Habitat Selection by Florida Grasshopper Sparrows in Response to Fire

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Abstract: Minimum population estimates of Florida grasshopper sparrows (*Ammodramus savannarum floridanus*) made using listening stations systematically located throughout a 2,374-ha portion of the Three Lakes Wildlife Management Area (WMA) in central Florida ranged from 219–234 individuals over a 3-year period. The study area was divided into 3 units and 1 was burned each year. Grasshopper sparrow population density was related to the 3 burn regimes: <1 year post-burn, 1–2 years post-burn, and >2 years post-burn. Grasshopper sparrows did not utilize each burn regime in proportion to its occurrence ($X^2 = 21.86$, df = 2, $P < 0.001$). Grasshopper sparrows preferred areas <1 year post-burn, avoided areas >2 years post-burn, and used the intermediate burn regime in proportion to its occurrence ($P < 0.01$). Grasshopper sparrows did not colonize areas of apparently suitable habitat that were spatially separated from the population by areas of unsuitable habitat. Recommendations for burning grasshopper sparrow habitat are presented. This study also suggests that experimental reintroduction of grasshopper sparrows into unoccupied habitat may be appropriate.

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The Florida grasshopper sparrow is listed by the state of Florida and the U.S. Fish and Wildlife Service as endangered. Although reportedly widespread throughout central Florida in the first half of this century (sources cited in Delany et al. 1985), surveys in recent years detected the presence of just a few hundred individuals (Delany and Cox 1986). The population decline is attributed to habitat loss, as the majority of the sparrow's required habitat (the dry prairie region adjacent to the Kissimmee River and Lake Okeechobee) has been converted to non-indigenous grass pastures and cropland, which have little or no utility to Florida grasshopper sparrows.

Fire is the dominant natural force maintaining the habitat of the Florida grasshopper sparrow. Central Florida has a greater number of thunderstorm days annually than any other area within the continental United States (Chen and Gerber 1990). The high frequency of lightning generated by these storms results in fire every few years on the dry prairie ecosystem (Wade et al. 1980). As such, both the dry prairie ecosystem and its inhabitants, including the Florida grasshopper sparrow, evolved under a regime of frequent fire. Smith (1968) stated that grasshopper sparrows seem to prefer recently burned areas. Delany and Cox (1986) noted that Florida grasshopper sparrow densities appeared to be lower in areas not burned within 2.5 years. The objectives of this study were to determine a minimum population estimate of Florida grasshopper sparrows at Three Lakes WMA and to quantify their habitat selection in relation to time post-burn.

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Methods

The study area was a 2,374-ha tract of dry prairie on the 21,571-ha Three Lakes WMA, Osceola County. This grassland was dominated by saw palmetto (*Serenoa repens*) and pineland threeawn (*Aristida stricta*), with various mixtures of shrubs (*Lyonia, Ilex, Vaccinium,* and *Quercus* spp.) occurring throughout. Interspersed within the prairie were occasional live oak (*Quercus virginiana*)—cabbage palm (*Sabal palmetto*) hammocks, with marsh vegetation occurring in numerous small drainages and depressions. Longleaf and south Florida slash pine (*Pinus palustris* and *P. elliottii* var. *densa*), pond cypress (*Taxodium ascendens*), and other trees dominated adjacent plant communities but were largely absent on the prairie. A more detailed vegetation description is available in Delany et al. (1985).

The topography was nearly level, and upland soils (primarily EauGallie fine sand, Myakka fine sand, and Immokalee fine sand series) were sandy throughout but poorly drained due to a weakly cemented subsoil (Soil Conserv. Serv. 1979). Depressional and drainage soils (predominant series include Malabar fine sand, Delray loamy fine sand and Bassinger fine sand, depressional) were sandy throughout or underlain by a loamy layer and poorly to very poorly drained. During the rainy season (June–September) water stood on the surface of the ground for extended periods, moving primarily through sheet flow action.

Florida grasshopper sparrows were surveyed using 168 listening stations established on a 0.4 km grid. Surveys began approximately at sunrise and continued for 3 hours, or until wind conditions made listening impossible. Observers listened for 5 minutes at each station. Surveys were replicated 2–3 times at each station during the March–June breeding season annually from 1991–1993. Observers recorded the number of grasshopper sparrows heard and/or seen at each station and plotted their locations on aerial photographs. When possible, sparrows were recorded by sex. Sparrows performing the territorial call were assumed to be male. When a non-calling sparrow accompanied a male, the non-calling sparrow was assumed to be female. Sex was not determined for silent grasshopper sparrows observed alone.

The study area was divided into 3 burn units and 1 unit was burned each year. Burn unit dimensions were not equal: respectively, the north, central, and south units measured approximately 1.2 x 4.0 km, 2.4 x 4.0 km, and 3.8 x 4.0 km. Burn units were subdivided into 32–65 ha subunits. Prescribed burning within a given year began in September or October and was terminated by February or March, with approximately half of each unit burned in the fall and half burned in the winter months. The primary burn technique used was aerial ignition from a helicopter using a Premo Mark V™[1] aerial ignition dispensing system.

M. Delany (pers. commun.) found that 3.24 ha approaches the maximum home range size for Florida grasshopper sparrows. In order to determine a minimum population estimate, the following assumptions were made: 1) sparrows observed on different days >203 m apart (the diameter of a circular area of 3.24 ha) were separate individuals, 2) female sparrows do not perform the territorial call, 3) there is an equal number of females and males. The minimum population estimate was calculated by doubling the total number of separate individual male sparrows to account for the undetected females, and adding the number of undetermined sparrows.

The number of separate individual sparrows observed throughout the 3-year study period was totalled by burn regime. The burn regimes were: <1 year post-burn, 1–2 years post-burn, and >2 years post-burn. A chi-square goodness-of-fit test was performed to determine whether sparrows used the burn regimes in direct proportion to their availability. Following the chi-square test, 99% "family of confidence intervals" (Neu et al. 1974) were calculated to allow simultaneous tests to determine which burn regimes were preferred and which were avoided. Relative sparrow population density (sparrows/ha) was calculated by dividing the number of separate individual sparrows observed by the area of each burn unit (this density estimate was relative in the sense that it was determined using only the separate individual sparrows observed, which were predominantly males and therefore accounted for approximately half of the true number of sparrows present).

Two additional sites of apparently suitable habitat within Three Lakes WMA located 4 and 7 km from the study area were also searched annually for Florida grasshopper sparrows. These areas were tracts of dry prairie >200 ha in size with fire histories similar to that of the study area.

[1] Use of trade names implies no product endorsement.

Results and Discussion

Minimum Population Estimate

Listening station surveys resulted in annual minimum population estimates of 219–234 grasshopper sparrows (Table 1). To our knowledge, there are no larger Florida grasshopper sparrow populations reported in the literature. Delany and Cox (1986) reported 37 Florida grasshopper sparrows (26 male, 9 female, 2 undetermined) at this location following surveys conducted in 1984. Using our formula for calculating a minimum population estimate, their minimum estimate would have been 54 sparrows. Although it is possible that the grasshopper sparrow population increased during the period 1984–1991, we find it more likely that the greater numbers of sparrows found 1991–93 are a function of survey techniques and intensity of effort.

Habitat Selection

Florida grasshopper sparrows did not use each burn regime in proportion to its occurrence ($X^2 = 21.86$, df = 2, $P < 0.001$, Table 2). Sparrows preferred areas <1 year post-burn, avoided areas >2 years post-burn, and used the intermediate burn regime in proportion to its occurrence. Delany and Cox (1986) suggested that burning on a 2–3 year rotation is suitable for maintaining the species' habitat. Based on our results at Three Lakes WMA we concur with this.

Table 1. Minimum population estimates of Florida grasshopper sparrows at Three Lakes WMA, Osceola County, Fla. from 1991–1993.

Sparrow sex	1991	1992	1993
Male	107	115	116
Female	3	0	2
Undetermined	5	4	1
Total	115	119	119
Minimum population estimate	219	234	233

Table 2. Burn regime preference and avoidance by Florida grasshopper sparrows at Three Lakes WMA, Osceola County, Florida, from 1991–1993.

Burn regime	1	2	3	Total
Area (ha)	2,286	2,249	2,587	7,122
Proportion of total area	0.32	0.32	0.36	1.00
N observed sparrows	146	119	89	354
Expected N sparrows	114	112	128	354
Actual proportion of usage	0.41	0.34	0.25	1.00
X^2	9.22	0.47	12.18	21.86**
Confidence interval	$0.33 < P < 0.50$*	$0.25 < P < 0.42$	$0.18 < P < 0.33$*	

*Indicates a difference at the 0.01 level of significance.
**Indicates a difference at the 0.001 level of significance.

Burn Regimes

Although the data presented here suggest that annual or biennial burns conducted in fall or winter may be most appropriate for managing Florida grasshopper sparrow habitat, we caution that there may be negative ecological consequences associated with rigid, uniform burn schedules that minimize the variability found under natural conditions (Abrahamson and Hartnett 1990). It is believed that during prehistoric times the dry prairie burned predominantly during the lightning season (April-June), yet periodically burned at any time during the remaining 9 months of the year (Robbins and Myers 1992). Burning outside the sparrow's breeding season may minimize nest destruction, but may also result in changes in plant communities adapted to burning frequently at other times in the year. We suggest that managers of small, expanding populations use annual or biennial fall or winter burns for a limited time (such as over 10–20 years) to minimize disturbance to nesting, then as the sparrow population builds to occupy all available space, change to a burn regime more similar to that under which the dry prairie evolved. A fire return interval varying between 1–4 years has been proposed as appropriate for the dry prairie (unpubl. rep., Guide to the Natural Communities of Florida, Fla. Nat. Areas Inventory and Fla. Dep. Nat. Resour., Tallahassee, Fla., 1990). Under this burn schedule, fire could be applied at any month of the year and at any return interval varying from 1–4 years, but the selection protocol dictates a higher probability of fire being applied during the lightening season rather than outside the lightening season, and at shorter (1–2 year) rather than longer (3–4 year) intervals.

Dispersal

Sparrow population density per burn unit changed each year as time post-burn changed (Fig. 1.). Population density increased during the first year post-burn, and decreased in subsequent years. The population density differences between burn regimes were most pronounced in the north burn unit, which was smallest and narrowest, and least pronounced in the south burn unit, which was largest. The difference was intermediate in the central burn unit, which was intermediate in size. Since the greatest change took place in the relatively narrow north burn unit where short dispersals or slight home range shifts could account for much of the change in population density, and magnitude of change decreased as surface:volume ratio of burn unit decreased, this suggests that Florida grasshopper sparrows have a relatively limited dispersal distance.

The Florida grasshopper sparrow is a colonial species, with widespread colonies of a few up to a few hundred individuals occurring throughout the species' range. Although habitat fragmentation is a reasonable explanation for the sparrow's current distribution, colonies apparently were widely distributed at a time when the dry prairie was much more extensive. Nicholson (1936) reported that the sparrows formed scattered colonies sometimes 48 km apart, and did not breed throughout their range. Howell (1932) reported searching for the

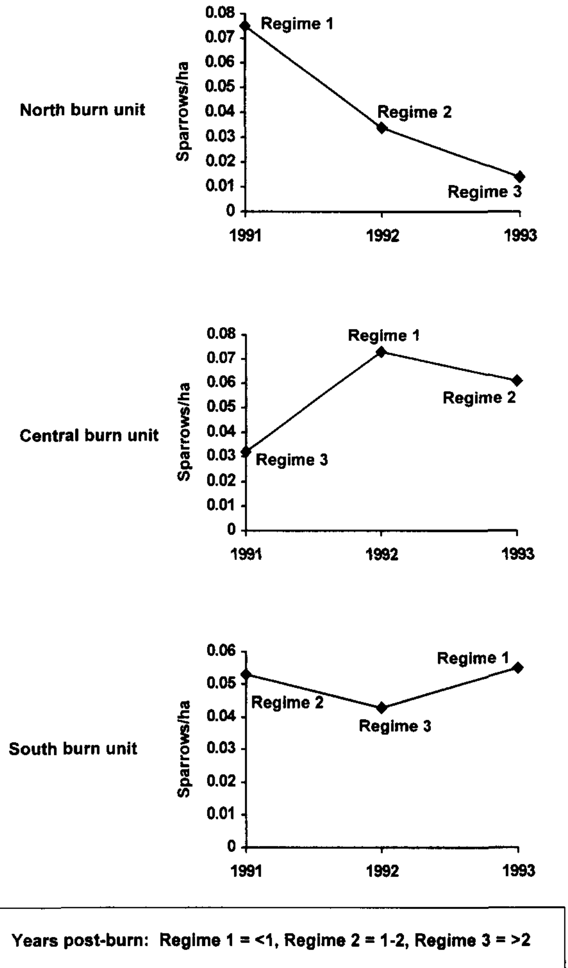

Figure 1. Relative population density of Florida grasshopper sparrows in units that were burned on a 3-year rotation at Three Lakes WMA from 1991–1993.

sparrow in prairie habitat but not encountering it. More recently, Delany and Cox (1985) searched 5 areas of apparent suitable habitat but found no sparrows. During the 3 years of this study, we found no sparrows on 2 other areas of apparently suitable habitat at Three Lakes WMA.

We surmise the following. First, since population density changed on Three Lakes WMA in response to burning, sparrows have a strategy that allows them to redistribute themselves over a limited area in order to capitalize on higher quality habitat resources. This strategy is probably the dispersal of juveniles just prior to age 1 as is true for numerous other species. Second, sparrow population density on the Three Lakes site responded to habitat quality change as 1 unit (when population density increased at 1 portion of the area, it decreased somewhere else). Therefore, we believe that grasshopper sparrows at Three Lakes

WMA form a single population. Third, although other seemingly suitable habitat occurred within relatively close proximity of the Three Lakes population, it was not colonized. The distances to these areas were less than the length of the area the Three Lakes population occupied, so distance alone must not be the factor preventing colonization. We suspect that there may be behavioral inhibitions to crossing areas of unsuitable habitat. The 2 unoccupied prairie sites at Three Lakes WMA are separated from the occupied site by forested and open water areas. Unwillingness to cross areas of unsuitable habitat could explain the distribution pattern of Florida grasshopper sparrows reported here and by earlier investigators. We believe that, although sparrows are able and willing to travel across marginal habitat to occupy better quality habitat (as was the case each year in response to burning), they are not willing to cross large areas of unsuitable habitat. If this is true, then spatially separated tracts of suitable habitat may never be colonized by Florida grasshopper sparrows through natural dispersal.

The Recovery Plan for the Florida Grasshopper Sparrow (U.S. Fish and Wildl. Serv. 1988) states that the subspecies may be considered for downgrading to threatened status if populations of 100–200 adults become established at 10 secure, discrete sites. This plan discusses relocation of captive-reared and wild sparrows into reintroduction areas as a strategy to achieve population recovery, but to date no reintroductions have been attempted. This study supports the recovery plan and suggests that relocation may be the only strategy for colonization of disjunct tracts of habitat.

Summary

This study indicates that Three Lakes WMA is composed of a single, stable population of at least 200 Florida grasshopper sparrows on a 2,374-ha dry prairie site. Population density changed within the site as habitat quality changed due to length of time post-burn. Grasshopper sparrows strongly preferred areas burned within 1 year, and avoided areas burned more than 2 years previously. Grasshopper sparrows did not colonize areas of apparently suitable habitat that were separated from the population by areas of unsuitable habitat. We recommend applying fire to Florida grasshopper sparrow habitat using a return interval that mimics the natural burn regime, although we suggest that artificial burn regimes may be appropriate for limited amounts of time for small, expanding grasshopper sparrow populations. We recommend experimental relocation of grasshopper sparrows to suitable unoccupied sites.

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