The Prairie Naturalist 45:77–83; 2013

Use of Seeded Exotic Grasslands by Wintering Birds

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ABSTRACT Despite widespread population declines of North American grassland birds, effects of anthropogenic disturbance on wintering habitat of this guild remain poorly understood. We compared avian abundance and habitat structure in fields planted to the exotic grass Old World bluestem (*Bothriochloa ischaemum*; OWB) to that in native mixed-grass prairie. During winters of 2007–2008 and 2008–2009, we conducted bird and vegetation surveys in six native grass and six OWB fields in Garfield, Grant, and Alfalfa counties, Oklahoma. We recorded 24 species of wintering birds in native fields and 14 species in OWB monocultures. While vegetation structure was similar between field types, abundance of short-eared owls (*Asio flammeus*), northern harriers (*Circus cyaneus*) and Smith's longspurs (*Calcarius pictus*) was higher in OWB fields during at least one year. The use of OWB fields by multiple species occupying different trophic positions suggested that vegetation structure of OWB can meet habitat requirements of some wintering birds, but there is insufficient evidence to determine if it provides superior conditions to native grasses.

KEY WORDS *Bothriochloa ischaemum*, Conservation Reserve Program, grassland birds, invasive species, mixed-grass prairie, Old World bluestem, winter residents

In North America, long-term population trends indicate persistent and widespread declines of multiple grassland bird species since at least 1966 (Askins et al. 2007, Sauer et al. 2008). Habitat loss, degradation, and fragmentation have been identified as primary causes of these declines during the breeding season (Vickery and Herkert 2001). However, many bird species rely on grassland cover in the southern Great Plains during winter, and some of these are also undergoing population declines (e.g., eastern [*Sturnella magna*] and western [*S. neglecta*] meadowlarks; Best et al. 1998, Niven et al. 2004, Sauer et al. 2008). Declines of some species may be attributed to population limitation on wintering grounds, but winter ecology of most migratory birds remains poorly understood (Sherry and Holmes 1996, Faaborg et al. 2010).

Habitat requirements of wintering grassland birds often contrast with those of species that rely on grasslands for breeding (Igl and Ballard 1999). For example, breeding passerines are usually insectivorous while winter residents are granivorous. Wintering birds use grasslands to avoid predators and adverse weather as they restore energy reserves in advance of their next migration and the subsequent breeding season (Gottfried and Franks 1975, Kricher 1975, Lima 1993, Marra et al. 2005). Therefore, grassland birds might respond negatively to anthropogenic disturbance that affects availability of food or cover during winter.

Exotic grasses such as Old World bluestems (*Bothriochloa ischaemum*; OWB) have become widespread in the Great Plains as a result of intentional plantings by landowners for pasture improvements (Schenk and Williamson 1991, Baker 2000) and especially in fields enrolled in the Conservation Reserve Program (CRP). For example, more than 1 million ha of OWB were planted in Oklahoma and Texas during the 1980s and 1990s (White and Dewald 1996), and in some western Oklahoma counties, more than 50% of the CRP land has been planted to OWB (Ripper and VerCauteren 2007). While these grasses may be widely tolerant of heat and drought and relatively easy to establish and manage, they also may become invasive, with negative consequences for native grassland ecosystems (D'Antonio and Vitousek 1992, Gabbard and Fowler 2007). There is evidence that OWB does not provide quality habitat for birds, including reduced food availability during the breeding season (McIntyre and Thompson 2003, Chapman et al. 2004, Hickman et al. 2006, George et al. 2013), but its use by wintering birds has not been investigated. Effects of OWB on wintering birds should reflect habitat requirements during winter (e.g., availability of seeds for food) and therefore might contrast with its effects on breeding birds. Given the widespread establishment of OWB and other exotic grasses, we assessed its potential as habitat for wintering grassland birds. Our objectives were to compare 1) species richness and abundance of wintering birds and 2) vegetation structure and composition between OWB monocultures and native mixed-grass prairie during the winter season.

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STUDY AREA

We conducted our study over two, 4-month sampling periods in December–March, 2007–2009 in the Prairie Tableland ecoregion of north-central Oklahoma (Woods et al. 2005). Mean high and low daily temperatures ranged from −3.1º C to 10.8º C and −3.1º C to 12.4º C in each of the two sampling periods, respectively. Total precipitation was 90.0 cm in 2007, with 9.4 cm falling in the first sampling period, and 92.5 cm in 2008, with 6.9 cm falling in the second sampling period (Oklahoma Climatological Survey 2013). We opportunistically selected 12 study sites in Alfalfa, Grant, and Garfield counties to provide six replicates each of OWB monoculture and native mixed-grass prairie (Fig. 1). Sites were 60–100 ha with two of each type in each county. Study-site selection was based on similarity in topography and management typical of the region. Dominant vegetation on native sites included little bluestem (*Schizachyrium scoparium*), big bluestem (*Andropogon gerardii*), sideoats grama (*Bouteloua curtipendula*), blue grama (*B. gracilis*), indiangrass (*Sorghastrum nutans*), switchgrass (*Panicum virgatum*), and buffalograss (*B. dactyloides*). Native fields contained small patches of woody vegetation, including sand plum (*Prunus angustifolia*) and fragrant sumac (*Rhus aromatica*), although they were minor landscape features. All sites were grazed by cattle during both study periods, although landowners varied stocking rates. We therefore classified grazing using measured vegetation characteristics and a relative estimate of cattle density. Eleven sites were lightly grazed, and one native site was heavily grazed (mean vegetation height >30 cm and <20 cm, respectively). Four of the OWB sites were hayed during late summer but we detected no differences in vegetation structure between field types in December–March. Regional land cover was dominated (68%) by cropland with 26% of the land area devoted to native grasses and seeded grass monocultures (U.S. Department of Agriculture 2008).

METHODS

We estimated bird species richness and abundance by counts conducted along transect lines following methods described in Bibby et al. (2000). We established two, 750-m transects in each field with no transects parallel to and within 50 m of field edges and riparian areas. The same transects were resampled throughout the duration of the study. Each field was sampled approximately biweekly (4× per winter) in alternating order from mid-December through mid-February on days with no rain and light winds (<10 km/hr). We sampled between early morning (>1 hr after sunrise) and late afternoon (<2 hrs before sunset) by slowly walking each transect and recording all individuals seen or heard. We counted flyovers only if birds were observed actively foraging over

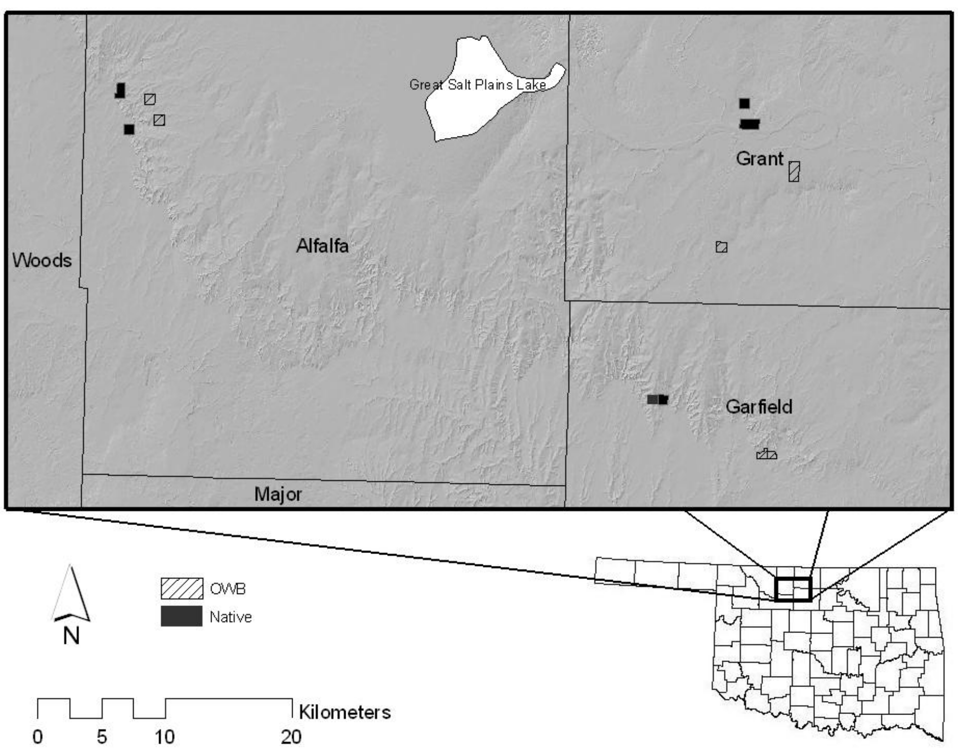

Figure 1. Map of study area showing locations of six Old World bluestem (OWB) and six native mixed-grass prairie sites in Alfalfa, Grant, and Garfield counties in north-central Oklahoma, winters 2007–2008 and 2008–2009.

the field.

Comparable abundance estimates of infrequently detected species could not be attained; therefore, we restricted statistical comparisons of abundance to bird species comprising at least 5% of all individuals detected within a field type during at least one sampling period. We calculated abundance as the number of individuals/km. We did not consider distance to transect because short-eared owls (*Asio flammeus*) and passerines were detected by flushing within 10 m of the transect line, while northern harriers (*Circus cyaneus*) and other diurnal raptors were observed in flight. Therefore, reliable estimates of density or detectability by distance could not be attained. We estimated abundance for Savannah sparrow (*Passerculus sandwichensis*), northern harrier, Smith's longspur (*Calcarius pictus*), chestnut-collared longspur (*C. ornatus*), short-eared owl, song sparrow (*Melospiza melodia*), and American tree sparrow (*Spizella arborea*). We counted all eastern and western meadowlarks as meadowlarks (*Sturnella* spp.) because of the difficulty distinguishing between the two. We estimated bird abundance for each visit to a site by dividing the total number of observations by transect length and averaging within years for statistical analyses. We used a Wilcoxon signed-rank to test for differences between years within field types and pooled data from both years when no year effect was detected. We used a Mann-Whitney *U*-test to detect differences in bird species richness and abundance between field types.

We measured vegetation during the third week of February in 2008 and 2009. At 30 random distances along each transect, we measured vertical obstruction from four directions using a Robel pole (Robel et al. 1970; $n = 120$ points/field). We recorded maximum vegetation height and the lowest visible point on the pole from 4 m at a height of 1 m above the ground. We used standard deviations of vertical obstruction at each point (4-m radius) and across each sampling transect (750 m) as measurements of structural heterogeneity at the point and field scales (e.g., Fuhlendorf and Engle 2004). We estimated canopy cover of vegetation directly in front of the Robel pole in the direction of the transect using a 1-m^2 frame (Daubenmire 1959). We only recorded plants rooted completely inside the frame. We categorized percent cover of grasses, forbs, litter, and bare ground into the following cover classes: 0%, >0–5%, >5–25%, >25–50%, >50–75%, >75–95%, and >95–100%. We defined litter as any plant material on the soil surface that did not appear rooted in the ground. We used the midpoints of each cover class to calculate percent canopy cover of vegetation (Towne et al. 2005). We used a repeated-measures analysis of variance (ANOVA) to compare vegetation structure and composition characteristics between the two field types with year as the repeated measure. We analyzed all data using SPSS 16.0 (SPSS Inc., Chicago, Illinois, USA); a significance level of $P \leq 0.05$ was used for all statistical tests.

RESULTS

In winter 2007–2008 and 2008–2009, we observed 24 bird species using native grass fields and 14 using OWB monocultures. Mean species richness per sampling site was 8.00 (SE = 0.63) for native fields and 7.33 (SE = 0.67) for OWB fields; we did not detect a difference between field types ($U = 14.5$, $P = 0.28$). Of the species comprising ≥5% of all individuals observed, Smith's longspur was the most abundant, followed by chestnut-collared longspur, meadowlarks, Savannah sparrow, short-eared owl, and northern harrier (Table 1). We detected year effects for two species. In native fields, Savannah sparrows ($Z = 1.83$, $P = 0.03$) were more abundant during the first year and in OWB fields, short-eared owls ($Z = 1.83$, $P = 0.03$) were more abundant in the second year. We detected field type effects for four species. In the first year, Smith's longspurs ($U = 3.0$, $P = 0.004$) were more abundant in OWB fields, and American tree sparrows ($U = 9.0$, $P = 0.03$) were more abundant in native fields. In the second year, northern harriers ($U = 7.0$, $P = 0.04$) and short-eared owls ($U = 8.0$, $P = 0.04$) were more abundant in OWB fields.

We detected year effects for four vegetation variables in both OWB and native fields (Table 2). Grass cover, forb cover, and litter cover, were higher ($F_{1, 10} \geq 14.83$, $P \leq 0.005$) in the first year, and bare ground was higher ($F_{1, 10} = 9.2$, $P = 0.02$) in the second year. We only detected field type effects for forb cover, which was higher ($F_{1, 10} \geq 79.37$, $P < 0.001$) in native fields in both years.

DISCUSSION

While we found similar mean bird species richness between field types, and significantly lower numbers of American tree sparrow in OWB fields during at least one year, our results suggest that OWB monocultures can provide wintering habitat for several grassland bird species, including northern harrier, short-eared owl, Smith's longspur and Savannah sparrow. Differences in response among bird species likely reflected whether individual fields met specific habitat requirements of food or cover for winter survival.

American tree sparrows use areas with at least some woody vegetation during winter, including field edges, where they forage on the ground in open areas and use nearby woody cover to roost or escape predators (Naugler 1993). Because we were concerned primarily with grassland bird species, we intentionally chose study fields without woody vegetation whenever possible and located sampling transects to avoid edges. While not included in our vegetation analysis, some of the native fields in this study contained small patches of sand plum and fragrant sumac. We attribute the presence of American tree sparrows in native fields to the presence of woody vegetation. Any influence of OWB on this species was likely indirect because fields managed as monocultures were less likely to have forbs or woody plants. Likewise, while mean

Table 1. Mean abundance (birds/km), standard error, and number of fields containing each bird species comprising ≥5% of the total abundance of all birds observed in Old World bluestem (OWB) monocultures and native mixed-grass prairie (Native) in winters 2007–2008 and 2008–2009.

	2007–2008						2008–2009					
	OWB			Native			OWB			Native		
Species	No. fields	x̄	SE	No. fields	x̄	SE	No. fields	x̄	SE	No. fields	x̄	SE
SMLO[a]	5	33.98	31.62	0			2	3.01	2.92	2	0.42	0.38
MODO	0			0			0			1	13.66	13.66
meadowlark spp.	6	3.81	1.23	6	7.70	4.24	5	2.13	1.02	6	5.00	3.10
CCLO	1	13.08	13.08	0			1	0.02	0.02	0		
SASP[b]	6	4.80	1.76	4	2.32	0.77	6	2.22	0.76	4	0.77	0.29
ATSP[a]	0			3	2.75	2.38	0			2	0.17	0.12
SEOW[ab]	0			0			4	1.39	0.92	1	0.05	0.05
NOHA[a]	5	0.34	0.15	3	0.25	0.15	6	0.96	0.27	5	0.40	0.14
NOBO	0			1	0.38	0.38	0			0		
SOSP	0			2	0.49	0.37	0			0		

Table 2. Vegetation characteristics (x̄ and SE) measured in Old World bluestem (OWB) monocultures and native mixed-grass prairie (Native) in north-central Oklahoma during winters 2007–2008 and 2008–2009.

	2007–2008				2008–2009			
	OWB		Native		OWB		Native	
	x̄	SE	x̄	SE	x̄	SE	x̄	SE
Grass cover (%)[b]	61.58	5.05	64.41	16.06	78.46	3.71	72.91	7.29
Forb[a,b]	0.14	0.10	6.75	1.21	0.10	0.04	4.06	1.06
Litter cover (%)[b]	3.49	1.07	20.97	12.44	27.33	1.35	38.60	8.44
Bare ground (%)[b]	43.89	6.18	29.70	17.25	21.61	3.79	23.63	7.38
Vegetation height (cm)	43.80	3.41	68.92	15.17	37.92	3.72	74.96	14.03
Vertical obstruction (dm)	0.73	0.14	1.26	0.50	0.65	0.11	1.20	0.27
Point heterogeneity	0.49	0.06	0.63	0.22	0.38	0.04	0.78	0.20
Field heterogeneity	0.60	0.09	1.00	0.34	0.58	0.11	0.87	0.21

[a] $P < 0.05$ between field types; [b] $P < 0.05$ between years.

species richness was similar between field types, the higher overall species richness in native fields may be due to forbs or small patches of woody vegetation in some fields.

Smith's longspurs are grassland specialists with a winter range limited to the Southern Plains (Briskie 2009). In the first year of our study, this species was observed in large flocks in a single OWB field, but it was concentrated in grazed areas with slight depressions, similar to those described by Kemsies (1968). Smith's longspurs use fields with moderate to heavy grazing pressure, often near patches of three-awn (*Aristida* spp.) and silver bluestem (*B. laguroides*; Grzybowski 1982, 1983). While our sampling protocol was not designed to estimate flock size or habitat patchiness, we generally observed Smith's longspurs in relatively small flocks (<50 individuals) in patches of shorter grass, including three-awn. Grass seed availability may be an important mechanism affecting longspur populations during the non-breeding season, and seed density may be positively correlated with grazing pressure in fields selected by Smith's longspurs (Grzybowski 1982). To increase understanding of longspur habitat selection in winter, future studies could focus on microhabitat use as it relates to grass species composition and food availability in both native and exotic grasslands.

Abundance of Savannah sparrows, the most commonly encountered species in our study, did not differ between field types. Savannah sparrows are grassland generalists during both the breeding and non-breeding seasons (Wheelwright and Rising 2008). Nevertheless, few studies have addressed habitat use by Savannah sparrows during winter, despite possible winter population limitation for some populations (Stobo and McLaren 1975, Gordon 2000, Smith et al. 2005). While Savannah sparrows eat a variety of seeds during the non-breeding season, it remains unclear to what extent OWB serves as a food source. If OWB seeds are not available as food, OWB fields may serve as ecological traps for Savannah sparrows and other seed-eating bird species (Dwernychuck and Boag 1972). For example, wintering grassland birds may select OWB fields because they provide structural cover from predators and adverse weather, but foraging opportunities in those fields might be limiting. Studies have not yet addressed OWB seed morphology and nutritional composition as it relates to food availability for birds.

It is possible that the higher abundance of northern harriers and short-eared owls in OWB fields resulted from differences in prey abundance and availability. Both species are nomadic, and populations are regulated by local food availability during breeding and non-breeding seasons (Grant et al. 1991, MacWhirter and Bildstein 1996, Wiggins et al. 2006). Because we did not find differences in vegetation structure between field types and did not measure rodent abundance, the extent to which predator prey dynamics factor into differences in raptor densities between OWB monocultures and native grasslands remains unclear (see Guthery et al. 1979).

Because our primary objective was to compare bird species richness and abundance between field types, we intentionally selected study fields that were superficially similar to one another and representative of the study region. Individual fields varied in vegetation structure and composition, but the fact that we found no structural differences between field types suggested that OWB fields may contain much of the structural variation typical of native fields in the study region. However, OWB fields typically are managed as monocultures, and while other plant species may occur in those fields, plant diversity is reduced compared with native mixed-grass prairie. Some breeding season studies have indicated that grass species composition is not an important determinant of grassland bird assemblages if species-specific structural needs are met (e.g., Scott and Lima 2004, Jones and Bock 2005), and some exotic grasses can meet those needs. Some bird species, however, may select habitats on the basis of plant species composition (Block and Brennan 1993, Rotenberry and Wiens 1998) and differences between the two field types may have contributed to the absence of some species from OWB fields in our study. We recorded <1% forb cover in our OWB fields, suggesting effects of this reduction in plant diversity on bird communities may be amplified during winter when most grassland birds are granivorous and rely on seeds from both grasses and forbs (West 1967). It is possible that our sampling array (30 points per field in each of two years) was not sufficient to detect differences in vegetation structure important to wintering birds, or that estimates of bird density (e.g., belt transects) could have permitted more robust comparisons of bird abundance. Nevertheless, our results provide evidence that several grassland bird species can use OWB monocultures during winter.

MANAGEMENT IMPLICATIONS

Although we observed higher numbers of some wintering bird species in OWB fields in our study (e.g., Smith's longspur, northern harrier, and short-eared owl), native fields supported more species overall. Therefore, maintaining native prairie could promote higher bird diversity during winter than OWB monocultures. While OWB fields might provide adequate wintering habitat for some species, negative effects of OWB and other exotic grasses on breeding birds have been well established, and potential benefits to specific species may rarely justify their use in conservation programs. In light of the widespread use of OWB, additional studies are needed to elucidate its effects on wintering grassland birds and inform decisions regarding grassland restoration.

ACKNOWLEDGMENTS

We thank the landowners, including Groendyke Transport Inc. and Johnston Enterprises Inc., who generously provided access to their lands. Financial support for this project was provided from State Wildlife Grants under Project T-36-P of the Oklahoma Department of Wildlife Conservation and Oklahoma State University and administered through the Oklahoma Cooperative Fish and Wildlife Research Unit (Oklahoma Department of Wildlife Conservation, Oklahoma State University, United States Geological Survey, United States Fish and Wildlife Service and Wildlife Management Institute cooperating). Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

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Submitted 8 January 2013. Accepted 18 July 2013. Associate Editor was Mark Vrtiska.