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Effects of livestock grazing on bird abundance and vegetation structure in shortgrass prairie

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The shortgrass prairie ecosystem evolved under substantial grazing pressure by herbivores, such as bison (*Bos bison*), black-tailed prairie dogs (*Cynomys ludovicianus*), and, to a lesser extent, elk (*Cervus elaphus*) and pronghorn (*Antilocapra americana*). These species, particularly the bison and black-tailed prairie dog, have been largely removed from their former ranges in shortgrass prairie and replaced with domestic livestock. Milchunas et al. (1988) suggested that shortgrass prairie may have changed very little since the introduction of livestock because bison were simply replaced by cattle as the primary large herbivore. However, ecological differences between cattle and bison coupled with other changes to the landscape, such as the installation of fences, suppression of fires, and implementation of agricultural practices, have altered the shortgrass prairie ecosystem. Free-ranging bison probably influenced the shortgrass prairie ecosystem differently than present-day cattle that are confined by fences (Benedict et al. 1996). Unfortunately, information on the historic (pre-livestock) composition and structure of avian communities in the shortgrass prairie ecosystem is sparse and anecdotal. Grassland bird populations are currently undergoing widespread declines (Askins 1993; Knopf 1994). Information on avian responses to present-day grazing systems is needed by land managers wishing to sustain or increase bird populations on lands under their control.

Our goals were to determine the present avian community composition in a shortgrass prairie ecosystem, and to determine the effects of differing grazing regimes on this composition. We also wished to evaluate vegetation and insect responses to varying regimes of grazing, as both are of importance to nesting birds. Relatively few studies have examined the effects of livestock grazing on birds in shortgrass prairie (Wiens 1973a, 1973b; Graul 1975; Milchunas et al. 1988, 1998; Rotenberry and Wiens 1980; Ryder 1980), and most have not specifically studied the differential effects of various grazing regimes within a local area. The practice of incorporating diverse methods of grazing in adjacent or nearby pastures at the Rita Blanca National Grassland in Texas provided an ideal opportunity to compare the effects of different grazing regimes.

STUDY AREA

Our research was conducted April–July, 1996, at the Rita Blanca National Grassland in the northern portion of the Texas Panhandle. The Rita Blanca National Grassland is jointly managed with the Kiowa National Grassland, and both are administered by the Cibola National Forest. The two grasslands constitute 100,000 ha and are partially contained within New Mexico, Texas, and Oklahoma. Our study sites were located within Dallam County, Texas, 24 km east of the town of Texline and 10 km south of the Oklahoma border.

Much of the Rita Blanca National Grassland (hereafter referred to as the grassland) was plowed for cultivating crops prior to the Great Plains Dust Bowl (1933–1940), and, as a consequence, much of the topsoil has been lost or redistributed through erosion. The federal government purchased the land in the 1930s and ceased cultivating it in favor of restoring native vegetation. Today, the grassland has been re-vegetated with plant species that are indicative of the native shortgrass prairie ecosystem. Common plant species include broom snakeweed (*Gutierrezia sarothrae*), blue grama (*Bouteloua gracilis*), buffalograss (*Buchloe dactyloides*), wooly Indian-wheat (*Plantago purshii*), prairie coneflower (*Ratibida columnifera*), and green verbena (*Verbena wrightii*). The grassland is grazed by privately owned cattle under paid permits, and several different grazing systems (e.g., continuous grazing through the growing season and several variations of rotational grazing) are employed within the grassland.

We used eight 16.2-ha study plots within five management units on the grassland. Plots 0A and 0B were in Rita Blanca National Grassland Unit 32 (373 ha), which had not been grazed since 1992 and was not grazed for the duration of our study. Plots 1A and 1B were in Unit 34 (741 ha), which was grazed continuously by 100 cattle during the growing season (16 May to 15 October). Plots 4A and 4B were in units 24 (398 ha) and 25 (166 ha), respectively. These two units were being managed as one, using a 4-pasture rotational grazing system, where 140 cattle were moved together between pastures approximately every 30 days from 1 April to 30 September. Plots 8A and 8B were in Unit 23 (774 ha). This unit was managed as an 8-pasture rotational grazing system, where 190 cattle were moved together between pastures approximately every seven days from 1 April to 30 September.

METHODS

A total of 169 evenly spaced, numbered wooden stakes provided a grid system to serve as reference points for conducting vegetation surveys, insect surveys, and point counts. These stakes were short, 10–15 cm above ground, so as to be unobtrusive and not provide perches for raptors or other predators. The study plots were originally intended to serve as nest searching areas, but because of severe drought (see Discussion), few nests were found, and we report here only on bird abundance, vegetation structure, and insect abundance.

Nine 67-m fixed-radius point counts (Ralph et al. 1993, 1995) were conducted in association with each plot, once each in May and June. Five of the nine point count centers were located within the boundaries of each plot, one in the center and four near the corners. These were arranged so that count circles were nonoverlapping. In addition, to obtain a more representative sample of the entire management unit and increase the amount of area sampled, four additional 67-m fixed radius point counts were conducted outside the study plot boundaries but still within the same management unit. The locations of these additional point count centers were selected using random distances and compass directions (taken from a random numbers table) from the center grid point of each study plot. Each point count was initiated between 15 min post sunrise and 08:00, and was completed within 10 min. This procedure provided two replicates at each of 18 point-count stations per treatment group (grazing regime).

Vegetation height and density were sampled in late April, late May, late June, and late July. Twenty grid points on each plot were randomly selected using a random numbers table and used as reference points for sampling vegetation. The same 20 points were used during each sampling period. Samples were taken 1 m north, south, east, and west of each grid point. An aluminum rod of 0.63 cm diameter was held vertically by one person while another counted the number of contacts the vegetation made with the rod within three strata: < 10 cm, 10–30 cm, and > 30 cm (modified from Wiens 1969). The height of the tallest piece of vegetation within a 1-m radius of the grid point was also recorded.

Insects were sampled on each study plot during mid May, mid June, and mid July. Both sides of a 6.3-cm by 7.6-cm step-stake flag were coated with Tanglefoot brand, nontoxic insect-trapping adhesive before being placed at four evenly-spaced point count centers near the corners of each plot. Two of the flags on each plot were oriented east-west, while the other two were oriented north-south. Flags were collected between 22 and 26 h after being placed. Insects adhering to either side of the flag were counted and categorized by taxonomic order and size class (< 2 mm, 2–5 mm, 6–10 mm, and > 10 mm). Counts were adjusted as needed by multiplying the number of insects captured per hour in each category by 24 h to reduce sampling time bias. The mean size of all insects captured was calculated by multiplying the number of insects in each size category times the midpoint of that category (in mm), totaling the resulting figures from each category, and dividing by the total number of insects captured. An insect biomass index was then calculated for each plot by taking the mean size of insects captured times the mean number captured per trap.

Continuous variables were compared individually among treatment groups using analysis of variance (ANOVA), blocking by May and June replicates. Post hoc comparisons between treatments were conducted using least significant difference (LSD) tests (Snedecor and Cochran 1967).

Table 1. Species and number of individuals observed within four grazing treatments (see text) at Rita Blanca National Grassland, Texas.

Species	Ungrazed	4-Pasture	8-Pasture	Continuous	Total
Horned Lark	13[a]	21[b]	27	41[a,b]	102
Western Meadowlark	29[c]	18	29[c]	6[c]	82
Grasshopper Sparrow	6	7	1	0	14
Mourning Dove	4	0	2	0	6
Common Nighthawk	1	1	0	0	2
Killdeer	0	0	1	0	1
Total	53	47	60	47	207

[a]Within rows, $P \leq 0.05$; [b]within rows, $P \leq 0.10$.
[c]Ungrazed and 8-pasture differed significantly ($P = 0.06$) from continuous, although not from each other.

In contrast to accepted convention, we accepted statistical significance at a level below $P = 0.10$. All statistical analyses were carried out using the statistical package CSS (StatSoft, Inc. 1988).

RESULTS

We recorded 207 birds of six species during 144 point-counts (Table 1). Horned Larks (*Eremophila alpestris*) and Western Meadowlarks (*Sturnella neglecta*) made up 49% and 40% of the birds observed, respectively (Table 1). Sixty birds, the highest number recorded for any treatment group, were observed on the 8-pasture rotational grazing treatment, while the lowest number, 47, was observed on the 4-pasture and the season-long continuously grazed treatments. All treatments contained at least four bird species, except the continuously grazed treatment that contained only two species.

Two species of birds, Horned Lark (102), and Western Meadowlark (82), were recorded in sufficient numbers on the plots to allow comparison of treatments within species. While no significant patterns emerge from the comparison of all species combined, individual species did vary in relative abundance according to treatment type. Horned Larks were most abundant in the continuously grazed treatment, differing significantly ($P = 0.02$) from the ungrazed treatment and from the 4-pasture treatment ($P = 0.07$). Differences in the 8-pasture vs. 4-pasture treatments and the ungrazed vs. 8-pasture treatments were not significant ($P = 0.55$ and 0.18, respectively). Western Meadowlarks were most abundant in ungrazed and 8-pasture treatments, which differed in meadowlark abundance from the continuously grazed treatment ($P = 0.06$). Relative abundance in the 4-pasture treatment was intermediate.

The mean insect biomass index for May, June, and July on the eight plots was 48.8, 151.8, and 10.6, respectively. Ungrazed plots contained the highest mean insect biomass index of 83.4, while 4-pasture rotationally grazed plots contained the lowest mean index of 62.4. None of the differences in the insect biomass index were significant among treatments ($P > 0.21$).

The overall mean number of vegetation contacts (at height of < 30 cm) for all eight plots was 7.6. The highest mean number of contacts, 8.7, occurred on the ungrazed plots, while the lowest number, 5.9, occurred on season-long continuously grazed plots, with the 4-pasture and 8-pasture treatments being intermediate. The mean number of contacts in the < 10 cm stratum during May and June on ungrazed, 4-pasture, 8-pasture, and continuously grazed plots was 7.75, 6.08, 6.09, and 5.34, respectively. No differences between plots were significant in the < 10 cm stratum ($P > 0.18$). The mean number of contacts in the 10–30 cm stratum during May and June on ungrazed, 4-pasture, 8-pasture, and continuously grazed plots was 0.94, 0.46, 0.64, and 0.10, respectively. Continuously grazed and ungrazed treatments differed significantly ($P = 0.03$).

The mean maximum vegetation height was highest at 42.4 cm on the ungrazed plots and lowest at 23.2 cm on the continuously grazed plots. The overall mean maximum vegetation height was 32.7 cm. Mean maximum vegetation height in May and June on ungrazed, 4-pasture, 8-pasture, and continuously grazed plots was 42.44, 26.54, 24.50, and 21.18 cm, respectively. Mean maximum vegetation height in the ungrazed treatment was significantly different from that in the 4-pasture, 8-pasture, and continuously grazed treatments ($P < 0.01$).

DISCUSSION

Results of the vegetation sampling suggest that Western Meadowlarks are not responding to maximum vegetation height, since ungrazed and 8-pasture treatments showed equal abundance despite significant differences in maximum vegetation height. Likewise, Horned Larks are not responding to maximum vegetation height since relative abundance was similar on ungrazed and 4-pasture treatments that also differed significantly with regard to maximum vegetation height. Four-pasture, 8-pasture, and continuously grazed treatments did not differ significantly in terms of maximum vegetation height. Rotenberry and Wiens (1980) showed a strongly negative correlation between Horned Lark abundance and maximum vegetation height, due perhaps to a larger sample size, wider variety of habitat types sampled, and a different method of measuring this characteristic. They defined maximum height as the maximum decimeter interval in which vegetation contact occurred while conducting vegetation density index sampling with a vertically held rod, while we measured actual maximum vegetation height within a 1-m radius of each sampling point.

Horned Larks did respond positively to heavy grazing pressure, with a significantly higher relative abundance on the continuously grazed plots than on ungrazed plots, a response consistent with other studies in shortgrass habitat (Wiens 1973; Ryder 1980). Meadowlarks had an opposite response, being more abundant in treatments with no or light (i. e., short duration) grazing pressure, again consistent with Wiens' (1973) and Ryder's (1980) results.

The mean insect biomass index for the eight plots peaked in June and dropped dramatically by July. Differences in insect biomass index among plots were not significant and therefore may not have affected bird populations.

It is unknown what effects a drought may have had on bird and insect abundance on our study sites. From January through May 1996, nearby Dalhart, Texas, received only 4.6 cm of precipitation, about 30% of the 30-year average (1971–2000) of 15.5 cm for this same time period (J. Ashby, pers. comm). Western Meadowlarks and Grasshopper Sparrows showed declining trends of 17.5 % and 26.2 %, respectively, from 1995 to 1996 in the Breeding Bird Survey Staked Plains physiographic region in which our study sites were located (Sauer et al. 1997). Lark Buntings (*Calamospiza melanocorys*) were nearly absent from U.S. Fish and Wildlife Service Breeding Bird Survey Routes in areas near Rita Blanca National Grassland where they had been abundant in previous years, and showed a 77 % decline from 1995–1996 in U.S. Fish and Wildlife Service Region 2, which includes our study sites (Sauer et al. 1997). George et al. (1992) noted reduced species richness, reduced species diversity, and reduced total grassland bird density in mixed grass prairie of western North Dakota during a severe drought year, although, as noted above, avian responses to grassland habitat disturbance may vary among regions. However, we suspect that the severe drought during our study may have affected the results.

The point count data provide some useful information for land managers wishing to enhance habitat for grassland bird species. The grazing regime in use does influence the relative abundances of some passerine species using shortgrass prairie habitat. The responses to particular regimes are species-specific and may be opposite for different species (e.g., Western Meadowlark and Horned Lark). Thus, if managing for diversity of grassland bird species is a priority, then providing the mosaic of habitats produced by varying grazing regimes across a landscape will be important.

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LITERATURE CITED

Askins, R. A. 1993. Population trends in grassland, shrubland, and forest birds of eastern North America. *Curr. Ornithol.* 11:1–34.

Benedict, R. A., P. W. Freeman, and H. H. Genoways. 1996. Prairie legacies—mammals. In: Prairie conservation (F. B. Samson and F. L. Knopf, eds.), pp. 149–160. Island Press, Washington, D.C.

George, T. L., A. C. Fowler, R. L. Knight, and L. McEwen. 1992. Impacts of a severe drought on grassland birds in western North Dakota. *Ecol. Appl.* 2:275–284.

Graul, W. D. 1975. Breeding biology of the Mountain Plover. *Wilson Bull.* 87:6–31.

Knopf, F. L. 1994. Avian assemblages on altered grasslands. Stud. Avian Biol. 15. Cooper Ornithological Society.

Milchunas, D. G., O. E. Sala, and W. K. Lauenroth. 1988. A generalized model of the effects of grazing by large herbivores on grassland community structure. *Am. Nat.* 132:87–106.

Milchunas, D. G., W. K. Lauenroth, and I. C. Burke. 1998. Livestock grazing: animal and plant biodiversity of shortgrass steppe and the relationship to ecosystem function. *Oikos* 83:65–74.

Ralph, C. J., G. R. Geupel, P. Pyle, T. E. Martin, and D. F. DeSante. 1993. Handbook of field methods for monitoring landbirds. Gen. Tech. Rep. PSW-GTR-144. Pacific Southwest Research Station, Albany, CA.

Ralph, C. J., J. R. Sauer, S. Droege, eds. 1995. Monitoring bird populations by point counts. Gen. Tech. Rep. PSW-GTR-149. Pacific Southwest Research Station, Albany, CA.

Rotenberry, J. T. and J. A. Wiens. 1980. Habitat structure, patchiness, and avian communities in North American steppe vegetation: a multivariate analysis. *Ecology* 61:1228–1250.

Ryder, R. A. 1980. Effects of grazing on bird habitats. In: Management of western forests and grasslands for nongame birds (R. M. Degraff and N. G. Tilghman, eds.), pp. 51–66. U.S. Forest Service Gen. Tech. Rep. INT-86.

Sauer, J. R., J. E. Hines, G. Gough, I. Thomas, and B. G. Peterjohn. 1997. The North American Breeding Bird Survey results and analysis. Version 96.4. Patuxent Wildlife Research Center, Laurel, MD.

Snedecor, G. W. and W. G. Cochran. 1967. Statistical methods. 6th ed. Iowa State Univ. Press, Ames, IA.

StatSoft, Inc. 1988. CSS: complete statistical system with data base management and graphics. StatSoft Inc., Tulsa, OK.

Wiens, J. A. 1969. An approach to the study of ecological relationships among grassland birds. *Ornithol. Monogr.* 8:1–93.

Wiens, J. A. 1973a. Pattern and process in grassland bird communities. *Ecol. Monogr.* 43:237–270.

Wiens, J. A. 1973b. Interterritorial habitat variation in Grasshopper and Savannah Sparrows. *Ecology* 54:877–883.

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