Avian Nest Survival in a Patch-burn Grazing System

Cameron Duquette and Torre Hovick
North Dakota State University School of Natural Resource Sciences, Fargo, N.D.

C.A. Duquette, NDSU

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) seasonlong grazing, (2) seasonlong grazing with dormant-season patch-burning (one-fourth of the pasture) at a four-year return interval and (3) seasonlong 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 one year 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 (Vermiere 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 a heterogeneous vegetation structure 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 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 during 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 will study 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 inform conservation 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 Kidder and Stutsman counties in North Dakota (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 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 cm (15.9 inches) and average annual temperatures 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 subpatches. The treatments are: (1) seasonlong grazing, (2) seasonlong grazing with dormant-season patch-burning (one-fourth of the pasture) at a four-year return interval and (3) seasonlong 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.

Annual burn plots in treatment 3 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 are designed to mimic the historical disturbance regime of mixed-grass prairie.

Cow-calf pairs graze freely within pastures from mid-May to mid-Sept. each year at a moderate stocking rate designed to achieve 30 percent 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 subpatch (one-eighth of the pasture) for a total of 96 plots. We searched each plot four times from May 20 to July 15. We searched for nests via hand-dragging a 30-meter (m)-long rope with aluminum can bundles attached every 2.5 m.

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 et al., 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).

We included Kentucky bluegrass and smooth brome as separate functional categories because they are nonnative and of management interest (Madden et al., 2000).

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).

Species	Number of Nests
Clay-colored sparrow	77
Western meadowlark	48
Grasshopper sparrow	37
Blue-winged teal	33
Common grackle	33
Northern pintail	27
Mallard	24
Red-winged blackbird	19
Savannah sparrow	16
Gadwall	15
Chestnut-collared longspur	11
Common nighthawk	6
Mourning dove	6
Upland sandpiper	5
Bobolink	3
Northern shoveler	3
Sharp-tailed grouse	2
American wigeon	1
Common snipe	1
Eastern kingbird	1
Killdeer	1
Lesser scaup	1
Wilson's phalarope	1
Yellow-headed blackbird	1

Table 1. Nesting species monitored and number of nests by species for individuals monitored at the Central Grasslands Research Extension Center, May-August 2017.

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 among time-since-fire groupings.

Species ($N \geq 20$)	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 -
Common grackle	0.95	time^2 -, BHCO parasitism -, 5m vegetation height +, nest C3 grass -

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

Nest density per plot was adjusted for nest detectability based on modeled survival for each species in a Bayesian generalized linear mixed-model framework (Conkling et al., 2017). We then assessed total nest density across treatments and compared with seasonlong control pastures.

Results

In 2017, we monitored 381 nests from 24 species (Table 1).

Daily Survival Rate

We were able to run nest survival metrics on every species with 20 or more detections (six species, total; Table 2). We were not able to compare nest survival among treatments this year because with only two time-since-fire categories established, no overlap in nesting communities occurred across treatments. However, we were able to assess the effect of local and microsite vegetation structure.

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 nesting success 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*) had a daily nest survival rate of 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.

Common grackle (*Quiscalus quiscula*) had a daily survival probability of 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 one year of data collection, early results highlight the differences in preferred vegetation structure among grassland species. We hypothesize that local topoedaphic features drive selection for vegetation structure.

Additionally, we discovered that new burns create habitat for grackles and is reflected in grackle density and grackle 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.

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