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Alternative Rangeland Management Strategies and the Nesting Ecology of Greater Prairie-Chickens☆,☆☆

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ABSTRACT

Population declines of grassland birds over the past 30 yr have followed the widespread implementation of intensive rangeland management practices that create homogenous grassland habitats. Patch-burn grazing (PBG) was tested as an alternative management technique that is ecologically similar to historically heterogeneous fire and grazing regimes and holds promise as a rangeland management tool that may benefit grassland wildlife. We conducted a 3-year study to compare nest-site selection and nest survival of greater prairie-chickens, an umbrella species for tallgrass prairie conservation, on private lands managed with PBG or intensive fire and grazing in the Flint Hills of Kansas. The goal of our field study was to evaluate the relationships among rangeland management practices, habitat conditions, and nesting ecology of greater prairie-chickens. Nest-site selection and nest survival of prairie-chickens were both directly related to vertical nesting cover, which was determined by the fire return interval of a pasture. Nesting habitat was affected little by stocking rate in PBG management regimes because preferred nest sites were unburned patches that were not grazed by cattle. Overall, the quantity and quality of nesting sites was improved under PBG management when compared with more intensive rangeland management regimes. Our results join a growing body of evidence that rangeland management strategies that mimic historical heterogeneous fire and grazing regimes benefit native species of prairie wildlife.

Introduction

Tallgrass prairie is the most intensively altered biome in North America with more than 95% lost to rowcrop agriculture or other development during the last century (Samson et al., 2004; Hoekstra et al., 2005). The Flint Hills ecoregion of eastern Kansas and Oklahoma contains the largest remaining tracts of tallgrass prairie and supports populations of many sensitive species of wildlife (Powell, 2006; With et al., 2008). The Flint Hills ecoregion is vital to the long-term persistence of many obligate grassland birds (Svedarsky et al., 2000; With et al., 2008). The Flint Hills is generally unsuitable for cultivation but supports an economically important cattle industry, with cattle grazing occurring on > 90% of its native prairies (With et al., 2008). During the past 30 yr, rangeland management has intensified with a shift from periodic prescribed burning and season-long grazing of cows and calves, to intensive early stocking of steers during April–July combined with annual spring burning (IESB) (Smith and Owensby, 1978). IESB benefits cattle production in the short-term by promoting the growth of high quality forage and allows ranchers to stock ranges with cattle early. However, IESB may negatively affect native wildlife by reducing structural heterogeneity of grassland habitats, and implementation of IESB has coincided with population declines among grassland birds (Reinking, 2005; Fuhlendorf et al., 2006; Rahmig et al., 2008).

Patch-burn grazing (PBG) has been proposed as an alternative management technique that increases plant diversity and structural heterogeneity of grazed grasslands while providing viable revenue for cattle producers and landowners (Fuhlendorf and Engle, 2001, 2004). PBG is a rotational burning management scheme that is ecologically similar to presettlement grazing—fire interactions and could improve habitat conditions for many declining prairie species (Churchwell et al., 2008; Coppedge et al., 2008; Powell, 2008). Recent studies have shown that PBG holds promise as a conservation tool and is also economically viable as an alternative to more intensive rangeland management practices (Rensink, 2009; Limb et al.,

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2011). Wildlife biologists have speculated that widespread implementation of PBG could result in significant improvements in the quality of habitats for grassland birds in tallgrass prairie ecosystems (Fuhlendorf et al., 2006). However, studies evaluating the effectiveness of PBG as a conservation strategy to improve population viability of grassland birds in unfragmented tallgrass ecosystems have been limited.

The greater prairie-chicken (*Tympanuchus cupido*; hereafter "prairie-chicken") is an obligate grassland bird and umbrella species for tallgrass prairie conservation (Poiani et al., 2001; Johnson et al., 2011). Population declines of prairie-chickens have paralleled continental losses of native tallgrass prairie, and much of the species' remaining distribution occurs in the relatively unfragmented Flint Hills ecoregion. Consistent with declines in other grassland birds, prairie-chicken numbers in the Flint Hills have decreased by as much as 50% over the last 30 yr (Pitman, 2012). Prairie-chickens require a diverse mosaic of floristic and structural grassland habitats for successful reproduction and survival: open sites at relatively high elevations for display arenas or leks, dense vegetative cover for concealment during nesting, and intermediate vegetative structure rich in forbs for brood-rearing (Svedarsky et al., 2000; Johnson et al., 2011). Our recent research indicates that high predation on nests and young is the primary cause of population declines, and that predation risk is linked to a lack of adequate vegetative cover at prairie-chicken nest sites in the Flint Hills (McNew et al., 2012a, 2014). However, the relationships between rangeland management practices, nesting cover, and prairie-chicken fecundity have not been evaluated.

More than 95% of the remaining native tallgrass prairie in the Flint Hills ecoregion is privately owned with the vast majority (~91%) managed for cattle production (With et al., 2008). Information on how standard and alternative (e.g., PBG) rangeland management practices affect space use and demography are needed to build effective conservation strategies for prairie-chickens in the ecoregion. The goal of our field study was to evaluate the relationships between rangeland management practices, habitat conditions, and nesting ecology of prairie-chickens in the central Flint Hills. Our objectives were to evaluate 1) the degree to which rangeland management factors such as fire return interval and stocking rate influenced vegetative structure and composition of prairie-chicken habitat, 2) how vegetative conditions influenced selection of nest sites and nest survival of prairie-chickens in areas managed with PBG versus areas managed with standard management regimes like IESB, and 3) the effectiveness of PBG as a rangeland management technique to improve habitat conditions for prairie-chickens.

Methods

Study Area

Our field study was conducted in a 5-county area (Butler, Chase, Greenwood, Lyon, and Morris Counties) in the central Flint Hills ecoregion of Kansas during 2011–2013. The Flint Hills ecoregion is a landscape of relatively unfragmented tallgrass prairie, and native grassland managed for cattle production was the dominant land cover type on our study area (>90%). Our study included 72.2 km^2 of grassland on 2 properties managed with PBG and ca. 479 km^2 ha of grassland on 78 properties managed with standard rangeland management practices in the Flint Hills, predominantly IESB (hereafter 'intensive').

We conducted research at two large ranching properties managed with PBG: Tallgrass Prairie National Preserve in Chase County and the privately owned Browning Ranch in Chase and Greenwood Counties (Fig. 1). The 4,407-ha Tallgrass Prairie National Preserve is owned by The Nature Conservancy and managed by the National Park Service. Most pastures are grazed with steers during all or part of the growing season during April–October (1.59 ± 0.73 animal unit months per hectare [AUM·ha-1]); one 445-ha pasture is grazed year-long by bison (0.45 AUM·ha-1). We pooled bison and cattle PBG pastures into a general PBG treatment because the effects of grazing by bison and cattle on tallgrass prairie vegetation are comparable (Towne et al., 2005), and have similar effects on the long-term habitat use by prairie-chickens (McNew et al., 2012b). The privately-owned 2,812-ha Browning Ranch had a mean stocking rate of 2.0 ± 0.84 AUM·ha-1 during April–August in 2011–13. A total of 11 pastures (488 ± 125SE ha pasture-1) at both PBG properties were divided into 2 or 3 patches (i.e., half or third of pasture) with fire breaks not cross-fences, and each patch was burned rotationally every second or third year. Under a PBG management regime, cattle have freedom to move among patch treatments within a pasture but spend the majority of their time grazing on the most recently burned patches that were typically burned in the preceding spring (Fuhlendorf and Engle, 2004).

Management strategies on the PBG properties were consistent over our 3-yr field study, but fire and grazing applications on the intensive properties varied from year to year and were dependent upon weather conditions and individual ranch managers. In the past, intensive properties were managed with IESB with a stocking rate of ca. 3–4 AUM·ha-1 during April–July. However, drought conditions in 2012 and 2013 resulted in many property managers foregoing burning pastures and switching to lower stocking rates during these growing seasons. Thus, stocking rates during the study on reference properties ranged from 1 to 6 AUM·ha-1, though stocking rates ≥ 3 AUM·ha-1 were rare.

Field Methods

We captured prairie-chickens during March–May at 34 leks (25 leks on 9 intensive ranches, 9 leks on 2 PBG ranches with walk-in traps or drop-nets). We equipped females with VHF radio-transmitters (model A3950, Advanced Telemetry Systems, Isanti, MN), and located nests via daily telemetry of radio-marked females during egg-laying and incubation (McNew et al., 2013). If telemetry indicated a female had departed a completed nesting attempt, we visited the nest site to identify nest fate. We classified nest fate as successful (produced ≥ 1 one chick) or failed based on pipped vs. broken eggshells, signs of predator activity at the nest site, and female behavior (McNew et al., 2014).

We surveyed habitat conditions within 3 d of hatching or failure at nests. We conducted parallel habitat surveys at random points located within 5-km of nest locations (McNew et al., 2013, 2014). We evaluated an index of vertical nesting cover by averaging 4 visual obstruction readings (VOR) at a distance of 2 m and a height of 0.5 m (Robel et al., 1970) and estimated the proportion of grass, forb, shrub, and bare ground cover in a 20 × 50 cm quadrat frame at 12 subsampling locations within 6 m of each nest or random point (Daubenmire, 1959). We recorded the distance (m) and height (cm) to nearest shrub in the field and estimated the distance (m) from each nest to nearest state highway, county road, nongrassland habitat edge and water edge using ArcMap 10.1 (Environmental Systems Research Institute, Redlands, CA). For landcover analyses, we used the 30-m resolution land cover map depicting 11 biologically relevant landcover classes in Kansas in 2005, which has an average overall accuracy of 86% (Whistler et al., 2006). We included road system datasets for Kansas in 2006 (Kansas Department of Transportation: Bureau of Transportation Planning). We gathered information on rangeland management for every patch or pasture in the study area for each year of study by interviewing property managers to determine years since last prescribed fire and stocking rate (AUM·ha-1) for each nest or random point. We considered the potential lag effects of previous fire history by determining the number of years between 2000 and 2011 a nest site or random point burned using a fire classification map for our entire study area based on remote sensing (Mohler and Goodin, 2012a,b).

Statistical Analyses

Habitat conditions

We tested the effects of rangeland management practices on habitat conditions using generalized linear models. Elsewhere, we have shown