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TERRITORY SIZE AND MOVEMENTS OF FLORIDA GRASSHOPPER SPARROWS

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Abstract.—Florida Grasshopper Sparrows (*Ammodramus savannarum floridanus*) (n = 73) were color-banded and monitored on the U.S. Air Force Avon Park Range in southcentral Florida, 1989–1992, to obtain information on minimum area requirements and movements of this endangered subspecies. Estimates (100% convex polygon) of 30 breeding territories averaged 1.8 ha (SD = 0.96) and ranged from 0.6 to 4.8 ha. The mean territory size (95% convex polygon) of mated males was not significantly (P = 0.159) greater than that of unmated males. Population density was 0.0371–0.0614 territories/ha. Adults were sedentary, 21 of 25 resighted or recaptured individuals occupied the same breeding territories for 2–4 successive years. The maximum territory size and minimum population density suggest a minimum viable population of 50 breeding pairs may require 240–1348 ha of prairie habitat. Information on the breeding biology and winter ecology of the Florida Grasshopper Sparrow is needed to assess recovery efforts.

TAMAÑO TERRITORIAL Y MOVIMIENTOS DE *AMMODRAMUS SAVANNARUM FLORIDANUS*

Sinopsis.—Entre 1989 y 1992 se marcaron 73 individuos de *Ammodramus savannarum floridanus* con anillas de color y se estudiaron en los terrenos de la Base Avon de la Fuerza Aérea de los E.U.A. en la zona sur central de la Florida. El objetivo fue obtener información sobre los requisitos minimos de área y sobre los movimientos de esta subespecie en peligro de extinción. Estimados (polígonos 100% convexos) de 30 territorios reproductivos promediaron 1.8 ha (SD = 0.96) y variaron entre 0.6 y 4.8 ha. El tamaño territorial promedio (polígonos 95% convexos) de machos apareados no fue significativamente (P = 0.159) mayor que los de machos sin aparear. La densidad poblacional fluctuó entre 0.0371 y 0.0614 territorios/ha. Los adultos fueron sedentarios, 21 de 25 individuos redetectados o recapturados anidaron en los mismos territorios por 2 a 4 años consecutivos. El tamaño territorial máximo y la densidad poblacional mínima sugieren que una población viable mínima de 50 parejas requeriría entre 240 y 1348 ha de praderas disponibles. Se necesita información sobre la biología reproductiva y la ecología invernal de esta especie para establecer los esfuerzos pertinentes para recuperarla.

The Florida Grasshopper Sparrow (*Ammodramus savannarum floridanus*) is endemic to the southcentral prairie region of the state and during the breeding season (March–June) isolated from the eastern race (*A. s. pratensis*) by ≥500 km (American Ornithologists' Union 1957). As a result of its restricted distribution, loss of habitat and population decline, the Florida subspecies was classified as endangered in 1986 (Federal Register

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1986). No critical habitat was designated because suitable areas (Delany et al. 1985) appeared to be ephemeral due to successional changes, and it was thought that sparrows moved in response to range conditions (Delany and Cox 1986). Minimum area requirements and movements of *A. s. floridanus,* however, are not known. The subspecies could be reclassified as threatened if 50–100 breeding pairs become established at each of 10 secure, discrete sites throughout its former range, or delisted if 25 such sites are established (U.S. Fish and Wildlife Service 1988). We monitored individual movements within a breeding aggregation of Florida Grasshopper Sparrows to obtain basic information needed to manage this population (U.S. Fish and Wildlife Service 1988).

STUDY AREA AND METHODS

The study was conducted 21 Mar. 1989–27 Jun. 1992 on the 430-km^2 U.S. Air Force Avon Park Range in Highlands and Polk counties, Florida. The study area was a 700-ha prairie (27°38.08′N, 81°19.30′E) dominated by saw palmetto (*Serenoa repens*), dwarf oak (*Quercus minima*), pineland threeawn (*Aristida stricta*), bluestems (*Andropogon* spp.) and yellow-eyed grass (*Xyris* spp.); scattered cypress domes and small (<4 ha) hypericum (*Hypericum* spp.) ponds also occurred in the study area. The prairie was bordered by pine plantations, improved pastures (plowed and planted with non-native grasses), and freshwater marsh. The study area was grazed by cattle at 1 animal per 8.7–28.3 ha. Cattle grazed pastures for ≤21-d periods followed by longer periods of exclusion. Pastures were burned with a head fire (burned with the wind) on a 3-yr rotation between December and mid-March to enhance forage production.

Florida Grasshopper Sparrows (n = 73) were captured with mist nets and marked with an aluminum U.S. Fish and Wildlife Service band and a unique combination of two colored, plastic leg bands. Capture and banding activities were authorized by U.S. Fish and Wildlife Service permit No. 21980 and described by Delany et al. (1992). The sex of adult sparrows was determined during the breeding season (March–June) by the presence or absence of a cloacal protuberance. Age (juvenile, <1 yr old; or adult, ≥1 yr old) was determined by plumage (Smith 1968). Birds were released at the site of capture. Capture locations were plotted on 1:2400 aerial photographs. Explicit ground references (saw palmetto patches, fences and ditches) permitted accurate plotting (estimated to ≤2 m). The study area was systematically searched (according to Delany et al. 1985) during each breeding season to detect Florida Grasshopper Sparrows. Grasshopper Sparrows also were captured during 357 net hours (total hours × 18.3 m sections of mist net) between 20 Nov. 1991 and 13 Feb. 1992 to determine locations outside the breeding season.

Thirty breeding territories were represented by 21 color-marked males, eight of which were found in 2–3 consecutive years. Sparrows were observed for 1–4-h periods during all stages of the breeding cycle. Mating status was determined by the capture of a female within a territory or by the recurrent presence of a non-aggressive conspecific with the male.

Locations of undisturbed individuals were recorded at 5-min intervals to reduce the likelihood of bias in territory size estimation through autocorrelation of locations (Swihart and Slade 1985). Most territories (24) were visited weekly, and all were visited at ≤15-d intervals during April–June. Observations were made between sunrise and 1300 hours. Individual territories, as defined by Burt (1943) were determined by recording locations (69–134, $\bar{x}$ = 84) on the aerial photographs. Locations were digitized and converted to Cartesian (x, y) coordinates. Schoener ratios (Schoener 1981) tested for autocorrelation among consecutive locations. We calculated 100% convex polygon (Southwood 1966) estimates of territory size (ha) through use of Program Home Range (Ackerman et al. 1989). We calculated 95% convex polygon estimates to reduce the effect of possible outlying locations, and used a *t*-test on rank-transformed (Conover and Iman 1981) values to test for a difference in mean territory size with respect to mating status.

RESULTS AND DISCUSSION

Mated and unmated male Florida Grasshopper Sparrows defended territories, and boundaries were usually stable throughout the breeding season. Most adjacent territories were separated by ≥30 m of seemingly homogeneous habitat. Territories did not include trees, and sparrows avoided areas of even widely scattered (<1 tree/ha) pines (*Pinus* spp.). Territories near trees were ≥75 m from the edges of cypress domes or pine plantations. Singing perches on staggerbush (*Lyonia* spp.) and tarflower (*Befaria racemosa*) were ≤0.9 m above the surrounding vegetation and delineated most territory boundaries.

Sizes of 30 territories (100% convex polygon) averaged 1.8 ha (SD = 0.96) and ranged from 0.6 to 4.8 ha. The median territory size was 1.6 ha. Schoener (1981) ratios calculated for each sparrow indicated that locations were positively correlated ($\ell^2/r^2 \leq 1.05$) indicating that territory size may be underestimated (Swihart and Slade 1985). Successive locations were often an iteration of perch use, however, and autocorrelation probably cannot be avoided. Mean territory size (95% convex polygon) of mated males ($\bar{x}$ = 1.55 ha, SD = 0.09, N = 25) was not significantly (P = 0.159) greater than that of unmated males ($\bar{x}$ = 1.01 ha, SD = 0.48, N = 5). Annually, 26–43 territories were located on the study area (0.0371–0.0614 territories/ha).

Of 48 color-marked males, 25 individuals were resighted or recaptured, and 21 of these individuals occupied the same breeding territories during 2–4 successive years. Three movements from the previous year's breeding territory were 183, 366 and 570 m. The longest observed movement was by a male that moved 2.0 km from his natal site to a breeding territory the following spring. Outside the breeding season, two banded Florida Grasshopper Sparrows were recaptured on 23 Jan. 1992, 15 m and 135 m from their former breeding territories; and one banded on 13 Feb. 1992 was recaptured 274 m from his original location on 10 Jun. 1992.

The average territory size of *A. s. floridanus* was larger than estimates

for *A. s. pratensis* (0.81–1.38 ha) (Kendeigh 1941, Smith 1963, Wiens 1973) and population density was much lower than ranges (0.22–0.93 territories/ha) reported by Wiens (1973) and Whitmore (1979). Intraspecific differences in the territory size of grassland sparrows have been associated with features of vegetation structure (Reid and Weatherhead 1988, Wiens 1973) and may evince habitat quality (Wiens et al. 1985). Most sites occupied by Florida Grasshopper Sparrows are currently managed for cattle (Delany and Cox 1986), and burning is the most common practice used to improve prairie pastures for grazing (Lewis 1964). Variation in territory sizes and densities of Florida Grasshopper Sparrows may be related to changes in prairie physiognomy following fire (Delany and Cox 1986, Smith 1968) and have important management implications.

As we may have underestimated territory size, and "average values" should be viewed with caution (Wiens et al. 1985), our maximum estimate of 4.8 ha of treeless prairie should be allocated to sustain a breeding pair of Florida Grasshopper Sparrows. Thus, the recovery plan (U.S. Fish and Wildlife Service 1988) objective of a minimum viable population of 50 breeding pairs would require at least 240 ha of contiguous habitat. On the basis of the known population density, however, 814–1348 ha may be needed.

Recaptures outside the breeding season are consistent with the assumption that the Florida subspecies is non-migratory (Stevenson 1978). Prior evidence of a resident population was limited to two specimens (U.S. National Museum, Nos. 341353 and 341455) collected in January 1937 (R. B. Clapp, pers. comm.). Information on the breeding biology and winter ecology of the subspecies is needed to assess habitat quality and recovery efforts (U.S. Fish and Wildlife Service 1988).

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