Florida Field Naturalist

PUBLISHED BY THE FLORIDA ORNITHOLOGICAL SOCIETY

VOL. 26, NO. 2 MAY 1998 PAGES 33-76

Florida Field Nat. 26(2):33-39, 1998.

NESTING HABITAT OF FLORIDA GRASSHOPPER SPARROWS AT AVON PARK AIR FORCE RANGE

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Abstract.—We examined nest sites (n = 20) of the endangered Florida Grasshopper Sparrow (*Ammodramus savannarum floridanus*) at Avon Park Air Force Range, Florida, from 20 May 1993 to 31 July 1996. Vegetation composition did not differ significantly (P = 0.47) between nest and non-nest sites. Vegetation density was significantly greater (P = 0.02) at nests (<1 cm) and lower (P < 0.072) at 1 m and 2 m from nests than at non-nest sites. The availability of clumps of dense shielding vegetation within low-density patches may be an important factor in nest site selection. Nest placement in clumps of dense vegetation may be an anti-predation strategy and ameliorate the microclimate at nests. Areas of low vegetation density near nests may facilitate adult access and provide an area for distraction displays. Range management via prescribed fire and cattle grazing may expand nesting habitat for some populations.

Grasshopper Sparrows (*Ammodramus savannarum*) are locally distributed in grasslands throughout most of the continental United States, from Mexico to Ecuador, and in the West Indies. Breeding bird surveys evince a decline in some populations caused by habitat degradation (Vickery 1996). The Florida subspecies (*A. s. floridanus*) was listed as endangered in 1986 (Fed. Reg. 1986).

Intensive management of grassland for cattle grazing and conversion of grassland to farmland are the greatest threats to *A. s. floridanus*. Structural characteristics of occupied and abandoned territories indicate the sparrow cannot adapt to habitat perturbations that remove potential nest sites (Delany and Linda 1994). Delany and Linda (1998) described Florida Grasshopper Sparrow nests, however, little information is available on Grasshopper Sparrow nest-site microhabitat (Vickery 1996). We examined habitat structure at Florida Grasshopper Sparrow nest sites and compared habitat variables with those at randomly chosen non-nest sites within the breeding territory.

STUDY AREA AND METHODS

Our study was conducted from 20 May 1993 to 31 July 1996 on the U.S. Air Force Avon Park Range in Highlands County, Florida. The 700-ha pyrogenic plant association of grass, forbs, saw palmetto (*Serenoa repens*), and shrubs was described by Delany et al. (1985). Cattle grazed the study area at one animal (cow and calf) per 8.7 to 28.3 ha. Cattle used pastures for ≤21-day periods followed by longer periods of exclusion. Pastures were burned with head fires (burned with the wind) between December and mid-March on a two- to three-year rotation.

The study area was systematically searched by walking transects at 50-m intervals. Observations of female Grasshopper Sparrows flushed from nests and delivering food to nestlings were used to locate nests. After each nesting attempt, we measured features of the vegetation composition and structure along transects oriented to the four cardinal directions from each nest. Point subsample and transect measurements at 1-cm, 1-m, and 2-m distances (12 per nest) included: (1) vertical density—the number of vegetation contacts with a 7-mm metal rod placed vertically into the vegetation; (2) height—the height of the highest contact with the rod; and (3) percentage cover—the cover by each of the vegetation components (grasses, forbs, shrubs, litter, and bare ground) as determined by counting the number of cm of each component along a 1 m subsection of transect adjacent to point samples. Nest shielding vegetation and time post-burn was recorded for all sample locations.

The same habitat variables were measured for locations in non-nesting areas within the breeding territory to compare nest sites to available habitat. The center of the territory was determined according to Wiens (1969) and was the starting point for two randomly oriented 25-m transects. Point subsamples (10/territory) were located at 5-m intervals along transects (Whitmore 1981).

A multiple analysis of variance (MANOVA) was performed to test the effects of distance from the nest on vegetation composition. A value of 0% for a vegetation component in the dataset was changed to 1%, and a generalized logit transformation was used for the vegetation component proportions (Aitchison 1986). Thus, in the MANOVA, the response vector for a given observation was:

$$\begin{bmatrix} \log\left(\dfrac{\text{percent shrubs}}{\text{percent grass}}\right) \\ \log\left(\dfrac{\text{percent forbs}}{\text{percent grass}}\right) \\ \log\left(\dfrac{\text{percent litter}}{\text{percent grass}}\right) \\ \log\left(\dfrac{\text{percent bare ground}}{\text{percent grass}}\right) \end{bmatrix}$$

A split-plot model was used, in which the main-plot factor was months post-burn (MONPOSTB), the main-plot error term was nest identification number within months post-burn NESTNUM(MONPOSTB), the sub-plot factor was distance from nest (DISTANCE), and the sub-plot error term was DISTANCE × NESTNUM(MONPOSTB). If the fixed effect interaction was clearly not significant ($P > 0.20$), then that term was deleted from the model and the reduced model was fitted.

Tests of the effects of distance from the nest on vegetation density (CONTACTS) and maximum height of vegetation contact (HTMAX) also were performed using the Box-Cox variance-stabilizing transformation for each of the variables. A univariate analysis was performed for each of these variables, in which the split-plot model was fitted using estimated generalized least-squares (EGLS) as implemented in PROC MIXED in the SAS System (SAS Institute, Inc. 1996). Approximate denominator degrees of freedom for the F tests were determined using the Satterthwaite approach (SAS Institute, Inc. 1996). Corrected treatment means in the original scale were obtained by back-transformation, and their standard errors were obtained by the delta method.

Vegetation characteristics at nest sites were compared with those at non-nest sites. Methods were similar to those described above, with the following modifications: a split-plot model was used in which the main-plot factor was months post-burn (MONPOSTB), the main-plot error term was NESTNUM(MONPOSTB), the sub-plot factor was type of area (TYPE), and the sub-plot error term was TYPE × NESTNUM(MONPOSTB). For the MANOVA of the vegetation components and for the univariate EGLS analysis of HTMAX, TYPE had two possible values: nest or non-nest. Since the EGLS analysis indicated that CONTACTS depended on distance from the nest (see Results), TYPE had four possible values for the univariate EGLS analysis of CONTACTS: nest at ≤1 cm, nest at 1 m, nest at 2 m, and non-nest.

All computations were performed using the SAS System (SAS Institute, Inc., 1990). In the following, least-squares means are denoted by $\hat{x}$, and the estimate of the standard error of the least-squares mean is denoted by $\hat{SE}$.

RESULTS

Twenty active nests (containing eggs or young) of grass construction were located on the ground in shallow (≤3.2 cm) excavations in the sand substrate. Most (15 of 20) were shielded by low (≤29.5 cm) clumps of dwarf live oak (*Quercus minima*) that provided concealment from above and the sides.

Although there was a significant months post-burn effect (P = 0.002), vegetation composition did not significantly change with distance from the nest (P = 0.19 for DISTANCE, P = 0.37 for MONPOSTB × DISTANCE). However, univariate EGLS analysis showed the number of vegetation contacts differed significantly ($P < 0.0001$) among distances, and distance effects did not depend on months post-burn (P = 0.84 for MONPOSTB × DISTANCE). Vegetation density was significantly higher within 1 cm of the nest ($\hat{\bar{x}}$ = 9.59, $\hat{SE}$ = 1.13) than at 1 m ($\hat{\bar{x}}$ = 5.00, $\hat{SE}$ = 0.59) and 2 m ($\hat{\bar{x}}$ = 6.34, $\hat{SE}$ = 0.75) distances ($P <$ 0.001 for each pairwise contrast). The number of contacts at 1 m from the nest was significantly lower than at the other two distances (P = 0.05 for 1 m vs 2 m) (Fig. 1). The maximum height of vegetation contact ($\hat{\bar{x}}$ = 30.89 cm) did not significantly change with distance from the nest (P = 0.12 for DISTANCE, P = 0.39 for MONPOSTB × DISTANCE).

Vegetation composition did not differ significantly between nest and non-nest sites (P = 0.47 for TYPE, P = 0.65 for MONPOSTB × TYPE) although there was a significant (P = 0.0004) months post-burn effect (Table 1). Univariate EGLS analysis showed the number of vegetation contacts differed significantly (P < 0.0001) among location

Table 1. Vegetation composition at Florida Grasshopper Sparrow nest sites and non-nest sites within breeding territories at different times post-burn, Avon Park Air Force Range, Highlands County, Florida, May 1993 to July 1996.

	Means (SE)					
	4 months post-burn		16 months post-burn		27 months post-burn	
	(n = 16)		(n = 1)		(n = 3)	
Vegetation component	Nest	Non-nest	Nest	Non-nest	Nest	Non-nest
Shrub cover (%)	24.0 (2.3)	21.3 (1.7)	6.4 (-)	9.7 (-)	16.2 (7.7)	8.7 (2.9)
Forb cover (%)	9.1 (1.0)	9.0 (0.8)	6.8 (-)	6.7 (-)	6.1 (1.7)	5.7 (1.7)
Litter cover (%)	6.3 (0.6)	7.5 (1.1)	7.9 (-)	8.3 (-)	12.9 (4.1)	9.3 (2.6)
Bare ground cover (%)	35.1 (2.2)	34.0 (1.7)	17.0 (-)	21.8 (-)	12.0 (3.5)	10.9 (5.0)
Grass cover (%)	25.4 (2.7)	28.2 (2.3)	61.9 (-)	53.5 (-)	52.7 (8.8)	65.4 (4.8)

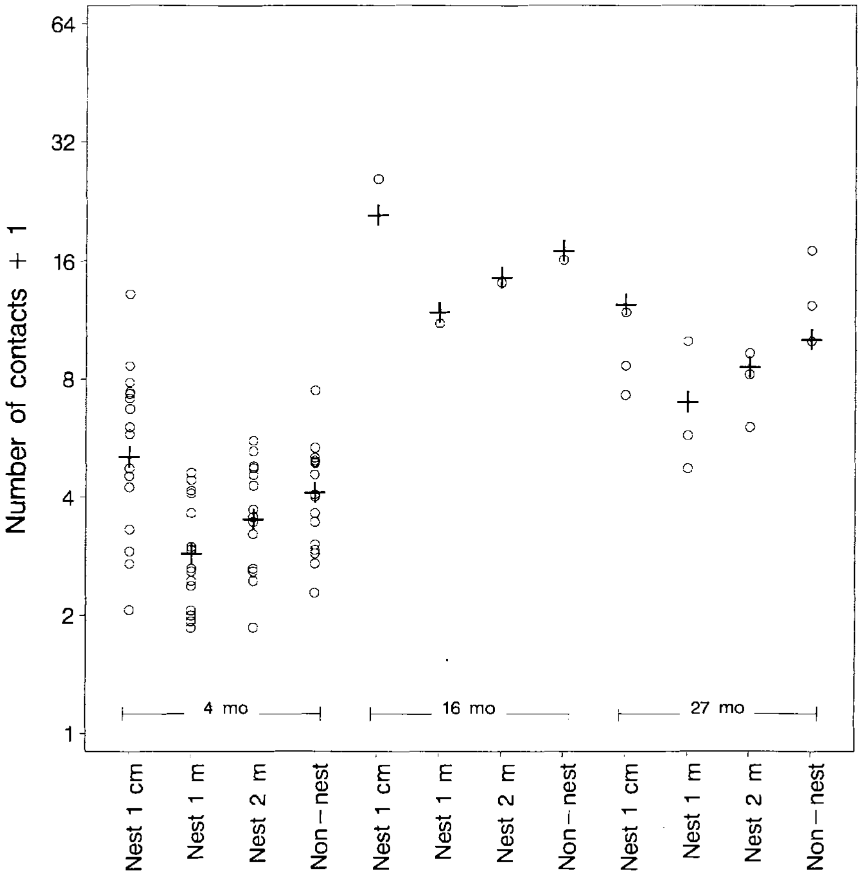

Figure 1. Plot of the number of vegetation contacts (density) for each unique months post-burn and type (nest site or non-nest site) combination. "+" symbols indicate the back-transformed least squares means based on the reduced split-plot model.

TYPES (nest at ≤1 cm, nest at 1 m, nest at 2 m, or non-nest), and those differences did not depend on MONPOSTB ($P = 0.18$). Vegetation density at non-nest sites ($\hat{\bar{x}} = 7.90$, $\widehat{SE} = 0.84$) was significantly ($P = 0.02$) lower than at ≤1 cm from nests, and was significantly higher than at 1 m ($P < 0.0001$) and 2 m ($P = 0.07$) from nests (Fig. 1). The maximum height of vegetation contact was significantly lower ($P = 0.02$ for TYPE, $P = 0.22$ for MONPOSTB × TYPE) at nest sites ($\hat{\bar{x}} = 29.05$ cm, $\widehat{SE} = 1.66$) than at non-nest sites ($\hat{\bar{x}} = 32.00$ cm, $\widehat{SE} = 1.73$).

DISCUSSION

The most important nesting component for Florida Grasshopper Sparrows was vegetation density. The availability of small clumps of dense vegetation (slightly more than nest diameter) within more open patches (≥4 m in diameter) was an important factor influencing nest site selection. Vegetation composition was not a significant factor in site selection. Patterns of vegetation structure and composition at nests appeared consistent despite significant successional changes related to time post-burn.

Nest sites often provide concealment that may reduce the risk of predation (Martin 1993) and ameliorate microclimate factors at the nest (With and Webb 1993). Florida Grasshopper Sparrow nest placement at the base of dense vegetation may have been an anti-predation strategy. Dense shielding vegetation also may provide thermal advantages. Grasshopper Sparrows are ground-dwelling birds that usually require >20% bare ground for unrestricted movement (Whitmore 1981). Low vegetation density within the nest patch may facilitate adult access. An exposed area near the nest also would allow a quick exit and make predator distraction displays (M. Delany pers. observ.) more visible.

Prairie grasslands in Florida are often altered for cattle grazing. Improved pastures are created and maintained by mechanical clearing and planting bahia grass (*Paspalum* sp.) and clover (*Trifolium* spp.) (Milleson et al. 1980). Prairies also are plowed and planted with bahia grass for sod production. Florida Grasshopper Sparrow preference for dense clumps of vegetation within more open patches may restrict nest placement. Breeding sites that had been converted to improved cattle pastures and sod fields lacked dense clumps of vegetation within more open patches and were abandoned by sparrows (Delany and Linda 1994). Unmanaged grasslands may develop into a dense successional stage that is also unsuitable for Florida Grasshopper Sparrows (Delany et al. 1985).

Managers of public lands occupied by Florida Grasshopper Sparrows use prescribed fire to maintain vegetation in a sparse, early successional stage associated with greater densities of sparrows (Walsh et al. 1995). Cattle grazing also affects grassland composition and structure, and may create conditions suitable for Grasshopper Sparrows at some locations (Bock and Webb 1984). The low stocking rates and short duration grazing on the study area seemed compatible with sparrow nesting requirements. However, measures of reproductive success are needed to determine habitat quality.

Breeding aggregations of ≥11 pairs of Florida Grasshopper Sparrows are known from only six protected locations. The sparrow could be reclassified as threatened if 50 pairs become established at each of 10 secure, discrete locations throughout its former range (USFWS 1988). A minimum viable population may require 240 to 1,348 ha of prairie grassland (Delany et al. 1995). Florida Grasshopper Sparrows appear to be responsive to habitat restoration (Delany 1996), and the creation of additional nesting habitat adjacent to occupied sites via prescribed fire and grazing may expand some populations.

ACKNOWLEDGMENTS

This study was funded by the Florida Nongame Wildlife Trust Fund. The U.S. Air Force allowed access to the study area and Natural Resources personnel at Avon Park Air Force Range provided assistance. C. S. Collins, T. F. Dean, D. K. Ford, L. N. Herrlinger, B. W. Mansell, B. C. Pranty, D. R. Progulske, Jr., M. D. Scheurell, and P. B. Walsh helped search for nests. T. L. Steele assisted with word processing. J. R. Brady, S. A. Nesbitt, J. A. Rodgers, Jr., P. D. Vickery, D. A. Wiedenfeld, D. A. Wood, and J. L. Zimmerman reviewed previous drafts.

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