Avian Nest Survival in a Patch-burn Grazing System

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Wilson's Snipe (*Gallinago delicata*)
Photo by C.A. Duquette

Summary

We are evaluating the effect of a patch-burn grazing management strategy on avian nest success. Results highlight the differences in preferred vegetation structure among grassland species. Combined with our community results, patch contrast seems to create more niches for nesting and breeding birds and enhances abundance and diversity of birds, compared with traditional range management. Our duck nest selection work shows that waterfowl benefit from areas managed with fire and grazing. These results cover four years, from 2017 through 2020.

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 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 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. 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).

Woody species can increase the incidence of predation and cowbird parasitism and reduce nesting

Mourning dove (*Zenaida macroura*) Photo by C.A. Duquette cues for grassland species (Archer et al., 2017; Klug et al., 2010; With, 1994). 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, selection 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 from this study will help in the selection of grazing systems that 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 Kidder and Stutsman counties, N.D., (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 (cm) (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 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 (PBG40) and (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). 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 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 subpatch (one-eighth 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 2.5 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 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.

Table 1. Summary of 2017-2020 nest sampling at CGREC near Streeter, N.D.

Species	PBG20	PBG40	SLG	Total
American Bittern	0	0	**2**	2
American Wigeon	6	4	**13**	23
Blue-winged Teal	**164**	91	128	383
Bobolink	1	1	**6**	8
Brewer's Blackbird	49	**70**	3	122
Canada Goose	0	0	**3**	3
Chestnut-collared Longspur	**36**	33	3	72
Clay-colored Sparrow	70	102	**121**	293
Common Nighthawk	**14**	6	0	20
Eastern Kingbird	0	0	**2**	2
Gadwall	39	28	**55**	122
Grasshopper Sparrow	**42**	29	31	102
Green-winged Teal	**1**	0	0	1
Horned Lark	2	**3**	0	5
Killdeer	**10**	3	0	13
Lesser Scaup	0	2	**4**	6
Mallard	**34**	19	20	73
Marbled Godwit	**3**	**3**	0	6
Mourning Dove	34	15	**39**	88
Northern Pintail	**52**	51	37	140
Northern Shoveler	27	**33**	20	80
Red-winged Blackbird	**15**	**15**	10	40
Savannah Sparrow	13	**18**	14	45
Sharp-tailed Grouse	3	**6**	3	12
Upland Sandpiper	**10**	4	5	19
Western Meadowlark	**100**	93	82	275
Willet	**7**	6	1	14
Wilson's Phalarope	**5**	3	0	8
Wilson's Snipe	**14**	9	5	28
Yellow-headed Blackbird	**1**	0	0	**1**
All species	**752**	**647**	**607**	**2006**

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.

We calculated waterfowl nest site selection for the different time-since-fire patches using Manly selection ratios (Duquette et al., 2020). To better understand the role of time since fire in duck nest site selection, we combined our nesting data with patch-burn duck nest data from the Hettinger Research Extension

Center. Because we are interested explicitly in the role of time since fire, and an unburned area in a pasture without fire theoretically should have a different structure than an unburned area in a patch-burn pasture, we only used patch-burn grazing pastures for analysis.

Results

During the past four years, we have monitored 2,006 nests in our treatment structure, totaling 30 species. Many species have similar numbers of nests among treatments (Table 1), but others, such as the chestnut-collared longspur, 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, total; 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.

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.

Species	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	Brown-headed Cowbird parasitism - Nest visual obstruction +
Grasshopper Sparrow	0.92	Stage + Nest vegetation height -
Western Meadowlark	0.95	Stage + 5m cool-season invasive grasses + 5m bluegrass + Nest visual obstruction -
Brewer’s Blackbird	0.95	Julian day - Brown-headed Cowbird parasitism - 5m vegetation height + Nest cool-season invasive grass -

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 with brown-headed cowbird parasitism and nest-site cool-season grass cover. Nest survival increased with greater vegetation height.

Waterfowl Nest Site Selection

Blue-winged teal, gadwall and mallard preferred to nest in later time-since-fire patches, but these species also preferred burned patches to unburned patches. Northern pintail showed little preference for nesting with respect to time since fire (Figure 1).

Discussion

Results highlight the differences in preferred vegetation structure among grassland species. Combined with our community results, patch contrast seems to create more niches for nesting and breeding birds and enhance abundance and diversity of birds, compared with traditional range management. Our duck nest selection work shows that waterfowl benefit from areas managed with fire and grazing, and that later time-since-fire values differ ecologically from a waterfowl selection standpoint from unburned areas.

Literature Cited

Archer, S.R., Andersen, E.M., Predick, K.I., Schwinning, S., Steidl, R.J., Woods, S.R. 2017. Woody plant encroachment, causes and consequences. In: Briske D. (eds) Rangeland Systems. Springer Series on Environmental Management. Springer, Cham.

Bakker, K.K., 2003. The effect of woody vegetation on grassland nesting birds: An annotated bibliography. Proceedings of the South Dakota Academy of Science 82, 119-141.

Bleho, B.I., Koper, N., Machtans, C.S. 2014. Direct effects of cattle on grassland birds in Canada. Conservation Biology 28, 724-734.

Briske, D.D., Sayre, N.F., Huntsinger, L., Fernandez-Gimenez, M., Budd, B., Derner, J.D. 2011. Origin, persistence, and resolution of the rotational grazing debate: Integrating human dimensions into rangeland research. Rangeland Ecology and Management 64, 325-334.

Churchwell, R.T., Davis, C.A., Fuhlendorf, S.D., Engle, D.M. 2008. Effects of patch-burn management on dickcissel nest success in a tallgrass prairie. Journal of Wildlife Management 72, 1596-1604.

Coppedge, B.R., Engle, D.M., Masters, R.E., Gregory, M.S. 2001. Avian response to landscape change in fragmented southern great plains grasslands. Ecological Applications 11, 47-59.

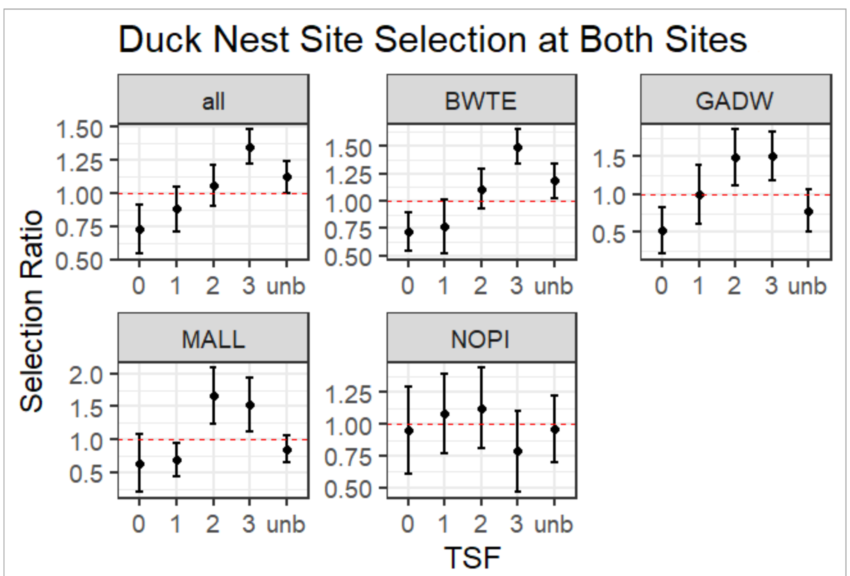

Figure 1. Duck nest site selection in proportion to availability of time since fire (zero to three years) and unburned at the Central Grasslands Research Extension Center and the Hettinger Research Extension Center from 2017-2020. A value less than 1 indicates ducks select nest sites in that time-since-fire category less often than would be expected given its availability on the landscape, while a value greater than 1 indicates the opposite.

BWTE = Blue-winged Teal, GADW = Gadwall, MALL = Mallard, NOPI = Northern Pintail.

Daubenmire, R.F. 1959. A canopy coverage method of vegetational analysis. Northwest Science 33, 43-64.

Davis, C.A., Churchwell, R.T., Fuhlendorf, S.D., Engle, D.M., Hovick, T.J. 2016. Effect of pyric herbivory on source-sink dynamics in grassland birds. Journal of Applied Ecology 53, 1004-1012.

Dieni, J.S., Jones, S.L. 2003. Grassland songbird nest site selection patterns in northcentral Montana. Wilson Ornithological Society 115, 388-396.

Dinsmore, S.J., Dinsmore, J.J. 2007. Modeling avian nest survival in program MARK. Studies in Avian Biology 34, 73-83.

Doxon, E.D., Davis, C.A., Fuhlendorf, S.D., Winter, S.L. 2011. Aboveground macroinvertebrate diversity and abundance in sand sagebrush prairie managed with the use of pyric herbivory. Rangeland Ecology and Management 64, 394-403.

Duquette, C.A., Hovick, T.J., Limb, R.F., McGranahan, D.A., Sedivec, K.K. 2020. Restored fire and grazing regimes influence nest selection and survival of Brewer's blackbirds (*Euphagus cyanocephalus*).

Fuhlendorf, S.D., Engle, D.M. 2001. Restoring heterogeneity on rangelands: Ecosystem management based on evolutionary grazing patterns. BioScience 51(8), 625–632.

Fuhlendorf, S.D., Engle, D.M. 2004. Application of the fire-grazing interaction to restore a shifting mosaic on tallgrass prairie. Journal of Applied Ecology 41(4), 604–614.

Fuhlendorf, S.D., Engle, D.M., Kerby, J., Hamilton, R. 2009. Pyric herbivory: rewilding landscapes through the recoupling of fire and grazing. Conservation Biology 23, 588-598.

Fuhlendorf, S.D., Harrell, W.C., Engle, D.M., Hamilton, R.G., Davis, C.A., Leslie, D.M. Jr. 2006. Should heterogeneity be the basis for conservation? Grassland bird response to fire and grazing. Ecological Applications 41, 604-614.

Fuhlendorf, S.D., Townsend, D.E. Jr., Elmore, R.D., Engle, D.M. 2010. Pyric-herbivory to promote rangeland heterogeneity: Evidence from small mammal communities. Rangeland Ecology and Management 63, 670-678.

Graul, W.D. 1975. Breeding biology of the mountain plover. The Wilson Bulletin 87, 6-31.

Hovick, T.J., Elmore, R.D., Fuhlendorf, S.D. 2014. Structural heterogeneity increases diversity of non-breeding grassland birds. Ecosphere 5, 1-13.

Hovick, T.J., Elmore, R.D., Fuhlendorf, S.D., Engle, D.M., Hamilton, R.G. 2015. Spatial heterogeneity increases diversity and stability in grassland bird communities. Ecological Applications 25, 662-672.

Hovick, T.J., Miller, J.R., Dinsmore, S.J., Engle, D.M., Debinski, D.M., Fuhlendorf, S.D. 2012. Effects of fire and grazing on grasshopper sparrow nest survival. Journal of Wildlife Management 76, 19-27.

Klug, P.E., Jackrel, S.L., With, K.A. 2010. Linking snake habitat use to nest predation risk in grassland birds: The dangers of shrub cover. Oecologia 162, 803-813.

Laake, J.L. 2013. RMark: an R Interface for analysis of capture-recapture data with MARK. AFSC Processed Rep 2013-01, 25 p. Alaska Fisheries Science Center, NOAA, National Marine Fisheries Service, Seattle, Wash.

Lokemoen, J.T., Koford, R.R. 1996. Using candlers to determine egg incubation stage of passerine eggs. Journal of Field Ornithology 67, 660-668.

McConnell, M.D., Monroe, A.P., Burger Jr., L.W., Martin, J.A. 2017. Timing of nest vegetation measurement may obscure adaptive significance of nest-site characteristics: A simulation study. Ecology and Evolution 7, 1259-1270.

Oksanen, J. 2009. Multivariate analysis of ecological communities in R: VEGAN Tutorial. http://cran.r-project.org.

Patton B.D., Dong X., Nyren P.E., Nyren, A. 2007. Effects of grazing intensity, precipitation, and temperature on forage production. Range Ecology and Management 60:656-665.

Rogers, W.M., Kirby, D.R., Nyren, P.E., Patton, B.D., Dekeyser, E.S. 2005. Grazing intensity effects on northern plains mixed-grass prairie. Prairie Naturalist 37:73-83.

Rotella, J.J., Dinsmore, S.J., Shaffer, T.L. 2004. Modeling nest-survival data: a comparison of recently developed methods that can be implemented in MARK and SAS. Animal Biodiversity and Conservation 27, 187-205.

Scasta, J.D., Thacker, E.T., Hovick, T.J., Engle, D.M., Allred, B.W., Fuhlendorf, S.D., Weir, J.R. 2016. Patch-burn grazing (PBG) as a livestock management alternative for fire-prone ecosystems of North America. Renewable Agriculture and Food Ecosystems 31,550-567.

Shaffer, J.A., Goldade, C.M., Dinkins, M.F., Johnson, D.H., Igl, L.D. 2003. Brown-headed cowbirds in grasslands: Their habitats, hosts, and response to management. Prairie Naturalist 35, 145-186.

Sirami, C., Seymour, C., Midgley, G., Barnard, P., The impact of shrub encroachment on savanna bird diversity from local to regional scale. Diversity and Distributions 2009, 948-957.

Van Hengstum, T., Hooftman, D.A., Oostermeijer, J.G.B., van Tienderen, P.H. 2013. Impact of plant invasions on local arthropod communities: a meta-analysis. Journal of Ecology 102, 4-11.

Vermeire, L.T., Mitchell, R.B., Fuhlendorf, S.D., Gillen, R.L. 2003. Patch burning effects on grazing distribution. Journal of Range Management 57, 248-252.

With, K.A. 1994. The hazards of nesting near shrubs for a grassland bird, the McCown's longspur. The Condor 96, 1009-1019.

Winter, W., Hawks, S.E., Shaffer, J.A., Johnson, D.H. 2003. Guidelines for finding nests of passerine birds in tallgrass prairie. Prairie Naturalist 35: 197-211.


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