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Temporal Effects of Grazing Regimes on Non-Game Birds in North Dakota Grasslands

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Abstract

Grazing occurred naturally in the northern Great Plains and influenced many natural processes in grassland ecosystems, including the habitat selection of breeding birds. Grazing, mainly for livestock production, is still an important land use practice and is one that impacts millions of hectares on both public and private land in the United States. To better understand how long-term grazing treatments affect non-game breeding birds, a study was conducted at the Central Grasslands Research Extension Center (CGREC) in south-central North Dakota during 2001 and 2002 and results were compared to two earlier studies, one in native prairie and the other in Conservation Reserve Program (CRP) grasslands. Season-long and twice-over grazing treatments were in place for 19 years on native prairie sites and 10 years on CRP sites. Bird surveys were conducted along permanent belt transects three times per year and vegetation structure was characterized from measurements taken parallel to each bird survey transect, twice per year for each treatment plot. Non-game bird densities and species richness during this study period were lower for all grazing treatments in native prairie and CRP grazing system grasslands when compared to earlier studies. Among grazing treatments, rotational grazing treatments supported more species and are probably more beneficial because they provide areas of undisturbed habitat during the breeding season. Results from this study suggest that some grazing practices on native or seeded grassland habitats can be applied for long-periods of time without negative effects on certain species of grassland non-game birds.

Keywords: grazing systems, non-game birds, North Dakota, CRP grasslands, mixed-grass prairie

Introduction

Traditional rangeland management practices typically involved the use of season-long grazing regimes, which for most species of upland nesting birds have been considered detrimental to their reproductive success (Kirsch and others 1978). In the 1970s and 1980s interest in specialized grazing systems increased because of their possible implications in improving range condition, wildlife habitat quality, and red meat production on private land (Barker and others 1990). Researchers working at the Central Grasslands Research Extension Center (CGREC) have investigated several grazing regimes to determine how they affected livestock production, range condition and wildlife use in grassland habitats. Conclusions from these studies suggest that specialized grazing systems can be used to mutually improve production of livestock, upland game, waterfowl (Sedivec and others 1990), and non-game bird breeding populations in native mixed-grass prairie (Messmer 1985, 1990) and Conservation Reserve Program (CRP) grassland tracts (Kennedy 1994). Results from these earlier studies suggest that some grazing regimes are not detrimental to most non-game bird populations and that these grazing system treatments may actually benefit many avian species that use grasslands (Messmer 1985, 1990; Kennedy 1994). However, knowledge is lacking on the long-term affects of these grazing regimes on avian populations.

Objectives

Messmer (1990) repeated his original study (Messmer 1985) after the grazing systems had been in operation for five to six years and suggested some possible changes due to the short-term temporal affects of grazing. To our knowledge there have been no investigations preformed on the long-term temporal effects of grazing systems on grassland birds on either native or tame grass rangeland. Our objectives were to determine if there have been any changes in vegetation structure characteristics or in avian populations due to the long-term temporal effects of grazing regimes in native mixed-grass and CRP grasslands.

Study Area

Two study areas were re-evaluated during this investigation to determine the temporal effects of grazing regimes. They included plots that were managed for grazing systems research in native mixed-grass native prairie on the CGREC (Messmer 1985, 1990) (Figure 1) and in CRP fields (Figure 2) near the CGREC (Kennedy 1994). Some of the grazing system treatments were slightly modified over the years, which is typical of privately owned rangelands. Private producers sometimes change grazing practices, such as stocking rates, to account for weather conditions (drought) and fluctuating herd sizes. Even though some of the grazing treatments were slightly modified, these sites still provided the opportunity to evaluate the long-term temporal effects of grazing regimes on bird populations under typical rangeland management and grazing regimes.

All native prairie plots used during this study were located on lands owned and/or managed by North Dakota State University as part of the CGREC. The idle (nonuse) areas were located on Waterfowl Production areas managed by the U.S. Fish and Wildlife Service's Klum Wetland Management District and Long Lake National Wildlife Refuge and all within 8 km (5 mi) of the CGREC. The CGREC is located about 14.4 km (9 mi) northwest of Streeter, North Dakota, along the border of Stutsman and Kidder counties. The CGREC is located on the Missouri Coteau, which is the largest area of hummocky collapsed glacial topography that occurs in North Dakota (Bluemle 2000). In all, this physiographic region covers about 25,584 km^2 (Higgins and others 1992), or just over 14% of North Dakota's land area. The Missouri Coteau area was formed as stagnate glaciers started melting away about 12,000 years ago, leaving deposited glacial till throughout the region (Bluemle 2000). Due to the large amounts of rocky debris deposited during this period, much of the Coteau region is not tillable, making grazing an important land use in the area.

The Missouri Coteau is well known for its importance to wildlife, especially breeding birds (Stewart and Kantrud 1972, 1973, Higgins and others 1992). Due to the fact that much of the land is not tillable, thousands of hectares of native prairie remain in the region. These prairie tracts in combination with numerous prairie potholes comprise many different critical habitat types used by numerous species of waterfowl, upland game birds, non-game birds, and shorebirds.

Vegetation characteristic of upland mixed-grass prairie at CGREC includes a variety of graminoids, forbs, and a few shrub species. Important graminoids include western wheatgrass (*Pascopyrum smithii* (Rydb.) A. Love), blue grama (*Bouteloua gracilis* (H.B.K.) Lag. ex Griffiths), Kentucky bluegrass (*Poa pratensis* L.), smooth brome (*Bromus inermis* Leyss.), needle-and-thread grass (*Hesperostipa comata* Trin. and Rupr.), green needlegrass (*Nassella viridula* Trin.), quackgrass (*Elymus repens* (L.) Desv.), little bluestem (*Schizachyrium scoparium* (Michx.) Nash), prairie Junegrass (*Koeleria macrantha* (Ledeb.) Schultes) porcupine grass (*Hesperostipa spartea* Trin.), and numerous sedges (*Carex* spp.) (Lura and others 1988, Messmer 1990). Forb components include fringed sage (*Artemisia frigida* Willd.), white sage (*Artemisia ludoviciana* Nutt.), silver-leaf scurf pea (*Pediomelum argophyllum* Pursh), white heath aster (*Symphyotichum ericoides* L.), dotted gayfeather (*Liatris punctata* Hook.), prairie coneflower (*Ratibida columnifera* (Nutt.) Woot. and Standl.), Canada anemone (*Anemone canadensis* L.), and goldenrods (*Solidago* spp.) (Lura and others 1988, Messmer 1990). The most dominant shrub species is western snowberry (*Symphoricarpos occidentalis* Hook.) with lesser amounts of prairie rose (*Rosa arkansana* Porter), and leadplant (*Amorpha canescens* Pursh) (Lura and others 1988, Messmer 1990).

The CRP demonstration project (Figure 2) is located about 3.2 km (2 miles) west of Streeter, North Dakota, and 8 km (5 miles) southeast of CGREC. These plots were planted in 1985 to a mixture of tall wheatgrass (*Elytrigia elongatum*), intermediate wheatgrass (*E. intermedium*), smooth brome, yellow sweet clover (*Melilotus officinalis*), white sweet clover (*M. alba*), and alfalfa (*Medicago sativa*) (Kennedy 1994).

Climate of the study area is characterized as a cool, subhumid continental type (Omodt and others 1968) with relatively long, cold winters and short, moderately hot summers. The long-term mean annual precipitation for the area is 44.73 cm (17.61 in), 80% of which occurs from April through September (Messmer 1985). Precipitation on the study areas varied between the two years of the bird study. Total precipitation at CGREC was 46.84 cm (18.44 inches) during the 2000–2001 crop year (1 Oct. – 30 Sept.) and 42.39 cm (16.69 inches) during the 2001–2002 crop year. Thus either year was slightly wetter or drier than the long–term average.

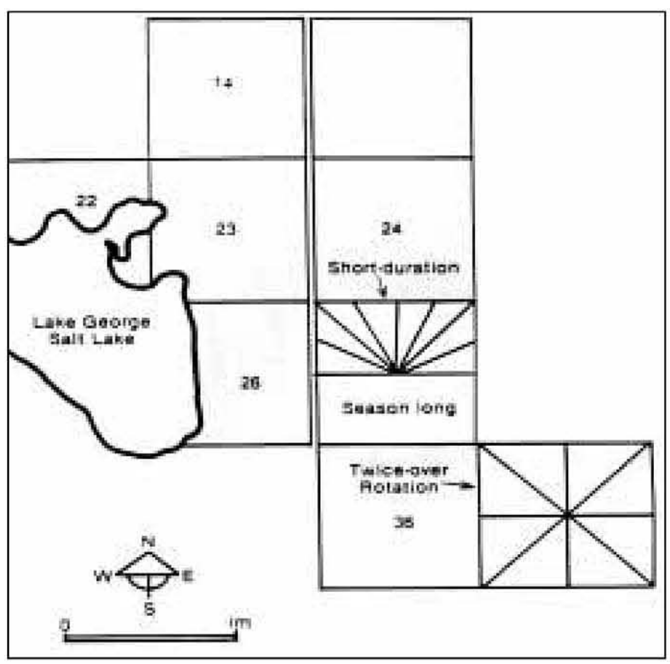

Figure 1. Spatial relationship between grazing treatments in native mixed-grass prairie at Central Grasslands Research Extension Center, Streeter, ND.

Native Prairie Grazing Systems

The two long-term grazing treatments studied by Messmer (1990) and us were the season-long and twice-over rotation grazing systems (Figure 1, Table 1). In the season-long grazing treatment, cattle were grazed continuously in one pasture throughout the grazing season. We researched two replications of a four-pasture, twice-over rotation grazing system (Figure 1). Each cell in this grazing system is grazed twice per year for 28 days and then rested for 56 days between rotations (Messmer 1990). The grazing season on these study plots began about mid–May each year. The season-long grazing treatments had been applied on the same plots for 20 years, since 1982 (Messmer1985) and the twice-over rotation grazing treatment, established in 1983, had been in place for 19 years (Messmer 1985).

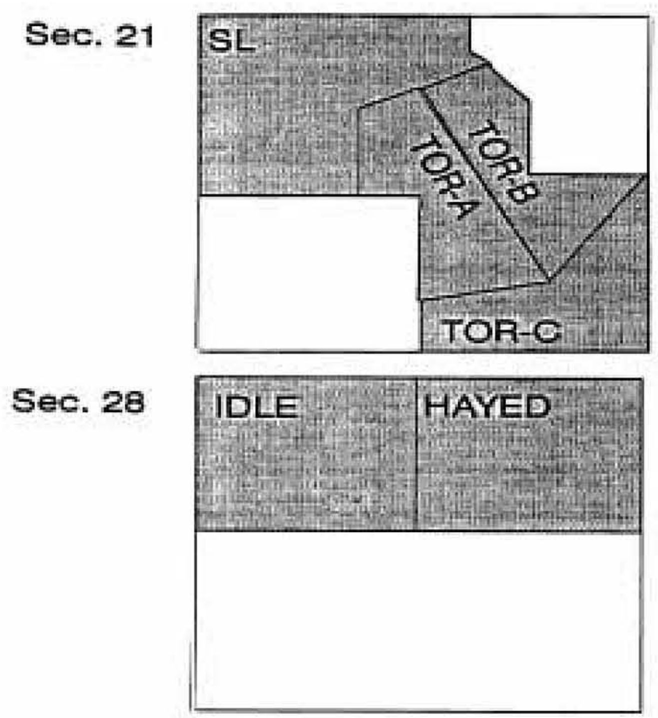

Figure 2. Spatial relationship among CRP Demonstration Project treatments near Central Grasslands Research Extension Center, Streeter, ND (Kennedy 1994).

CRP Study Area Grazing Systems

Treatments in the CRP study area included a twice-over rotation system, a season-long grazed pasture and an idle area. The CRP season-long grazing treatment (Kennedy 1994) has been managed similarly to the season-long treatment in native mixed-grass prairie since 1992 (ten years). A slight modification in the grazing regime occurred in the CRP twice-over rotation treatment. Between 1992 and 1997 each cell in the three-pasture, twice-over rotation system was grazed twice a year for 21 days with approximately 42 days of rest between rotations (Kennedy 1994). In 1998 this treatment was changed from a twice-over rotation system to a once-over rotation grazing system (Figure 2). During 1998 through 2002, each cell (n = 3) in the once-over rotation grazing system was grazed for an average of 23 days and then rested for the remainder of the grazing season. Cattle entry dates for CRP grazing treatments in 2001 were similar to entry dates during the early study period (1992 and 1993: Kennedy 1994), however, they were later (May 29) during the 2002 field season due to drought conditions. The length of the grazing season was also changed for both the season-long and rotational grazing plots. The grazing season was 126 days long during 1992 and 1993, whereas it was 78 days long in 2001 and 72 days in 2002. Stocking rates (AUMs) and utilization were fairly similar for native and CRP grasslands between the two study periods (Table 1).

Table 1. Treatment field sizes, mean stocking rates (AUMs/acre), and mean % herbage utilization by cattle in CRP (1992–2002) and native prairie (1983–2002) grasslands at the CGREC in southcentral North Dakota.

Grazing Treatment Type	Size of Treatment Grasslands ha (acres)	$\bar{x}$ Stocking Rates[A] AUMs/acre		$\bar{x}$ % Utilization	
		Earlier[B]	Later[C]	Earlier[B]	Later[C]
Native prairie					
Twice-over Deferred Rotation (4 cells)	130 (320)	1.1	0.9	54	53
Season-Long	130 (320)	1.1	1.0	54	56
CRP fields					
Twice-over Deferred Rotation (3 cells)	95 (235)	1.1	1.2	53	59
Season-Long	55 (135)	1.9	1.3	41	47

[A]The USDA (U.S.S.C.S. 1984) recommended stocking rate for native prairie is 0.9 – 1.2/AUMs/acre for Stutsman County, ND.
[B]Years 1983–1997.
[C]Years 2001–2002.

Methods

Habitat Structure

Vegetation structure surveys were conducted at 25 stations, spaced 8 m (26 ft) apart along transect lines, paralleling the permanent bird survey transects. Vegetation structure was characterized by measurements taken to the nearest quarter-decimeter on a modified Robel pole (Robel and others 1970, Higgins and Barker 1982). Visual obstruction readings were recorded at the point of 100% visual obstruction of the pole, at a distance of 4 m (13 ft) and a height of 1 m (3.3 ft) (Robel and others 1970). Readings on the Robel pole were recorded from each of the four cardinal directions around the pole. Other vegetation variables measured included heights of the tallest plant overall (any life form)

recorded to the nearest quarter-decimeter and litter depth was measured in millimeters. Vegetation variables other than visual obstruction were all recorded within a 30 cm (11.8 in) diameter of the Robel pole at each station.

Vegetation structure data were collected two times per year for each transect. The first sampling period of each year was conducted to characterize vegetation structure available to birds as they arrived on the breeding areas. The second sampling period was conducted to characterize the maximum vegetation structure available during the breeding season. To determine the temporal effects of grazing systems, data from this study were compared to data reported for mixed-grass prairie by Messmer (1990) and for CRP grasslands by Kennedy (1994). Data from early studies in the native mixed-grass prairie plots were taken from two different sources to get an idea of vegetation structure during that time period. Litter depth data were taken from Messmer (1990) and visual obstruction and tallest plant data were taken from Sedivec (1989).

Bird Surveys

Birds were surveyed in grasslands from sunrise until three to four hours after sunrise from 30 May to 27 June 2001 and 31 May to 3 July 2002 along 15 permanent (n = 3 for each treatment), systematically placed belt transects of fixed length (100 to 200 m or 328 to 656 ft) and width (100 m = 328 ft) (Wakeley 1987). Transects were placed more than 30 m (98 ft) from field edges and large obstacles (Arnold and Higgins 1986). We noted bird movements to avoid double counting. Transects were walked slowly (ca. 1 km/hr or 0.6 mi/hr) with frequent stops to identify birds by sight or sound. Counts were not completed when there was heavy to moderate rain, heavy fog, strong winds (> 10 km/ hour or 6.2 mi/hour), or extreme temperatures (< 7°C or > 24°C = < 44.6°F or > 75°F) (Mikol 1980). Bird surveys were repeated three times each season by rotating survey times for each transect. Transect bird data were used to determine species occurrence (presence/absence), species richness, and relative bird density (singing males and/or territorial pairs/100 ha [247 ac]).

Shannon-Wiener indices (Shannon and Weaver 1963) for species diversity (H'), and species evenness (J') were calculated for comparisons between grazing regimes and the early and late study periods. Species diversity (H') is highly correlated with species richness or as the species richness at a site increases the index value will increase. Species evenness (J') is a value between 0 and 1 and is a measure of how evenly the total bird numbers are distributed among the species present in the surveys; a value of 1 would indicate completely even distribution of numbers among all species present in the sample.

Results

Temporal Effects: Native Mixed-grass Prairie

Vegetation characteristics

When comparing mean visual obstruction values within each treatment between the early (Messmer 1990) and late (2001 – 2002) research periods, visual obstruction decreased slightly in the twice-over rotation grazing treatment and the idle treatment but mean values for the season-long treatments remained about the same (Table 2). Tallest plant mean values increased in all treatments from the early to the late study periods whereas litter depth mean values decreased for all treatments between the early and the late study periods (Table 2).

Bird populations

Some temporal differences in bird use of native mixed-grass prairie grazing-system study areas were apparent between the early (Messmer 1990) study period and the later study period (2001 - 2002) (Table 3). Differences in percent composition of non-game bird species were apparent between the study periods. The most common species occurring in belt transects during our study (2001 - 2002) were the clay-colored sparrow (*Spizella pallida*), grasshopper sparrow (*Ammodramus savannarum*), and chestnut-collared longspur (*Calcarius ornatus*), which comprised 33.7, 22.6, and 10.2% of the birds surveyed, respectively. The most common species reported by Messmer (1990) included the clay-colored sparrow, red-winged black-

Table 2. Differences in vegetation variable means between years in grazing system treatments in native mixed-grass prairies and CRP grasslands for Early (native mixed-grass, 1987–1989: Messmer 1990; and CRP, 1992–1993:Kennedy 1994) and Late (2001–2002) research periods at the Central Grasslands Research Extension Center, Streeter, ND.

Vegetation Variable	Treatment	Year	
		Early	Late
Mixed-grass Prairie			
VOR (dm)	Rotational	1.17	0.77
	Season-Long	1.15	1.17
	Short Duration	1.19	1.15
	Idle	2.25	1.90
Tallest Plant (dm)	Rotational	2.90	4.74
	Season-Long	2.90	4.81
	Short Duration	2.76	5.09
	Idle	4.18	6.05
Litter Depth (mm)	Rotational	95.00	32.00
	Season-Long	80.00	35.30
	Short Duration	80.00	34.73
	Idle	105.00	71.54
CRP Grasslands			
VOR (dm)	Rotational	1.57	1.13
	Season-Long	1.34	0.90
	Idle	1.98	2.37

bird (*Agelaius phoeniceus*) and grasshopper sparrow at 22.3, 15.0, and 14.4% of the non-game birds surveyed, respectively.

Messmer (1990) detected 22 non-game bird species during the duration of his study while we detected 19 non-game bird species during the 2001–2002 field seasons (Table 3). Shannon-Weiner species diversity (2.464 vs. 2.047) and evenness (0.797 vs. 0.683) indices were also greater during the 1987–89 study when compared to the 2001–02 study period (Table 3). Species richness values were lower for all treatments during the late study period than values from the early study (Messmer 1990) (Table 4). Avian species richness decreased by seven (n = 21 to n = 14) in the twice-over rotation treatment, by nine (n = 18 to n = 9) in the season-long treatment, and by eight (n = 18 to n = 10) in the idle treatment. Additionally, breeding bird densities decreased for all treatments from the early (Messmer 1990) to the late (2001–2002) study periods (Table 5).

Percent population composition of several individual bird species varied as a result of the temporal effects of grazing systems from the early (Messmer 1990) to the late (2001–2002) study periods (Table 6). This included several non-game bird species that have been reported to respond positively to grazing at heavier intensities including upland sandpipers (*Bartramia longicauda*), marbled godwits (*Limosa fedoa*), killdeer (*Charadrius vociferous*), common nighthawks (*Chordeiles minor*), and willets (*Catoptrophorus semipalmatus*). However, Shannon-Weiner diversity indices revealed that bird populations were more diverse in Messmer's (1990) when compared with our (later) study and were also more balanced in all but the season-long grazing treatment during the early study period.

Most bird species decreased in abundance from the early study period to the late study period. Few avian species increased in abundance between the two study periods and even then in only a couple of the treatments. Chestnut-collared longspurs increased substantially through time from 2.3 to 26.7% composition in the twice-over rotation grazing system treatment, clay-colored sparrows increased from 30.5 to 44.4% composition in the idle treatments, and savannah sparrow abundance increased slightly across all treatments (Tables 5).

Table 3. Temporal comparison of percent bird species composition and diversity indices in belt transects for all native prairie treatments combined at the Central Grasslands Research Extension Center, Streeter, ND during Early (1987–1989: Messmer 1990) and Late (2001–2002) survey periods.

Species	Percent Species Composition	
	Early	Late
Clay-colored sparrow (*Spizella pallida*)	22.3	33.7
Grasshopper sparrow (*Ammodramus savannarum*)	14.4	22.6
Chestnut-collared longspur (*Calcarius ornatus*)	0.7	10.2
Savannah sparrow (*Passrculus sandwichensis*)	2.0	6.9
Brown-headed cowbird (*Molothrus ater*)	8.7	7.1
Red-winged blackbird (*Agelaius phoeniceus*)	15.0	4.9
Western meadowlark (*Sturnella neglecta*)	5.5	3.7
Eastern kingbird (*Tyrannus tyrannus*)	1.8	2.8
Common yellowthroat (*Geothlypis trichas*)	8.2	1.8
Bobolink (*Dolichonyx oryzivorus*)	4.7	2.4
American goldfinch (*Carduelis tristis*)	0.0	0.6
Baird's sparrow (*Ammodramus bairdii*)	2.1	0.6
Common grackle (*Quiscalus quiscula*)	0.0	0.4
Willet (*Catoptrophorus semipalmatus*)	0.3	0.4
Yellow warbler (*Dendroica petechia*)	0.0	0.2
Western kingbird (*Tyrannus verticalis*)	0.0	0.2
Northern harrier (*Circus cyaneus*)	0.8	0.0
Upland sandpiper (*Bartramia longicauda*)	1.4	0.2
Marbled godwit (*Limosa fedoa*)	1.0	0.2
Killdeer (*Charadrius vociferus*)	0.8	0.0
Common nighthawk (*Chordeiles minor*)	0.2	0.0
Horned lark (*Eremophila alpestris*)	0.8	0.2
Lark bunting (*Calamospiza melanocorys*)	4.7	0.0
Yellow-headed blackbird (*Xanthocephalus xanthocephalus*)	1.4	0.0
Marsh wren (*Cistothorus palustris*)	0.6	0.0
Sedge wren (*Costothorus platensis*)	2.4	0.0
Unknown	0.0	0.8
Total Species Observed (Species Richness)	22.0	19.0
Species Diversity (Shannon-Weiner H')	2.464	2.047
Species Evenness (Shannon-Weiner J')	0.797	0.683

Table 4. Bird species richness from Early studies (Kennedy 1994; Messmer 1990) and Late studies (2001–2002) for grazing system treatments surveyed at Central Grasslands Research Extension Center, Streeter, ND.

Study Area	Treatment	Number of Species	
		Early	Late
CRP	Twice-over Rotation	9	7
	Season Long	6	5
	Idle	7	5
Native	Twice-over Rotation	21	14
	Season Long	18	9
	Idle	18	10

Temporal Effects: CRP Grasslands

Vegetation characteristics

Mean visual obstruction values decreased for both the season-long and the rotational grazing treatments in CRP grasslands

Table 5. Mean density (singing males and/or territorial pairs/100 ha) estimates from Early studies (Kennedy 1994; Messmer 1990) and Late studies (2001–2002) for grazing system treatments surveyed at Central Grasslands Research Extension Center, Streeter, ND.

Study Area	Treatment	Density	
		Early	Late
CRP	Twice-over Rotation	254.6	203.3
	Season Long	356.3	249.5
	Idle	228.5	296.6
Native	Twice-over Rotation	342.5	190.8
	Season Long	326.2	224.8
	Idle	321.0	250.1

Table 6. Temporal comparisons of percent species composition (singing males or territorial pairs/100 ha) and species diversity indices by different land-use treatments in native mixed-grass prairies for Early (1987–1989: Messmer 1990) and Late (2001–2002) research periods at the Central Grasslands Research Extension Center, Streeter, ND.

Species	Rotational Grazing		Season-long Grazing		Idle	
	Early	Late	Early	Late	Early	Late
Clay-colored sparrow	13.6	20.8	25.3	37.1	30.5	44.4
Grasshopper sparrow	18.8	32.2	24.5	26.0	1.3	14.4
Chestnut-collared longspur	2.3	26.7	0.6	7.4	0.0	0.0
Savannah sparrow	2.7	6.0	1.8	3.7	2.8	4.4
Brown-headed cowbird	12.4	3.8	7.1	0.0	4.3	2.2
Red-winged blackbird	14.3	0.5	13.1	7.4	14.0	12.2
Western meadowlark	4.9	0.7	6.1	3.7	4.3	0.0
Eastern kingbird	2.9	2.2	1.5	3.7	2.8	6.7
Common yellowthroat	2.4	0.0	5.7	3.7	15.6	4.4
American goldfinch	0.0	0.5	0.0	0.0	0.0	1.1
Bobolink	4.6	1.6	4.8	0.0	4.5	8.9
Baird's sparrow	4.4	1.6	0.9	0.0	1.4	0.0
Common grackle	0.0	1.0	0.0	0.0	0.0	0.0
Willet	0.8	0.5	0.2	0.0	0.0	0.0
Yellow warbler	0.0	0.0	0.0	0.0	0.0	1.1
Western kingbird	0.0	0.0	0.0	3.7	0.0	0.0
Northern harrier	0.5	0.0	0.0	0.0	2.0	0.0
Upland sandpiper	1.5	0.0	1.9	0.0	0.0	0.0
Marbled godwit	1.1	0.0	0.3	0.0	0.0	0.0
Killdeer	1.8	0.0	0.4	0.0	0.3	0.0
Common nighthawk	0.7	0.0	0.0	0.0	0.0	0.0
Horned lark	2.9	0.5	0.2	0.0	0.0	0.0
Lark bunting	5.3	0.0	4.4	0.0	0.9	0.0
Yellow-headed blackbird	2.0	0.0	0.0	0.0	2.8	0.0
Marsh wren	0.0	0.0	0.0	0.0	2.9	0.0
Sedge wren	0.3	0.0	1.2	0.0	9.7	0.0
Unknown	0.0	1.1	0.0	3.7	0.0	0.0
Species Richness	21.0	14.0	18.0	9.0	16.0	10.0
Species Diversity*	2.562	1.792	2.165	1.835	2.220	1.752
Species Evenness*	0.841	0.662	0.749	0.797	0.801	0.761

* Species diversity and species evenness indices are derived from the Shannon-Weiner H' and J' indices, respectively (Shannon and Weaver 1963).

between the early (Kennedy 1994) and late (2001–2002) study periods (Table 2). In comparison, visual obstruction mean values increased from the early to the late study period in the idle treatment, indicating a greater treatment effect by the season-long and once-over grazing treatments.

Bird populations

Temporal differences were apparent in avian species use of grazing systems in CRP grasslands between the early study period (Kennedy 1994) and our study period (2001–2002) (Table 7). The species with the highest percent composition were similar between the two studies; however, there were changes in rank order of these species. The most common species occurring in belt transects during our study (2001–2002) were the savannah sparrow (*Passrculus sandwichensis*), bobolink (*Dolichonyx oryzivorus*), grasshopper sparrow, and clay-colored sparrow, which comprised 30.2, 23.8, 20.6, and 16.7% of the birds surveyed, respectively. The most common species reported by Kennedy (1994) included the grasshopper sparrow, bobolink, and savannah sparrow at 50.2, 14.5 and 10.3% of the non-game birds surveyed, respectively. Total avian species richness values for all treatments combined decreased between the two study periods; Kennedy (1994) detected 11 non-game bird species during the duration of her study whereas we detected nine species of non-game birds during the 2001–2002 field seasons. However, species diversity and evenness indices increased from the early (Kennedy 1994) to later study periods.

Avian species richness decreased slightly for all grazing treatments from the early (Kennedy 1994) to the late (2001–2002) study period. Species richness decreased by two in the rotational (nine vs. seven) grazing treatment and the idle (seven vs. five) treatment and by one in the season-long (six vs. five) grazing treatment (Table 4). Mean breeding bird densities also decreased in the rotational and season-long grazing treatments, whereas they increased in the idle treatment (Table 5).

Changes in percent composition for several avian species were apparent between the two study periods (Table 8). Clay-colored sparrow percent composition increased in all three treatments, especially in the season-long and rotational grazing treatments between the two study periods.

Table 7. Temporal comparisons of percent species composition and species diversity indices of males surveyed in belt transects on CRP for all treatments combined during Early (1992–1993: Kennedy 1994) and Late (2001–2002) research periods at the Central Grasslands Research Extension Center, Streeter, ND.

Species	Percent Species Composition	
	Early	Late
Savannah sparrow	10.3	30.2
Bobolink	14.5	23.8
Grasshopper sparrow	50.2	20.6
Clay-colored sparrow	0.4	16.7
Red-winged blackbird	4.9	4.8
Brown-headed cowbird	8.4	0.8
Western meadowlark	8.6	0.8
Eastern kingbird	0.0	0.8
Western kingbird	0.0	0.8
Lark bunting	1.7	0.0
Common yellowthroat	0.2	0.0
Sedge wren	0.6	0.0
Yellow-headed blackbird	0.4	0.0
Unknown	0.0	0.8
Species Richness	11.0	9.0
Species Diversity (Shannon-Weiner H')	1.582	1.666
Species Evenness (Shannon-Weiner J')	0.660	0.723

Table 8. Temporal comparisons of percent composition and species diversity indices of males surveyed in belt transects in different land-use treatments on CRP fields during Early (1992–1993: Kennedy 1994) and Late (2001–2002) research periods at the Central Grasslands Research Extension Center, Streeter, ND.

Species	Rotational Grazing		Season-long Grazing		Idle	
	Early	Late	Early	Late	Early	Late
Savannah sparrow	12.4	25.3	11.6	37.9	1.1	37.9
Bobolink	8.1	25.0	15.9	10.3	33.7	34.5
Grasshopper sparrow	51.3	17.4	44.9	34.4	55.1	13.9
Clay-colored sparrow	0.0	20.5	0.0	13.8	1.1	10.3
Red-winged blackbird	5.0	8.8	7.3	0.0	1.1	0.0
Brown-headed cowbird	8.4	1.5	13.8	0.0	0.0	0.0
Western meadowlark	12.1	0.0	6.5	3.4	0.0	0.0
Eastern kingbird	0.0	1.5	0.0	0.0	0.0	0.0
Western kingbird	0.0	0.0	0.0	0.0	0.0	3.4
Lark bunting	1.7	0.0	0.0	0.0	4.5	0.0
Common yellowthroat	0.3	0.0	0.0	0.0	0.0	0.0
Sedge wren	0.0	0.0	0.0	0.0	3.4	0.0
Yellow-headed blackbird	0.7	0.0	0.0	0.0	0.0	0.0
Species Richness	9.0	7.0	6.0	5.0	7.0	5.0
Species Diversity*	1.540	1.663	1.544	1.358	1.098	1.358
Species Evenness*	0.701	0.855	0.862	0.844	0.564	0.844

* Species diversity and species evenness indices are derived from the Shannon-Weiner H' and J' indices, respectively (Shannon and Weaver 1963).

Savannah sparrow percent composition also increased in all treatments between the two study periods. Between the two study periods, bobolink percent composition increased in the rotational grazing treatment, whereas they were about the same in the season-long and idle treatments between the study periods. Percent composition of non-game birds making up less than 5% of the avian population was highly variable making it difficult to suggest how these treatments actually affected their use of these areas (Table 8). Likewise, species diversity index values (Shannon-Weiner H') were variable across the treatments and study periods (Table 8). However, the bird community was consistently more evenly distributed across species (Shannon-Weiner J' value) during the later study period for all treatments.

Discussion

Grazing regimes can vary in intensity, timing of grazing and the distribution of animals within the area being grazed, making it difficult to determine how grazing affects wildlife populations (Kirsch and others 1978). Although both increasing and decreasing temporal changes were detected among vegetation characteristics and avian populations within the mixed-grass prairie and CRP study areas, most species of grassland birds were still present in the later (our) study period. Temporal changes of avian species occurring within the native prairie plots were more evident than changes in the CRP study plots. Many of the non-game bird species that exhibited population declines between the two study periods included ones that prefer dense wetland vegetation in which to nest (red-winged blackbird, common yellowthroat [*Geothlypis trichas*], sedge wren [*Costothorus platensis*], those that have ephemeral distributions (lark bunting [*Calamospiza melanocorys*]), and several species who exhibited low or trace occurrence during the first study periods (upland sandpiper, killdeer, marbled godwit, horned lark [*Eremophila alpestris*], common nighthawk, and others). These differences account for the decrease in Shannon-Weiner diversity indices from the early to the late study period, but decrease in the indices may also be attributable to an overall decrease in habitat quality and complexity over the 10+ years between studies.

Several other species of upland nesting passerines also exhibited population fluctuations. However, not all of the declining population trends appear to be detrimental and could be due to natural distribution changes or nation wide population declines rather than to the affects of the grazing treatments. For example, according to Breeding Bird Survey data Baird's sparrows,

horned larks, and lark buntings exhibited significant declines of 5.8%, 8.1%, and 15.3%, respectively, in North Dakota between 1989 and 2002 (Sauer and others 2005). Our overall results indicate that the effects of grazing systems on non-game birds are not necessarily detected immediately, but some responses are more dependent on the length of time that these grazing regimes are in continuous operation.

Changes in vegetation structure were apparent within grazing treatments between the two study periods in native mixed-grass prairie. Vegetation height-density and litter depth are important characteristics of vegetation structure that are associated with many avian species. Our results suggest a negative relationship between litter depth and the temporal effects of grazing treatments for all native prairie grazing system plots. In comparison height-density (visual obstruction) decreased in the twice-over rotation and idle treatment during the treatment period but remained similar in the season-long treatment areas. Overall non-game bird relative densities and avian species richness values were lower during the late study period for all grazing treatments than values reported by Messmer (1990). The individual species of non-game birds that occurred in these grazing treatments responded to these changes in varying degrees within each treatment. Few species were absent during surveys when comparing data between the two study periods and ones that did not occur—yellow-headed blackbird (*Xanthocephalus xanthocephalus*) and marsh wren (*Cistothorus palustris*)—during the late study period could be responding to changes in wetland habitat (wetland abundance, water regime, vegetation structure) rather than to changes occurring due to grazing in the upland habitats.

Changes that occurred within CRP treatments were not as dramatic as changes in native prairie treatments. Vegetation height-density decreased in the two grazing treatments, while it increased in the idle treatment. Management changes in the CRP season-long and rotation-grazing treatments may have been responsible for some of the changes in vegetation structure and non-game bird use of these treatments.

Overall, even though species richness, species diversity, and mean density values decreased between the early and late study periods, these changes mirrored continental population trends for some grassland nesting birds (Sauer and others 2005). Additionally, the variability of grassland habitat conditions due to ecological successional changes coupled with regional drought/wet cycles will cause grassland bird populations to fluctuate widely on a regional basis (Johnson 2000). Therefore, the temporal effects of grazing regimes do not appear to be detrimental to the populations of non-game birds.

In order to maximize habitat potential for all species of non-game birds, it is important to provide an abundance of different habitat types on a landscape scale. This can be accomplished by idling some tracts of land while managing others with the use of grazing treatments or other means of disturbance (fire) for proper maintenance of grassland habitats.

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