Proceedings of the Fourth International
Partners in Flight Conference: Tundra to Tropics
691–697

INFLUENCE OF OLD WORLD BLUESTEM (*BOTHRICHLOA ISCHAEMUM*) MONOCULTURES ON BREEDING DENSITY OF THREE GRASSLAND SONGBIRDS IN OKLAHOMA

Andrew D. George,[1,2,4] Timothy J. O'Connell,[1] Karen R. Hickman,[1] David M. Leslie, Jr.[1,3]

[1]*Department of Natural Resource Ecology and Management, Oklahoma State University, Stillwater, Oklahoma 74078, USA;*

[2]*U.S. Geological Survey, Oklahoma State University, Stillwater, Oklahoma 74078, USA; and*

[3]*Oklahoma Cooperative Fish and Wildlife Research Unit, Oklahoma State University, Stillwater, Oklahoma 74078, USA*

Abstract. Despite persistent and widespread declines of grassland birds in North America, few studies have assessed differences between native grasslands and seeded monocultures 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. Our objectives were to investigate the influence of OWB monocultures on vegetation structure, composition, and breeding densities of three common grassland bird species. In 2007, we used distance sampling to survey breeding songbirds in 6 native mixed grass prairie and 6 OWB fields in Garfield, Grant, and Alfalfa counties, Oklahoma. Native mixed grass prairie supported taller and denser vegetation, as well as greater forb cover than OWB fields. Breeding density of Grasshopper Sparrow (*Ammodramus savannarum*) was higher in OWB monocultures, while density of Dickcissel (*Spiza americana*) and Eastern Meadowlark (*Sturnella magna*) was similar among field types.

Key Words: Bothriochloa ischaemum, Dickcissel, Eastern Meadowlark, Grasshopper Sparrow, grassland birds, invasive species, Old World bluestem.

INFLUENCIA DE LOS MONOCULTIVOS DEL PASTO DEL VIEJO MUNDO (*BOTHRICHLOA ISCHAENUM*) SOBRE LA DENSIDAD REPRODUCTIVE DE TRES ESPECIES DE AVES DE PASTIZALES EN OKLAHOMA

Resumen. A pesar de que el número de aves de pastizales en general haya disminuido de manera persistente, pocos estudios se han dedicado a las diferencias entre los pastizales nativos y las monoculturas como habitat para los paserinos. En los llanos norteamericanos, muchos campos registrados en el Programa estadounidense de Conservación de Reservas (CRP, Conservation Reserve Program) se han convertido en pastos sembrados con el gramíneo *Bothriochloa ischaemum*, pero hay evidencia que esta especie no provee las condiciones requeridas por varias especies de aves de pastizales. Nuestros objetivos incluyeron la investigación de la influencia de las monoculturas de *Bothriochloa ischaemum* en la estructura de la vegetación y en la composición y la densidad de tres especies de aves nidificantes comunes de los pastizales. En el 2007, utilizamos el muestreo de distancia para el monitoreo de paserinos nidificantes en 6 zonas de estepa nativa semiáridas y 6 pastos de *Bothriochloa ischaemum* en los condados de Garfield, Grant y Alfalfa en el estado norteamericano de Oklahoma. La vegetación de las estepas nativas era más alta y más densa y además incluía más plantas florecientes que los pastos sembrados con *Bothriochloa ischaemum*. Las densidades del Gorrión Chapulín (*Ammodramus savannarum*) eran significativamente más altas en las monoculturas, mientras que la densidad del Arrocero Americano (*Spiza americana*) y del Pradero Común (*Sturnella magna*) era similar entre las dos áreas.

INTRODUCTION

Throughout North America, grassland birds have exhibited more rapid and widespread declines than any other group of birds (Peterjohn and Sauer 1999, Askins et al. 2007, Sauer et al. 2007). These declines have been attributed to habitat loss, degradation, fragmentation (Vickery and Herkert 2001), changes in grazing management (Kantrud 1981, Baker

[4] E-mail: adgeorge@mizzou.edu

and Guthery 1990), increased row crop acreage associated with farming (Warner 1994), and planting exotic grasses (Delisle and Savidge 1997, Sutter and Brigham 1998, Hickman et al. 2006). In the mid 1980s, more than 30% of the grassland cover in Montana, North Dakota, Wyoming, South Dakota, Colorado, Nebraska, Kansas, Oklahoma, New Mexico, and Texas was comprised of seeded monocultures (USDA 1986). Millions of additional hectares of cropland were converted to exotic monocultures with the passage of the 1985 Food Security Act's Conservation Reserve Program (CRP) (Schenk and Williamson 1991, Baker 2000).

The CRP provides landowners financial incentives to retire "highly erodible" cropland from production and place it in permanent cover under 10 or 15-year contracts (USDA 2008a). Because the CRP's primary goal was erosion control, the original signup allowed, and in some cases encouraged (Baker 2000) landowners to plant exotic grasses such as weeping lovegrass (*Eragrostis curvula*), crested wheatgrass (*Agropyron cristatum*), or Old World bluestems (*Bothriochloa* spp). These grasses have a wide tolerance of environmental conditions and are easy to establish, but they may also become invasive and negatively affects native grassland ecosystems (D'Antonio and Vitousek 1992). Despite more stringent requirements to plant native grasses in both new CRP signups and renewals after 1996, fields planted to a single exotic species are still common. It has been estimated that >1 million ha were planted in Oklahoma and Texas alone over a 10-year period (White and Dewald 1996). Over 50% of the CRP land has been planted to Old World bluestems (OWB) in some western Oklahoma counties (Ripper and VerCauteren 2007). Despite its widespread use and invasive potential, few studies have assessed differences among native grasslands and OWB monocultures as wildlife habitat (McIntyre and Thompson 2003, Chapman et al. 2004, Hickman et al. 2006).

Our objectives were to compare between OWB monocultures and native mixed-grass prairie 1) the breeding densities of three common grassland bird species (Dickcissel [*Spiza Americana*], Grasshopper Sparrow [*Ammodramus savannarum*], and Eastern Meadowlark [*Sturnella magna*]) and 2) vegetation structure and composition. We specifically aimed to test the hypothesis that breeding density of the most common grassland songbirds was similar between fields of OWB and native grasses and determine if vegetation structure and/or composition could be related to any observed differences.

METHODS

Study Area

We conducted this study during 2007 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 annual daily high temperature ranges from 13°C to 35°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 for small grain agriculture, primarily in winter wheat, grain sorghum, or alfalfa. 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 on steeper slopes (Woods et al. 2005). We selected all study sites within a broad agricultural matrix interspersed with grassland cover. Dominant land cover consisted of approximately 68% cropland and 26% grassland across Alfalfa, Grant, and Garfield counties (USDA 2008d).

We selected 12 privately owned study sites to provide 6 replicates of OWB monoculture and 6 replicates of native mixed grass prairie. We selected study fields based on similarity in area (60–100 ha), topography (flat to gently rolling), and management. Eleven sites were lightly grazed by cattle during the study; one field of native grasses was heavily grazed. Four of the OWB sites were also managed for hay production. Because OWB is a warm season grass, haying in the study area occurred once or twice annually, and exclusively in mid-July to mid-August after the breeding season for most grassland songbirds had concluded. 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.

Bird Surveys and Density Estimation

We focused avian sampling on the three most abundant grassland songbirds in the study area: Dickcissel, Grasshopper Sparrow, and Eastern Meadowlark. We estimated bird

abundance and density among OWB monocultures and native mixed-grass prairie using distance sampling (Buckland et al. 2001). We used 2003 National Agricultural Imagery Program (NAIP) air photos to establish 750-m transects in each field; no transect was placed within 50 m of a field's edge. We avoided placing transects parallel and close to field edges and riparian zones. Transects were marked with a hand-held GPS unit and the same transects were re-sampled throughout the study.

A single observer sampled each field weekly from mid-May through mid-July on days with no rain and light winds (<10 km h^{-1}). We sampled between 05:30 and 10:00 CDT by slowly walking each transect and recording all individuals seen or heard. Flyovers and birds using field edges were not counted. We 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.

We estimated density (number of individuals per ha) using program DISTANCE (Thomas et al. 1998, Buckland et al. 2001). DISTANCE uses the perpendicular distance of each bird from the transect line to generate a detection model used to provide a direct density estimate. Distance sampling is described in detail by Buckland et al. (2001). We estimated density for Grasshopper Sparrow, Eastern Meadowlark, and Dickcissel in each of the two field types. We interpreted differences in breeding density as significant based on non-overlapping 95% confidence intervals in density estimates provided by program DISTANCE.

Vegetation Sampling

We measured vegetation once during our study period in the third week of July (before the start of haying in our fields). We established points at 30 random distances along the same transects used to sample birds. At each point we measured vertical obstruction from 4 directions using a Robel pole (Robel et al. 1970; n = 120 points per field). The lowest obstructed point visible from 4 m at a height of 1 m above the ground was recorded. We estimated plant canopy cover 1 m in front of the Robel pole in the direction of the transect using a modified 1-m^2 frame (Daubenmire 1959). Only plants rooted completely inside the frame were recorded. We estimated the percent cover of OWB, other grasses, forbs, litter, and bare ground. Litter was defined as any dead plant material on the soil surface in any state of decomposition. We used the midpoints of each cover class to calculate percent canopy cover of vegetation characteristics (Daubenmire 1959, Towne et al. 2005), so cover classes could overlap, or exceed 100%. We also recorded the maximum vegetation height inside the frame. We used ANOVA to determine if vegetation structure and composition differed between the two field types.

RESULTS

Of the three grassland bird species sampled, Grasshopper Sparrows were the most abundant in the study area (Fig. 1). Density of Grasshopper Sparrows was significantly different and higher in OWB monocultures. Densities of Dickcissels and Eastern Meadowlarks did not differ between the two field types.

Vegetation structure and composition differed between the two field types (Table 1). In native fields, mean maximum height (F = 15.1, P < 0.001), visual obstruction (F = 12.3, P < 0.001), structural variation (F = 52.7, P < 0.001), forb cover (F = 112.9, P < 0.001), and litter cover (F = 13.3, P < 0.001) were higher than in OWB fields. Percent bare ground was similar between the two field types (F = 0.7, P < 0.395).

DISCUSSION

In our study, maximum height, visual obstruction, and structural variation were higher in native mixed grass prairie compared with OWB fields. Because OWB monocultures are seeded and managed as monocultures, plant species diversity and therefore structural variation is

TABLE 1. Vegetation variables (mean ± SE) measured in OWB monocultures and native mixed-grass prairie. Only percent bare ground did not differ significantly between the two field types.

Variable	OWB	Native
vegetation height (cm)	76.93 ± 1.38	91.52 ± 3.49
vertical obstruction (dm)	3.96 ± 0.21	5.51 ± 0.39
structural variation	0.60 ± 0.02	1.24 ± 0.09
litter cover (%)	3.01 ± 0.46	5.76 ± 0.60
forb cover (%)	1.26 ± 0.26	14.99 ± 1.27
bare ground (%)	27.26 ± 1.50	25.18 ±1.93

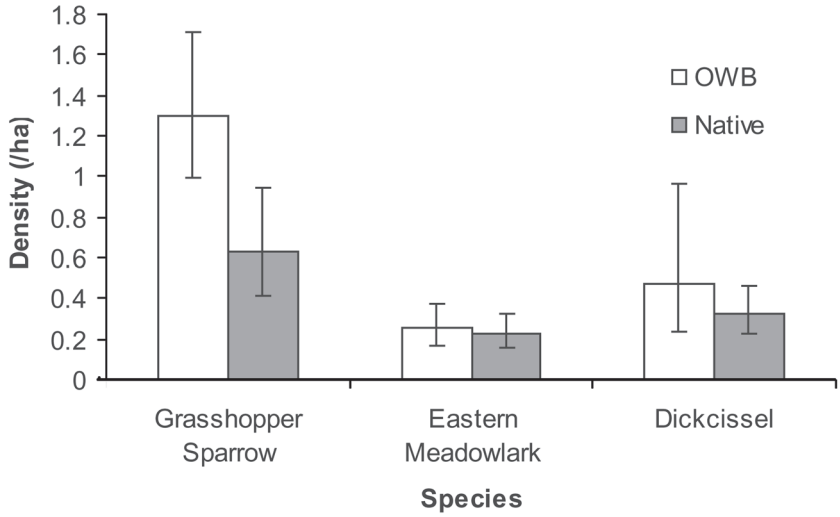

FIGURE 1. Estimated density of Grasshopper Sparrow, Eastern Meadowlark, and Dickcissel in OWB monocultures and native mixed-grass prairie. Error bars indicate 95% confidence intervals.

low. Native fields had higher maximum height and visual obstruction because some native grass species (e.g., *S. nutans, A. gerardii)* grow taller than OWB, which reaches a maximum height of about 120 cm (USDA 2008b).

Forb and litter cover also were higher in our native fields than in OWB monocultures. Although Hull et al. (1996) did not report a relationship, the potential for arthropod biomass (an important food for nesting songbirds) to be positively correlated with forb cover has subsequently been established (Jonas et al. 2002, McIntyre and Thompson 2003, Hickman et al. 2006). Some bird species may be less abundant in OWB fields because less food is available. Thus, compositional differences between OWB and native fields may have ramifications for breeding habitat quality.

Densities of Dickcissel and Eastern Meadowlark were similar between native and OWB fields. Dickcissels nest in a variety of grassland habitats, including hayfields and native prairie. Dense cover, moderate to tall vegetation, moderately deep litter, and presence of elevated song perches are characteristics of fields selected by Dickcissels (Temple 2002). In our study area, Dickcissel densities were highest where such structural characteristics were evident, whether the fields supported OWB or native grasses. Despite studies (e.g., Dechant et al. 2003) that indicate a positive relationship between forbs/woody cover and Dickcissel abundance, we found no such relationship. This was surprising as the difference in forb cover between field types (1% in OWB fields and 15% in native fields) was dramatic. Perhaps the structure of OWB, which grows as a bunchgrass, can provide the nesting cover typically sought by nesting Dickcissels in fields with more forbs, thereby decreasing the significance of a forb component where OWB is abundant. Future studies on the functional value of OWB as nesting habitat for Dickcissel should investigate this issue.

Like Dickcissels, Eastern Meadowlarks nest in a variety of grassland habitats, including pastures and hayfields (Roseberry and Klimstra 1970, Lanyon 1995), showing preference for areas with high grass and litter cover (Wiens and Rotenberry 1981). Both native and OWB fields in our study provided vegetation structure suitable to support Eastern Meadowlarks.

In contrast, OWB monocultures supported breeding densities of Grasshopper Sparrows nearly twice that of native mixed-grass prairie. Numerous studies, (e.g., Patterson and Best 1996, Delisle and Savidge 1997, Vickery 1996) have shown that Grasshopper Sparrows select larger tracts of uninterrupted habitat, with shorter vegetation, less vertical cover, and little shrub cover: all characteristics of the OWB fields in our study relative to native grass fields.

We do not attribute the difference in Grasshopper Sparrow breeding density between OWB and native grass fields to landscape differences between the two types of fields. All of our fields were similar in size, shape, elevation, and topography, and all occurred in a similar agricultural/grassland matrix. All study sites were large (60–100 ha)

relative to the minimum area requirements reported Grasshopper Sparrows from other parts of the range where the species is abundant (e.g., Herkert 1994, Helzer and Jelinksi 1991). We conclude that the difference in breeding density between OWB and native grasses was related to structural differences between the two types of fields, and that more Grasshopper Sparrows attempted to nest in the OWB fields. Future research in this system should first determine if our observation represents a consistent or spurious phenomenon, and then address the functional significance of OWB for Grasshopper Sparrow. Research that focuses on reproductive success and site fidelity of Grasshopper Sparrow in OWB fields could shed light on the degree to which these fields generally provide favorable conditions or constitute ecological traps (Dwernychuk and Boag 1972).

Natural resource agencies have encouraged the planting of native grasses to benefit wildlife (USDA 2008c). We found, however, no evidence to indicate that OWB was detrimental to the three most abundant breeding grassland songbirds in the study region. Additional research should be directed toward the potential influence of OWB on less abundant species, including multiple species of conservation priority. In addition, many priority species are winter residents of grassland habitats in the study region, and the influence of OWB compared to native grasses on these species has not been investigated.

Vegetation structure 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. In our study, we made every effort to select fields in which management was as similar as possible. All sites but one were lightly grazed by cattle; we included one relatively heavily grazed native grass field in the study. Four OWB fields were hayed during the summer of 2007, but that activity occurred after we had concluded our bird surveys and vegetation sampling for this analysis. Two OWB fields also received fertilizer applications, but these fields did not support significantly greater vegetation cover or height than the native grass fields. We conclude that differences in vegetation structure between the OWB and native grass fields in this study were due primarily to the difference in species composition, rather than differences in management. Those structural differences apparently provided suitable breeding habitat for Dickcissel and Eastern Meadowlark, and potentially provided more favorable habitat for Grasshopper Sparrow than did the native grass fields.

ACKNOWLEDGMENTS

We thank the private landowners in Alfalfa, Grant, and Garfield counties who provided access to their lands, including Groendyke Transport Inc. and Johnston Enterprises Inc. Financial support for this project was provided from State Wildlife Grants under Project T-36-P-1 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). The use of trade, product, industry or firm names or products or software or models, whether commercially available or not, is for informative purposes only and does not constitute an endorsement by the U.S. Government or the US Geological Survey.

LITERATURE CITED

Askins, R. A., F. Chavez-Ramirez, B. C. Dale, C. A. Haas, J. R. Herkert, F. L. Knopf, and P. D. Vickery. 2007. Conservation of grassland birds in North America: Understanding the ecological processes in different regions. Ornithological Monographs 64:1–46.

Baker, B. 2000. Farm Bill environmental program may threaten native prairie habitat. BioScience 50:400–400.

Baker, D. L., and F. S. Guthery. 1990. Effects of continuous grazing on habitat and density of ground-foraging birds in south Texas. Journal of Range Management 43:2.

Best, L. B., H. Campa, K. E. Kemp, R. J. Robel, M. R. Ryan, J. A. Savidge, H. P. Weeks, and S. R. Winterstein. 1997. Bird abundance and nesting in CRP fields and cropland in the Midwest: a regional approach. Wildlife Society Bulletin 25:864–877.

Buckland, S. T., D. R. Anderson, K. P. Burnham, J. L. Laake, D. L. Borchers, and L. Thomas. 2001. Introduction to distance sampling: estimating abundance of biological populations. Oxford University Press, NY.

Chapman, R. N., D. M. Engle, R. E. Masters, and D. M. Leslie, Jr. 2004. Grassland vegetation and bird communities in the southern Great Plains of North America. Agriculture, Ecosystems & Environment 104:577.

D'Antonio, C. M., and P. M. Vitousek. 1992. Biological invasions by exotic grasses, the grass/fire cycle, and global change. Annual Review of Ecology and Systematics 23:63–87.

Daubenmire, R. F. 1959. A canopy-coverage method. Northwest Science 33:43–64.

Dechant, J. A., M. L. Sondreal, D. H. Johnson, L. D. Igl, C. M. Goldade, A. L. Zimmerman, and B. R. Euliss. 2003. Effects of management practices on grassland birds: Dickcissel. Northern Prairie Wildlife Research Center Online. [Online.] <http://www.npwrc.usgs.gov/resource/literatr/grasbird/dick/dick.htm> (24 April 2008).

Delisle, J. M., and J. A. Savidge. 1997. Avian use and vegetation characteristics of Conservation Reserve Program fields. Journal of Wildlife Management 61:318.

Dwernychuk, L.W., and D.A. Boag. 1972. Ducks nesting in association with gulls-an ecological trap? Canadian Journal of Zoology 50: 559–563.

Herkert, J. R. 1994. The effects of habitat fragmentation on midwestern grassland bird communities. Ecological Applications 4:461–471.

Helzer, C. J., and D. E. Jelinski. 1999. The relative importance of patch area and perimeter-area ratio to grassland breeding birds. Ecological Applications 9:1448–1458

Hickman, K. R., G. H. Farley, R. Channell, and J. E. Steier. 2006. Effects of Old World Bluestem (*Bothriochloa ischaemum*) on food availability and avian community composition within the mixed grass prairie. Southwestern Naturalist 51:524–530.

Hull, S. D., R. J. Robel, and K. E. Kemp. 1996. Summer avian abundance, invertebrate biomass, and forbs in Kansas CRP. Prairie Naturalist 28:1–12.

Jonas, J. L., M. R. Whiles, and R. E. Charlton. 2002. Aboveground invertebrate responses to land management differences in a central Kansas grassland. Environmental Entomology 31:1142–1152

Kantrud, H. A. 1981. Grazing intensity effects on the breeding avifauna of North- Dakota native grasslands. Canadian Field-Naturalist 95:404–417.

Lanyon, W. E. 1995. Eastern meadowlark (*Sturnella magna*). *In* A. Poole, [ed.], The Birds on North America Online. Cornell Lab of Ornithology, Ithaca, NY. [Online.] <http://bna.birds.cornell.edu.bnaproxy.birds.cornell.edu/bna/species/160> (24 April 2008).

McIntyre, N. E., and T. R. Thompson. 2003. A comparison of Conservation Reserve Program habitat plantings with respect to arthropod prey for grassland birds. American Midland Naturalist 150:291–301.

Oklahoma Climatological Survey. 2008. Oklahoma mesonet data. [Online.] <http://climate.Mesonet.Org/> (24 April 2008).

Patterson, M. P., and L. B. Best. 1996. Bird abundance and nesting success in Iowa CRP fields: the importance of vegetation structure and composition. American Midland Naturalist 135:153–167.

Peterjohn, B. G., and J. R. Sauer. 1999. Population status of North American grassland birds. Studies in Avian Biology 19:27–44.

Ripper, D., and T. VerCauteren. 2007. Assessment of CRP fields within current Lesser Prairie-Chicken range. Technical Report # PPR-LEPC-ED07-01, Rocky Mountain Bird Observatory, Brighton, CO. 36 pp.

Robel, R. I., J. N. Briggs, A. D. Dayton, and L. C. Hulbert. 1970. Relationships between visual obstruction measurements and weight of grassland vegetation. Journal of Range Management 23:295.

Roseberry, J. L., and W. D. Klimstra. 1970. Nesting ecology and reproductive performance of Eastern Meadowlark. Wilson Bulletin 82:243.

Sauer, J. R., J. E. Hines, and J. Fallon. 2007. The North American Breeding Bird Survey, results and analysis 1966–2006. USGS Patuxent Wildlife Research Center, Laurel, MD.

Schenk, E. W., and L. L. Williamson. 1991. The Conservation Reserve Program – yesterday, today, and tomorrow. p. 7–10. *In* USDA Forest Service General Technical Report RM-203.

Sutter, G. C., and R. M. Brigham. 1998. Avifaunal and habitat changes resulting from conversion of native prairie to Crested Wheat Grass: patterns at songbird community and species levels. Canadian Journal of Zoology 76:869–875.

Temple, S. A. 2002. Dickcissel (*Spiza americana*). *In* A. Poole, [ed], The birds of North America Online. Cornell Lab of Ornithology, Ithaca, NY. [Online.] <http://bna.birds.cornell.edu/bna/species/703> (24 April 2008).

Thomas, L., J. L. Laake, J. F. Derry, S. T. Buckland, D. L. Borchers, D. R. Anderson, K. P. Burnham, S. Strindberg, S. L. Hedley, M. L. Burt, F. Marques, J. H. Pollard, and R. M. Fewster. 1998. Distance 3.5. Research Unit for Wildlife Population Assessment, University of St. Andrews, St. Andrews, UK.

Towne, E. G., D. C. Hartnett, and R. C. Cochran. 2005. Vegetation trends in tallgrass prairie from bison and cattle grazing. Ecological Applications 15:1550–1559.

United States Department of Agriculture (USDA). 1986. Grazing lands and people: A national program statement and guidelines for the cooperative extension service. ECOP/ANR Grazing Lands Committee, Washington, DC.

United States Department of Agriculture (USDA). 2008a. Conservation Reserve Program. [Online.] <http://www.nrcs.usda.gov/programs/crp/> (24 April 2008).

United States Department of Agriculture (USDA). [online]. 2008b. Plants Database. <http://plants.usda.gov/> (24 April 2008).

United States Department of Agriculture (USDA). 2008c. Wildlife Habitat Incentives Program. [Online.] <http://www.nrcs.usda.gov/programs/whip/> (24 April 2008).

United States Department of Agriculture (USDA). 2008d. 10 Acre MIADS Landuse Data by County. [Online.] <http://www.ok.nrcs.usda.gov/technical/GIS/miads_county_index.html> (24 April 2008).

Vickery, P. D. 1996. Grasshopper Sparrow (*Ammodramus savannarum*). *In* A. Poole [ed.], The birds of North America Online. Cornell Lab of Ornithology, Ithaca, NY. [Online.] <http://bna.birds.cornell.edu/bna/species/239> (24 April 2008).

Vickery, P. D., and J. R. Herkert. 2001. Recent advances in grassland bird research: Where do we go from here? Auk 118:11–15.

Warner, R. E. 1994. Agricultural land-use and grassland habitat in Illinois—future- shock for midwestern birds. Conservation Biology 8:147–156.

White, L. M., and C. L. Dewald. 1996. Yield and quality of WW-Iron Master and Caucasian Bluestem regrowth. Journal of Range Management 49:42–45.

Wiens, J. A., and J. T. Rotenberry. 1981. Habitat associations and community structure of birds in shrubsteppe environments. Ecological Monographs 51:21– 42.

Woods, A. J., J. M. Omernik, D. R. Buttler, J. G. Ford, J. E. Henley, B. W. Hoagland, D. S. Arndt, and B. C. Moran. 2005. Ecoregions of Oklahoma (color poster with map, descriptive text, summary tables, and photographs). U.S. Geological Survey, Reston, VA.