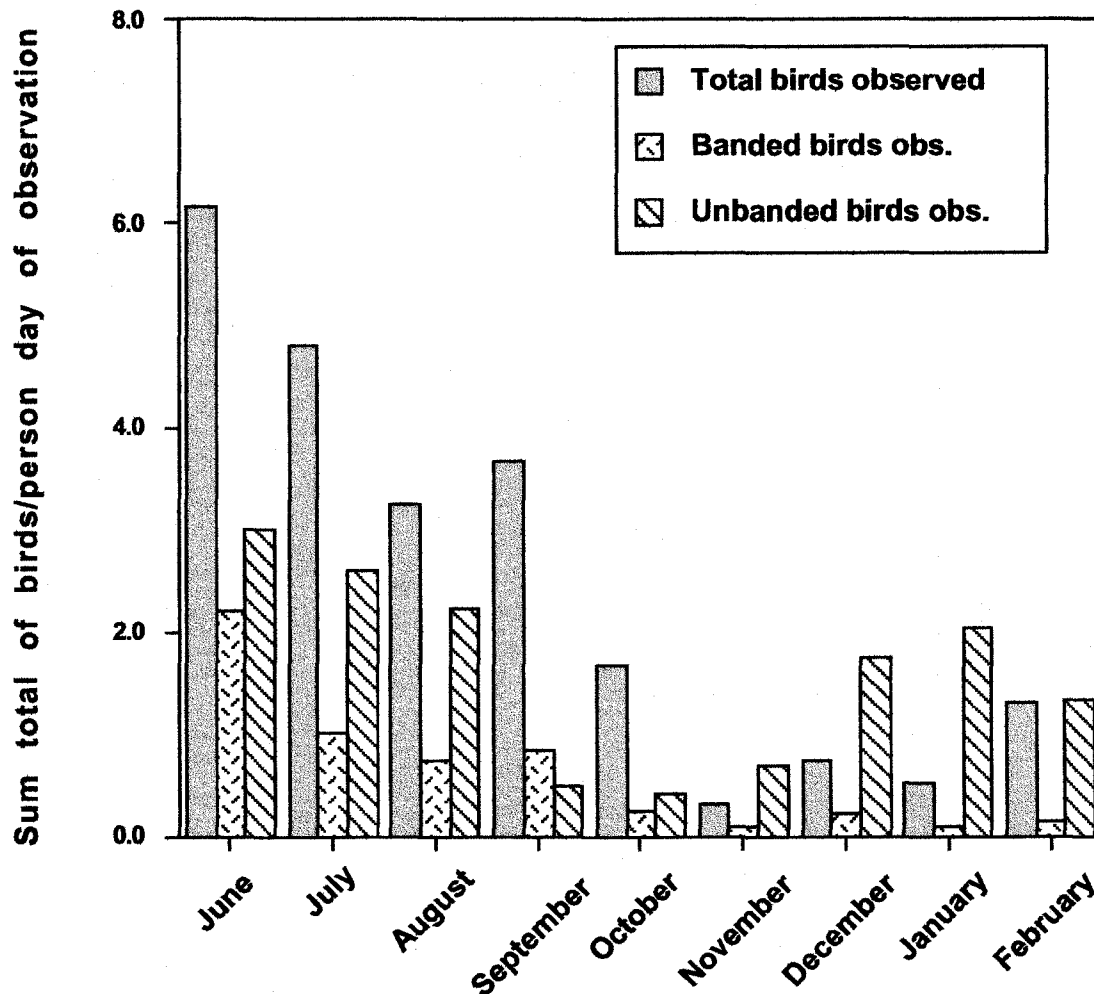


FIG. 4. Sum total of birds seen throughout the wet season per person days. bds=birds; bbds=banded birds; ubbds=unbanded birds.

birds, however, increase as the wet season ends (Fig. 4) and the breeding season begins. Thus, the increase in total number of birds detected late in the wet season can be attributed entirely to the increase in detection of unbanded individuals.

A total of 51 hours of point count surveys conducted throughout ENP during the non-breeding season found no Cape Sable Seaside Sparrows in habitats other than marl prairie. These surveys included the fringe prairies of Cape Sable and mixed prairies or dwarf cypress stands lying adjacent to the marl prairies where the sparrow breeds. Simply, we did not detect sparrows outside of their breeding range despite the fact that sparrow detections within their breeding range declined steadily throughout the wet-season.

Indeed, we observed little movement of Cape Sable Seaside Sparrows. Marking the locations of banded birds allowed us to follow individual movements throughout the wet season. Twenty-one banded birds were resighted. Of these, 14 had all bands intact and could be positively re-identified. The remaining seven were either missing a color band (two birds), or were not in visual contact long enough to be positively identified (five birds).

The 14 banded birds positively re-identified were found an average of 277 m ($N=14$, range=77 m to 986 m) from the spot where they were banded in the spring of 1995 or 1996. The majority of the all banded birds resighted (15 out of 21 birds) were only seen once. When locations of banded birds were revisited (sites were revisited at least once per month), the same individuals were not found again. The six individuals resighted more than once were usually found within a 10 to 20 m area of the initial resight spot.

For example, the bird banded WH/AL–YL/WH was resighted on three occasions. This bird was first resighted 250 m away from its breeding territory of spring 1996. This bird remained within 20 m of its initial resight location during the month of September. In early October, this bird moved North to an area 326 m away from its first resight spot (resighted 1 October) but only 115 m from its 1996 breeding territory. It was not seen again during the wet season, and was not resighted during the 1997 breeding season (Lockwood pers. obs.).

Only two birds were resighted in a study plot other than the one in which they were originally banded. One bird from Alligator Hammock plot was found in Dogleg plot, and vice versa. These plots are separated by Main Park Road, a distance of no more than 20 m. No birds from the Ingraham plots were found out of their original plot (i.e., where they were banded) despite the two Ingraham plots being separated by only 20 to 30 m. These observations are consistent with the high degree of philopatry observed between breeding seasons (Pimm et al. 1996, Lockwood et al. 1997). However, recent wet season telemetry studies have found 2 birds which traveled 6 km from the Ingraham study plots; they made no habitat change, but were subsequently found in marl prairie (T. Dean, pers. comm.). No birds have yet been found breeding in one plot one year, and a different one the next (Pimm et al. 1997).

Nine positively identified birds from the wet season survey were resighted during the 1997 breeding season (Pimm et al. 1997). They moved an average of 223 m from their wet season point ($N=5$, range=76 m to 460 m; UTM coordinates not available for all nine birds).

Five birds seen during the wet season were not resighted during the 1997 breeding season, despite the intensity of the observations and banding efforts during that time (Pimm et al. 1997). Conversely, 18 banded birds present in the breeding seasons of 1996 and 1997 were not seen during the wet season survey.

Influence of Water.— Water depth increased dramatically within marl prairies with the onset of summer rains in early June. Surface water depth across all plots averaged 7 cm at the end of May and had increased to 20 cm by 22 June. The loss of two late season nests in 1996 were attributed to this surface water increase (Lockwood et al. 1997). By mid-July however, surface water depth dropped substantially to 4 cm and remained low until the marl prairies dried in early November. For the next four months, these prairies contained no standing water, except in some deeper "alligator holes" (Fig. 5). Sparrow detections within marl prairie decreased substantially in late October as these prairies dried (Fig 5.). Detections began to increase in late January, however surface water levels remained unchanged.

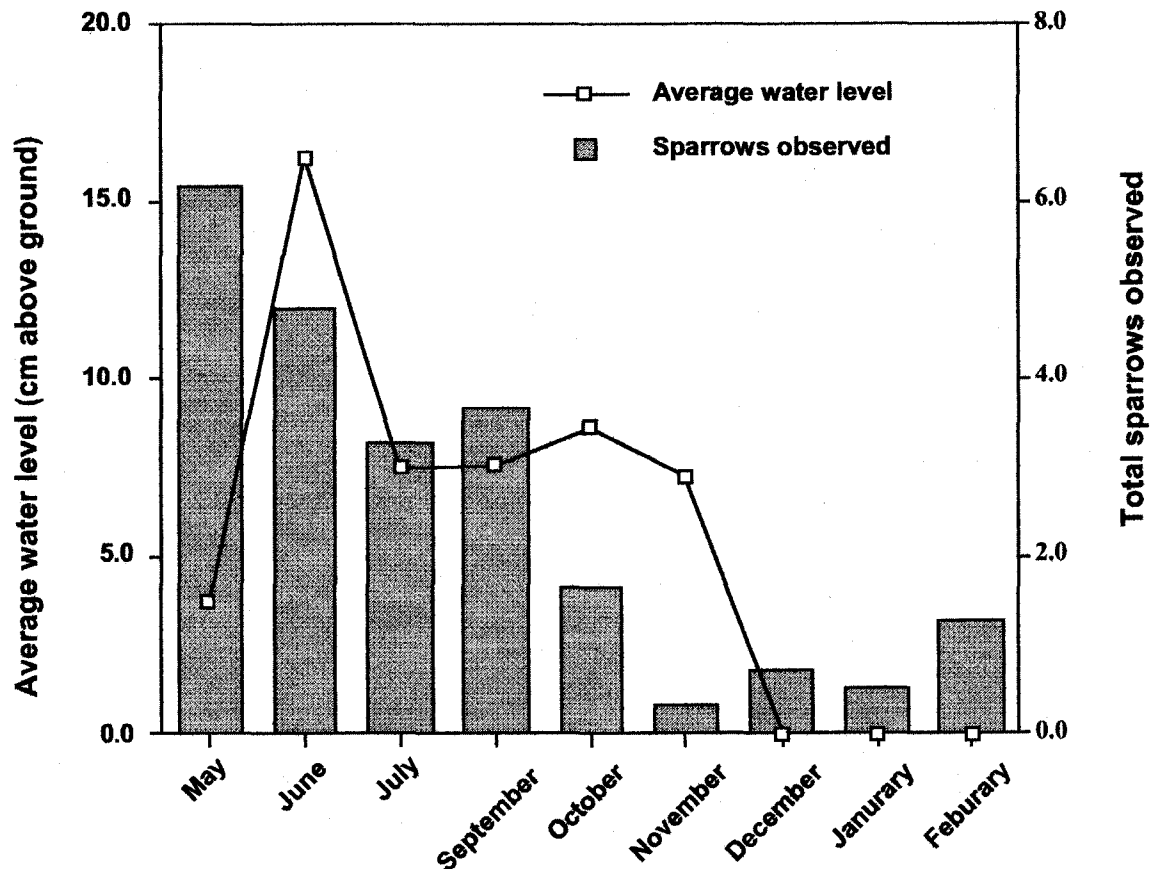


FIG. 5. Surface water levels (cm) within marl prairies plotted with the total number of sparrows observed per month.

DISCUSSION

Our results indicate that neither long-distance nor local migration occurs in the Cape Sable Seaside Sparrow. At least a portion of the Cape Sable Seaside Sparrow population spends the winter in the same prairies in which they breed. This indicates that this sparrow may be completely dependent on the existence of marl prairies for their long term survival.]

They do, however, show a change in microhabitat use within those prairies. By the end of the 1996 breeding season, the birds began to move out of the open prairies and into small tree hammocks and sawgrass sways (see also Lockwood et al. 1997). These sawgrass sways likely provide cover and refuge during molt, and perhaps an increased food supply during the wet season.

For other wintering subspecies of Seaside sparrows, smooth cordgrass (*Spartina alterniflora*) provides an assortment of food, and these birds concentrate in these stands during the non-breeding season (Post and Greenlaw 1994). While feeding observations of the Cape Sable Seaside Sparrow were rare during this study, a sparrow was observed eating seeds from a

sawgrass seed head. Qualitative foraging observations of birds gathering insects for young show a preference for sawgrass stands (J. Lockwood and K.H. Fenn, pers. obs.), but whether these stands typically host more insects than open marl prairie is not known.

We do report a decrease in observations of sparrows throughout the wet season (October, November, December) and a subsequent increase in their numbers and activity by mid-February. This pattern is suggestive of a migration or movement out of the marl prairies. However, we may also attribute this to the birds' change in behavior during molt and its choice of non-breeding microhabitat. This movement to higher (stem-wise), and more dense vegetation coupled with the birds' already secretive nature, confounds the ability of an observer to readily find these birds. The increase in detection by mid-February is clearly a result of male birds competing for territories for the oncoming breeding season. While banded bird observations decreased through the wet season and remained low as unbanded bird observations increased, those banded birds that were seen had not moved more than 1 km from their breeding territory.

In addition to protection during molt and food availability, sawgrass stands may provide an escape, in the form of higher perches, from rising surface waters. Marl prairies usually stay inundated with water from June to March, and seeking higher "ground", the sparrows may move into sawgrass sways and tree islands to avoid the rising water. The 1996-1997 wet season, however, proved to be a particularly dry one. By mid-November, standing water had virtually disappeared from the marl prairies and did not return until late March (and then only during flash floods). Had the prairies remained flooded, the sparrows may have abandoned the marl prairies and moved into a drier habitat, such as coastal prairie. This possibility seems unlikely because we never observed an individual in any habitat other than marl prairie. Continuing to monitor the habitat use and distribution of the Cape Sable Seaside Sparrow through several years, some inevitably wetter, could confirm or deny this possibility.

ACKNOWLEDGMENTS

We thank O.L. Bass and S.L. Pimm for helpful advice and insight, T. Brooks and C. Norment for helpful comments on earlier drafts. We thank J. Hand and T. Obenauer for providing safe refuge. Funding was provided by a grant from the National Park Service, United States Army Corps of Engineers and United States Fish and Wildlife Service to S.L. Pimm.

LITERATURE CITED

- BASS, O. JR. AND J. KUSHLAN. 1982. Status of the Cape Sable Sparrow. South Florida Research Center Report T-672, Everglades National Park, Homestead, Florida.
- CURNUTT, J. AND S. PIMM. 1993. Cape Sable Seaside Annual Report. NBS/NPS, Everglades National Park, Homestead, Florida.
- CURNUTT, J., A. MAYER, T. BROOKS, L. MANNE, O. BASS, JR., D. FLEMING, M. NOTT AND S. PIMM. 1998. Population Dynamics of the Endangered Cape Sable Seaside Sparrow. *Animal Conservation* 1:11-21.
- GREENLAW, J. 1992. Seaside Sparrow, *Ammodramus maritimus*. Pp. 211-232 in *Migratory nongame birds of management concern in the northeast*. (K. Schneider and D. Pence, eds.). U.S. Dept. of Interior, Fish and Wildlife Service, Newton Corner, Massachusetts.

- GUNDERSON, L. 1994. Vegetation of the Everglades: determinants of community composition. Pp. XX-XX in *Everglades: the ecosystem and its restoration* (S. Davis, J. Ogden, and W. Park, Eds.). St. Lucie Press, Delray Beach, Florida.
- GUTZWILLER, K. 1991. Estimating winter species richness with unlimited- distance point counts. *Auk* 108:853-862.
- HOWELL, A. 1919. Description of a new seaside sparrow from Florida. *Auk* 36:86-87.
- HUTTO, R., S. PLETSCHE AND P. HENDRICKS. 1986. A fixed-radius point count method for nonbreeding and breeding season use. *Auk* 103:593-602.
- LOCKWOOD, J., K. FENN, J. CURNUTT, D. ROSENTHAL, K. BALENT AND A. MAYER. 1997. Life history of the endangered Cape Sable Seaside-Sparrow. *Wilson Bull.* 109:720-731.
- NOTT, M., O. BASS, JR., D. FLEMING, S. KILLEFFER, N. FRALEY, L. MANNE, J. CURNUTT, T. BROOKS, B. POWELL AND S. PIMM. 1998. Water levels, rapid vegetational changes, and the endangered Cape Sable Seaside-Sparrow. *Animal Conservation* 1:22-31.
- PIMM, S., T. BROOKS, J. CURNUTT, J. LOCKWOOD, L. MANNE, A. MAYER, M. NOTT, K. BALENT AND G. RUSSELL. 1995. Population ecology of the Cape Sable Seaside Sparrow (*Ammodramus maritimus mirabilis*). Annual report, 1995. NBS/NPS, Everglades National Park, Homestead, Florida.
- PIMM, S., J. CURNUTT, J. LOCKWOOD, L. MANNE, A. MAYER, M. NOTT, AND K. BALENT. 1996. Population ecology of the Cape Sable Seaside Sparrow (*Ammodramus maritimus mirabilis*). Annual report, 1996. NBS/NPS, Everglades National Park, Homestead, Florida.
- PIMM, S., J. CURNUTT, J. LOCKWOOD, L. MANNE, A. MAYER, M. NOTT, K. FENN, and , K. BALENT, 1997. The 1997 Annual Report on the Cape Sable Seaside Sparrow. NBS/NPS, Everglades National Park, Homestead, Florida.
- POST, W. AND J. GREENLAW. 1994. Seaside Sparrow (*Ammodramus maritimus*). Pp. 1-28 in *The Birds of North America*, No. 127. (A. Poole and F. Gill, eds.). American Ornithologists' Union, The Academy of Natural Sciences of Philadelphia.
- QUAY, T., J. FUNDERBURG JR., D. LEE, E. POTTER, AND C. ROBBINS. 1983. The seaside sparrow, its biology and management. Occas. Papers of the North Carolina Biol. Survey 1983-5, Raleigh, North Carolina.
- STIMSON, L. 1954. Cape Sable seaside sparrow: *Ammodramus mirabilis* (Howell). Pp. 479- 481 in *Florida Bird Life* (A. Sprunt, Jr., ed.). Coward-McCann, New York, New York.
- STIMSON, L. 1956. The Cape Sable seaside sparrow: Its former and present distribution. *Auk* 73:489-502.
- WERNER, D. 1971. Cape Sable sparrows rediscovered on Cape Sable. *Auk* 88:432.
- WERNER, D. 1975. The biology of the Cape Sable Sparrow. Report to Fish and Wildlife Service. Everglades National Park, Homestead, Florida.
- WERNER, D. AND G. WOOLFENDEN. 1983. The Cape Sable Sparrow: It's habitat, habits, and history. Pp. 55-75 in *The Seaside Sparrow, its biology and management* (T. Quay, J. Funderburg, Jr., D. Lee, E. Potter and C. Robbins, eds.). Occas. Papers of the North Carolina Biol. Survey 1983-5, Raleigh, North Carolina.

FIGURE LEGENDS

FIG. 1. Areas surveyed for Cape Sable Seaside Sparrows during the wet season of 1996-1997.

FIG. 2. Observation frequency of various non-breeding and breeding behavioral classes. A decrease in breeding behavior and an increase in wet season behavior approximates the 1996 end (1 June) and 1997 start (15 February) of the breeding season.

FIG. 3. Examples of behaviors that can be classified as either breeding season or wet season behaviors.

FIG. 4. Sum total of birds seen throughout the wet season per person days. bds=birds; bbds=banded birds; ubbds=unbanded birds.

FIG. 5. Surface water levels (cm) within marl prairies plotted with the total number of sparrows observed per month.