Breeding Bird Community Composition in Patch-burn and Modified Twice-over Rotational Grazing Systems

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Upland Sandpiper (*Bartramia longicauda*)
Photo by T.J. Hovick

We are evaluating the effects of patch-burn grazing and twice-over rotational grazing management strategies on avian breeding community composition. The results demonstrate the distinct preferences for vegetation structure in the breeding bird community.

Although species such as the chestnut-collared longspur prefer the patch-burn treatment, the dense vegetation in other treatments was preferred by species that need shrubs and thick litter for breeding. Community diversity is highest in the patch-burn pastures compared with the season-long (without burning) and twice-over rotational grazing pastures. Here we present results following four years of study, from 2017 through 2020.

Introduction

Broad-scale threats to grassland birds include habitat loss, agricultural intensification and climate change (Hill et al., 2014; McCauley et al., 2017; Pool et al., 2014). However, at finer scales, patch area and local vegetation structure are important factors governing grassland bird communities (Hovick et al., 2015; Davis, 2004).

Specifically, diversity in vegetation structure mediates grassland bird density, abundance and diversity. These vegetation drivers are shaped by inherent (topoedaphic) and imposed (management-based) factors and their interactions.

The majority of remnant grasslands in the U.S. are privately owned and thus often undergo managed grazing by herbivores (Ribic et al., 2009). Many privately owned grasslands use a rotational grazing system designed to achieve a uniform foraging distribution (Briske et al., 2008). This minimizes selection by grazers and results in homogenization of vegetation structure and composition toward the middle of a disturbance gradient (Fuhlendorf and Engle, 2004). Consistent usage also mutes the effects of inherent heterogeneity on vegetation structure.

A loss of structural heterogeneity causes associated declines in the diversity and stability of breeding bird communities (Hovick et al., 2015). Uniform grazing pressure can reduce the occurrence of low vegetation patches on the landscape (Derner et al., 2008), which are important for migratory grassland species, most of which are insectivorous.

The absence of fire in grassland landscapes also can cause the expansion of woody cover. Many obligate grassland birds are less likely to use patches with woody vegetation due to declines in food resources and increased predation risk (Grant et al., 2004; Thompson et al., 2016).

The interaction of fire and grazing can prevent woody plant encroachment, as well as provide vegetation structure for grassland generalists and those that specialize on either end of the disturbance spectrum (Hovick et al., 2014; Ratajczak et al., 2012). Grasslands managed with patch-burn grazing are more likely to be source habitats for grassland birds and retain a higher temporal stability in community structure (Davis et al., 2016; Hovick et al., 2015).

In this study, we evaluate the impacts of patch-burn grazing on breeding season avian community composition and density. We evaluate the densities of grassland species in each treatment, as well as study changes in the structure of the community among treatments and through time. We compare patch-burn grazing with season-long grazing and twice-over rotational grazing, two traditional management practices in the area.

In addition, we want to evaluate the competing effects of topoedaphic and management heterogeneity on bird densities during the course of the treatment cycle. These results will enable managers to select a grazing system that will promote grassland bird conservation in a working landscape.

Procedures

Study Area

The Central Grasslands Research Extension Center (CGREC) is in Kidder and Stutsman counties of North Dakota (46° 42’ 56” N, 99° 27’ 08” W) in the Missouri Coteau ecoregion of the northern mixed-grass prairie. Native cool-season grasses such as green needlegrass *(Nassella viridula*), western wheatgrass (*Pascopyrum smithii*) and needle-and-thread grass

(*Heterostipa comata*) dominate the herbaceous community.

Common invasive grasses on site include Kentucky bluegrass (*Poa pratensis*) and smooth brome (*Bromus inermis*) (Patton et al., 2007). Western snowberry (*Symphoricarpos occidentalis*) is the dominant woody species at the CGREC, although silverberry (*Eleagnus commutata*) and wild rose (*Rosa arkansana*) are present.

The forb community is diverse and dominated by western ragweed (*Ambrosia psilostachya*), prairie coneflower (*Ratibida columnifera*), goldenrod (*Solidago* spp.), yarrow (*Achillea millefolium*) and Flodman's thistle (*Cirsium flodmanii*) (Rogers et al., 2005). The climate is characterized as temperate and experiences an average yearly rainfall of 40.28 centimeters (15.9 inches) and an average annual temperature of 4.94 C (40.9 F) (1991-2016, North Dakota Agricultural Weather Network).

Treatment Structure

Our treatment structure consists of four replicates, each consisting of a 160-acre pasture divided into eight subpatches. The treatments are: (1) season-long grazing (SLG), (2) season-long grazing with dormant season patch burning (one-fourth pasture) at a four-year return interval and (PBG40), (3) season-long grazing with dormant-season (one-eighth pasture) and growing season (one-eighth pasture) patch burning at a four-year return interval (PBG20), (4) modified twice-over rotational grazing (MTORG).

Annual burn plots in PBG20 are two adjacent 20-acre subpatches. Growing season burns are incorporated to increase forage quality for livestock in the middle of the season (Scasta et al., 2016). Fire return intervals mirror the historical disturbance regime of mixed-grass prairie.

Cow-calf pairs graze freely within pastures from May 1 to Oct. 1each year at a moderate stocking rate designed to achieve 30% forage utilization. Soil type and vegetation communities are similar among replicates, as defined by Natural Resources Conservation Service (NRCS) ecological site descriptions and equivalent land use histories. This is the first time that patch-burn grazing management has been practiced on this site, so a full round of treatments was not implemented until the 2020 season, allowing us to study the relative importance of heterogeneity from different sources.

T.J. Hovick, NDSU

Community Monitoring

From June 1 to July 15, we monitored the breeding season avian community in each of our experimental pastures. In each subpatch (one-eighth of a 160-acre pasture), we conducted a 150-meter (m) transect survey four times during the season (512 surveys/ year total). Each time a bird was detected, we recorded the species, sex and behavior of the bird, as well as the individual's straight-line distance from the transect. Detections greater than 50 m from the transect were censored from analysis.

Vegetation Monitoring

Along each community transect, we performed vegetation surveys. On each side of the transect, we measured the cover of vegetation functional groups using a 1- by 0.5-m quadrat and modified Daubenmire cover classes (20 quadrats/transect; Daubenmire, 1959). The cover of vegetation functional groups was recorded. Additionally, at each plot, a Robel pole was used to quantify visual obstruction in each cardinal direction (Robel, 1970).

Quantifying Inherent Heterogeneity

For each patch in the PBG20, PBG40 and SLG treatments, we evaluated topographic roughness, the topographic wetness index, which determines relative rates of inflow and outflow, and the dominant soil type (NRCS).

Statistics

We calculated the density of detected bird species using the R package *unmarked* (Fiske and Chandler, 2011). For each year/ species combination, we used AIC model selection procedures (Burnham and Anderson, 1998) to evaluate relative support for inherent heterogeneity models versus imposed heterogeneity models. We used this information to evaluate the impacts of management-based versus inherent heterogeneity.

We used vegetation and management to describe variation in avian community composition. Significance of environmental variables was assessed using permutational analysis of variance (PERMANOVA, McArdle and Anderson, 2001). We used transect-level densities to compare differences between treatments.

Table 1. Relative influences of inherent (topoedaphic) versus imposed (management) heterogeneity on six species of grassland birds across PBG20, PBG40 and SLG treatments from 2017 to 2020.

Species	2017	2018	2019	2020
Bobolink	TE	TRT	TRT	TRT
Chestnut-collared longspur	TE	TE	TE	TE
Clay-colored sparrow	TRT	TE	TRT	TRT
Savannah sparrow	TE	TRT	-	TE
Western meadowlark	-	TE	TRT	TRT
Grasshopper sparrow	TE	-	TE	TRT

TE indicates that topoedaphic (inherent) heterogeneity was the main component driving species density that year.

TRT indicates that treatment-imposed (patch-burn grazing versus season-long without burn grazing) heterogeneity is the strongest driver of density that year.

Cells filled with **dashes** indicate that neither source of heterogeneity was associated with species density.

Results

Density

We found variable responses in bird species density through time with respect to inherent and imposed heterogeneity. From year two onwards, bobolink (*Dolichonyx oryzivorus*) density was more strongly influenced by imposed heterogeneity (Table 1). Chestnut-collared longspur (*Calcarius ornatus*) density was structured by inherent topoedaphic heterogeneity across all years (Table 1).

Clay-colored sparrow (*Spizella pallida*) density was more strongly affected by treatment structure (Table 1). Savannah sparrow (*Passerculus sandwichensis*) density also was not consistently associated with imposed or inherent heterogeneity features (Table 1).

Western meadowlark (*Sturnella neglecta*) density was weakly structured by inherent heterogeneity at the beginning of the study period and weakly associated with imposed heterogeneity by the latter half of the study period (Table 1). Grasshopper sparrow (*Ammodramus savannarum*) density was not strongly associated with levels of inherent or imposed heterogeneity at the scale studied but was more sensitive to treatment effects by the time our full treatment structure was implemented (Table 1).


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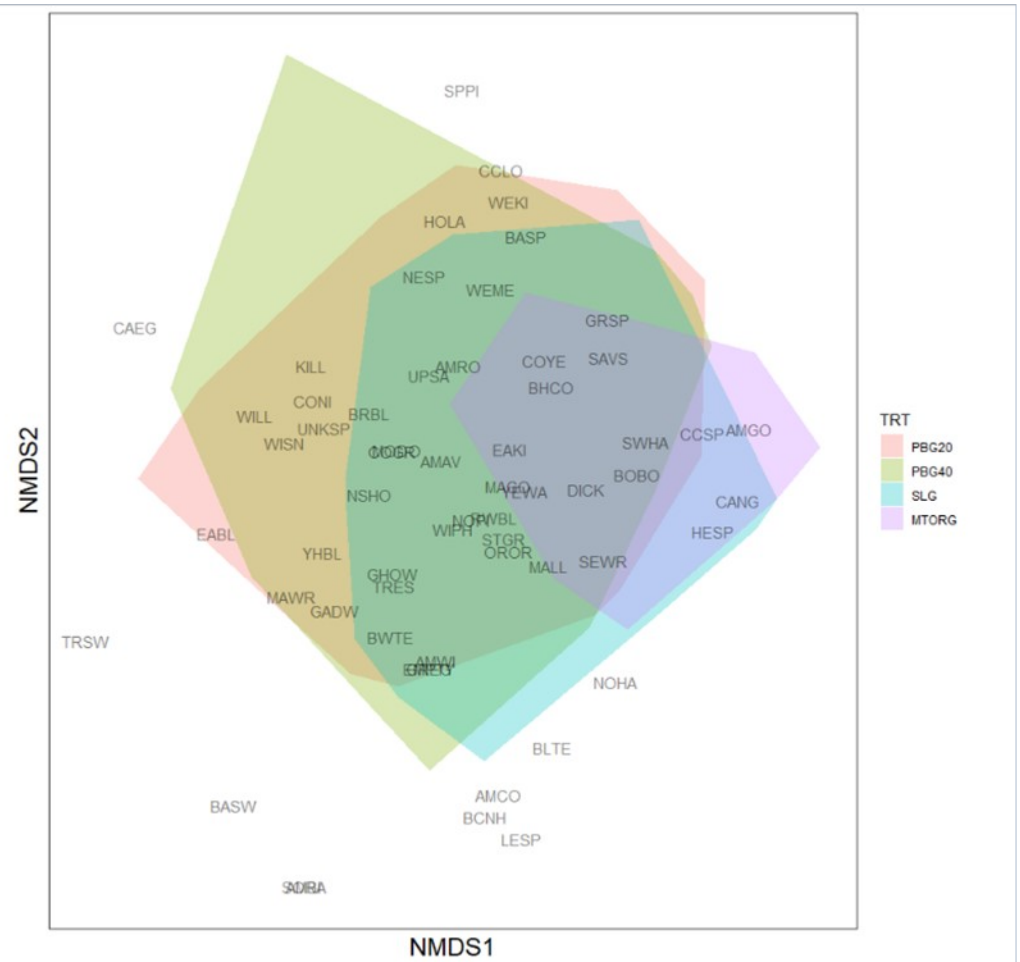

Figure 1. Nonmetric dimensional scaling (NMDS) ordination plot for abundances of grassland bird species in a landscape managed with patch-burn, season-long without burning and modified twice-over grazing treatments at the Central Grasslands Research Extension Center near Streeter, N.D. See Table 1 for species abbreviations.

Community

We see significant overlap in bird communities among treatments. However, the patch-burn communities are more diverse and variable than the SLG treatment, which is in turn more variable than the MTORG treatment (Figure 1). Detections of species by treatment are listed in Table 2 (next two pages).

Discussion

The results demonstrate the distinct preferences for vegetation structure in the breeding bird community. Although species such as chestnut-collared longspur prefer the patch-burn treatment, results also show that the dense vegetation in SLG and MTORG treatments are preferred by species that need shrubs and thick litter for breeding, such as bobolinks and clay-colored sparrows.

Community diversity is highest in the patch-burn pastures compared with the SLG and MTORG grazing pastures. We also see that treatment is the dominant source of heterogeneity affecting bobolink and clay-colored sparrow densities, while inherent landscape heterogeneity caused by topoedaphic features best explains chestnut-collared longspur density.

Together, these results suggest that a diversity of rangeland management strategies may be required to provide habitat structure for a full suite of grassland species, but patch-burn grazing management provides habitat for a diverse assemblage of breeding grassland birds on its own.

Table 2. Detections of species by treatment for patch-burn, season-long without burning and modified twice-over grazing treatments from 2017-2020.

Species	Code	PBG20	PBG40	SLG	MTORG
American avocet	AMAV	0	0	**3**	0
American bittern	AMBI	**1**	0	0	2
American coot	AMCO	**12**	2	0	0
American goldfinch	AMGO	3	1	3	**7**
American robin	AMRO	**6**	1	0	0
American wigeon	AMWI	0	0	**3**	**3**
Baird's sparrow	BASP	**1**	**1**	0	0
Barn swallow	BARS	0	0	**2**	0
Black-crowned night heron	BCNH	0	0	**2**	0
Brown-headed cowbird	BHCO	202	155	**380**	209
Black tern	BLTE	**21**	2	12	3
Bobolink	BOBO	60	61	**159**	83
Brewer's blackbird	BRBL	181	**344**	26	37
Blue-winged teal	BWTE	37	**46**	28	15
Cattle egret	CAEG	**6**	**6**	0	0
Canada goose	CAGO	0	0	**2**	1
Chestnut-colored longspur	CCLO	**108**	55	4	4
Clay-colored sparrow	CCSP	147	196	**345**	3
Common grackle	COGR	13	4	**38**	1
Common nighthawk	CONI	18	**20**	1	0
Common yellowthroat	COYE	9	6	**21**	0
Dickcissel	DICK	0	1	4	**18**
Eastern bluebird	EABL	0	0	**2**	0
Eastern kingbird	EAKI	24	**42**	37	20
Franklin's gull	FRGU	0	0	**2**	0
Gadwall	GADW	7	**14**	9	8
Great-horned owl	GHOW	0	0	**1**	0
Great egret	GREG	0	0	**1**	0
Green-winged teal	GWTE	0	0	**1**	0
Grasshopper sparrow	GRSP	257	**289**	268	98
Henslow's sparrow	HESP	0	0	**12**	0
Horned grebe	HOGR	0	0	**1**	0
Horned lark	HOLA	3	**6**	0	0

Bolded numbers are the treatment with the highest count. (*Continued on next page)*

Table 2 *(continued).* Detections by species by treatment for patch-burn, season-long without burning and modified twice-over grazing treatments from 2017-2020.

Species	Code	PBG20	PBG40	SLG	MTORG
Killdeer	KILL	31	**46**	16	8
LeConte's sparrow	LESP	2	0	**4**	1
Lesser yellowlegs	LEYE	0	1	**2**	0
Marbled godwit	MAGO	11	7	**16**	1
Mallard	MALL	**10**	8	5	8
Marsh wren	MAWR	9	3	**10**	0
Mourning dove	MODO	**9**	7	7	3
Nelson's sparrow	NESP	**1**	**1**	0	0
Northern harrier	NOHA	0	0	**4**	0
Northern pintail	NOPI	8	**17**	4	8
Northern shoveler	NSHO	**16**	11	6	3
Orchard oriole	OROR	0	2	**5**	0
Red-winged blackbird	RWBL	260	283	**331**	264
Ring-billed gull	RBGU	0	0	**1**	0
Ruddy duck	RUDU	**2**	1	1	0
Savannah sparrow	SAVS	101	**131**	109	96
Sedge wren	SEWR	5	2	**22**	8
Sora	SORA	**1**	0	0	0
Sprague's pipit	SPPI	0	**2**	0	0
Sharp-tailed grouse	STGR	3	5	**22**	6
Swainson's hawk	SWHA	0	0	**1**	0
Tree swallow	TRES	**10**	5	9	2
Upland sandpiper	UPSA	**21**	13	6	4
Western kingbird	WEKI	**4**	3	2	1
Western meadowlark	WEME	**139**	126	133	35
Willet	WILL	**11**	6	**11**	1
Wilson's phalarope	WIPH	5	**13**	2	4
Wilson's snipe	WISN	**12**	4	4	2
Yellow warbler	YEWA	0	0	**1**	0
Yellow-headed blackbird	YHBL	**43**	0	28	2
Total		1,830	1,949	**2,120**	1,330

Bolded numbers are the treatment with the highest count.

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Photos by Rick Bohn