AVIAN RESPONSE TO OLD WORLD BLUESTEM (*BOTHRIOCHLOA ISCHAEMUM*) MONOCULTURES IN MIXED-GRASS PRAIRIE

By

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TABLE OF CONTENTS

LIST OF TABLES

Table Page

Chapter I

Chapter II

LIST OF FIGURES

Figure Page

Chapter I

Chapter II

CHAPTER I

INFLUENCE OF SEEDED EXOTIC GRASSLANDS ON DENSITY AND COMMUNITY COMPOSITION OF BREEDING SONGBIRDS IN MIXED-GRASS PRAIRIE

Introduction

Grassland bird populations have exhibited more rapid and widespread declines than any other group of birds in North America (Peterjohn and Sauer 1999, Askins et al. 2007, Sauer et al. 2007), with habitat loss, degradation, and fragmentation often cited as the primary causes (Vickery and Herkert 2001). While the majority of habitat loss has involved conversion of native prairie to grain cultivation, seeded grasslands, managed to support a single or small number of exotic grass species, have become extensive throughout the Great Plains, and may be an important factor contributing to grassland bird declines (Delisle and Savidge 1997, Sutter and Brigham 1998, Hickman et al. 2006). In the mid 1980s, it was estimated that seeded monocultures accounted for > 30% of the total grassland cover in Montana, North Dakota, Wyoming, South Dakota, Colorado, Nebraska, Kansas, Oklahoma, New Mexico, and Texas (USDA 1986). With the passage of the 1985 Food Security Act's Conservation Reserve Program (CRP), millions of additional hectares were converted from cropland to exotic monocultures (Schenk and Williamson 1991, Baker 2000).

The CRP provides landowners financial incentives to remove cropland from production and place it in permanent cover under 10- or 15-year contracts (USDA 2008b, Anstey et al. 1995). The original CRP sign-up allowed, and in some cases encouraged (Baker 2000), landowners to plant exotic species such as weeping lovegrass (*Eragrostis curvula*), crested wheatgrass (*Agropyron cristatum*), and Old World bluestem (OWB; *Bothriochloa ischaemum*). These grasses have a wide tolerance of environmental conditions and are easy to establish, but they also may displace native species, thereby reducing diversity and disrupting native grassland ecosystems (D'Antonio and Vitousek 1992). Despite more stringent requirements to plant native grasses in both new CRP sign-ups and renewals after 1996, fields planted to a single, exotic species are still abundant. It has been estimated that >1 million ha were planted in Oklahoma and Texas alone over 10 years (White and Dewald 1996). Over 50% of the CRP land has been planted to OWB in some western Oklahoma counties (Ripper and VerCauteren 2007).

Studies examining effects of exotic grass species on birds have found mixed results. For example, Scott and Lima (2004) and Jones and Bock (2005) showed that some grassland birds, including species of conservation priority, can benefit from exotic grass fields if they meet specific area and structural requirements for breeding. Others suggest that exotic grasslands provide less suitable habitat for breeding birds because these fields support simplified plant communities and fewer arthropods than native fields (Flanders et al. 2006, Hickman et al. 2006). Despite widespread use and invasive potential of OWB, few studies have examined effects of seeded OWB monocultures on grassland songbirds (McIntyre and Thompson 2003, Chapman et al. 2004, Hickman et al. 2006), and these have not included a sampling method that allows for robust comparisons of abundance and density among different species. Moreover, the overall avian conservation value of OWB fields has not been compared to that of native mixed-grass prairie.

My objectives were to compare 1) abundance and community composition of breeding birds, 2) vegetation structure and composition, and 3) arthropod biomass between OWB monocultures and native mixed-grass prairie.

Methods

I conducted this study in May–July, 2007 and 2008 in Alfalfa, Grant, and Garfield counties in north-central Oklahoma, which is part of the Prairie Tableland ecoregion of the Central Great Plains (Woods et al. 2005). This ecoregion is characterized by level to slightly rolling plains (local relief, 3–42 m) with deep, fertile soils. The mean daily high temperature ranges from 13^{o}C to 35^{o}C from May through July. Mean precipitation is 68–94 cm, >30% of which falls from May through July (Oklahoma Climatological Survey 2008). The dominant land use in the study area is small grain agriculture (primarily winter wheat and grain sorghum) and alfalfa production. Seeded grassland is abundant, mainly as OWB monocultures (Ripper and VerCauteren 2007). The natural vegetation is mixed-grass prairie, dominated by little bluestem (*Schizachyrium scoparium*), big bluestem (*Andropogon gerardii*), side-oats grama (*Bouteloua curtipendula*), blue grama (*Bouteloua gracilis*), indiangrass (*Sorghastrum nutans*), switchgrass *(Panicum virgatum*), and buffalograss (*Buchloe dactyloides*). Rangeland is more common than cropland on steeper slopes (Woods et al. 2005). I selected all study sites within a broad agricultural matrix interspersed with grassland cover. Dominant land cover consisted of about 68% cropland and 26% native rangeland or exotic pastures in Alfalfa, Grant, and Garfield counties (USDA 2008a).

I selected 12 privately owned study sites to provide 6 replicates of OWB monoculture and 6 replicates of native mixed-grass prairie (Fig. 1). I attempted to select study fields representative of the region, with consideration given to area (60–100 ha), topography (flat to gently rolling), and management. Fields were classified according to a visual estimation of grazing intensity (Smith 1998). Fields with a higher proportion of vegetation visible than bare ground were classified as lightly grazed. Fields with a higher proportion of bare ground were classified as heavily grazed. Eleven of 12 sites were lightly grazed by cattle during the study; one field of native grasses was heavily grazed. Four of the OWB sites also were managed for hay production. Because OWB is a warm-season grass, haying in the study area occurred once or twice annually in mid-July to mid-August, after the completion of field sampling. Two of the OWB fields were fertilized during the study to promote hay production; no other specific disturbances related to hayfield management occurred at any of the sites during the study.

I estimated bird density at all fields using distance sampling (Buckland et al. 2001). I used National Agricultural Imagery Program (http://www.fsa.usda.gov/FSA) aerial photos to establish 750-m transects in each field; no transect was placed within 50 m of a field's edge. I avoided placing transects parallel and close to field edges and riparian zones to avoid biasing detection distances in response to linear features parallel to the transect line. Transects were marked with a hand-held GPS unit and the same transects were resampled throughout the study.

Each field was sampled between three and five times in 2007 and five times in 2008 from mid-May through mid-July on days with no rain and light winds (<10 km/hr). I sampled between 0530 and 1000 h CDT by slowly walking each transect and recording all individuals seen or heard. Flyovers and birds using field edges were not counted. I used a compass and laser rangefinder to determine the distance (m) and angle (azimuth degrees) to each bird from the point of detection and later calculated the perpendicular distance from each bird to the transect.

I restricted statistical analyses to those species detected on ≥ 25% of the surveys within a field type, in at least 1 year. I estimated density (number of individuals/ha) for Grasshopper Sparrow (*Ammodramus savannarum*), Eastern Meadowlark (*Sturnella magna*), and Dickcissel (*Spiza americana*) in each year and in each of the two field types using the program DISTANCE (Thomas et al. 1998, Buckland et al. 2001). DISTANCE used the perpendicular distance from the transect line to each individual bird detected to generate a detection model used to provide a density estimate. Distance Sampling is described in detail by Buckland et al. (2001). I interpreted differences in breeding density as statistically significant based on non-overlapping 95% confidence intervals in density estimates provided by DISTANCE. Because differences were not detected between years, data for each species were pooled to test for field type effects.

No other bird species, aside from the three mentioned above, encountered during this study occurred frequently enough on study sites to obtain adequate sample sizes ($n > 60$) for accurate density estimation with DISTANCE. Therefore, to minimize error resulting from differences in detectability, I compared detection-distance histograms among samples and truncated data to within 25 m of transects. That allowed analysis of 6 additional species with ≥ 25% detectability rates. Density (number of individuals/ha) was estimated for each visit to a site and averaged within years for statistical analyses. Data were pooled when no year effect was detected. I used a Wilcoxon signed-rank test for differences between years within field types and a Mann-Whitney *U*-test to detect differences between field types. SPSS 16.0 (SPSS Institute, Chicago IL) was used for statistical comparisons of all data not analyzed with DISTANCE.

To investigate differences in breeding bird community composition between OWB and native grasslands, I calculated and compared species richness, the Shannon index of diversity (*H '*; Magurran 2004), and two indices of conservation value (*CV*) among all fields. Conservation values were based on Partners in Flight priority scores (Carter et al. 2000, Nuttle et al. 2003), and calculated as:

$$CV_1 = \sum_{i=1}^{S} p_i w_i \text{ and } CV_2 = \sum_{i=1}^{S} r_i w_i,$$

where *S* was the number of species in the community, *p* was presence or absence of species *i*, *r* was relative abundance of the species, and *w* was a weighting factor derived from each species' PIF regional conservation score. The CV_2 score weighed each species' conservation value according to its relative abundance, while the CV_1 score weighed all species' conservation scores equally. Therefore, the CV_1 score was more sensitive to uncommon species. I used the Mann-Whitney *U*-test to compare community composition parameters between OWB and native sites.

I measured vegetation during the third week of July, 2007 and 2008. All vegetation sampling was conducted before the start of haying in each field. Points were established at 30 random distances along the same transects used to sample birds. At each point, I measured vertical obstruction from 4 directions using a Robel pole (Robel et al. 1970; $n = 120$ points/field). The lowest obstructed point visible from 4 m at a height of 1 m above the ground was recorded. Standard deviations of vertical obstruction at each point (within a 4 m radius) and across each sampling transect (750 m) were used as measurements structural heterogeneity at the point and field scales (e.g., Fuhlendorf and Engle 2004). Plant canopy cover was estimated 1 m in front of the Robel pole in the direction of the transect using a 1-m^2 frame (Towne et el. 2005). Only plants rooted completely inside the frame were recorded. I estimated percent cover of OWB, other grasses, forbs, litter, and bare ground in cover classes (0%, 1–5%, 6–25%, 26–50%, 51–75%, 76–95%, 96–100%). Litter was defined as any dead plant material on the soil surface in any state of decomposition. Midpoints of each cover class were used to calculate percent canopy cover of vegetation characteristics (Daubenmire 1959, Towne et al. 2005). I also recorded the maximum vegetation height inside the frame. Repeated-measures ANOVA was used to compare July vegetation structure and composition characteristics between the two field types with year as the repeated measure. I identified relationships among vegetation variables and densities of uncommon bird species using a Spearman rank correlation matrix.

To determine effects of OWB on food availability for breeding grassland birds, I collected and compared arthropod samples in each site during the third week of July 2007 and 2008. I sampled arthropods with a 32-cm diameter net in 2007 and a gasoline-powered, hand-held vacuum (D-vac; Dietrick et al. 1960) in 2008 along the same transects used to sample birds and vegetation. Following the method of Hull et al. (1996), I walked slowly along a randomly chosen 100-m section of each transect, sweeping the top of the vegetation with the D-vac or net (100 sweeps). Samples were frozen immediately following collection. I sorted all arthropods by order and obtained dry biomass (g/transect) for each order in each field. I tested for differences in biomass between OWB and native sites for the most abundant arthropod orders using ANOVA. Because of differences in sampling methods between 2007 and 2008, no comparisons of arthropod biomass were made between years.

Results

In the 2007 and 2008 breeding seasons, I observed 40 bird species using native fields and 28 using OWB monocultures (Tab. 1). Nine species had $\geq$ 25% detection rates in at least one field type and were compared between field types (Fig. 2). No year effects were detected between 2007 and 2008, so data were pooled for tests of differences between field types. Grasshopper Sparrow was the most abundant species, followed by Eastern Meadowlark and Dickcissel. Of those species analyzed with DISTANCE, density of Grasshopper Sparrow was significantly different and higher in OWB monocultures ($P = 0.01$). Densities of Dickcissel and Eastern Meadowlark did not differ between the two field types. Of the less abundant species, Killdeer ($U = 3.5$, $P = 0.01$) occurred at higher densities in fields planted to OWB, while Northern Bobwhite ($U = 3.0$, $P < 0.01$) and Lark Sparrow ($U = 9.0$, $P = 0.05$) occurred at higher densities in native mixed-grass prairie. I detected no differences among other species.

Mean Shannon diversity ($U = 6.00$, $P = 0.03$), species richness ($U = 4.50$, $P = 0.02$), and CV_1 ($U = 5.00$, $P = 0.02$) were higher in native fields. Mean CV_2 was higher in OWB fields than in native prairie (Tab. 2; $U = 0.00$, $P < 0.01$).

Differences in structure and composition of vegetation variables were detected between years and between field types (Tab. 3). Litter cover ($F = 10.1$, $P = 0.01$) was lower, and vegetation height ($F = 39.63$, $P < 0.001$), vertical obstruction ($F = 13.1$, $P = 0.01$), and point heterogeneity ($F = 8.56$, $P = 0.02$) were higher in July 2007 than in July

2008. Forb cover ($F = 21.2$, $P = 0.002$) and litter cover ($F = 9.09$, $P = 0.017$) were higher in native fields than OWB in both years.

Spearman-rank correlations revealed relationships between some bird species and vegetation characteristics (Tab. 4; Fig. 3). Dickcissel density was correlated positively to forb cover ($P = 0.05$), vertical obstruction ($P < 0.01$), and point structural heterogeneity ($P = 0.03$). Density of Brown-headed Cowbirds was correlated negatively to vegetation height ($P = 0.04$), and vertical obstruction ($P = 0.01$). Killdeer density was correlated negatively to forb cover ($P = 0.02$), vertical obstruction ($P = 0.04$), and point structural heterogeneity ($P = 0.04$). Mourning Dove density was correlated positively to bare ground ($P = 0.01$). Density of Northern Bobwhite was correlated positively to forb cover ($P = 0.01$), and litter cover ($P < 0.01$), and negatively correlated to bare ground ($P = 0.01$). Density of Lark Sparrow was correlated negatively to vegetation height ($P = 0.01$).

Total arthropod biomass was higher in native fields than OWB monocultures during both years (Fig. 4): 2007 ($F = 4.59$, $P = 0.05$) and 2008 ($F = 11.83$, $P = 0.01$). Orthoptera was the dominant arthropod order by biomass in both sampling periods, followed by Hemiptera, Coleoptera, and Aranaea (Fig. 5). Biomass of Orthoptera ($F = 10.12$, $P = 0.01$) and Coleoptera ($F = 4.64$, $P = 0.05$) in July 2007, and biomass of Orthoptera ($F = 6.90$, $P = 0.03$), Hemiptera ($F = 21.17$, $P < 0.01$), and Coleoptera ($F = 5.14$, $P = 0.05$) in July 2008 were higher in native-mixed grass prairie than seeded monocultures.

Discussion

Exotic species invasions can threaten native ecosystems, with potential negative consequences to community composition, competitive interactions, and disturbance regimes (Bock et al. 1986, D'Antonio and Vitousek 1992, Wilcove et al. 1998, Mack et al. 2000). Several studies have indicated that OWB may have substantial negative effects on native grasslands. Eck and Sims (1984) and Gabbard and Fowler (2007) showed that OWB can invade areas where it was not planted, reducing plant community diversity. Studies by McIntyre (2003) and McIntyre and Thompson (2003) suggest that OWB fields support lower arthropod diversity than do stands of native grasses. Hickman et al. (2006) found that bird species richness and abundance and arthropod biomass were lower in OWB monoculture fields relative to native mixed-grass prairie.

In this study, some bird community metrics were reduced on fields seeded to OWB and managed as monocultures, but these fields can provide usable and potentially superior breeding habitat for some grassland species such as Killdeer and Grasshopper Sparrow. For example, Grasshopper Sparrow occurred in OWB fields at more than twice the densities of native fields. Other studies have shown that Grasshopper Sparrows select larger tracts of uninterrupted habitat, with shorter vegetation, less vertical cover, and little shrub cover (e.g, Patterson and Best 1996, Vickery 1996, Delisle and Savidge 1997). Because OWB fields are often established on former cropland and are managed as monocultures, they generally meet the above characteristics. While vertical obstruction and vegetation height did not differ in this study, OWB fields did provide larger tracts of homogenous habitat, devoid of woody plants. It is unlikely, however, that the difference in Grasshopper Sparrow breeding density between OWB and native grass fields was due to landscape differences between the two types of fields. All fields occurred in similar agricultural/grassland matrices and all were large (60–100 ha) relative to the minimum area requirements reported for Grasshopper Sparrows in other parts of their range where they are abundant (e.g., 10–30 ha, Herkert 1994; 8–12 ha, Helzer and Jelinski 1999).

At a fine scale, Vickery et al. (1994) reported a positive association between Grasshopper Sparrow abundance and litter and forb cover. I found no correlation; rather, these two variables were higher in native fields than in OWB fields. In Wisconsin, Wiens (1969) found 30% forb cover in fields selected by Grasshopper Sparrows, in contrast to my findings of < 2% and < 15% in OWB and native fields, respectively, perhaps reflecting regional variation in habitats selected by this species. While Grasshopper Sparrow was abundant in both types of fields, the higher breeding density observed in OWB monocultures indicated that homogenous fields with fewer forbs and relatively less litter were perceived by the birds as appropriate breeding habitat.

These findings appear consistent with other studies (Jones and Bock 2005) that suggest that grass species composition is less important than vegetation structure in providing habitat for individual species of grassland birds. In eastern North America, for example, exotic grass fields support multiple species of grassland birds (Norment 2002, Scott et al. 2002). In some instances, however, high breeding densities may be correlated negatively with individual reproductive success (Dwernychuck and Boag 1972, Van Horne 1983). The fact that I observed a higher density of Grasshopper Sparrows in OWB fields despite decreased arthropod biomass suggested that individual reproductive success could have been lower in OWB fields than in native fields. Future research in this system should address the functional significance of OWB for Grasshopper Sparrow. Research that focuses on reproductive success and site fidelity of Grasshopper Sparrow in OWB fields elucidate the degree to which these fields generally provide favorable conditions for breeding or constitute ecological traps.

In contrast to Grasshopper Sparrows, the OWB fields in this study supported lower densities of species such as Northern Bobwhite and Lark Sparrow than native fields. These findings are supported by other studies (e.g., Bock et al. 1986, Flanders et al. 2006, Hickman et al. 2006) suggesting that exotic plant invasions alter vegetation structure and composition, reducing habitat suitability for various bird species. Differences in plant species composition between OWB and native fields may have contributed to differences in bird densities. Some researchers have shown that birds choose habitats on the basis of species composition of plant communities (Block and Brennan 1993, Rotenberry and Wiens 1998). While I did not compare specific plant composition, I did find a higher percentage of forbs in native fields. Because OWB fields are seeded and managed as monocultures, they contain lower plant species richness and structural diversity, resulting in reduced habitat for many grassland birds.

Vegetation structure, and by extension bird community composition, in managed grasslands can be influenced as much by the frequency of haying, intensity of grazing, and application of fertilizers as by the plant species composition. For example, densities of several bird species were related to vegetation characteristics that are influenced by management. Dickcissel density was correlated positively to forb cover, vertical obstruction, and field structural heterogeneity. Dickcissels nest in a variety of grassland habitats, including hayfields and native prairie. Dense cover, forbs or woody vegetation, moderate to tall vegetation, a layer of litter, and presence of elevated song perches are characteristics of fields selected by Dickcissels (Temple 2002. Dechant et al. 2003). In my study area, Dickcissel densities were highest where such structural characteristics were evident, regardless of field type.

Brown-headed Cowbird densities were correlated negatively to vegetation height and vertical obstruction. This reflects Brown-headed Cowbirds' affinity for livestock (Lowther 1993); vertical obstruction and vegetation height decrease with grazing intensity. Killdeer densities were correlated negatively to forb cover, vertical obstruction, and point heterogeneity. Killdeer require open habitats with short or no vegetation to employ the "running" foraging strategy characteristic of plovers (Jackson and Jackson 2000). Density of Mourning Doves, which often nest and exclusively forage on the ground (Otis et al. 2008), was correlated positively to bare ground. Northern Bobwhite densities were correlated positively to forb cover and litter cover, and negatively correlated to bare ground. Northern Bobwhites can inhabit a wide variety of early successional areas that provide woody cover and forbs, which make up an important component of adult diets (Brennan 1999). Density of Lark Sparrow, a ground foraging omnivore during the breeding season (Martin and Parrish 2000), was correlated negatively to vegetation height. With the exception litter and forb cover, the vegetation characteristics measured did not differ between the two field types; densities of the above bird species were correlated to vegetation characteristics regardless of whether fields were managed as OWB monocultures or native mixed grass prairie.

While individual species varied in response to numerous vegetative characteristics, bird community characteristics responded more clearly to field type. Mean species richness and diversity were higher in native fields than those planted to

OWB. This was expected because grasslands managed as monocultures typically provide less habitat heterogeneity, and fewer niches available for birds than native prairie (Sutter and Brigham 1998).

In addition to these traditional community metrics, I supplemented species richness and diversity calculations with indices of conservation value (*CV*) derived from Partners in Flight (PIF) categorical scores (Carter et al. 2000, Nuttle et al. 2003). Mean CV_1 scores, based on presence-absence, were higher in native fields than OWB. The CV_1 scores weigh all species equally, and that maximized the influence of rare species, such as Painted Bunting (*Passerina ciris*) and Bell's Vireo (*Vireo bellii*) on the assessment.

In contrast to CV_1 scores, CV_2 scores were determined using relative abundance (as a percentage of total abundance of all birds observed), so the influence of rare species remained limited in the equation. The CV_2 scores were higher in OWB fields, and this was due to the high relative abundance of grassland priority species, such as Grasshopper Sparrow. It is important to interpret *CV* indices in the context of other measurements of diversity and community composition (Nuttle et al. 2003). In this study, grasslands managed as OWB monocultures supported a lower richness, diversity, and one measure of *CV* of breeding bird communities. However, a *CV* based on relative abundance (i.e. CV_2) favored OWB fields, illustrating the importance of using multiple indicators a habitat's condition.

Exotic grasses may have detrimental effects on the functional relationships among birds and their prey. That arthropods are crucial to birds during the breeding season has been well established (Wiens 1969; 1973). Insects (Orthoptera, Lepidoptera, Coleoptera, Hemiptera, Hymenoptera) and spiders (Aranaea) are important to meet dietary requirements for molting, reproduction, and nestling development (Bent 1960, Baldwin 1970, Maher 1979). In this study, total arthropod biomass and biomass of taxa important for birds (e.g., Orthoptera, Hemiptera, and Coleoptera) were lower in OWB fields than in native fields. This is consistent with other studies (Jonas et al. 2002, McIntyre and Thompson 2003, Hickman et al. 2006) and may be an important mechanism limiting some bird species. For example, Martin (1987) showed that food limitation is an important ecological phenomenon and can influence life-history traits, population sizes, and community structure. As food availability decreases, territory size often increases, forcing breeding birds to spend more time and energy foraging for exogenous resources, resulting in lower nest success or adult survival. Effects of food limitation may be further compounded by interspecific competition, with community composition changing to favor those species with superior competitive abilities. Furthermore, species with high nest-site fidelity that undergo decreased reproductive success and adult survival due to food limitation may be more prone to site-specific population declines. Thus, compositional differences influencing food availability between OWB and native fields may have ramifications for breeding habitat quality.

The degree to which food availability influences habitat selection, however, is unclear (Cody 1981). For example, Shochat et al. (2005) suggested that arthropod abundance is important in determining where Grasshopper Sparrows, Eastern Meadowlarks, and Dickcissels establish territories. In their study, disturbed areas served as ecological traps because they produced more arthropods (thereby increasing breeding densities) but supported more nest predators. In my study, while reduced arthropod biomass may have caused some bird species to avoid OWB fields, this was not the case for Grasshopper Sparrows, which were present at higher densities in OWB than in native fields. Bock et al. (1986) likewise found higher densities of grassland birds in exotic grass fields than native prairie despite lower arthropod abundance, and Hull et al. (1996) found no relationship in Kansas CRP fields, further suggesting that food availability has a limited role in habitat selection for these species. Nevertheless, arthropods must be available as a food resource in grassland habitats during the breeding season for bird populations to persist. If bird species such as Grasshopper Sparrow select OWB fields based on structural or landscape factors, despite insufficient food resources, these fields may serve as ecological traps.

Recently, natural resource agencies have encouraged the planting of native grasses to benefit wildlife (USDA 2008c) but seeded OWB monocultures, established in the 1980's–1990's, are still abundant throughout the southern Great Plains. While the planting of OWB and other exotic grasses may provide superior wildlife habitat compared with areas of intensive agriculture (Johnson and Schwartz 1993, Best et al. 1997), and may be preferable for select bird species (Jones and Bock 2005), it is clear from this study and others (Flanders et al. 2006, Hickman et al. 2006) that native grasslands support more complex bird communities, including a number of species of conservation priority. In light of the negative impacts of exotic species on native biodiversity in general (Mack et al. 2000), I recommend that native grasses be used in future conservation programs.

Future research should be directed toward the potential influence of OWB on mechanisms of bird reproductive success and source/sink dynamics of common species and species of conservation priority. Additionally, studies should investigate landscape level effects of OWB monocultures on bird populations, incorporating the cropland-exotic monoculture-native grassland matrix at different scales. Understanding the mechanisms by which OWB and other exotic grasses influence native ecosystems will allow prioritization of conservation activities and the mitigation of negative impacts through more effective management practices.

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Table 1. Partners in Flight Regional Combined Scores (PIF RCS), total abundance (*n*), and frequency of sites in which detected (%) of all bird species observed using Old World Bluestem (OWB) monocultures and native grasslands during the 2007 and 2008 breeding seasons. Only species documented as breeding in the study area and defined as landbirds by PIF received RCS.

			OWB		Native	
Common Name	Scientific Name	PIF RCS	*n*	%	*n*	%
Grasshopper Sparrow	*Ammodramus savannarum*	15	610	100	312	100
Eastern Meadowlark	*Sturnella magna*	15	346	100	272	100
Dickcissel	*Spiza Americana*	15	232	100	447	100
Brown-headed Cowbird	*Molothrus ater*	12	66	83	43	100
Killdeer	*Charadrius vociferous*	–	43	83	4	33
Mourning Dove	*Zenaida macroura*	12	29	67	41	83
Common Nighthawk	*Chordeiles minor*	12	20	50	2	17
Western Meadowlark	*Sturnella neglecta*	15	16	83	2	17
Upland Sandpiper	*Bartramia longicauda*	–	13	83	2	33
Scissor-tailed Flycatcher	*Tyrannus forficatus*	16	11	67	22	50
Lark Sparrow	*Chondestes grammacus*	14	7	17	54	67
Baltimore Oriole	*Icterus galbula*	16	6	17	7	33
Ring-necked Pheasant	*Phasianus colchicus*	12	5	33	13	67
Horned Lark	*Eremophila alpestris*	11	5	33	0	0
Red-winged Blackbird	*Agelaius phoeniceus*	11	3	50	5	50
Eastern Kingbird	*Tyrannus tyrannus*	14	3	17	3	50
Common Grackle	*Quiscalus quiscula*	11	3	17	0	0
Cattle Egret	*Bubulcus ibis*	–	2	17	27	50
Western Kingbird	*Tyrannus verticalis*	14	2	17	4	50
American Goldfinch	*Carduelis tristis*	9	2	17	0	0
Mallard	*Anas platyrhynchos*	–	2	33	0	0
Northern Bobwhite	*Colinus virginianus*	14	1	17	90	100
Eastern Bluebird	*Sialia sialis*	9	1	17	1	17
Barn Swallow	*Hirundo rustica*	13	1	17	0	0
Great Egret	*Ardea alba*	–	1	17	0	0
Orchard Oriole	*Icterus spurious*	15	1	17	0	0
Swainson's Hawk	*Buteo swainsoni*	18	1	17	0	0
Turkey Vulture	*Cathartes aura*	11	1	17	0	0
Northern Mockingbird	*Mimus polyglottos*	11	0	0	12	50
Red-tailed Hawk	*Buteo jamaicensis*	11	0	0	12	83
Bell's Vireo	*Vireo bellii*	17	0	0	5	67
Clay-colored Sparrow	*Spizella pallid*	–	0	0	4	33
American Crow	*Corvus brachyrhynchos*	9	0	0	3	17
Bewick's Wren	*Thryomanes bewickii*	13	0	0	3	33
Yellow-billed Cuckoo	*Coccyzus americanus*	15	0	0	3	17
Blue Grosbeak	*Passerina caerulea*	12	0	0	2	33
Brown Thrasher	*Toxostoma rufum*	14	0	0	2	33
Great Crested Flycatcher	*Myiarchus crinitus*	11	0	0	2	17
Least Flycatcher	*Empidonax minimus*	9	0	0	2	17
Northern Cardinal	*Cardinalis cardinalis*	8	0	0	2	33
Painted Bunting	*Passerina ciris*	17	0	0	2	17
Wild Turkey	*Meleagris gallopavo*	12	0	0	2	33
Yellow Warbler	*Dendroica petechia*	10	0	0	2	33

Table 1. Continued.

Common Name	Scientific Name	PIF RCS	OWB		Native	
			n	%	*n*	%
Blue-gray Gnatcatcher	*Polioptila caerulea*	9	0	0	1	17
Eastern Phoebe	*Sayornis phoebe*	9	0	0	1	17
Field Sparrow	*Spizella pusilla*	14	0	0	1	17
Great Horned Owl	*Bubo virginianus*	12	0	0	1	17
Loggerhead Shrike	*Lanius ludovicianus*	16	0	0	1	17
Red-headed Woodpecker	*Melanerpes erythrocephalus*	16	0	0	1	17

Table 2. Bird community composition parameters (mean and SE): Shannon-Weiner diversity (*H'*), species richness, and conservation values (CV_1 and CV_2) of OWB monocultures and native mixed-grass prairie in north-central Oklahoma during the 2007 and 2008 breeding seasons.

	OWB			Native		
	$\bar{x}$	$\pm$	SE	$\bar{x}$	$\pm$	SE
*H'**	1.44	$\pm$	0.14	1.86	$\pm$	0.11
Richness*	9.50	$\pm$	1.75	16.00	$\pm$	1.88
CV_1*	129.17	$\pm$	22.99	209.00	$\pm$	25.24
CV_2*	14.20	$\pm$	0.27	8.82	$\pm$	0.64

* $P < 0.05$

Table 3. Vegetation characteristics (mean and SE) of OWB monocultures and native mixed-grass prairie in north-central Oklahoma in July 2007 and 2008.

	July-07						July-08					
	OWB			Native			OWB			Native		
	$\bar{x}$	±	SE	$\bar{x}$	±	SE	$\bar{x}$	±	SE	$\bar{x}$	±	SE
Grass cover (%)	72.48	±	3.49	52.57	±	8.57	50.49	±	16.06	62.05	±	10.76
Forb cover (%) [a]	1.26	±	0.63	14.99	±	3.84	1.62	±	0.66	10.60	±	2.98
Litter cover (%) [a b]	3.01	±	0.73	5.76	±	0.91	7.66	±	2.53	19.75	±	3.63
Bare ground (%)	27.26	±	4.13	25.18	±	7.40	25.15	±	5.76	28.59	±	10.48
Vegetation height (cm) [b]	76.93	±	6.12	91.52	±	18.87	47.74	±	3.07	59.71	±	9.90
Vertical obstruction (dm) [b]	3.96	±	1.14	5.51	±	1.95	1.79	±	0.22	2.32	±	0.57
Point heterogeneity [b]	0.60	±	0.04	1.24	±	0.34	0.53	±	0.03	0.69	±	0.15
Field heterogeneity	1.22	±	0.16	2.36	±	0.73	1.10	±	0.22	1.08	±	0.19

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

Table 4. Spearman rank correlations between breeding bird densities (birds/ha) and July vegetation characteristics in OWB monocultures and native mixed-grass prairie in north-central Oklahoma during the 2007 and 2008 breeding seasons.

	Forb cover	Litter cover	Bare ground	Vegetation height	Vertical obstruction	Point heterogeneity
Brown-headed cowbird				-.434*	-.523*	
Killdeer	-.508*				-.441*	-.440*
Mourning Dove			.559**			
Northern Bobwhite	.540**	.580**	-.533*			
Lark Sparrow				-.522*		

* = P < 0.05   ** = P < 0.01

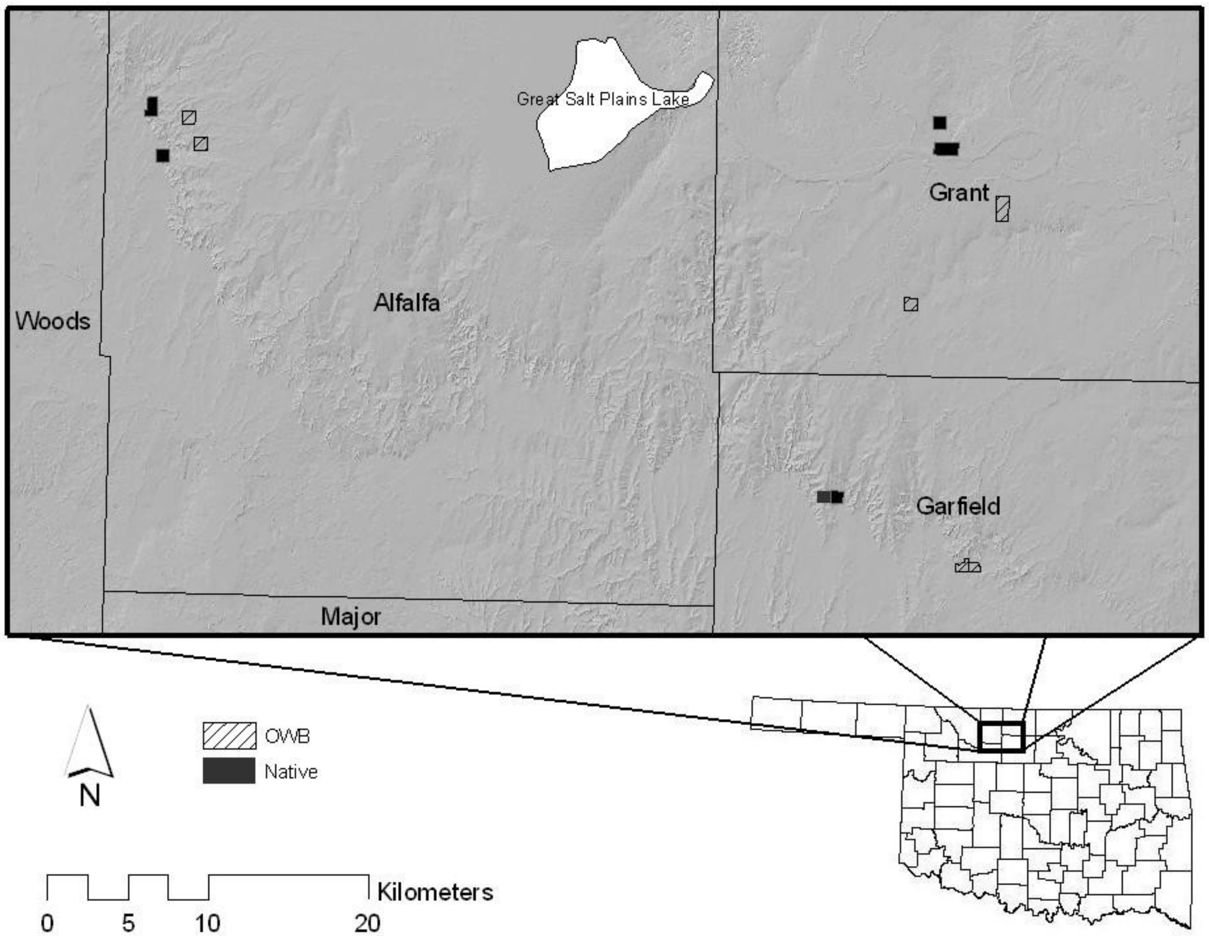


Figure 1. Map of study area showing all study sites: 6 OWB monocultures and 6 native fields in Alfalfa, Grant, and Garfield Counties in north-central Oklahoma.

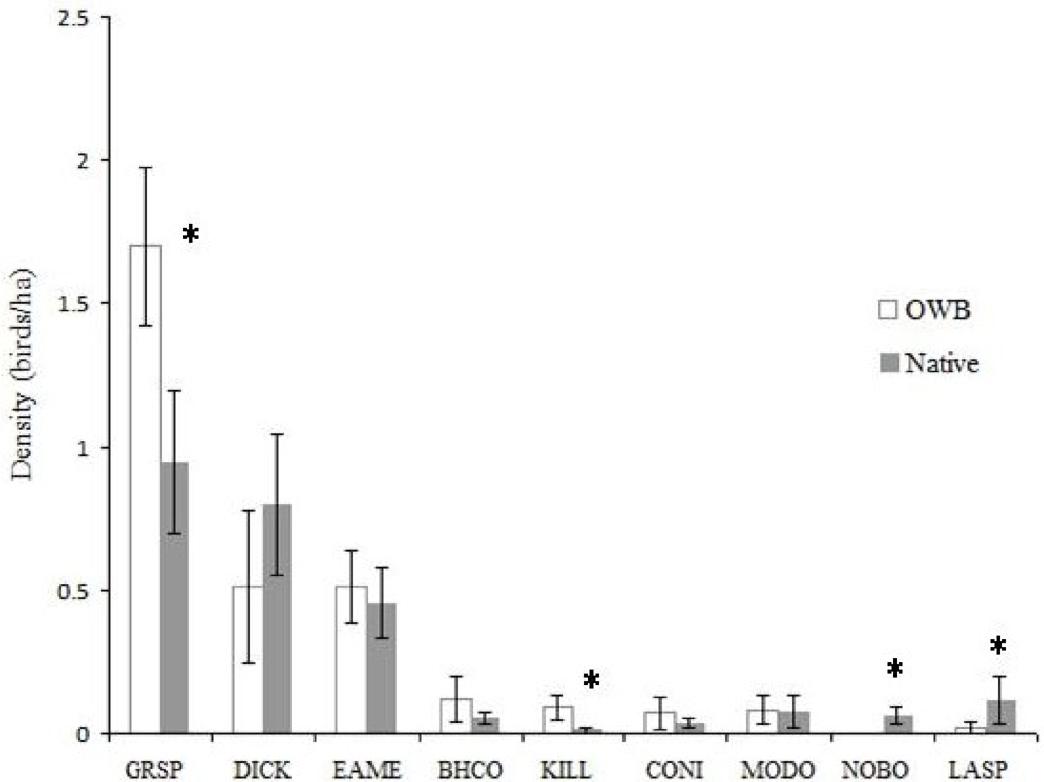


Figure 2. Mean density of bird species detected on at least 25% of surveys within a field type (OWB monocultures and native mixed-grass prairie) during the breeding season in north-central Oklahoma in 2007 and 2008. Error bars represent SE. Species included Grasshopper Sparrow (GRSP), Dickcissel (DICK), Eastern Meadowlark (EAME), Brown-headed Cowbird (BHCO), Killdeer (KILL), Common Nighthawk (CONI), Mourning Dove (MODO), Northern Bobwhite (NOBO), and Lark Sparrow (LASP). * designates those species with $P < 0.05$

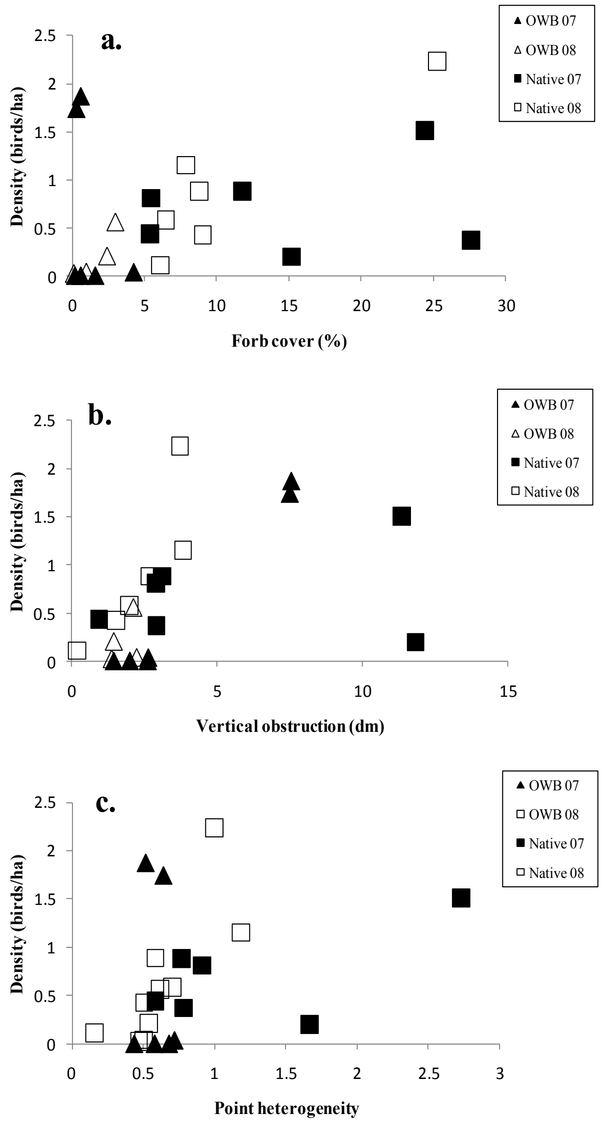


Figure 3. Relationship between Dickcissel density and a) forb cover, b) vertical obstruction, and c) point heterogeneity in OWB monocultures and native prairie during the 2007 and 2008 breeding seasons in north-central Oklahoma.

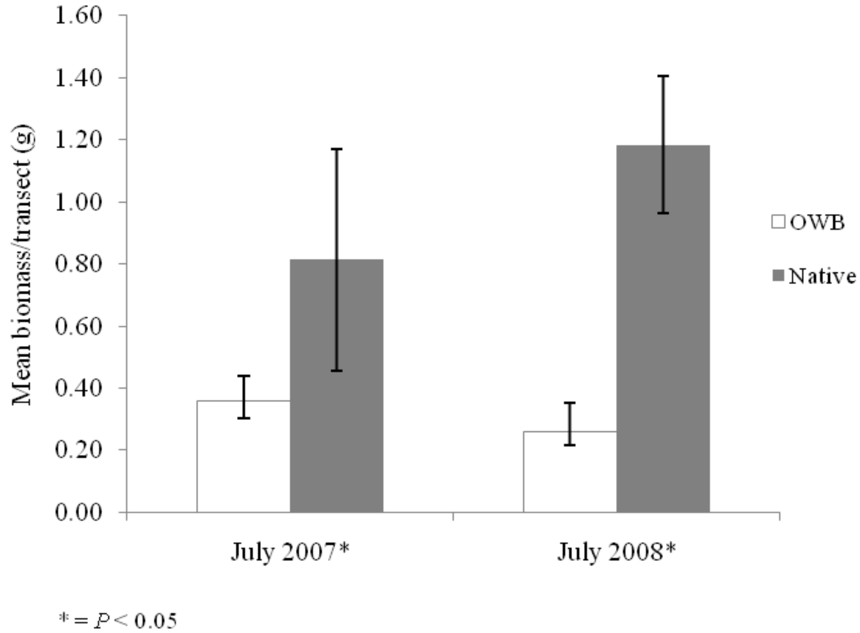
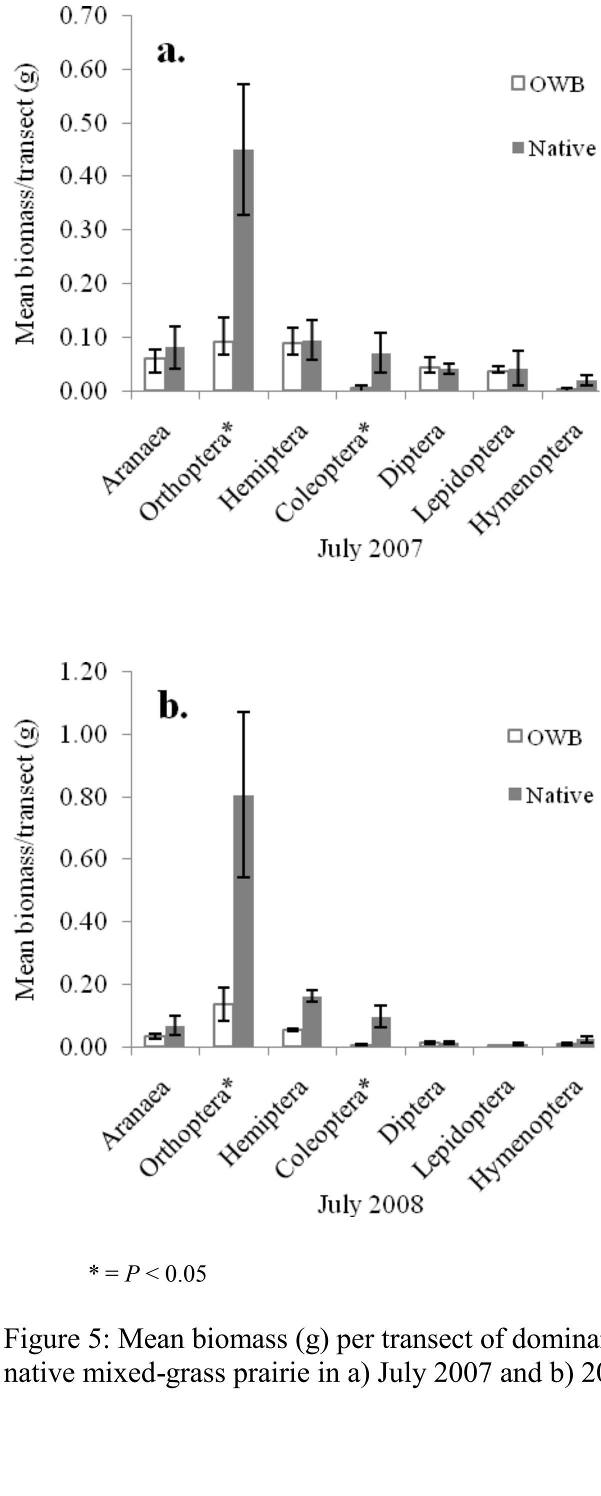


Figure 4. Mean biomass (g) per transect of all arthropod orders in Old World Bluestem (OWB) monocultures and native mixed-grass prairie in July 2007 and 2008. Error bars represent SE.



* = $P < 0.05$

Figure 5: Mean biomass (g) per transect of dominant arthropod orders in OWB monocultures and native mixed-grass prairie in a) July 2007 and b) 2008. Error bars represent SE.

CHAPTER II

INFLUENCE OF SEEDED EXOTIC GRASSLANDS ON WINTERING SONGBIRDS IN MIXED-GRASS PRAIRIE

Introduction

In North America, grassland birds have shown persistent and widespread declines since at least 1966 (Peterjohn and Sauer 1999, Askins et al. 2007, Sauer et al. 2007). Habitat loss, degradation, fragmentation (Vickery and Herkert 2001), changes in grazing management (Kantrud 1981, Baker and Guthery 1990), increased acreage of row-crops (Warner 1994), and invasions by exotic grasses (Delisle and Savidge 1997, Sutter and Brigham 1998, Hickman et al. 2006) have been identified as possible causes of these declines during the breeding season. Yet, many species that rely on grassland habitat in the southern Great Plains are winter residents, and these species also may be undergoing regional declines (Root 1988, Best et al. 1998, Sauer et al. 2007). Grasslands in the southern plains may support winter assemblages dominated by Nearctic migrants like longspurs (*Calcarius* spp.) that breed in northern grasslands and tundra and are therefore poorly sampled by monitoring programs such as the North American Breeding Bird Survey.

Habitat requirements of wintering grassland birds often contrast with those of species that rely on grasslands for breeding. For example, breeding passerines are usually insectivorous while winter residents are granivorous. Non-breeding season use of grassland habitat includes protection from predators and adverse weather as well as aplace to rest and restore energy reserves (Gottfried and Franks 1975, Kricher 1975, Lima 1993, Marra et al. 2005). Therefore, effects of anthropogenic disturbance on breeding birds could differ from on winter residents.

In the mid 1980s, > 30% of the grassland cover in the Great Plains states was seeded monocultures (USDA 1986). After the Conservation Reserve Program (CRP) was established as part of the 1985 Food Security Act, millions of additional hectares of cropland were converted to seeded grassland (Schenk and Williamson 1991, Baker 2000). The CRP provides financial incentives to landowners who retire cropland from production and place it in permanent cover under 10- or 15-year contracts (USDA 2008b), but because the CRP's primary goal was erosion control, the original sign-up often promoted the planting of exotic grasses such as weeping lovegrass (*Eragrostis curvula*), crested wheatgrass (*Agropyron cristatum*), or Old World bluestems (OWB; *Bothriochloa* spp). While these grasses may be widely tolerant of environmental conditions and are relatively easy to establish and manage, they also may become invasive, with negative consequences for native grasslands ecosystems (D'Antonio and Vitousek 1992). Despite more stringent requirements to plant native vegetation in the CRP after 1996, exotic monocultures are still widespread throughout the southern Great Plains. More than 1 million ha of OWB were planted in Oklahoma and Texas alone during a 10-year period (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). Despite the invasive potential and widespread use of OWB, only a few studies have compared OWB monocultures to native grasslands with respect to wildlife habitat (McIntyre and Thompson 2003, Chapman et al. 2004, Hickman et al. 2006), and none have examined the effects of OWB during winter.

My objectives were to compare 1) abundance and community composition of wintering birds and 2) vegetation structure and composition between OWB monocultures and native mixed-grass prairie during the winter season.

Methods

I conducted this study in December–March, 2007–2009 in the Prairie Tableland ecoregion of north-central Oklahoma (Woods et al. 2005), which is characterized by level to slightly rolling plains (local relief, 3–42 m) and deep, fertile soils. Mean high and low daily temperatures range from -1.76^{o}C to 11.43^{o}C in December–March. Mean precipitation is 37.1 cm in December–March; 20.07 cm of which is snow or ice (Oklahoma Climatological Survey 2008). Land use in the area is dominated by small grain agriculture or alfalfa. Grasslands seeded and managed as OWB monocultures are widespread throughout the region (Ripper and VerCauteren 2007). The natural vegetation is classified as mixed-grass prairie; dominants include little bluestem (*Schizachyrium scoparium*), big bluestem (*Andropogon gerardii*), side-oats grama (*Bouteloua curtipendula*), blue grama (*Bouteloua gracilis*), indiangrass (*Sorghastrum nutans*), switchgrass *(Panicum virgatum*), and buffalograss (*Buchloe dactyloides*). Rangeland is more common where topography is not suitable for cropland (Woods et al. 2005). Study sites were selected within a broad agricultural matrix interspersed with grassland cover. Dominant land cover in the area consisted of about 68% cropland and 26% native rangeland and exotic grass pastures (USDA 2008a).

I selected 12 study sites in Alfalfa, Grant, and Garfield counties to provide 6 replicates each of OWB monoculture and native mixed-grass prairie (Fig. 1). Study site selection was based on similarity in topography and management to what is typical in the region. Some of the native fields contained small patches of woody vegetation, including sand plum (*Prunus angustifolia*) and fragrant sumac (*Rhus aromatica*) although this was a minor landscape feature. Grazing intensity was visually estimated in each field (Smith 1998). Eleven of the fields had a higher proportion of vegetative cover than bare ground and were classified as lightly grazed by livestock; one field of native grasses had a higher proportion of bare ground than vegetative cover and was classified as heavily grazed. Four of the OWB fields were hayed once or twice annually in mid-July to mid-August. Two of the OWB fields were fertilized at an unknown date prior to the study to promote hay production.

I estimated bird abundance by counts conducted along transect lines following methods described by Bibby et al. (2000). I used aerial photos to establish 750-m transects in each field. I avoided placing 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 from mid-December through mid-February on days with no rain and light winds (<10 km/hr), with each field sampled 4x per winter. I sampled between early morning (>1 hr after sunrise) and late afternoon (>2 hr before sunset) by slowly walking each transect and recording all individuals seen or heard. Flyovers were only counted if they were actively foraging over the field.

I restricted statistical comparisons to bird species comprising at least 5% of all individuals detected within a field type, in at least one season. Abundance was calculated as number of individuals/km of transect. Distance to transect was not considered because Short-eared Owls (*Asio flammeus*) and virtually all passerines were detected by flushing within 10 m of the transect line, while most 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. I estimated abundance for Savannah Sparrow (*Passerculus sandwichensis*), meadowlarks (*Sturnella* spp.), Northern Harrier, Smith's Longspur (*Calcarius pictus*), Short-eared Owl, Song Sparrow (*Melospiza melodia*), and American Tree Sparrow (*Spizella arborea*). Because of difficulty in distinguishing between the two, all Eastern (*Sturnella magna*) and Western (*Sturnella neglecta*) meadowlarks were counted as meadowlarks. Bird abundance was estimated for each visit to a site and averaged within years for statistical analyses. Data from both years were pooled when no year effect was detected. A Wilcoxon signed-rank was used to test for differences between years within field types and a Mann-Whitney *U*-test was used to detect differences between field types.

I measured vegetation during the third week of February in 2008 and 2009. At 30 random distances along each transect, vertical obstruction was measured from 4 directions using a Robel pole (Robel et al. 1970; n = 120 points/field). Maximum vegetation height and the lowest visible point on the pole from 4 m at a height of 1 m above the ground were recorded. Standard deviations of vertical obstruction at each point (4 m radius) and across each sampling transect (750 m) were used as measurements of structural heterogeneity at the point and field scales (e.g. Fuhlendorf and Engle 2004). I 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). I only recorded plants rooted completely inside the frame. Percent cover of grasses, forbs, litter, and bare ground were estimated in cover classes (0%, 1-5%, 6-25%, 26-50%, 51-75%, 76-95%, 96-100%). Litter was defined as any plant material on the soil surface which did not appear rooted in the ground. I used the midpoints of each cover class to calculate percent canopy cover of vegetation (Towne et al. 2005). I used repeated-measures ANOVA to compare vegetation structure and composition characteristics between the two field types with year as the repeated measure.

To investigate compositional differences in wintering bird communities between OWB and native grasslands, I calculated and compared bird species richness, the Shannon index of diversity (*H'*; Magurran 2003), and two indices of conservation value (*CV*) for each field. Partners in Flight priority scores were used to derive *CV*s (Carter et al. 2000, Nuttle et al. 2003), which were calculated as:

$$CV_1 = \sum_{i=1}^{S} p_i w_i \text{ and } CV_2 = \sum_{i=1}^{S} r_i w_i,$$

where *S* was the number of species *i* in the community, *p* was presence or absence (0 or 1) of species, *r* was relative abundance of species, and *w* was a weighting factor derived from each species' PIF regional conservation score. The CV_2 score weighed each species' conservation score according to its relative abundance (% of total bird community) and the CV_1 score weighed each species' conservation score equally, given that it was detected in a study site. Therefore, the CV_1 score was more sensitive to uncommon species. Diversity, species richness, and conservation values were compared between field types with the Mann-Whitney *U*-test. All data were analyzed using SPSS 16.0 (SPSS Institute, Chicago IL). A significance level of $P \leq 0.10$ was used for comparisons of bird abundance and $P \leq 0.05$ for comparisons of community composition and vegetation variables between field types.

Results

In winter 2007–2008 and 2008–2009, I observed 26 bird species using native grass fields and 14 using OWB monocultures (Tab. 1). 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 (Tab. 2). Year effects were detected for five species. In native fields, Smith's Longspurs ($Z = 1.34$, $P = 0.09$) were more abundant during the second year, and Savannah ($Z = 1.83$, $P = 0.03$), American Tree ($Z = 1.46$, $P = 0.07$), and Song sparrows ($Z = 1.34$, $P = 0.09$) were more abundant during the first year. In OWB fields, Savannah Sparrows ($Z = 1.57$, $P = 0.06$) were more abundant in the first year, and Short-eared Owls ($Z = 1.83$, $P = 0.03$) were more abundant in the second year. Field-type effects were detected for six species. Smith's Longspurs ($U = 3.0$, $P < 0.01$) were more abundant in OWB fields, and Song ($U = 12.0$, $P = 0.07$) and American Tree ($U = 9.0$, $P = 0.03$) sparrows were more abundant in native fields in the first year. In the second year, Savannah Sparrows ($U = 10.0$, $P = 0.10$), Northern Harriers ($U = 7.00$, $P = 0.04$), and Short-eared Owls ($U = 8.00$, $P = 0.04$) were more abundant in OWB fields and American Tree Sparrows ($U = 12.0$, $P = 0.07$) were more abundant in native fields.

Year effects were detected for four vegetation variables in both OWB and native fields (Tab. 3). Grass cover ($F = 15.36$, $P < 0.01$), forb cover ($F = 14.83$, $P = 0.01$), and litter cover ($F = 24.4$, $P < 0.01$), were higher in the first year, and bare ground ($F = 9.2$, $P = 0.02$) was higher in the second year. Field type effects were only detected for forb cover, which was higher in native fields in both years ($F = 115.94$, $P < 0.01$; $F = 79.37$, $P < 0.01$).

Mean Shannon-Weiner diversity, species richness, and the CV_1 score did not differ between field types (Tab. 4). The CV_2 score was significantly higher in OWB fields ($U = 6.0$, $P = 0.03$).

Discussion

Several studies have reported that OWB may have negative impacts on native grasslands in the southern Great Plains where it has been widely introduced, including potential threats to breeding bird communities (Eck and Sims 1984, Gabbard and Fowler 2007, Hickman et al. 2006). Yet, the influence of OWB monocultures on wintering grassland birds is largely unknown. While I found low bird species richness during winter, and significantly lower numbers of Song Sparrow and American Tree Sparrow in OWB fields during at least one year, my results suggest that OWB monocultures may provide suitable wintering habitat for several grassland bird species, including Smith's Longspur, Chestnut-collared Longspur, Short Eared Owl, and Savannah Sparrow. Differences in response were likely due to differences in wintering habitat affinities among the species surveyed.

Song and American Tree sparrows use areas with at least some woody vegetation during winter, including field edges. Both species often forage on the ground in open areas and use nearby woody cover to roost or escape predators (West 1967, Naugler 1993, Arcese et al. 2002). Because I was concerned primarily with grassland bird species, I intentionally chose study fields without woody vegetation whenever possible and placed sampling transects to avoid edges. While not included in my vegetation analysis, some of the native fields in this study contained small patches of sand plum (*Prunus angustifolia*) and fragrant sumac (*Rhus aromatica*). I attribute the presence of Song and American Tree sparrows in native fields to the presence of woody vegetation. Any influence of OWB on these two species was likely indirect because fields managed as monocultures were less likely to have forbs or woody plants.

Smith's Longspurs are grassland specialists with a winter range limited to the southern plains (Anstey et al. 1995, Briskie 2009). In the first year of my study, this species was observed in large flocks in a single field seeded to OWB but was concentrated in heavily grazed areas with slight depressions, similar to those described by Kemsies (1968). Grzybowski (1982; 1983) found Smith's Longspurs in fields with moderate to heavy grazing pressure and near patches of three-awn (*Aristida* spp.) and silver bluestem (*Bothriochloa laguroides*). I likewise found 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. Grzybowski (1982) showed a positive correlation between seed density and grazing pressure in habitats selected by Longspurs. Future studies on wintering Longspurs should focus on microhabitat use as it relates to grass species composition and food availability in both native and exotic grasslands.

Savannah Sparrows, the most commonly encountered species in my study, were more abundant in OWB monocultures than native grasslands during the second year. Savannah Sparrows are grassland generalists during both the breeding and wintering seasons (Wheelwright and Rising 2008). However, few studies have addressed habitat selection by Savannah Sparrows during winter (Gordon 2000, Smith et al. 2005). It is likely that some populations have undergone increases resulting from human disturbance such as pasture and hayfield management (Wheelwright and Rising 2008), and in some cases, this species may benefit from exotic grasses (Mattice et al. 2005). Stobo and McLaren (1975) suggested that populations may be regulated in part by density-dependent over-wintering survival in areas where carrying capacity is limited by food availability. 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. Chapman et al. (2004) suggested that grassland birds avoid OWB because it produces "chaffy seeds." If this is true, OWB fields may serve as ecological traps (Dwernychuck and Boag 1972) for Savannah Sparrows and other seed-eating bird species. For example, wintering grassland birds may select OWB fields as wintering habitat because they provide adequate shelter from predators and adverse weather, but OWB seeds may not meet dietary requirements for winter survival. However, studies have not yet addressed OWB seed morphology and nutritional composition as it relates to food availability for birds.

Because vegetation structure was similar between the OWB monocultures and native grasslands in my study, it is possible that the higher abundance of Northern Harriers and Short-eared Owls in OWB fields was caused by differences in prey abundance and availability. Both species are nomadic, and populations are regulated by local food availability during the breeding and non-breeding seasons (Grant et al. 1991, MacWhirter and Bildstein 1996, Wiggins et al. 2006). In the southern part of their wintering range, diets of both species include a combination of rodent and bird prey, the latter of which is apparently available in fields seeded to OWB. Sammon and Wilkins (2005) showed that hispid cotton rats (*Sigmodon hispidus*), an important food source for raptors, can use OWB litter for cover throughout the year, although at lower densities than in native fields, and found a positive relationship between litter cover and density of cotton rats. Guthery et al. (1979) found cotton rat densities up to four times greater during August in exotic grass fields, including OWB, than in native grasslands, likely caused by an increase in standing vegetative biomass. However, because I 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.

While OWB fields supported higher numbers of some wintering bird species, overall, native fields supported more species. Other studies have shown that invasions by exotic grasses can reduce habitat quality for breeding birds by altering vegetation structure and composition (e.g., Bock et al. 1986, Flanders et al. 2006, Hickman et al. 2006). Differences in plant species composition between the two field types may have contributed to the absence of some species from OWB fields. Some bird species may select habitats on the basis of plant species composition (Block and Brennan 1993, Rotenberry and Wiens 1998). Old World bluestem fields typically are managed as monocultures, and while other plant species may persist alongside OWB, the vegetation community diversity is drastically reduced compared with native mixed-grass prairie. Effects of this simplification may be amplified during winter, when most grassland birds rely heavily on vegetative material for food.

My findings are consistent with other studies that suggest grass species composition is not an important determinant of grassland bird assemblages, provided species-specific structural needs are met (e.g., Scott and Lima 2004, Jones and Bock

2005). In some cases, exotic grasses meet those needs. However, studies addressing food availability and survival of wintering birds are needed to determine whether OWB monocultures represent superior wintering habitat or an ecological trap.

Nuttle et al. (2003) presented an index based on PIF priority scores to be used along with traditional measurements of community composition when determining a habitat's overall conservation value. However, PIF-derived indices have not been widely used and a standard has not been developed as to how to incorporate *CV*s with other methods for habitat assessment. To test for differences in community composition between field types, I used two measurements of *CV* based on the indices described by Nuttle et al. (2003), in addition to species richness and diversity. I found only the CV_2 score to be significantly different and higher in OWB fields than native fields. This higher score reflects my findings that OWB fields supported higher densities of several bird species of high conservation priority, such as Smith's Longspur and Short-eared Owl, than native fields. By revealing important differences in bird species composition, these results provide further evidence that priority based *CV*s should be used in habitat assessment.

Compared with cropland, seeded exotic grasslands may provide better habitat for grassland birds (Johnson and Schwartz 1993, Best et al. 1997) and may attract select bird species during both the breeding and winter seasons. Native grasslands, however, support more complex bird communities during the breeding season (Flanders et al. 2006, Hickman et al. 2006). Negative effects of exotic species on native plants and animals have been well established (e.g., Mack et al. 2000), and potential benefits to select species will rarely justify their use in conservation programs. That OWB can provide adequate wintering habitat for some species of conservation priority, however, should be considered when managers make decisions regarding grassland restoration.

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Table 1. Partners in Flight Continental Combined Scores (PIF CCS), total abundance (*n*), and frequency of sites in which detected (%) of all bird species observed using OWB monocultures and native grasslands in winter 2007–2008 and 2008–2009. Only species assigned as landbirds by PIF were assigned CCS.

			OWB		Native	
Species	Scientific name	*PIF CCS*	*n*	*%*	*n*	*%*
Smith's Longspur	*Calcarius pictus*	15	920	83	14	33
Chestnut-collard Longspur	*Calcarius ornatus*	13	291	33	0	0
Savannah Sparrow	*Passerculus sandwichensis*	9	193	100	89	67
meadowlark spp.	*Sturnella* spp.	11	157	100	323	100
Short-eared Owl	*Asio flammeus*	13	75	67	2	17
Northern Harrier	*Circus cyaneus*	11	49	100	21	83
Red-tailed Hawk	*Buteo jamaicensis*	6	5	67	11	50
Prairie Falcon	*Falco mexicanus*	12	4	67	1	17
Killdeer	*Charadrius vociferus*	–	4	17	0	0
Loggerhead Shrike	*Lanius ludovicianus*	12	2	33	1	17
Sedge Wren	*Cistothorus platensis*	9	2	17	0	0
Ring-necked Pheasant	*Phasianus colchicus*	8	1	17	11	67
Common Snipe	*Gallinago gallinago*	–	1	17	0	0
Horned Lark	*Eremophila alpestris*	8	1	17	0	0
Mourning Dove	*Zenaida macroura*	5	0	0	580	17
American Tree Sparrow	*Spizella arborea*	10	0	0	36	67
Northern Bobwhite	*Colinus virginianus*	12	0	0	13	17
Song Sparrow	*Melospiza melodia*	8	0	0	13	33
Brown-headed Cowbird	*Molothrus ater*	7	0	0	6	33
Eastern Bluebird	*Sialia sialis*	7	0	0	5	33
American Goldfinch	*Carduelis tristis*	6	0	0	4	33
Dark-eyed Junco	*Junco hyemalis*	8	0	0	4	33
American Crow	*Corvus brachyrhynchos*	6	0	0	3	17
Great Horned Owl	*Bubo virginianus*	7	0	0	2	17
Red-bellied Woodpecker	*Melanerpes carolinus*	9	0	0	2	17
Rough-legged Hawk	*Buteo lagopus*	8	0	0	2	17
Ferruginous Hawk	*Buteo regalis*	13	0	0	1	17
Great Blue Heron	*Ardea herodias*	–	0	0	1	17
Harris's Sparrow	*Zonotrichia querula*	14	0	0	1	17
Le Conte's Sparrow	*Ammodramus leconteii*	13	0	0	1	17
Northern Mockingbird	*Mimus polyglottos*	8	0	0	1	17

Table 2. Mean abundance (birds/km) and standard error of bird species comprising $\geq$ 5% of the total abundance of all birds observed in OWB monocultures and native mixed-grass prairie in winters 2007–2008 and 2008–2009.

	Year 1						Year 2					
	OWB			Native			OWB			Native		
	$\bar{x}$	$\pm$	SE	$\bar{x}$	$\pm$	SE	$\bar{x}$	$\pm$	SE	$\bar{x}$	$\pm$	SE
Smith's Longspur [a,b]	33.98	$\pm$	31.62	–	$\pm$	–	3.01	$\pm$	2.92	0.42	$\pm$	0.38
Mourning Dove	–	$\pm$	–	–	$\pm$	–	–	$\pm$	–	13.66	$\pm$	13.66
meadowlark spp.	3.81	$\pm$	1.23	7.70	$\pm$	4.24	2.13	$\pm$	1.02	5.00	$\pm$	3.10
Chestnut-collared Longspur	13.08	$\pm$	13.08	–	$\pm$	–	0.02	$\pm$	0.02	–	$\pm$	–
Savannah Sparrow [a,b]	4.80	$\pm$	1.76	2.32	$\pm$	0.77	2.22	$\pm$	0.76	0.77	$\pm$	0.29
American Tree Sparrow [a,b]	–	$\pm$	–	2.75	$\pm$	2.38	–	$\pm$	–	0.17	$\pm$	0.12
Short-eared Owl [a,b]	–	$\pm$	–	–	$\pm$	–	1.39	$\pm$	0.92	0.05	$\pm$	0.05
Northern Harrier [b]	0.34	$\pm$	0.15	0.25	$\pm$	0.15	0.96	$\pm$	0.27	0.40	$\pm$	0.14
Northern Bobwhite	–	$\pm$	–	–	$\pm$	–	–	$\pm$	–	0.38	$\pm$	0.38
Song Sparrow [a,b]	–	$\pm$	–	0.49	$\pm$	0.37	–	$\pm$	–	–	$\pm$	–

[a] = $P \leq 0.10$ between field types [b] = $P \leq 0.10$ between years

Table 3. Vegetation characteristics (mean and SE) measured OWB monocultures and native mixed-grass prairie in north-central Oklahoma during winters 2007–2008 and 2008–2009.

	Year 1						Year 2					
	Native			OWB			Native			OWB		
	$\bar{x}$	±	SE	$\bar{x}$	±	SE	$\bar{x}$	±	SE	$\bar{x}$	±	SE
Grass cover (%) [b]	64.41	±	16.06	61.58	±	5.05	72.91	±	7.29	78.46	±	3.71
Forb cover (%) [a b]	6.75	±	1.21	0.14	±	0.10	4.06	±	1.06	0.1	±	0.04
Litter cover (%) [b]	20.97	±	12.44	3.49	±	1.07	38.6	±	8.44	27.33	±	1.35
Bare ground (%) [b]	29.70	±	17.25	43.89	±	6.18	23.63	±	7.38	21.61	±	3.79
Veg. Height (cm)	68.92	±	15.17	43.8	±	3.41	74.96	±	14.03	37.92	±	3.72
Vert. Obstruction (dm)	1.26	±	0.5	0.73	±	0.14	1.2	±	0.27	0.65	±	0.11
Point heterogeneity	0.63	±	0.22	0.49	±	0.06	0.78	±	0.20	0.38	±	0.04
Field heterogeneity	1.00	±	0.34	0.6	±	0.09	0.87	±	0.21	0.58	±	0.11

[a] = $P \leq 0.05$ between field types [b] = $P \leq 0.05$ between years

Table 4. Community composition parameters (mean and SE): Shannon-Weiner diversity (*H'*), species richness, and conservation values (CV_1 and CV_2) of OWB monocultures and native mixed-grass prairie in north-central Oklahoma during winters 2007–2008 and 2008–2009.

	Native			OWB		
	$\bar{x}$	±	SE	$\bar{x}$	±	SE
Richness	8.00	±	0.73	7.33	±	0.67
H'	1.16	±	0.27	1.21	±	0.10
CV_1	73.17	±	5.46	76.67	±	5.85
CV_2*	9.18	±	0.88	11.55	±	0.73

* = $P \leq 0.05$

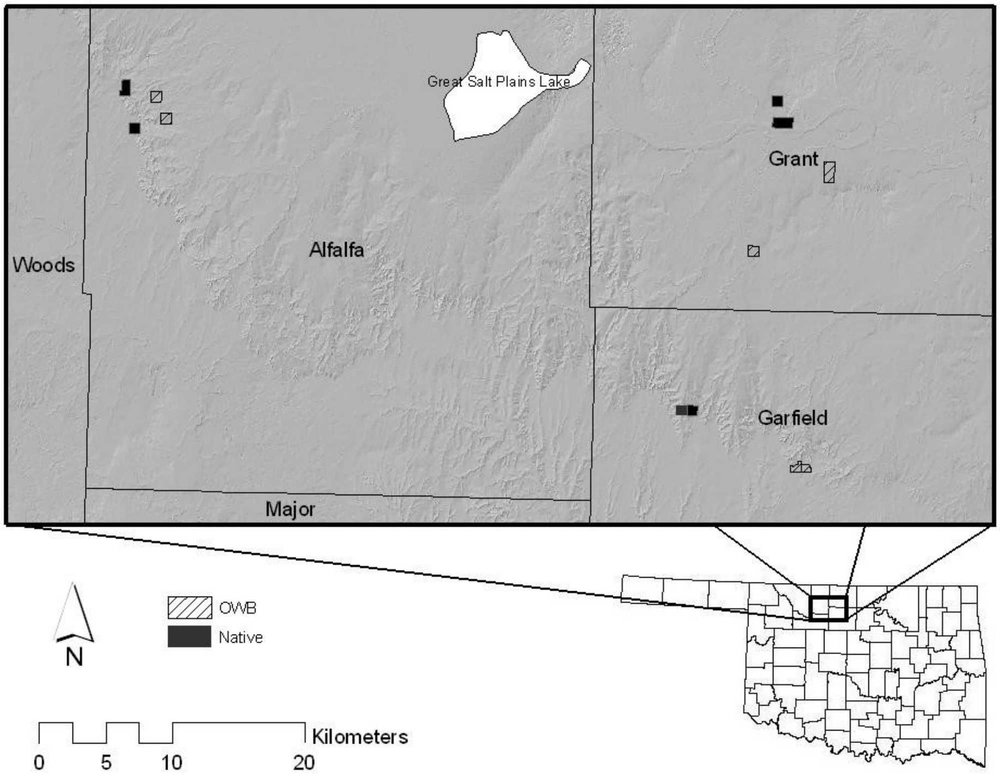

Figure 1. Map of study area showing all study sites: 6 OWB monocultures and 6 native fields in Alfalfa, Grant, and Garfield Counties in north-central Oklahoma.

VITA

Andrew D. George

Candidate for the Degree of

Master of Science

Thesis: AVIAN RESPONSE TO OLD WORLD BLUESTEM (*BOTHRIOCHLOA ISCHAEMUM*) MONOCULTURES IN MIXED-GRASS PRAIRIE.

Major Field: Natural Resource Ecology and Management

Biographical:

Personal Data: Born in Tulsa, Oklahoma, on January 27, 1981. Married to Emily Anne George.

Education: Completed the requirements for the Master of Science in Natural Resource Ecology and Management at Oklahoma State University, Stillwater, Oklahoma in July, 2009; received Bachelor of Science degree, Summa Cum Laude, in Fisheries in Wildlife Biology from Arkansas Tech University, Russellville, Arkansas, 2006; received Associate of Science degree from Collin County Community College, Plano, Texas, 2003; graduated from Garland Christian Academy, Garland, Texas, 1999.

Experience: Worked as a research technician for the USDA Forest Service, Southern Research Station, in the Ozark National Forest from 2005-2007. Worked for the Arkansas Tech University Biology Department as a research technician on a bird habitat study, and as an undergraduate teaching assistant from 2003-2005. Worked as an electro/mechanical technician for Headway Research Inc., Garland, Texas from 1999-2003.

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Name: Andrew Douglas George Date of Degree: July, 2009

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: AVIAN RESPONSE TO OLD WORLD BLUESTEM (*BOTHRIOCHLOA ISCHAEMUM*) MONOCULTURES IN MIXED-GRASS PRAIRIE

Pages in Study: 62 Candidate for the Degree of Master of Science

Major Field: Natural Resource Ecology and Management

Scope and Method of Study: Despite persistent and widespread declines of grassland birds in North America, few studies have assessed differences between native and exotic grasslands as songbird habitat. In the Great Plains, many fields enrolled in the Conservation Reserve Program have been seeded to Old World bluestems (OWB), but there is evidence to suggest that OWB may not provide suitable conditions for several grassland bird species. My objectives were to investigate the influence of OWB monocultures on grassland bird abundance and community composition by identifying patterns in vegetation structure and food availability. In the breeding and winter seasons of 2007–2009, I used distance sampling to survey breeding and wintering songbirds, and conducted vegetation and arthropod surveys in 6 native 6 OWB fields in Garfield, Grant, and Alfalfa counties, Oklahoma.

Findings and Conclusions: While OWB fields supported a higher abundance of some bird species, native fields supported more complex bird communities during the breeding and winter seasons, including several species of conservation priority. Additionally, native fields supported higher arthropod biomass, an important food source for breeding birds. Some bird species were correlated with vegetation characteristics, regardless of field type, suggesting that management may be more important than plant species composition for some bird species. Native vegetation is superior to OWB monocultures for grassland bird habitat and should be promoted in conservation programs such as the CRP.

ADVISER'S APPROVAL: Dr. Timothy J. O'Connell