

**Fire effects on Cape Sable seaside sparrow demography; year
two.**

A proposal to the US National Park Service, Everglades National Park, Homestead,
Florida.

Julie L. Lockwood
Department of Environmental Studies
1156 High Street
University of California
Santa Cruz, CA 95064
e-mail: lockwood@cats.ucsc.edu

INTRODUCTION

Between 1948 and 1992 the wetland areas of Everglades National Park experienced 752 fires for an average of 17 fires per year (Gunderson and Snyder 1994). Fire is a necessary component of the Everglades. It maintains a habitat mosaic and prevents hardwood shrubs from invading the characteristically open Everglades marshes (Robertson 1953, Egler 1952, Taylor 1983). The Cape Sable seaside sparrow (*Ammodramus miratimus mirabilis*), an endangered subspecies endemic to the southern Everglades, relies on marl prairies that are influenced by fire regimes (Werner 1975). The sparrow lives exclusively on Federally protected land, principally within Everglades National Park (ENP). Currently ENP manages fire through prescribed burning and strategic control of naturally caused fires. Of central concern to ENP officials is the development of a fire management protocol that promotes USFWS recovery goals for this subspecies. The conception of this fire management plan is profoundly inhibited by the lack of knowledge surrounding the sparrow's response to, and recovery from, fire.

I propose the continuation of a detailed demographic study of individual sparrows subjected to a recent fire event. Because ENP managers allowed a recent fire to burn through a portion of an existing study plot, I have the option of utilizing a study design that can better detect fire effects than previous research. This includes evaluating the long-term effects of fire on sparrow populations, and evaluating the reasons for any lasting negative effects. The demographic information collected, if continued for three more years, can also be used to project the fates of sparrow populations subjected to proposed fire management plans (Whelan 1995). This study is designed to compliment existing information on how sparrow populations respond to flooding regimes, allowing for the possibility of projecting population changes caused by the combined effects of fire and flood. Finally, conceptually this study fits squarely between concurrent research, and thus has already begun to mechanistically tie together fire effects observed at other spatial and temporal scales after one year of data collection.

STUDY DESIGN AND METHODOLOGY

We employ a quasi-experimental design that involves a two-group comparison without randomization (Manly 2001). The manipulation (i.e. fire) is introduced into one plot, while another is left unaffected. Figures 1 and 2 show our study site and design as well as the locations of banded sparrows before and after the fire burned half the plot in May 2001. We have been monitoring variables of interest (see below) for three years before, and one year after the fire. In order to account for underlying annual variations in the effect variables, Whelan (1995) suggests monitoring such plots for equal amounts of time before and after the manipulation is introduced. For vertebrate populations, this typically requires two or more years of information collected before fire is introduced, followed by a further two or more years of post-fire information (Whelan 1995). Accordingly, this represents the second year of a four-year project.

The assumption in quasi-experimental designs is that any naturally occurring (i.e. unaccounted for) changes in sparrow density will be nearly the same in the control and burned plots. Any extreme changes in density within the burned plot can then be attributed to the fire (Manly 2001). Evidence for an effect of fire on sparrow populations is provided by a statistically significant change in the difference between the control and burned plot before and after the time of burning. On the other hand, if the two plots

remain exactly the same before and after fire, then there is no evidence of an effect on sparrow population dynamics.

Our results from the first year provide strong evidence for the latter scenario; that is to say the fire negatively effected the sparrow study population. We documented no use of the burned area one year post-fire by Cape Sable seaside sparrows (Figure 2, and Interim Report). Thus, the remaining focus of this proposal is on (1) determination of the longer-term negative effects on the sparrow population and (2) why sparrows are not returning to the burned area.

(1). This study design allows us to determine the nature of any lasting effects of fire on sparrow populations by comparing the population in the burned area to the unburned area through time. There are at least four lasting effects fire may have on sparrow populations. First, sparrow numbers may decrease after fire and never returns to levels equal to the control site. Second, sparrow numbers may decrease after fire and eventually recover to levels that are indistinguishable from the control site. Third, sparrow numbers may initially decrease after fire, but later significantly increase and never return to control site levels. Fourth, numbers may initially decrease after fire, but later increase, eventually returning to control site levels.

By continuing to aurally survey, capture and band, and document territorial use by sparrows we can amass evidence for one of these scenarios. After three or more years of post-fire information such as this, it should be possible to objectively choose between these competing models using maximum likelihood statistics (Steward-Oaten et al. 1986).

(2). We not only want to understand how sparrow numbers change after fire, but also why they change. A significant limitation of previous research was their exclusive reliance on sparrow density as a gauge to the effect of fire on sparrow populations. Density is a crude measure of a population's response to local disturbances such as fire (Whelan 1995). Using density information we may learn that the number of individuals increases or decreases after a fire, however we have little knowledge as to the response of demographic attributes such as fecundity, mortality, and dispersal. Any one, or all, of these demographic variables could be effected. A detailed understanding of how sparrow demography responds to a fire provides a great deal more insight into how fire may be managed to minimize risks to the subspecies' survival (Akçakaya et al. 1999). For example, each life stage (e.g. adults, juveniles, nestlings) may experience unique rates of mortality, fecundity, and dispersal.

So far, our results are inconclusive as too little time has passed to detect a clear demographic signal related to fire. We propose to continue monitoring these demographic segments of the sparrow's population adding another year of post-fire information. After three or more years of collecting such information we should be able to build a stage- or age-structured model that allows population size to be projected into the future (Akçakaya et al. 1999). Using this approach, the effects of proposed fire regimes can be inferred from the results of relatively short-term studies (Wellington and Noble 1985, Whelan 1995). Demographic variables are re-set to their post-fire state based on proposed burning schedules. Each burning schedule is modeled independently and the range of possible effects on sparrow populations are produced. These projections

can then allow managers to choose a fire management option that best minimizes the risk of sparrow extinction while maximizing other ecosystem benefits (Akçakaya et al. 1999).

Because we know a great deal about the limiting factors for the sparrow (Pimm et al. 2002), we can begin to document the reasons why reproduction, mortality, and dispersal may change in the years after a fire. The primary limits on reproduction are predation, localized weather patterns that flood active nests, and food availability (Lockwood et al. 1997, Lockwood et al. 2001). The primary limits on juvenile and adult survival rates are less clear, but are likely influenced by predation and food availability (Dean and Morrison 2001). Our quasi-experimental study design allows us to document differences between the control and burned sites in these secondary variables and then look any correlations to changes in demographic variables.

For example, to document demographic changes related to the availability of food we can measure body condition of adults, fledging weight of young, and types of food brought to nestlings. Similarly, we can document reasons why fecundity varies between sites by documenting differences in nest predation rates, and types of nest predators, between sites. Because sparrows did not return to the burned site in 2002, we could not measure these factors. However, we are prepared to do so when sparrows begin to return to the burned area, perhaps in this next year. In the meantime, we continue to collect such information within the unburned site.

We did document changes to important vegetation components between the two sites (e.g., percent ground cover, presence and height of perching substrate, presence and cover of bunchgrasses). Our preliminary results indicate that the response of the important vegetation components was very rapid, and according to some of these metrics (e.g., species composition) the burned area is now indistinguishable from the unburned area. However, other vegetation variables, such as ground cover, have not returned. This suggests sparrows are responding to a specific set of vegetation components that do not return as quickly as other components (e.g. species composition). We propose continuing collecting vegetation information at our permanent vegetation plots within and outside the burn. Documenting the status of various vegetation metrics when sparrows do begin to return should prove enormously informative not only in terms of the lasting effects of fire, but also related to the general habitat needs of the sparrow.

Migration between burned and unburned habitat is also likely to play a relatively large role in the degree of fire impact, and the rate of population recovery after fire. Populations may recovery quickly if displaced adults and mobile juveniles simply move to adjacent unburned habitat and then return immediately after the habitat returns to a suitable breeding condition. In the first year after fire, we did not observe adults or juveniles originally from the burned areas within the unburned sites. It is not clear where these displaced individuals have gone. By continuing to re-sight and map all banded individuals we can continue to monitor for such migrations. In particular, we can monitor for the reverse effect; adults moving into the burned site once it becomes suitable from the unburned site. Differences in reproduction and mortality between the burned and control sites may reflect the tendency for young birds to preferentially recolonize recently burned sites. Thus, we will also resight fledglings throughout the breeding season and early non-breeding season, documenting their movements and eventual site of

settlement. The opportunity to collect such information on vertebrate populations subjected to fire is rare (Whelan 1995), and thus our results should be of general interest.

RELATIONSHIP OF PROPOSED STUDY TO CONCURRENT RESEARCH

There are at least two other proposed (or funded) studies that address the relationship between fire and Cape Sable seaside sparrow populations. This proposal was designed to compliment these approaches by recognizing their various limitations and spatially linking population and ecosystem-wide fire effects. This study is limited in two important respects, each reflecting a fundamental trade-off between obtaining detailed demographic information versus incorporating the full complexity of the combined effects of fire and flooding.

First, the proposed study can not adequately address how sparrow habitat responds to the combined effects of fire and flood. The study is uniquely conceived to address how sparrow demography responds to one fire event. I have purposefully limited the spatial extent of the study such that the burned and control sites differ as little as possible; this includes differences in vegetation and flood regime. Because this study will correlate changes in demographic parameters to fire-induced changes in vegetation (given a static flooding regime), the results can be combined with the proposed research of M. Ross and colleagues at Florida International University. Their study plan calls for a detailed analysis of how fire and flood alter vegetation, and can thus provide the basis for predicting how alterations in sparrow habitat will induce sparrow population changes across the entirety of the sparrow's range. I have already begun to exchange information with M. Ross and his collaborators. In particular, the results we have obtained for the effects of fire on the vegetation are very useful in helping to define the set of vegetation characteristics they should monitor.

Second, this study is limited in spatial and temporal extent. Thus, I can not address long-term (>4 year) changes in sparrow populations except through projection matrix models. Further, this study can not address the effects of fires that burn at other times of the year (i.e., wet-season fires), are ignited by resource managers or lightning, or burn over much larger (or smaller) areas. The information exists to document how segments of the sparrow population responded to 10+ years of fire events, including analyzing how sparrow populations and habitat responded to landscape-scale differences between these events. This is the spatial and temporal domain of the proposed work of S. Pimm at Duke University. The results of my proposal will provide needed insight into why various patterns emerge from Pimm's analyses, and whether or not we would have predicted the presence of these patterns given what we know about how demographic variables respond to fire. The two approaches also provide important checks on one another, especially when attempting to project the response of sparrow populations to proposed fire management options. If results from the two approaches reinforce one another, this provides a stronger assurance that any fire management actions adopted will satisfy, and not obstruct, recovery goals (Tyre et al. 2000, Hilborn and Mangel 1997).

BUDGET AND JUSTIFICATION

This original budget was projected over a four-year span. This represents the second year of that plan of study. There are two primary expenses for the coming year; personnel and equipment. The study site is in a portion of Everglades National Park that is only

accessible via helicopter. Relatively constant monitoring is required to obtain reliable demographic information, thus the successful completion of the study requires very frequent overnight stays within a backcountry camp. Using prior funds, we have built (and rebuilt) a camp within this study plot. Staffing this backcountry camp requires the rotation of skilled and independent research assistants over the span of the breeding season (4+ months). These research assistants work independently and must therefore show very good personal safety and data collection judgement. For these reasons, the majority of requested funds are to continue to fund an experienced research associate (Michelle Davis) that will reside in Florida, oversee the majority of the day-to-day field operations (including banding), and provide post-field season assistance. Also included are funds to support a graduate student (David La Puma). In consultation with the PI, this student will be responsible for the analysis and publication of resulting information. This student will also likely reside in Florida (as much as is feasible) and, together with the research associate, provide the backbone of the yearly field crew. Associated personnel expenses include the support of two experienced field biologists, travel funds, and PI summer salary.

Of considerably less magnitude, but providing the remainder of the budget costs, is the acquisition of equipment. From previous funds, we already possess needed equipment for camp living and for frequent helicopter flights. This budget includes costs associated with keeping this equipment in good condition, replacing lost or damaged items, and maintaining the camp structure. Additional equipment costs include the acquisition of a computer, camera systems for monitoring nest predation, banding equipment, solar equipment (for powering electronics while at the camp), and automated dataloggers.

The field season will run from March to August. Data analysis, and preparation of annual reports, will occur from August to February. An interim report will be delivered on December 1, 2003. The final annual report will be produced by March 1, 2003. I will present updated findings to resource managers and associated research personnel annually at a November meeting time to be arranged.

LITERATURE CITED

- Akçakaya, H.R., M.A. Burgman, and L.R. Ginzburg. 1999. Applied population biology. Sinauer Associates, Inc. Sunderland, MA.
- Dean, T.F. and J.L. Morrison. 2001. Non-breeding season ecology of the Cape Sable seaside sparrow (*Ammodramus maritimus mirabilis*). Final Report submitted to USFWS, South Florida Ecosystem Office, Vero Beach, FL.
- Egler, F.E. 1952. Southeast saline Everglades vegetation, Florida, and its management. *Vegetatio* 3:213-265.
- Gunderson, L.H. and J.R. Snyder. 1994. Fire patterns in the southern Everglades. In *Everglades: the ecosystem and its restoration* (S.M. Davis and J.M. Ogden, eds.). Pages 291-306, St. Lucie Press, Boca Raton, FL.
- Hilborn, R. and M. Mangel. 1997. *The ecological detective*. Princeton University Press, Princeton, N.J.
- Lockwood, J.L., K.H. Fenn, J.M. Caudill, D. Okines, O.L. Bass Jr., J.R. Duncan, and S.L. Pimm. 2001. The implications of Cape Sable seaside sparrow demography for Everglades restoration. *Animal Conservation* 4:275-281.
- Lockwood, J.L., K. H. Fenn, J.L. Curnutt, D. Rosenthal, K.L. Balent, and A.L. Mayer. 1997. Life history of the endangered Cape Sable seaside sparrow. *Wilson Bulletin* 109:720-731.
- Manly, B.F.J. 2001. *Statistics for environmental science and management*. Chapman & Hall/CRC Press, Boca Raton, FL.
- Pimm, S.L. J.L. Lockwood, C.N. Jenkins, J.L. Curnutt, M.P. Nott, R.D. Powell, and O.L. Bass Jr. 2002. Sparrow in the grass. A report on the first ten years of research on the Cape Sable Seaside Sparrow (*Ammodramus maritimus mirabilis*). Everglades National Park, Homestead, FL.
- Robertson, W.B. Jr. 1953. A survey of the effects of fire in Everglades National Park, Everglades National Park, National Park Service, U.S. Department of Interior, Homestead, FL.
- Taylor, D.L. 1983. Fire management and the Cape Sable sparrow. In: *The seaside sparrow, its biology and management*. (Quay, T.L., J.B. Funderburd Jr., D. Lee, E.F. Potter, and C.S. Robbins, eds). North Carolina Biological Survey and North Carolina State Museum.
- Tyre, A.J., B. Tenhumberg, M.A. McCarthy, and H.P. Possingham. 2000. Swapping space for time and unfair tests of ecological models. *Austral Ecology* 25:327-331.
- Wellington, A.B. and I.R. Noble. 1985. Post-fire recruitment and mortality in a population of the mallee *Eucalyptus incrassata* in semi-arid, southeastern Australia. *Journal of Ecology* 73:645-656.
- Werner, H. 1975. The biology of the Cape Sable seaside sparrow. Report to US Fish and Wildlife Service. Everglades National Park, Homestead, FL.
- Whelan, R.J. 1995. *Ecology of fire*. Cambridge University Press, Cambridge, UK.

2003 Budget

Salaries

PI summer salary	2.5 months		\$16,944.00
Fringe		9.20%	\$1,558.85
Graduate Research Assistantship	2 quarters		\$11,850.00
Post-graduate research associate	1 year		\$25,000.00
	sub-total		\$55,352.85

Travel

Car rental	5 weeks @ \$200 per week		\$1,000.00
Airfare	2 trips @ \$600.00 ea.		\$1,200.00
Housing	1 month @ \$1000		\$1,000.00
P.I. per deim	35 days @ \$40.00 per day		\$1,400.00
Volunteer per deim	30 days @ \$40.00 per day		\$1,200.00
	sub-total		\$5,800.00

Other costs

Supplies	equipment, cameras		\$7,000.00
Computer/hardware	Dell desktop		\$3,000.00
Personnel services	2 people * 4 months * \$1200.00 per month		\$9,600.00
	sub-total		\$19,600.00

Direct Costs

			\$80,752.85
Overhead		15%	\$12,112.93
Grand total			\$92,865.78

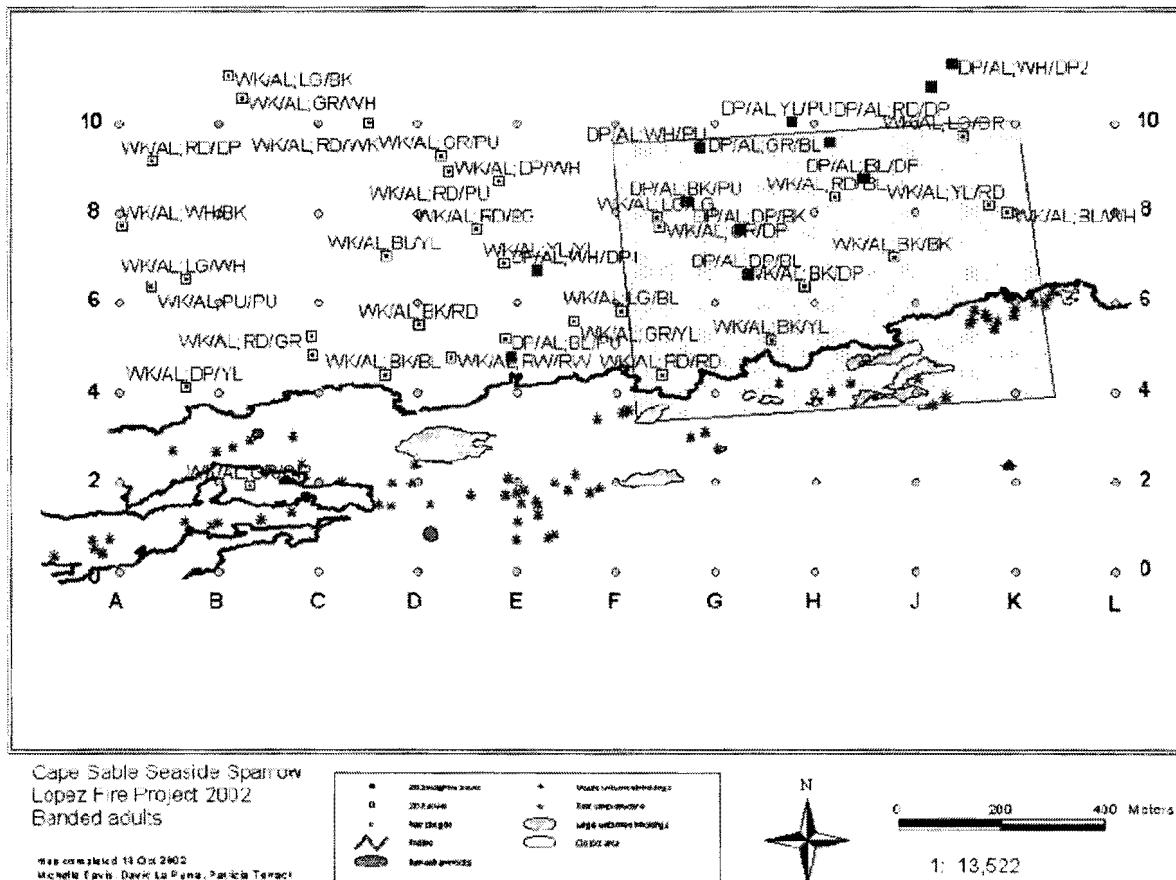


Figure 2. In 2001 we re-occupied the entirety of the former plot in order to document the effects of the May 2001 (Lopez) fire. This figure shows the sparrows banded or re-sighted during the 2002 breeding season. Notice that we observed no sparrows (juveniles or adults) using the burned area one-year post fire.