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Territory Characteristics of Cassin's Sparrows in Northwestern Oklahoma

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ABSTRACT.—We examined Cassin's sparrow (Aimophila cassinii) territory characteristics in shrub-grassland in northwestern Oklahoma during the 2008 breeding season. We estimated Cassin's sparrow territory area using territory mapping and song playback. Additionally, we determined vegetation cover, and aspect within territories and at nonterritorial sites, at both small scale (214 ha) and large scale (4856 ha). Mean territory size was 0.55 ha. Territories were 1.8 × more likely to be on north aspects than expected. Additionally, territories had greater shrub [sand sagebrush (Artemisia filifolia)] cover than the surrounding landscape.

INTRODUCTION

Cassin's sparrows (Aimophila cassinii) have decreased at rates of 1.35% per y nationally and 2.30% per y in Oklahoma from 1966–2007 (Sauer et al., 2008). Dunning et al. (1999) suggested that Cassin's sparrows appear in high densities in suitable habitat, yet there is limited information regarding the breeding habitat of Cassin's sparrows. This is partially due to their extreme abundance fluctuations, lack of breeding site fidelity, and secretive migration patterns (Ruth, 2000). The lack of year to year site fidelity may be based on variable precipitation patterns in regions in which the species occurs (Andrews and Righter, 1992; Baumgartner and Baumgartner, 1992; and Gordon, 2000).

Cassin's sparrow breeding habitat consists of a shrub component which may include Artemesia sp., mesquite (Prosopis sp.), hackberry (Celtis spp.), rabbitbrush (Chrysothamnus sp.), and oak (Quercus spp.) (Ruth, 2000). Their numbers have generally been shown to be positively correlated to shrub cover and negatively correlated to bare ground (McLachlan, 2007; Rogers and Sexon, 1990; Doxon, 2005). Territory characteristics within shrublands are poorly documented for this species. Schnase (1984) found their mean territory size to be 2.6 ha in southern Texas (n = 21) and Ruth (2000) found ten territories per 40 ha plot in Arizona for an average of a territory every 4 ha.

Based on the need for more detailed data on the natural history of Cassin's sparrows, we evaluated physical and biotic properties of their territories in northwestern Oklahoma during 2008. We compared habitat characteristics within territories with characteristics at nonterritorial sites and at the larger landscape to investigate territory size and habitat use during the breeding season.

STUDY AREA

We conducted our study on a private ranch located at latitude 36.392793° and longitude −99.674557° in Ellis County, Oklahoma. The ranch covers 4856 ha. This site receives 55.9 cm of precipitation annually with a mean annual temperature of 15.3 C (Tyrl et al.,

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2008). It consists of sand sagebrush (*Artemisia filifolia*) mixed-prairie with sand sagebrush, and sand plum (*Prunus angustifolia*) as dominant shrubs. Shrub composition is patchy and grasses such as little bluestem (*Schizachyrium scoparium*), side-oats grama (*Bouteloua curtipendula*), blue grama (*B. gracilis*), and buffalograss (*Buchloe dactyloides*) occur throughout. Soils consist primarily of the Lincoln, Eda and Eda-Tivoli complexes. Topography varies from flat to rolling (Tyrl *et al.*, 2008). The area is moderately grazed annually by cattle.

METHODS

From 5 Jun.–22 Jun. 2008, we used territory mapping with song playback to estimate area of Cassin's sparrow breeding territories (Bibby *et al.*, 2000; Budnik *et al.*, 2000). This time period was chosen to avoid migrating birds, to ensure that birds detected were breeding within the study area. We used the Oklahoma Breeding Bird Atlas (Reinking, 2004) as a general reference of breeding chronology. We chose a 214 ha patch of sand sagebrush-dominated rangeland because preliminary surveys revealed this area to contain dozens of breeding pairs. The survey period stopped once the entire area had been completely mapped and all Cassin's territories determined (*i.e.*, 22 Jun. 2008). Within the study area, we conducted a survey by walking parallel transects moving west to east 100 m apart such that the entire area was covered. We surveyed 50 m on both sides of the transect using a compass. We recorded the location of each Cassin's sparrow detected that exhibited territorial behavior such as song or display flights. We also used song playback (Stokes Field Guide to Bird Songs, Boston, MA) to elicit a response along the transect lines, using an iPOD Shuffle portable MP3 player (MP3; Apple, Cupertino, CA) connected to a Radio Shack 40–1441 portable folding amplified speaker system (speaker; Radio Shack, Fort Worth, TX) to play Cassin's sparrow songs. Once a bird was detected, we moved the speaker backwards and around the perimeter of a possible territory until the male would not move any further towards the playback song. We visually marked territory boundaries using two observers with Global Positioning System (GPS; Garmin etrex Vista HCx Handheld GPS Unit, Garmin International, Olathe, KS) units and then moved in and recorded the precise locations of territory boundaries with the GPS units. GPS units were accurate within ± 3 m. An attempt was made to acquire points around the entire perimeter of the territory in order to calculate precise areas. We assigned each registration (UTM coordinates of location) a unique label. Bibby *et al.* (2000) recommended ≥ 2 registrations per territory on two separate visits. All territories included in our analysis had ≥ 4 registrations on at least two separate visits before inclusion into analysis of territory size. We defined a visit as a separate sample day ≥ 10 d apart from the previous sample day (Bibby *et al.*, 2000). We conducted the territory observations from 0700–1400 (Schnase *et al.*, 1991; Ruth, 2000): on mostly clear days with no precipitation, with winds <20 km h, and temperatures from 26–32 C. We assumed that males within a defined territory were the same individual from visit to visit.

After plotting registrations, it became apparent there were large areas within the study site where no Cassin's sparrows were detected that appeared to have similar habitat characteristics (sand sagebrush dominated grasslands). Within these unoccupied areas, we placed 18 random points (using GIS) to compare habitat characteristics between territories and nonterritorial sites. The number of nonterritorial points (18) was chosen based on variability in habitat characteristics we found between random points within the study area. In other words, adding additional points did not significantly change the variance of the data.

We used the convex hull selection in the XTools Pro extension for ArcView to construct minimal convex polygons (MCP) from registrations, and then calculated the area (ha) of

each polygon (territory). MCP was used because it fits straight lines over each point (registration) instead of the curved fit that is produced by a kernel estimator (Burgman and Fox, 2003). As we had actual territory boundaries rather than random observations that could occur anywhere within boundaries (we only took coordinates for boundaries), kernel estimations would have been biased larger than the actual defended territories. Therefore, when known boundaries can be determined, MCP is the appropriate technique.

We constructed a triangulated irregular network (TIN) file from the territory polygons using the GIS extension 3D analyst. Each sample point had an x, y coordinate and an elevation or z value. We connected the points by edges to form a network of nonoverlapping triangles that collectively represented the terrain surface. This allowed us to build aspect features around each point to evaluate potential topographic selection.

We collected vegetation data at each of the territories and nonterritorial sites within the study area, after all territory mapping was completed in late Jun. We used four 20 m line-intercept transects, radiating in each cardinal direction from the center of each territory and nonterritorial, point to describe shrub cover (cm) (Canfield, 1941). We chose 20 m based on the average size of the Cassin's sparrow territories. We then placed a 20×50 cm quadrat (Daubenmire, 1959) every 5 m along each of the four transects, per territory or nonterritorial site to measure cover. Therefore, for each point, there were 16 quadrats. We visually estimated percent canopy cover for each plant functional group (grass, forb, and shrub), litter (defined as any dead plant material covering the surface of the ground), and exposed soil (Daubenmire, 1959). Additionally, we measured maximum vegetation height (cm) at each quadrat with a steel measuring tape as an index of vertical structure.

We had access to vegetation data from 15 stratified random points from across the ranch from a concurrent study. This allowed us to compare habitat within the 214 ha area with the larger landscape (4856 ha). We include this comparison due to the fact that while the landscape is a mixed-grass prairie, smaller discrete patches of sand-sagebrush shrubland are scattered within. These patches of sand-sagebrush are primarily related to soil type. By comparing territory selection of Cassin's sparrow within sand sagebrush to the surrounding landscape, we could elucidate both the coarse-scale plant community and micro-scale habitat selection. Recognizing 15 points represent a small sample size relative to the landscape, inferences were limited to only the most obvious and broad patterns. All vegetation measurements at these 15 points were similar to the methods described above.

We used confidence limits to compare and contrast means from territories and random points. Nonoverlapping 95% confidence intervals are a conservative homologue of statistical significance (i.e., $\alpha < 0.05$; Payton et al., 2003). We compared all habitat characteristics between territories and nonterritorial sites within the 214 ha study area. We additionally compared vegetation measures between the landscape points and both territories and nonterritorial sites.

RESULTS

We detected 62 Cassin's sparrow territories in the 214 ha study area (one territory every 3.45 ha). However, only 52 of these territories had sufficient registrations for calculation of territory size. The mean number of registrations was 4.8 per bird. Mean territory size for the 52 territories was 0.55 ha (SE = 0.04; range = 0.17–1.23 ha; 95% CI = 0.47–0.63 ha; n = 52). Most territories (71%) were clustered together with shared boundaries. The area occupied by these clustered territories accounted for only 11% of the total study site (214 ha scale).

Cassin's sparrows were found to occur more frequently on north aspects (39%), as opposed to south aspects (29%), east aspects (23%), west aspects (3%), or areas with little

TABLE 1.—Means and 95% upper (UCL) and lower (LCL) confidence limits for vegetation attributes in territories of Cassin's sparrows (n = 62), nonterritorial sites (n = 18), and random points in the landscape (n = 15), northwestern Oklahoma, summer 2008

	Territory			Nonterritorial			Landscape		
Variable	$\bar{x}$	LCL	UCL	$\bar{x}$	LCL	UCL	$\bar{x}$	LCL	UCL
Cover (%)									
Shrub	36.0	33.2	38.8	34.9	28.7	41.0	12.0	1.8	22.2
Grass	36.9	33.1	40.9	41.9	34.8	49.0	30.0	24.7	35.2
Forb	11.1	9.8	12.3	12.5	9.4	15.5	15.8	9.5	22.1
Bare ground	28.0	24.7	31.2	24.8	17.9	31.7	49.5	39.8	59.2
Maximum herbaceous Plant height (cm)	62.7	59.5	65.9	62.3	53.9	70.7	58.4	48.4	68.4

relief (7%). The study site contained 54% southerly aspects and only 21% northerly aspects; thus, territories were 1.8× more likely to be on north-facing aspects than expected.

Most vegetation characteristics were found to be statistically similar. An exception was mean shrub cover within territories, which was 3× greater than on the entire landscape, yet territories were similar to nonterritorial sites (Table 1). The difference between mean shrub cover on southerly and northerly aspects did not differ (Table 2). Mean grass cover for territories was similar to nonterritorial and landscape sites (Table 1). Likewise, mean grass cover was similar on southerly and northerly aspects (Table 2). Mean forb cover for territories was also similar to forb cover at nonterritorial sites and the landscape mean (Table 1). Further, means between southerly and northerly aspects were not different (Table 2). Mean bare ground in territories was similar to nonterritorial sites. However, mean bare ground at the landscape level was approximately twice as great as on territories or nonterritorial sites (Table 1). The difference in mean bare ground between southerly and northerly aspects was similar (Table 2). The mean maximum height of herbaceous vegetation in territories and nonterritorial sites and the landscape were also similar (Table 1). Further, maximum herbaceous height for territories with southerly aspects did not differ from territories with northerly aspect (Table 2).

Finally, while no attempt was made to detect Cassin's sparrows nests during this study, one nest was recorded during the territory mapping (Van Els *et al.*, 2009). This nest was parasitized by a brown-headed cowbird (*Molothrus ater*).

DISCUSSION

Cassin's sparrow territories in our study ($\bar{x}$ = 0.55 ha) were approximately 2.0 ha smaller than those reported by Schnase (1984). The Texas habitat [mesquite (*Prosopis glandulosa*)-mixed grass prairie] differed structurally from our study site, which was dominated by sand sagebrush, and neither study may be representative of the species across its range. However, the difference between territory sizes may be, at least partially, explained by methodology rather than habitat. Schnase (1984) used observations and a flushing method that involved following or pushing males until they turned back into their territory. Therefore, it is possible that territory size would be overestimated if birds overflew territory boundaries.

Territories typically were adjacent to each other with minimal interspace, and territorial conflict between males aided in boundary identification. In fact, clustered territories (≥3

TABLE 2.—Means and 95% upper (UCL) and lower (LCL) confidence limits for vegetation attributes in Cassin's sparrow territories on southerly (n = 18) and northerly (n = 24) aspects, northwestern Oklahoma, summer 2008

	Southerly			Northerly		
Variable	$\bar{x}$	LCL	UCL	$\bar{x}$	LCL	UCL
Cover (%)						
Shrub	39.5	34.2	44.8	33.8	29.9	37.7
Grass	36.7	29.0	44.3	36.7	30.4	43.0
Forb	10.5	8.5	12.4	11.9	9.3	14.7
Bare ground	26.6	20.7	32.4	29.7	23.4	36.0
Maximum herbaceous Plant height (cm)	64.7	59.0	70.4	63.1	58.1	68.1

territories with shared boundaries) accounted for 71% of the total number of territories in our study. We considered this as a possible semi-colonial nesting strategy. Williams and Le Sassier (1968) and Johnsgard (1979) also noted semi-colonial behavior by breeding Cassin's sparrow males. Due to the consistent territory defense of boundaries, we feel that our estimate of Cassin's sparrow territory size was representative for our sand sagebrush study area. However, as there is limited information for territory size for Cassin's sparrow, territory size both within and between various plant communities, caution should be exercised in extrapolating breeding density based on current research. Our data represent 1 y on one landscape and should not be overinterpreted, as we would expect there to be variation between years and locations.

Cassin's sparrows seemed to occupy northerly aspects in our study. A possible hypothesis for this observation would be southern facing aspects receive the most solar energy, which causes greater rates of evapotranspiration from soil and plants, leading to greater temperatures and lower soil moisture, when compared with northern facing aspects (Smith and Smith, 2001). This would be expected to result in differences in vegetation between aspects. However, this hypothesis was not supported by our data, as we observed trivial effects of aspect (north versus south) on habitat structure and composition (Tables 1 and 2). Our data indicated there was a substantial amount of habitat with similar vegetation characteristics that was not occupied by territorial males. In fact, the area occupied by the clustered territories (71% of all detected territories) accounted for only 11% of the total study site (214 ha scale). It is possible there exist some habitat variable we did not test, or Cassin's sparrows select for habitat differences, that are biologically relevant but not statistically significant given the data.

Finally, Cassin's sparrows in our study established territories in habitats that had more shrub cover (sand sagebrush) than the surrounding landscape. Other research has indicated shrubs are important to Cassin's sparrows (Ruth, 2000) and most data indicate increasing abundance with increasing shrub cover. Maintaining shrub communities on the landscape appears important to breeding Cassin's sparrows. Within this matrix, the mechanisms driving clustering of Cassin's sparrow territories remain unclear. Future research is needed to evaluate this territory clustering, as well as possible preferential selection of northern aspects within shrub communities.

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