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Planted Grasslands and Native Sod Prairie: Equivalent Habitat for Grassland Birds

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PLANTED GRASSLANDS AND NATIVE SOD PRAIRIE: EQUIVALENT HABITAT FOR GRASSLAND BIRDS?

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ABSTRACT.—Little is known about how avian relationships to tracts of native sod prairie compare with avian relationships to single and multiple species of cool- and warm-season grassland plantings. We compared grassland bird species richness and density in 5 grassland cover types ($n = 97$) in the tallgrass prairie region of eastern South Dakota and western Minnesota, 2001–2004. Grassland bird species richness was significantly higher in native sod prairies than it was in all planted cover types except warm-season mixes. Grasslands dominated by exotic species did not support as many grassland bird species or have species densities as high as grasslands containing native species. Intermediate wheatgrass monotypes and cool-season mixes comprised of exotic species contained 40%–60% fewer grassland bird species than native sod prairie. Bobolink (*Dolichonyx oryzivorus*) density was 68% and 51% lower in intermediate wheatgrass monotypes and cool-season mixes, respectively, than it was in switchgrass monotypes. Clay-colored Sparrow (*Spizella pallida*) density was 75%–91% higher in native sod prairies than it was in any other cover type. Savannah Sparrow (*Passerculus sandwichensis*) density was 72% higher in native prairie than it was in grasslands dominated by exotic species. We recommend incorporating a diversity of native plant species into grassland plantings for biomass fuels or wildlife, rather than using monotypes or exotic species, to provide habitat for grassland birds. Although replacing croplands with planted grasslands would benefit grassland bird populations, we caution that replacing existing native sod tracts with planted grasslands would be detrimental to populations of several grassland bird species.

Key words: grassland birds, plant species diversity, planted cover types, native sod prairie, South Dakota, tallgrass prairie region, biofuels.

Native prairie ecosystems continue to be lost at alarming rates (Noss et al. 1995, Higgins et al. 2002). For example, nearly 134,000 ha of previously untilled land were converted to agricultural uses in South Dakota in just 6 years (2001–2006; Farm Service Agency). The loss and fragmentation of prairie habitat correspond to steep, consistent, and widespread declines in grassland bird populations (Herkert 1995, Igl and Johnson 1997, Sauer et al. 2008). Planting grassland habitat for the Conservation Reserve Program (CRP) has changed the prairie landscape, and population increases of several grassland bird species have been linked to increases in CRP grassland habitat (Johnson and Igl 1995, Herkert 1998, Haroldson et al. 2006, Herkert 2007). Alternative energy sources, such as biomass fuels, may also potentially provide additional habitat for grassland birds (Higgins et al. 2004). Numerous studies have focused on the benefits that planted grasslands provide for birds (Johnson and Igl 1995, Best et al. 1997, Delisle and Savidge 1997, Koford 1999, Johnson 2000), but our study is the first to simultaneously compare avian communities in multiple seeded cover types and native sod prairie. Previous studies have been limited to comparisons between 2 different cover types (McCoy et al. 2001, Bakker et al. 2004) or have examined the effect invasive grassland plant species have on bird use (Flanders et al. 2006, Hickman et al. 2006). Given the continued loss of native sod, loss of CRP habitat, and the current emphasis on alternative fuels, it is important to understand avian relationships to single and multiple species of cool- and warm-season grassland plantings and how they compare with avian relationships to native sod prairie. Insights into how birds respond to different cover types will enhance our ability to direct and prioritize conservation efforts for grassland birds. Our objectives were to examine species richness and density of grassland-nesting birds in cool-season exotic and warm-season native monotypes and mixes and to determine how use of these grasslands by birds compares to use of native sod prairie

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TABLE 1. Minimum, maximum, and mean ($s_{\bar{x}}$) field size[a] and vegetation values in study grasslands (n = 97) of 5 cover types[b] in the tallgrass prairie region of eastern South Dakota and western Minnesota, 2001–2004. Within rows, different letters indicate values that are significantly different from each other.

Mean values	Wheatgrass n = 18	Switchgrass n = 17	Cool mix n = 19	Warm mix n = 26	Native sod n = 17
Min–max size (ha)	4.1–63.1	4.0–97.8	7.3–97.9	4.0–50.7	4.9–145.7
Field size (ha)	17.1 (3.5)	21.8 (5.3)	27.6 (5.2)	24.7 (2.9)	55.6 (13.0)
Robel (dm)	3.6 (0.5) a	3.7 (0.4) a	3.6 (0.3) a	2.7 (0.3) b	2.0 (0.3) c
Grass height (dm)	13.5 (1.1) a	10.7 (0.7) bd	12.4 (0.6) ab	16.6 (0.9) c	9.6 (0.6) d
Forb height (dm)	4.5 (0.8)	5.8 (1.6)	6.7 (1.0)	4.3 (0.6)	5.5 (0.6)
Wood height (dm)	0.0 a	0.2 (0.2) ab	2.0 (1.0) ab	1.3 (0.4) ab	3.1 (0.7) b
Litter depth (mm)	30.6 (5.7) ab	16.1 (2.5) b	33.7 (7.5) ab	40.9 (4.6) a	26.1 (5.4) b

[a]Included as a covariate in analyses.
[b]Wheatgrass (intermediate wheatgrass monotype), switchgrass (switchgrass monotype), cool mix (cool-season mixture), warm mix (warm-season mixture) and Native sod (native sod prairie tracts).

tracts. We predicted that seeded grasslands would exhibit depleted grassland bird communities compared to native sod prairie because of habitat homogeneity of plantings. However, we also predicted that bird species whose habitat requirements are met by specific types of plantings would be abundant in those seeded grasslands.

METHODS

Study Areas

During 2001–2004, we evaluated the effects of plant species diversity on species richness and density of grassland birds in 97 fields that were randomly selected from the pool of available grasslands in eastern South Dakota and western Minnesota. Because grassland bird response to vegetation and patch size varies across regions (Bakker et al. 2002), we restricted our sample to the tallgrass prairie region. Planted cover types consisted of intermediate wheatgrass (*Thinopyrum intermedium;* n = 18) and switchgrass (*Panicum virgatum;* n = 17) monotypes and cool-season (n = 19) and warm-season (n = 26) mixes containing 3–5 plant species each. Tracts of native sod tallgrass prairie (n = 17) with no history of tillage contained as many as 119 plant species (Higgins et al. 2001). Cool-season mixes were dominated by exotic species including smooth brome (*Bromus inermis*), yellow sweet clover (*Melilotus officinalis*) and intermediate wheatgrass. Warm-season mixes were composed of native species including switchgrass, big bluestem (*Andropogon gerardii*) and Indiangrass (*Sorghastrum nutans*). These types of plantings were selected because they are the most common plantings used for CRP and wildlife grasslands and/or they are being considered for use in biofuel production. Previous research indicated that 3–6-year-old fields had greater avian productivity than younger fields (1–2 years old; Millenbah et al. 1996) and that bird communities differ between young (0–3 years old) and old fields (10–13 years old; Bakker et al. 2004), so we limited our sample to fields between 4 and 9 years old. Tracts of native sod prairie were privately owned or managed preserves. No study fields were grazed, burned, or mowed in the year prior to or during our surveys. We surveyed similar numbers of fields from each cover type in each season, and a new sample of grasslands was selected annually.

A field was defined as a grassland area contiguous with the survey area (i.e., bird survey transect) and having the same cover type and being in the same condition as the survey area (Bakker et al. 2002). Field boundaries were delineated as per Bakker et al. (2002). Study fields were selected to incorporate a range of similar sizes within each grassland type (Table 1). However, the size and location of native prairie remnants and the nature of planted grasslands precluded identical ranges or mean field sizes; that is, planted grasslands as large as remaining native sod tracts are rare to nonexistent within our study area. Because some grassland species are area sensitive in part or all of their range (Herkert 1994, Vickery et al. 1994, Winter and Faaborg 1999, Johnson and Igl 2001, Bakker et al. 2002, Davis 2004), area was incorporated into the analyses to remove the variability in the dependent variables due to field size.

Vegetation Measurements

At 20-m intervals along the bird survey transects, we measured height-density, tallest grass plant, tallest forb, tallest woody plant, and litter depth. Height-density was assessed at each interval by obtaining one visual-obstruction reading in each cardinal direction using a modified Robel pole (Robel et al. 1970, Higgins and Barker 1982). Readings were taken at the highest point where vegetation limited visibility of the pole by 100% from a sighting height of 1 m and a distance of 4 m (Robel et al. 1970). Tallest grass, tallest forb, and tallest woody plant within 4 m of each transect interval were measured to the nearest decimeter. Litter depth was measured to the nearest millimeter with a ruler inserted into the detritus until it made contact with soil.

Grassland Bird Surveys

We surveyed breeding birds using fixed-width belt transects during favorable conditions from sunrise to 10:00 from 25 May to 5 July 2001–2004 (Emlen 1971, Ralph et al. 1993). Fixed-width transects were 200 m long and all birds seen or heard within 50 m of the transect were counted. We used 100-m fixed widths (50 m on each side of the observer) because beyond 50 m, detection probabilities of some grassland species drop rapidly (Diefenbach et al. 2003). We used only singing males in the analysis to avoid issues related to differences in detectability among species or by gender. We avoided double counting by noting bird movements. Transects were walked slowly (approximately 1 km · h^{-1}) with frequent stops to identify birds. Transects were randomly placed >50 m from field edges and large obstacles. Surveys were conducted once per study field. We used equal-area sampling (i.e., one transect per patch regardless of grassland area) to avoid issues of passive sampling (Connor and McCoy 1979, Horn et al. 2000). Only one transect was surveyed per field, as some fields were not large enough to contain multiple transects and the field-edge buffer. A grassland was surveyed only if the transect fit within the field.

Statistical Analyses

We hypothesized that different cover types would influence species richness and density. For each study field, we calculated means for height-density, tallest grass, tallest forb, tallest woody plant, and litter depth and used ANOVA to evaluate vegetation structure among fields of differing cover types. Year was not included in analyses because a new sample of grasslands was selected annually. For density analyses, we used the maximum number of males counted in each transect standardized to males per 100 ha. We calculated grassland bird species richness only within the transect for each study field and used ANCOVA to evaluate effects of cover type on these estimates. Bird-richness estimates included only species that are considered facultative or obligate grassland species (Vickery et al. 1999, Table 2). We used the log of field area as a covariate in richness and density analyses to remove the variability in the these variables due to field size. A Tukey's post hoc test was used to determine where differences in species richness or density occurred among grassland types. All statistical tests were considered significant at $P \leq 0.05$. Data were analyzed using SYSTAT, version 12 (SYSTAT 2007).

RESULTS

Vegetation

Mean height-density (Robel) was 25%–27% lower in warm-season mixes and 26%–46% lower in native sod tracts than it was in other cover types ($F_{4, 91} = 4.80$, $P \leq 0.05$; Table 1). Field area accounted for significant amounts of variation in height-densities not attributable to the effects of grassland cover type ($F_{1, 91} = 4.26$, $P \leq 0.05$). Grass heights were taller (by 19%–43%) in warm-season mixes than they were in all other cover types. Grass heights were intermediate in intermediate wheatgrass and cool-season mixes and shorter in switchgrass monotypes and native sod than they were in other cover types ($F_{4, 91} = 10.81$, $P \leq 0.05$, Table 1). Woody vegetation was similar among planted cover types and similar among mixes and native sod prairie ($F_{4, 91} = 5.0$, $P \leq 0.05$; Table 1). Litter depths were lowest in switchgrass monotypes and native sod prairie and highest in warm-season mixes; intermediate wheatgrass monotypes and cool-season mixes had similar litter depths ($F_{4, 91} = 3.0$, $P \leq 0.05$; Table 1). There were no differences in mean tallest forb heights among cover types (Table 1). Field area did not account for additional

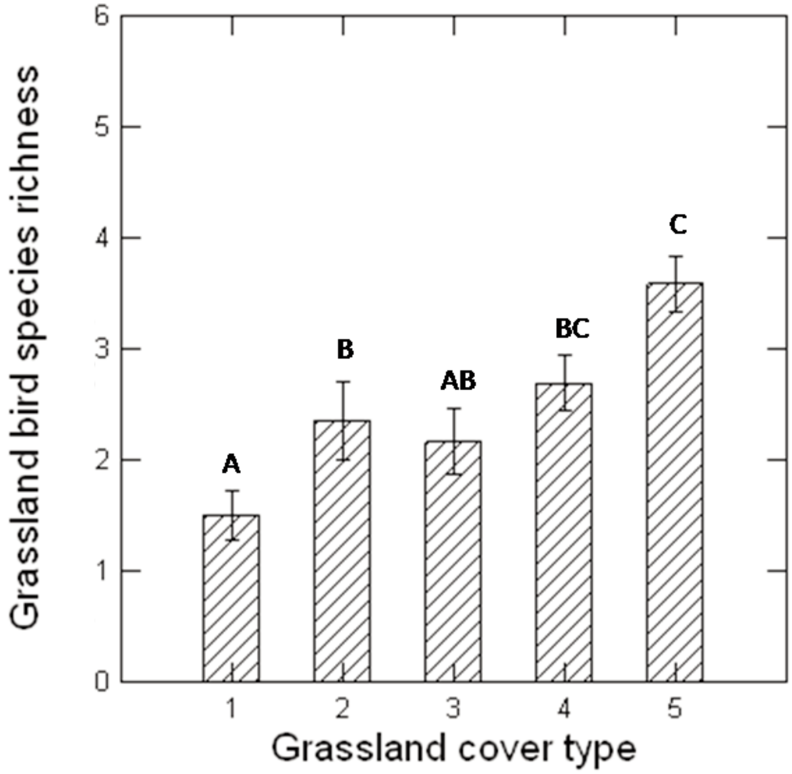

Fig. 1. Grassland bird species richness estimates in study grasslands (n = 97) of 5 cover types in the tallgrass prairie region of eastern South Dakota and western Minnesota, 2001–2004. 1 = intermediate wheatgrass monotype, 2 = switchgrass monotype, 3 = cool-season mixture, 4 = warm-season mixture, and 5 = tracts of native sod prairie. Error bars represent one standard error on each side of the mean, and means with different letters are significantly different from each other.

variation (not attributable to the effects of cover type) in vegetation heights or litter depth.

Grassland Birds

Species richness of grassland-obligate birds was significantly higher in native sod tracts than it was in intermediate wheatgrass and switchgrass monotypes or cool-season mixes, but it was similar to the bird richness in warm-season mixes ($F_{4,91}$ = 4.43, $P \leq 0.05$; Fig. 1). Richness estimates were 39%–46% lower in intermediate wheatgrass monotypes than they were in plantings containing native grasses. Field area accounted for significant amounts of variation in grassland bird richness that were not attributable to the effects of cover type ($F_{1,91}$ = 11.3, $P \leq 0.05$).

Sedge Wren (*Cistothorus platensis*) densities in warm-season mixes were 71%–73% higher than they were in monotypes, 81% higher than they were in native sod prairie, and similar to densities in cool-season mixes ($F_{4,91}$ = 4.63, $P \leq 0.05$; Table 2). Common Yellowthroat (*Geothlypis trichas*) densities were 34%–63% higher in cool- and warm-season mixes than they were in monotypes, and 81% higher than in native sod tracts ($F_{4,91}$ = 2.87, $P \leq 0.05$; Table 2). Clay-colored Sparrows were not detected in switchgrass monotypes and their densities were 75%–91% greater in native sod prairies than they were in other planted grasslands ($F_{4,91}$ = 3.12, $P \leq 0.05$; Table 2). Savannah Sparrow densities were 59%–72% higher in switchgrass monotypes and native sod prairie than they were in all other cover types ($F_{4,91}$ = 2.43, $P \leq 0.05$; Table 2). Bobolink densities were 51% and 68% higher in switchgrass monotypes than they were in cool-season mixes and intermediate wheatgrass monotypes, respectively, but switchgrass densities were similar to densities in warm-season mixes and native sod prairie

TABLE 2. Mean species[a] density (males · 100 ha^{-1}) values[b] ($s_{\bar{x}}$) in study grasslands (n = 97) of 5 cover types[c] in the tallgrass prairie region of eastern South Dakota and western Minnesota, 2001–2004.

Avian species	Wheatgrass n = 18	Switchgrass n = 17	Cool mix n = 19	Warm mix n = 26	Native sod n = 17
Sedge Wren*	22.2 (13.5) a	20.6 (9.6) a	47.43 (15.0) ab	76.9 (13.4) b	14.7 (8.3) a
Common Yellowthroat	30.6 (8.2) ab	17.6 (7.4) ac	47.4 (11.1) b	46.2 (10.0) b	8.8 (6.4) c
Dickcissel*	38.9 (14.3)	44.1 (17.1)	36.8 (16.2)	9.6 (5.6)	11.8 (6.8)
Clay-colored Sparrow*	2.8 (2.8) a	0.0 a	2.6 (2.6) a	7.7 (4.6) a	29.4 (16.1) b
Grasshopper Sparrow*	16.7 (8.1)	14.7 (8.3)	26.3 (13.4)	53.8 (16.6)	58.8 (15.0)
Savannah Sparrow*	16.7 (7.0) a	50.0 (16.6) b	15.8 (7.7) a	21.2 (6.9) a	55.9 (17.1) b
Red-winged Blackbird	52.8 (10.8)	61.8 (17.9)	81.6 (15.9)	55.8 (14.8)	29.4 (14.9)
Bobolink*	22.2 (12.3) a	102.9 (25.5) b	50.0 (13.7) a	65.4 (8.1) ab	82.4 (14.8)ab
Western Meadowlark*	8.3 (6.1)	23.5 (10.6)	23.7 (11.1)	44.2 (14.2)	47.1 (10.0)
Brown-headed Cowbird	0.0	8.8 (4.8)	15.8 (7.7)	13.5 (6.5)	0.0

[a]Species included in the grassland bird species richness estimate (see Fig. 1) are noted with an asterisk (*).
[b]Superscripts with different letters indicate male densities that are significantly different from other values within the row.
[c]Wheatgrass (intermediate wheatgrass monotype), switchgrass (switchgrass monotype), cool mix (cool-season mixture), warm mix (warm-season mixture) and native sod (native sod prairie tracts).

($F_{4,91}$ = 2.87, $P \leq 0.05$; Table 2). Field area accounted for additional amounts of variation in Bobolink densities not attributable to cover type ($F_{1,91}$ = 6.17, $P \leq 0.05$). But field area did not account for additional variation in densities of the Clay-colored Sparrow, Savannah Sparrow, Sedge Wren, or Common Yellowthroat that were not attributable to the effects of cover type. Densities of Dickcissels (*Spiza americana;* P = 0.13), Grasshopper Sparrows (*Ammodramus savannarum;* P = 0.14), Western Meadowlarks (*Sturnella neglecta;* P = 0.22), Red-winged Blackbirds (*Agelaius phoeniceus;* P = 0.10), and Brown-headed Cowbirds (*Molothrus ater;* P = 0.14) did not differ among grassland cover types. However, Brown-headed Cowbirds were not detected in transects in intermediate wheatgrass monotypes or native sod tracts (Table 2).

DISCUSSION

The preservation of native prairie ecosystems is critically important to grassland-nesting birds because these ecosystems provide habitat not available in planted habitats. Although some birds used all grasslands, native sod prairies supported a richer grassland bird community and higher densities of several species. Other studies have found that increased vegetative heterogeneity in tracts of native sod prairie may support more arthropod prey for grassland birds (McIntyre and Thompson 2003, Hickman et al. 2006) and that prey diversity is positively associated with grassland bird richness (Hamer et al. 2006). Other studies have associated vegetation structure with differences in grassland bird densities (Fritcher et al. 2004). Our results indicate that vegetative differences among cover types result in altered bird communities and that native sod prairie sustains habitat for the greatest number of bird species.

Native sod prairies are especially important to bird species that utilize habitat not generally available in planted grasslands. Clay-colored Sparrow densities were 3–11 times greater in native sod prairies than in planted grasslands. Tracts of native sod prairie contained shrubby vegetation not found in planted cover types in our study in which Clay-colored Sparrows commonly place their nests (Winter et al. 2004). Similar to our results, Grant et al. (2004) detected more Clay-colored Sparrows as the percentage of shrubs within survey plots increased in north central North Dakota.

Savannah Sparrow density was highest in native sod prairie and switchgrass monotypes, where litter depths and average grass heights were lower than they were in other cover types. In previous research conducted in eastern South Dakota, Savannah Sparrow density was negatively associated with litter depth in the tallgrass region but not in the mixed-grass prairie region, where litter accumulates more slowly (Bakker et al. 2002). While not significantly different from each other, Grasshopper Sparrow and Western Meadowlark densities were more than twice as high in native sod prairies and warm-season mixes, where height-density readings were 27%–46% lower than they were in other cover types. Our results suggest that as planted grasslands age, they may ultimately become unsuitable for some species because they become progressively thicker and denser (Bakker et al. 2004). Conversely, the Sedge Wren preferred tall vegetation typical of the habitat available in warm-season mixes, and the Common Yellowthroat was most abundant in both cool- and warm-season mixes. Previous research in South Dakota indicates that these 2 species prefer tall, dense vegetation typical of older grassland plantings (Bakker et al. 2002, 2004).

We found that planted cover types dominated by exotic species, intermediate wheatgrass monotypes, and cool-season mixes supported depleted grassland bird communities as compared to the bird communities supported by native-species-dominated grasslands. In fact, intermediate wheatgrass monotypes had the lowest estimates of grassland bird species richness of any cover type, while native warm-season mixes had estimates of grassland bird richness similar to those of native sod. Some species exhibited their lowest densities in exotic plantings. For example, Bobolink densities were 68% lower in intermediate wheatgrass monotypes than they were in switchgrass monotypes. Several other studies have revealed decreased bird species occurrence, density, or nesting success in grasslands dominated by exotic species (Scheiman et al. 2003, Lloyd and Martin 2005, Flanders et al. 2006, Hickman et al. 2006). For instance, Flanders et al. (2006) found that bird abundance and arthropod diversity were significantly higher in rangelands dominated by native grasses than they were in rangelands dominated by exotic grass species (Lehmann lovegrass [*Eragrostis lehmanniana*] and buffelgrass [*Pennisetum ciliare*]) in south Texas, and Hickman et al. (2006) associated decreased forb cover in old world bluestem (*Bothriochloa ischaemum*) pastures with significantly lower arthropod biomass and avian richness and abundance compared to expired CRP pastures and native pastures in Kansas.

Converting annually tilled croplands that grassland birds rarely use (DeJong et al. 2004, Quamen 2007) either to grassland plantings used to produce biomass fuels or to set-aside acres such as CRP fields would provide habitat for this declining group of birds. Although only warm-season mixes approached the bird richness that is found in native prairie habitats, all cover types supported some grassland bird species. We recommend incorporating a diversity of native plant species into such plantings, rather than using exotic species, in order to increase grassland bird richness. However, our results suggest that converting existing native sod prairie to planted grasslands would be detrimental to populations of several grassland species, because these species utilize habitat not available in planted grasslands. Our results suggest that the preservation of remaining tracts of native sod prairies is critically important because planted cover types do not act as equivalent grassland bird habitats.

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