Avian Nest Survival in a Patch-burn Grazing System

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We are evaluating the effect of a patch-burn grazing management strategy on avian nest success. Our treatment structure includes four replicates of the following: (1) season-long grazing, (2) season-long grazing with dormant-season patch burning (one-fourth of the pasture) at a four-year return interval and (3) season-long grazing with dormant-season (one-eighth of the pasture) and growing-season (one-eighth of the pasture) patch burning at a four-year return interval. Here we present preliminary results following three years of study.

Introduction

Common range management practices focus on even utilization of forage by grazers. This grazing strategy produces a homogeneous vegetation structure and composition centered on the middle of the disturbance gradient (Fuhlendorf and Engle, 2001). In contrast, grassland species have evolved with a shifting mosaic of disturbance through the interaction of fire and grazing (Fuhlendorf and Engle, 2004).

In intact disturbance regimes, grazers preferentially select for high-quality forage in patches regenerating after fire (Vermeire et al., 2003). Selection for newly burned areas by grazers releases unburned patches from grazing pressure, resulting in biomass accumulation. This, in turn, increases the propensity of unburned patches to carry fire and perpetuate the fire cycle (Fuhlendorf and Engle, 2004).

In fire-adapted rangeland systems, an intact natural disturbance regime creates heterogeneous vegetation structures across the landscape. This diversity in habitat conditions maintains or promotes biodiversity in plants, arthropods, small mammals and birds (Doxon et al., 2011; Fuhlendorf et al., 2006; Fuhlendorf et al., 2010).

Patch-burn grazing also increases the temporal stability of grassland avian communities (Hovick et al., 2015). Through a shifting mosaic of vegetation structure, the application of fire and grazing (hereafter, patch-burn grazing) can provide habitat for species relying on diverse aspects of the disturbance gradient to complete their life histories (Fuhlendorf et al., 2009).

Traditional range management can be especially limiting to avian species that rely on the vegetation structure characteristic of the far ends of the grazer utilization spectrum as part of their nesting strategy. Some examples include mountain plovers, which rely on sparse ground cover and Le Conte's sparrows, which use areas with thick litter as part of their nesting strategy (Graul, 1975; Hovick et al., 2014).

When using a traditional management strategy, managers often achieve uniform grazing pressure through fencing and rapid rotation of grazers (Briske et al., 2011). This increased intensity of use by grazers for short time periods increases the risk of nest trampling (Bleho et al., 2014; Churchwell et al., 2008).

Woody encroachment also threatens rangeland systems subject to an inactive disturbance regime. Woody species can increase the incidence of predation and cowbird parasitism and reduce nesting cues for grassland species (Archer et al., 2017; Klug et al., 2010; With, 1994).

In grassland avian species, woody encroachment has been shown to impact landscape-level species diversity and nesting success (Bakker, 2003; Coppedge et al., 2001; Sirami et al., 2009). Increases in grassland shrub cover also result in decreases in arthropod richness and abundance, which may impact the initiation timing and success of nesting attempts (van Hengstum et al., 2013).

We have been studying the use of experimental pastures by nesting birds during a time-since-fire gradient by monitoring nest success and density, as well as associated vegetation characteristics. Increases in within-patch homogeneity with accompanying heterogeneity between patches may create spatially explicit nesting habitat for a higher diversity of species, in turn creating more source habitat for grassland birds (Davis et al., 2016).

In addition, imposed heterogeneity should allow species to select for vegetation structure that maximizes nest success. Results will improve management of grassland bird species of conservation concern such as the grasshopper sparrow (*Ammodramus savannarum*), Sprague's pipit (*Anthus spragueii*) and upland sandpiper (*Bartramia longicauda*).

Procedures

Study Area

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

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 includes four replicates, each consisting of a 160-acre pasture divided into eight sub-patches. The treatments include: (1) season-long grazing (SLG), (2) season-long grazing with dormant-season patch burning (one-fourth of the pasture) at a four-year return interval (PBG40) and (3) season-long grazing with dormant-season (one-eighth of the pasture) and growing-season (one-eighth of the pasture) patch burning at a four-year return interval (PBG20).

Annual burn plots in treatment 3 are be two adjacent 20-acre sub-patches. Growing-season burns are incorporated to increase forage quality for livestock in the middle of the season (Scasta et al., 2016). Fire return intervals are designed to mimic the historical disturbance regime of mixed-grass prairie.

Cow-calf pairs graze freely within pastures from May 1 to Oct. 1 each 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 ecological site descriptions and equivalent land use histories.

Nest Searching

We designated a 4-hectare (ha) nest searching plot in each sub-patch (one-eighth of the pasture) for a total of 96 plots. We searched each plot four times from May 19 to July 15. We searched for nests via hand-dragging a 30-meter (m)-long rope with aluminum can bundles attached every 2.5m.

Upon flushing a bird, we searched the immediate area for a nest. If the bird displayed a nesting behavior, such as chipping, a broken wing display or a refusal to leave the immediate area, we marked the location and searched the area again within three days (Hovick et al., 2012). We recorded the coordinates of each nest, and flagged vegetation 5 m north and south of the nest to avoid the association between markings and nest by visual predators (Winter et al., 2003).

We candled two representative eggs from each nest to determine nest age (Lokemoen and Koford, 1996). We also assessed parasitism rates by brown-headed cowbirds (*Molothrus ater*) because cowbird parasitism may lower nest success in grassland species (Shaffer et al., 2003).

We monitored active nests every two to four days until depredation, completion or abandonment. We considered nests successful if at least one conspecific individual fledged.

Vegetation Monitoring

We standardized the collection date of all nest vegetation data to the actual or expected fledge date of each nest (McConnell et al., 2017). At each nest and at 5 m in each cardinal direction, we assessed the cover of vegetation functional groups using a Daubenmire frame and Daubenmire cover classes, as well as assessed visual obstruction and litter depth (Daubenmire, 1959; Dieni and Jones, 2003).

Statistics

We analyzed nest survival in the RMark interface (Laake, 2013). Daily nest survival was modeled using a logit function in a generalized linear model (Rotella et al., 2004).

For each species, we constructed a continuous model for daily survival, as well as a scale-based hierarchical model detailing the effects of vegetation and management (Dinsmore and Dinsmore, 2007; Hovick et al., 2012; Winter et al., 2003). The first model step evaluates the effects of cowbird parasitism, time since fire and incubation stage (laying, incubating or brooding).

The second step considers the effects of local (5 m) vegetation. The final modeling step includes nest-site vegetation measurements.

We used nonmetric dimension scaling to evaluate the divergence of avian nesting communities along a time-since-fire gradient using the VEGAN package in R (Oksanen, 2009). We used the anosim function to test for differences between time-since-fire groupings.

Results

During the past three years, we have monitored 1,421 nests in our treatment structure, totaling 29 species. Many species have similar numbers of nests among treatments (Table 1), but chestnut-collared longspurs prefer nesting in the patch-burn pastures. Future work will evaluate the effect of treatment structure on nest survival and patch-burn and nest-specific variables.

Daily Survival Rate

We were able to run nest survival metrics on every species with 20 or more nests per year (six species; Table 2). Blue-winged teal (*Anas discors*) had a constant daily survival rate of 0.96. This corresponds to a total survival rate of 0.38. Greater cover of woody vegetation at the nest site decreased overall survival.

Northern pintails (*Anas acuta*) also had a constant daily survival rate of 0.96, corresponding with a total survival rate of 0.39. Shrub cover enhanced nesting success at the microsite-scale and was decreased by bare ground cover at the nest site.

Clay-colored sparrows (*Spizella pallida*) had a daily nest survival rate of 0.94, corresponding with a total survival rate of 0.29. Their nest success was decreased by brown-headed cowbird parasitism and positively correlated with visual obstruction at the nest site.

Western meadowlark (*Sturnella neglecta*) daily nest survival was 0.95, with a total survival rate of 0.20. Western meadowlark survival was higher in the nestling stage, as well as in areas with a greater cover of smooth brome at the nest site and bluegrass at the microsite level. Nesting success decreased with increasing visual obstruction.

Brewer's blackbird (*Euphagus cyanocephalus*) daily survival probability was 0.95, corresponding to a total survival rate of 0.20. Their survival decreased during the course of the nesting season, and with brown-headed cowbird parasitism and nest-site cool-season grass cover. Nest survival increased with greater vegetation height.

Discussion

After three years of data collection, early results highlight the differences in preferred vegetation structure among grassland species. We discovered that new burns create habitat for blackbirds and is reflected in blackbird density and blackbird selection for unburned areas for nesting.

In upcoming years, additional times since fire will allow for bird species to exhibit selection for vegetation characteristics at an experimental patch level. We will test to see if patch contrast creates more niches for nesting and breeding birds and enhances abundance and diversity of birds, compared with traditional range management.

Chestnut-collared longspur (Calcarius ornatus) nestlings. Photo credit: C.A. Duquette

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Table 1. Summary of 2017-2019 nest sampling at the CGREC near Streeter, N.D.

Species	PBG20	PBG40	SLG	
American bittern	0	0	**2**	
American wigeon	5	4	**8**	
Gadwall	26	17	**30**	
bobolink	1	0	6	
Brewer's blackbird	25	**58**	2	
Blue-winged teal	**100**	51	68	
Canada goose	0	0	**3**	
Chestnut-collared longspur	**27**	17	3	
Clay-colored sparrow	55	83	**90**	
Common nighthawk	**11**	4	0	
Eastern kingbird	0	0	2	
Grasshopper sparrow	**37**	26	31	
Horned lark	**2**	**2**	0	
Killdeer	**9**	2	0	
Lesser scaup	0	**1**	**1**	
arbled godwit	**3**	1	0	
Mallard	**28**	15	14	
Mourning dove	24	10	**32**	
Northern pintail	**41**	36	29	
Northern shoveler	18	**25**	13	
Wilson's phalarope	**5**	0	0	
Red-winged blackbird	**10**	7	6	
Savannah sparrow	11	**12**	**12**	
Sharp-tailed grouse	2	**6**	3	
Upland sandpiper	**8**	3	5	
Western meadowlark	**77**	62	69	
Willet	**5**	4	0	
Wilson's snipe	**6**	5	4	
Yellow-headed blackbird	**1**	0	0	
Total	**537**	**451**	**433**	**1,421**

Table 2. Daily nest survival rates, final hierarchical model coefficients and directionality for grassland bird species at the Central Grasslands Research Extension Center near Streeter, N.D from 2017-2019. BHCO = brown-headed cowbird; C3 = cool-season.

Species (n ≥ 20)	Daily Survival Probability	Model Coefficients
Blue-winged teal	0.96	Nest shrub -
Northern pintail	0.96	5m shrub+, Nest Bare -
Clay-colored sparrow	0.94	BHCO Parasitism-, nest visual obstruction +
Grasshopper sparrow	0.92	Stage +, nest vegetation height -
Western meadowlark	0.95	stage +, 5m C3 invasive grasses +, 5m bluegrass +, nest visual obstruction -
Brewer's Blackbird	0.95	time² -, BHCO parasitism -, 5m vegetation height +, nest C3 grass -