BIRD COMMUNITIES OF RESTORED PRAIRIES AND OLD-FIELD HABITATS IN AGRICULTURAL AND URBAN AREAS OF WINONA COUNTY, MINNESOTA

NEAL MUNDAHL, Department of Biology, Winona State University, Winona, MN 55987, nmundahl@winona.edu

NAOMI COREY, Department of Biology, Winona State University, Winona, MN 55987

BRUNO BORSARI, Department of Biology, Winona State University, Winona, MN 55987

Abstract: Native prairie and savanna habitats in southeastern Minnesota have been mostly eliminated by agriculture and urbanization. Resource management agencies and private landowners have idled former agricultural land and planted prairie vegetation or grassland cover on some sites to restore native plant and animal communities. The goal of this study was to survey bird communities in small (<10 ha) restored prairies and idled old-field habitats in agricultural and urban areas of Winona County, Minnesota. Six sites were surveyed five times each during one or two breeding seasons (May-August, 2008 and 2009). Perched or flushed birds along transects were identified and tallied to determine bird community structure and density. Over 900 birds representing 30 species were recorded during surveys, averaging 11 species/site (range = 7-19 species/site). Six generalist or woody-dependent species (American goldfinch, *Carduelis tristis*; red-winged blackbird, *Agelaius phoeniceus*; song sparrow, *Melospiza melodia*; indigo bunting, *Passerina cyanea*; chipping sparrow, *Spizella passerine*; house sparrow, *Passer domesticus*) were present at four or more sites, and represented >71% of all birds tallied. Species that strongly associate with grassland habitats (bobolink, *Dolichonyx oryzivorous*; dickcissel, *Spiza Americana*; field sparrow, *Spizella pusilla*; grasshopper sparrow, *Ammodramus savannarum*; ring-necked pheasant, *Phasianus colchicus*) represented only 8% of birds sighted and were found at only one or two sites each. Bird densities at most sites ranged from 13-17 birds/ha. Bird community diversity indices were similar at all sites, but bird community structure differed significantly (all Bray-Curtis similarity values <0.6) among all sites. Summer bird communities in small, restored grasslands and old fields of southeastern Minnesota appear to be highly variable and dominated by generalist and woody-dependent species, with grassland specialists present only in the larger (>3 ha) sites surveyed. Small grassland-habitat patch size and proximity of woody vegetation limited the attractiveness of grasslands in this region to native grassland birds.

Key Words/Search Terms: bird diversity, community similarity, community structure, bird density, grassland birds

INTRODUCTION

The majority (nearly 80%) of grasslands in North America have been lost during the past century, mostly as a result of conversion to agriculture or other human activities (Samson and Knopf 1994, Knopf and Sampson 1997). Tallgrass prairies are widely considered to be the single most endangered ecosystem in the United States (Steinauer and Collins 1996). Large-scale losses of prairie have continued to occur in some regions during the past decade (Higgins et al. 2002, Bakker et al. 2006), resulting in further fragmentation and isolation of grassland remnants (Herkert et al. 2003, Cunningham 2005, Askins et al. 2007, Peitz 2007).

Loss and degradation of grassland habitats has resulted in widespread and precipitous declines in abundances of many species of grassland birds in North America (Herkert 1994, Peterjohn and Sauer 1999). Endemic and obligate grassland birds often occur on both federal and state lists of endangered and threatened species, or lists of species of special concern. Loss of breeding habitat for these birds is the most likely cause of their declining numbers (Vickery et al. 1999, Herkert et al. 2003).

Grasslands in many parts of the upper midwestern United States are being restored or managed to enhance habitat for grassland birds (Knopf 1994). Several recent efforts have been initiated to increase the amount of perennial grassland cover available to grassland birds on the landscape, including the conversion of marginal farmland to prairie, the conversion of cropland to perennial grassland cover under the U.S. Department of Agriculture's Conservation Reserve Program (CRP), grassland habitat restoration projects supported by Ducks Unlimited and other conservation organizations, roadside vegetation projects, and biomass fuel plantings (e.g., Knopf 1994, Fritcher et al. 2004, Shochat et al. 2005, Bakker et al. 2006, Borsari and Onwueme 2008, Rahmig et al. 2009).

Grassland bird species differ in their response to changes in their grassland habitats (Knopf 1994, Rahmig et al. 2009). Many grassland bird species are sensitive to the amount of grassland in the landscape (Helzer and Jelinski 1999, Johnson 2001, Winter et al. 2006), and many habitat and landscape features can influence bird use of grasslands, including time since establishment or disturbance, degree of fragmentation/isolation, habitat patch shape, vegetation structure, and management regime (Helzer and Jelinski 1999, Herkert et al. 2003, Fritcher et al. 2004, Shochat et al. 2005, Bakker et al. 2006, Winter et al. 2006). Grassland restoration projects, therefore, can have widely ranging effects on grassland birds (Samson 1980, Knopf 1994).

Many grassland habitats have been restored or established in southern Minnesota in recent years for a variety of purposes (Camill et al. 2004, Cunningham 2005, Borsari and Onwueme 2008, Faber 2010). Restorations, old-field habitats, and CRP lands are scattered widely across this region (Cunningham 2005), creating potential habitat for grassland birds in both rural and urban landscapes. These grassland habitats are mostly small (<10 ha), but often occur in clusters, with other small grasslands nearby (N. Mundahl, personal observation). Management of these grasslands is highly variable, ranging from idle conditions (old fields) to ongoing restorations and annual harvests for biomass fuel production (Borsari and Onwueme 2008). Limited grassland bird research has been conducted on these lands (e.g., Driscoll 2004, Cunningham 2005, Faber 2010).

The objective of the present study was to examine bird communities in a variety of small (<10 ha) grassland habitats in southeastern Minnesota. Specifically, we were interested in comparing bird communities in rural versus urban habitats as well as restored versus old-field grasslands that differed greatly in management.

MATERIALS AND METHODS

STUDY SITES

Birds were surveyed in six small grassland sites in Winona County, Minnesota (Table 1). Two sites (Kriedermacher Farm, Kramer Ridge) were surveyed in 2008 and 2009, whereas the remaining four sites were surveyed only in 2009. Two sites (Kriedermacher Farm, Kramer Ridge) were located in a rural, agricultural setting, and the other four sites were located within the City of Winona, adjacent to residences, schools, and commercial buildings. Three of the sites had been "restored" by seeding with native prairie grasses and forbs, whereas three sites contained plant communities typical of old-field habitats within the region. Table 1 contains a qualitative listing of the common grasses and forbs at each

Table 1. Characteristics of grassland study sites surveyed for bird communities in Winona County, Minnesota, during summer, 2008 and 2009. Plants are listed alphabetically; scientific names are in appendix 1.

	GRASSLAND SITES					
CHARACTERISTIC	Kreidermacher	Kramer R.	SE Tech	Burns V. Ck.	Valley Oaks	Riverbend
SIZE (HA)	4.86	3.00	0.38	1.80	0.81	8.70
TYPE	Restored farm land	Restored farm land	Restored urban land	Old-field urban land	Old-field urban land	Old-field urban land
MANAGEMENT	Annual harvest	None	Annual fall mowing	None	None	Annual spring mowing
COMMON PLANTS	Big bluestem	Big bluestem	Big bluestem	Burr dock	Common milkweed	Black mustard
	Black-eyed susan	Compass plant	Canada thistle	Canada thistle	Goldenrod spp.	Canada thistle
	Canada wild rye	Golden alexanders	Canada wild rye	Common mullein	Queen Anne's lace	Lambs quarter
	Little bluestem	Goldenrod spp.	Compass plant	Goldenrod spp.	Red clover	Reed canarygrass
	Oxeye sunflower	Gray-headed coneflower	Goldenrod spp.	Queen Anne's lace	Reed canarygrass	Virginia wild rye
	Prairie coneflower	Indian grass	Gray-headed coneflower	Reed canarygrass	Rough bedstraw	White sweet clover
	Red clover	Little bluestem	Purple coneflower	White sweet clover	Smooth brome	Yellow sweet clover
	Side oats grama	Partridge pea	Purple prairie clover	Wild parsnip		
	Switch grass	Prairie spiderwort	Side oats grama			
	White sweet clover	Sedge spp.	Wild bergamot			
	Wild bergamot	White wild indigo				
		Wild bergamot				

site. Woody vegetation was not present within any of the study plots, but most sites were adjacent to wooded fence lines, residential plantings, or forest (see individual site descriptions below).

The survey site on the Kriedermacher Farm was a portion of a larger area (7.9 ha) used for biofuel (dry biomass) production (Borsari and Onwueme 2008). Irregularly shaped fields were planted either with mixed native grasses or with mixed grasses and forbs in 2007, and were harvested annually and pelletized for heating fuel for a commercial greenhouse business on site. Bird survey sites were located within three interconnected plots bordered by corn, hay, and soybean fields. Shrubs and trees were located nearby along fence lines, but none were within the biofuel fields. Bluebird nest boxes were scattered along the fence lines.

The Kramer Ridge site is a portion of the Whitewater Wildlife Management Area (managed by the Minnesota Department of Natural Resources), adjacent to the Kriedermacher Farm. Mixed native grasses or mixed grasses and forbs had been planted on 37.4 ha within 13 plots scattered across 5 township sections. Bird surveys were conducted on a single plot bordered by cornfields and forest. A bordering fenceline also contained shrubs and trees, but no woody vegetation grew within the restored plot.

The Southeast Tech site is located on the campus of Minnesota State College Southeast Technical in Winona, Minnesota. Mixed native grasses and forbs had been planted on a portion of a mowed grass lawn (soccer fields) adjacent to a truck drivers' training course. The site is bordered by mowed grass fields and a residential neighborhood and is mowed annually in the fall. Small trees were scattered along one side of the restored prairie.

The Burns Valley Creek site is a riparian grassland habitat bordering a coldwater trout stream. The area is confined within flood control levees that prevent Mississippi River waters from backing up into the creek and flooding the City of Winona. The area is mowed irregularly (every few years) to suppress the growth of woody vegetation. The site is bordered by hotels, small businesses (including a landscaping center and nursery with shrubs and small trees), and the Southeast Tech campus.

The Valley Oaks site is located in a city park, on a hillside with a 20°-30° slope and a westerly aspect. It was a former horse pasture and was mowed regularly for ~10 years after becoming a park. It has not been mowed or managed in any way during the past ten years and is used as a sledding hill during winter. Various bluebird nest boxes have been present on the site for nearly 20 years. The site is bordered by mowed parkland with scattered trees and shrubs, residential lawns, and forest, and is within 400 meters of a native dry bluffside prairie.

The Riverbend survey site is an undeveloped portion of an industrial park created on fill generated by a lake-dredging project in 2002. It was seeded with annual rye to protect the soil from erosion and has been mowed annually to suppress noxious weeds. The site is bordered by city streets, light industry, and two stormwater runoff retention basins. Trees and shrubs were absent in the study plot, but were present along the retention basins.

BIRD SURVEYS

Birds were surveyed along three transects at each study site during each year (May-July 2008, June-August 2009). A fourth transect was added to the Riverbend site after the initial survey date. Transects were 100 m in length except at Valley Oaks, where site size and shape limited the length of transects to 50 m.

Transects were walked slowly with frequent stops by a single observer on each of five survey dates each year. The same transects were used on each date. Perched or flushed birds were identified and tallied, and distance to each bird from the observer was measured with a rangefinder. Birds that flew over a site during surveys, or that could be heard but not located, were not tallied.

Bird data gathered from transects were used to estimate density, diversity, and community similarity. Bird densities were calculated for individual transects with the Hayne-King method for line transects (Buckland et al. 1993, Brower et al. 1998). The five density estimates calculated for a summer (2008 or 2009) for a specific transect were averaged before comparisons to avoid pseudoreplication issues (Krebs 1989). Density comparisons among all six sites were made using only 2009 data with single-factor analysis of variance (ANOVA). Overall bird community diversity at each site was estimated by calculating single Simpson diversity index values (Brower et al. 1998) for the combined data from all transects and dates within the same year for that site. Bird communities in 2009 were compared among all six sites by calculating Bray-Curtis community similarity index values for all possible site-pair combinations. A Bray-Curtis index value >0.6 was interpreted as similar communities between sites being compared, whereas an index value <0.6 was interpreted as significantly different communities. Density, diversity, and community similarity were compared between 2008 and 2009 surveys for the two sites studied in both years (Kriedermacher Farm, Kramer Ridge).

VEGETATION AND LITTER SURVEYS

Vegetation structure (i.e., cover for ground-nesting birds) and litter depth were assessed in late June 2010 at each of the six bird survey sites. Vegetation structure (a combination of vegetation height and density) was assessed by using the visual obstruction method of Robel et al. (1970) at 10 stations spaced 10-15 m apart along a single transect at each bird survey site. Structure was recorded as the highest point above ground where a graduated pole (2.5-cm increments) was completely obscured by vegetation when viewed from a sighting height of 1 m and a distance of 4 m (Robel et al.

1970). Two measurements were taken in opposite directions at each station and averaged. Two measurements of litter depth (nearest mm) also were made 8 m apart at each of the 10 vegetation structure stations by inserting a ruler into the litter until it made contact with the soil. Vegetation structure and litter depth each were compared among bird survey sites with single-factor ANOVA.

RESULTS

During 2008 and 2009 surveys, 918 birds comprising 30 species were observed (Table 2). Bird numbers varied greatly among the sites. The American goldfinch (*Carduelis tristis*) was the only species present at all sites, and it was the most common bird observed during surveys. Eight species (house wren, *Troglodytes aedon*; gray catbird, *Dumetella carolinensis*; red-winged blackbird, *Agelaius phoeniceus*; house sparrow, *Passer domesticus*; indigo bunting, *Passerina cyanea*; chipping sparrow, *Spizella passerine*; and song sparrow, *Melospiza melodia*) were found at four or more sites, and together comprised 67% of all birds observed. Five grassland species (bobolink *Dolichonyx oryzivorous*, dickcissel *Spiza Americana*, field sparrow *Spizella pusilla*, grasshopper sparrow *Ammodramus savannarum*, ring-necked pheasant *Phasianus colchicus*) were found at one or two sites each, with only three sites (Kreidermacher, Kramer Ridge, Riverbend) having any grassland species. These five species represented <9% of all birds observed. In addition, western meadowlarks (*Sturnella neglecta*) were observed at Riverbend, but not during transect surveys.

During 2009 when all sites were surveyed, most sites had similar bird species richness (~9 species/site) and diversity (~0.800) (Table 3). However, the Kreidermacher site had much higher species richness, with 19 species observed. Four species not observed at this site in 2009 were recorded in 2008, for a site total of 23 species for the two years combined. Kramer Ridge also had eight species present in 2008 that were not found in 2009, for a total of 16 species for the two seasons.

Table 2. Numbers of birds observed on transects at six grassland sites in Winona County, Minnesota, summers 2008 and 2009. Additional species observed at sites, but not found on transects, included red-tailed hawk, turkey vulture, bald eagle, American crow, barn swallow, tree swallow, bank swallow, and western meadowlark. Scientific names are in appendix 1.

SPECIES	GRASSLAND SITES							
	KREIDERMACHER	KRAMER R.	SE TECH	BURNS V. CK.	VALLEY OAKS	RIVERBEND	TOTALS	PERCENT
Sandhill Crane						3	3	0.3
Ring-necked Pheasant	3	1					4	0.4
Mourning Dove	2					13	15	1.6
Ruby-throated Hummingbird	2	2					4	0.4
Red-bellied Woodpecker	4						4	0.4
Downy Woodpecker			1	4			5	0.5
Blue Jay		1					1	0.1
Black-capped Chickadee	4	1	1				6	0.7
House Wren	2	1	6		3		12	1.3
Gray Catbird	7	10	1	1			19	2.1
Eastern Bluebird	11		1		6		18	2.0
American Robin	10				3		13	1.4
Cedar Waxwing	1	2					3	0.3
Yellow Warbler			1			2	3	0.3
Common Yellowthroat	22	33				4	59	6.4
Red-winged Blackbird	68	24	2	21		50	165	18.0
Brown-headed Cowbird	2	2			1		5	0.5
Common Grackle	1	1					2	0.2
Bobolink	8						8	0.9
European Starling		1					1	0.1
House Sparrow			1	17	9	4	31	3.4
Dickcissel	24					6	30	3.3
House Finch				10		77	87	9.5
American Goldfinch	63	20	13	58	6	39	199	21.7
Indigo Bunting	3	2		3		5	13	1.4
Rose-breasted Grosbeak	3						3	0.3
Chipping Sparrow	3		27	5	9		44	4.8
Field Sparrow	5	24					29	3.2
Grasshopper Sparrow	1						1	0.1
Song Sparrow	34	22		44		31	131	14.3
TOTALS	**283**	**147**	**54**	**163**	**37**	**234**	**918**	**100.0**

Bird densities at most sites averaged from 13 to 17 birds/ha (Table 3). Statistical testing indicated significant differences in densities (ANOVA $F_{5,13} = 3.78$, $P = 0.02$) among the six sites, but large density confidence intervals at many sites suggest that these differences are not truly meaningful (Johnson 1999). Densities of grassland bird species were low at all sites, ranging from zero to 3.96 birds/ha.

Table 3. Bird and vegetation characteristics for six grassland study sites in Winona County, Minnesota, summer 2009. Standard deviations are in parentheses.

CHARACTERISTIC	GRASSLAND SITES					
	Kreidermacher	Kramer R.	SE Tech	Burns V. Ck.	Valley Oaks	Riverbend
Total bird species richness	19	8	10	9	7	11
Grassland bird species richness	5	2	0	0	0	2
Simpson diversity	0.896	0.772	0.689	0.772	0.838	0.799
Density (birds/ha)	15.5 (6.8)	13.0 (4.3)	37.5 (16.0)	15.1 (1.8)	17.0 (8.1)	14.8 (6.2)
Visual obstruction (cm)	52 (19)	60 (10)	76 (19)	88 (9)	40 (6)	60 (27)
Litter depth (mm)	12 (11)	59 (28)	4 (5)	49 (29)	44 (15)	18 (24)

Bird communities were significantly different at all sites, based on all Bray-Curtis community similarity values being <0.6 (Table 4). Communities were most similar at Riverbend and Burns Valley Creek (red-winged blackbird, house finch [*Carpodacus mexicanus*], American goldfinch, song sparrow), and at the Kreidermacher and Kramer Ridge sites (common yellowthroat [*Geothlypis trichas*], red-winged blackbird, American goldfinch, field sparrow, song sparrow). In general, nearby sites had more-similar bird communities than did more distant sites.

Table 4. Bray-Curtis bird community similarity matrix for six grassland study sites surveyed in Winona County, Minnesota, summer 2009.

GRASSLAND SITES	GRASSLAND SITES				
	Kramer R.	SE Tech	Valley Oaks	Riverbend	Burns V. Ck.
Kreidermacher	0.477	0.240	0.241	0.366	0.415
Kramer R.	---	0.190	0.110	0.255	0.305
SE Tech	---	---	0.440	0.118	0.212
Valley Oaks	---	---	---	0.074	0.200
Riverbend	---	---	---	---	0.544

For the two sites surveyed in both 2008 and 2009 (Kreidermacher, Kramer Ridge), bird communities displayed both similarities and differences between the years (Table 5). Species richness and diversity varied between the years, but in opposite directions at the two sites. There were no significant differences in bird density between the two years at either the Kreidermacher site ($t_4 = 0.392$, $P = 0.709$) or Kramer Ridge ($t_4 = 0.216$, $P = 0.836$). However, bird communities were significantly different (Bray-Curtis index <0.6) between the years at both sites.

Table 5. Bird community characteristics for two grassland study sites ruveyed in Winona County, Minnesota, 2008 and 2009. Standard deviations are in parentheses.

CHARACTERISTIC	GRASSLAND SITES			
	Kreidermacher		Kramer Ridge	
	2008	2009	2008	2009
Bird species richness	14	19	13	8
Simpson diversity	0.772	0.896	0.799	0.772
Density (birds/ha)	18.2 (10.8)	15.5 (6.8)	11.9 (7.8)	13.0 (4.3)
Bray-Curtis index	0.420		0.335	

Vegetation structure (visual obstruction) (ANOVA $F_{5,54} = 8.30$, $P < 0.001$) and litter depth (ANOVA $F_{5,114} = 24.19$, $P < 0.001$) both differed significantly among the bird survey sites (Table 3). Vegetation structure was greatest at the wettest sites (Burns Valley Creek, SE Tech) and lowest at the driest site (Valley Oaks). There was no significant difference between restored sites and old-field sites with respect to either vegetation structure or litter depth (Fig. 1). Litter depths were significantly thicker at sites with no recent management compared to sites with regular harvest or mowing (Fig. 2).

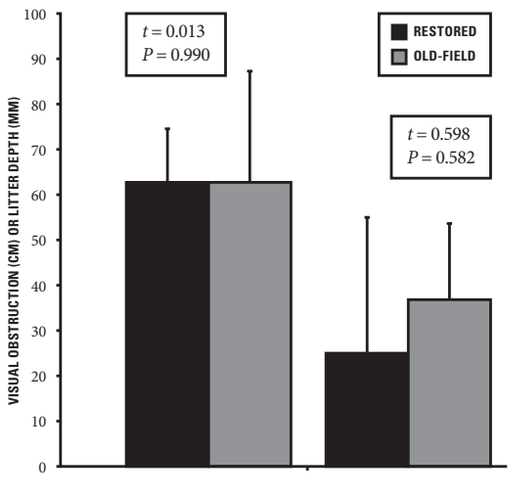
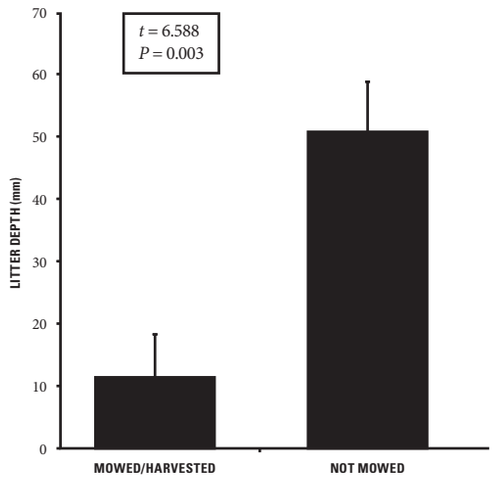


Figure 1. Vegetation structure (cm; visual obstruction reading) and litter depth (mm) at restored grassland and old-field bird survey sites. T-test comparison results are included above bars. Bars and vertical lines represent means and standard deviations, respectively.

Figure 2. Litter depths (mm) at brd survey grassland sites with and without mowing/harvest. T-test comparison results are included above bars. Bars and vertical lines represent means and standard deviations respectively.



DISCUSSION

Although the grassland habitats surveyed in this study varied in size, shape, vegetation composition and structure, degree of isolation, management type and frequency, and surrounding land use, most had similar densities of birds. Total bird densities in grasslands in Winona County also were similar to bird densities reported in grasslands over a wider geographic area (Warner 1994, Fritcher et al. 2004, Winter et al. 2005, Ahlering et al. 2006, Bakker et al. 2006, Peitz 2007, Rahmig et al. 2009, Skagen and Yackel Adams 2010), suggesting that restored grasslands and old-field habitats in southeastern Minnesota were as successful in attracting birds, in general, as are native prairies, managed grasslands on federal lands, and CRP fields elsewhere in Minnesota and in other states. However, the general lack of native grassland birds in the study grasslands suggests that these small grasslands may not be very suitable for grassland species.

In this study, only the three largest sites (3 ha and larger) attracted grassland bird species. Although several species of grassland birds, especially passerines, have small territories, many species require large tracts of land to reproduce successfully and/or sustain local populations (Samson 1980; Dechant et al. 1998; 1999a, b, c, d, e; Herkert 1998; Swanson 1998; Hull 2000). Many regional grassland species that either were not observed during the present study (eastern meadowlark, *Sturnella magna*; Henslow's sparrow, *Ammodramus henslowii*; savannah sparrow, *Passerculus sandwichensis*) or were observed in very low numbers (grasshopper sparrow, western meadowlark) typically occupy grasslands larger (> 10 ha) than those examined in this study, or they are very sensitive to grassland fragmentation and isolation (Dechant et al. 1998, 1999e, Herkert 1998, Swanson 1998, Hull 2000). Small, fragmented, and/or isolated grasslands are unattractive to many grassland birds (Samson 1980, Knopf 1994, Herkert et al. 2003; but see Ahlering et al. 2006), likely because nesting birds often suffer greater reproductive failure due to higher rates of nest predation and brood parasitism in these smaller grassland patches (Warner 1994, Howard et al. 2001, Cunningham 2005, Shochat et al. 2005, Skagen et al. 2005). No attempts were made in the present study to assess nesting attempts or nest success of grassland birds on the study sites, although adult bobolinks and dickcissels were observed feeding fledglings on at least two study sites. Future studies of grassland birds in this region should include larger (10-100 ha) restored grasslands and old-field habitats and some assessment of nesting success.

Vegetation structure and litter are important habitat components for many nesting grassland birds (e.g., Warner 1994, Cunningham 2005, Rahmig et al. 2009, Skagen and Yackel Adams 2010), although diversity in these characteristics (e.g., presence or absence of woody vegetation, thickness or absence of litter layer) is important to support the greatest diversity of grassland birds (Fritcher et al. 2004, Winter et al. 2005, Bakker et al. 2006, Rahmig et al. 2009). Varying management of the study sites, especially annual mowing or biomass harvest, may have had a detrimental effect on grassland birds by reducing the litter layer and/or disrupting nesting. For example, most grassland birds that are common to southeastern Minnesota prefer a well-developed (i.e., thick) litter layer (Dechant et al. 1998, 1999a, b, c, d, e; Herkert 1998; Swanson 1998; Hull 2000). Significantly reduced litter layers were typical of mowed/harvested sites in this study, and this may have reduced grassland bird use of these habitats relative to other areas. However, the site with annual biomass harvest (Borsari and Onwueme 2008) and the second lowest litter depth had the same density of grassland birds (3.96 birds/ha) as the site with the thickest litter, suggesting that other factors (habitat size and/or shape, isolation, vegetation structure, presence of woody vegetation nearby) may be able to compensate for one substandard habitat characteristic.

Both rural and urban grasslands, as well as restored and old-field habitats, provided habitat for small numbers of grassland birds in southeastern Minnesota. Native grassland birds can thrive in some urban grasslands, even while sharing habitats with increasing numbers of naturalized bird species (Engle et al. 1999, Marzluff et al. 2001, Jones and Bock 2002). Restored and old-field sites had similar vegetation structure and litter depths, allowing both types of grasslands to meet some of the basic structural habitat needs of grassland birds. However, the plant communities of restored and old-field habitats differed dramatically, and this may affect food resources (i.e., seeds, insects) needed by grassland birds. In general, it appears that grasslands in southeastern Minnesota, regardless of their management, may attract native grassland birds, as long as sites are large enough to meet minimum area requirements of some of these species.

Bird communities at the study grasslands were dominated by species usually associated with woody vegetation, including shrub, tree, and cavity nesters (Ehrlich et al. 1988). Although shrubs and trees were not present within any of the study grasslands, woody vegetation adjacent to all of the sites likely influenced the use of these grasslands by non-grassland birds. The majority of grassland birds that breed in southeastern Minnesota are either intolerant of woody vegetation within their nesting habitats or experience reduced nesting success when shrubs and trees increase in abundance (Dechant et al. 1998, 1999a, b, c, d, e; Herkert 1998; Swanson 1998; Hull 2000). Regardless of the plant community or management of the grasslands in this study, only 50% of small restored grasslands and old-field habitats in southeastern Minnesota attracted even small numbers of native grassland birds, likely resulting from a combination of small size and proximity of woody vegetation. Protection or restoration of larger tracts of grassland habitat may be necessary to attract and sustain grassland bird populations within this region.

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Appendix 1. Common names (alphabetical order) and scientific names of birds and plants observed during surveys of six grassland sites in Winona County, Minnesota, summers 2008 and 2009.

BIRDS	
COMMON NAME	**SCIENTIFIC NAME**
American Crow	*Corvus brachyrhynchos*
American Goldfinch	*Carduelis tristis*
American Robin	*Turdus migratorius*
Bald Eagle	*Haliaeetus leucocephalus*
Bank Swallow	*Riparia riparia*
Barn Swallow	*Hirundo rustica*
Black-capped Chickadee	*Poecile atricapillus*
Blue Jay	*Cyanocitta cristata*
Bobolink	*Dolichonyx oryzivorus*
Brown-headed Cowbird	*Molothrus ater*
Cedar Waxwing	*Bombycilla cedrorum*
Chipping Sparrow	*Spizella passerina*
Common Grackle	*Quiscalus quiscula*
Common Yellowthroat	*Geothlypis trichas*
Dickcissel	*Spiza americana*
Downy Woodpecker	*Picoides pubescens*
Eastern Bluebird	*Sialia sialis*
European Starling	*Sturnus vulgaris*
Field Sparrow	*Spizella pusilla*
Grasshopper Sparrow	*Ammodramus savannarum*
Gray Catbird	*Dumatella carolinensis*
House Finch	*Carpodacus mexicanus*
House Sparrow	*Passer domesticus*
House Wren	*Troglodytes aedon*
Indigo Bunting	*Passerina cyanea*
Mourning Dove	*Zenaida macroura*
Red-bellied Woodpecker	*Melanerpes carolinus*
Red-tailed Hawk	*Buteo jamaicensis*
Red-winged Blackbird	*Agelaius phoeniceus*
Ring-necked Pheasant	*Phasianus colchicus*
Rose-breasted Grosbeak	*Pheucticus ludovicianus*
Ruby-throated Hummingbird	*Archilochus colubris*
Sandhill Crane	*Grus canadensis*
Song Sparrow	*Melospiza melodia*
Tree Swallow	*Tachycineta bicolor*
Turkey Vulture	*Cathartes aura*
Western Meadowlark	*Sturnella neglecta*
Yellow Warbler	*Dendroica petechia*

PLANTS	
COMMON NAME	**SCIENTIFIC NAME**
Big bluestem	*Andropogon gerardii*
Black mustard	*Brassica nigra*
Black-eyed susan	*Rudbeckia hirta*
Burdock	*Arctium minus*
Canada thistle	*Cirsium arvense*
Canada wild rye	*Elymus canadensis*
Common milkweed	*Asclepias syriaca*
Compass plant	*Silphium laciniatum*
Goldenrod spp.	*Solidago spp.*
Gray-headed coneflower	*Ratibida pinnata*
Indian grass	*Sorghastrum nutans*
Lamb's quarters	*Chenopodium album*
Little bluestem	*Andropogon scoparius*
Common mullein	*Verbascum thapsus*
Oxeye sunflower	*Heliopsis helianthoides*
Partridge pea	*Cassia fasciculata*
Prairie brome	*Bromus kalmii*
Prairie coneflower	*Ratibida columnifera*
Prairie spiderwort	*Tradescantia bracteata*
Purple coneflower	*Echinacea purpurea*
Purple prairie clover	*Petalostemum purpureum*
Queen Anne's lace	*Daucus carota*
Red clover	*Trifolium pratense*
Reed canarygrass	*Phalaris arundinacea*
Rough bedstraw	*Galium asprellum*
Sedge spp.	*Carex spp.*
Side-oats grama	*Bouteloua curtipendula*
Smooth brome	*Bromus inermis*
Virginia wild rye	*Elymus virginicus*
White sweet clover	*Melilotus alba*
White wild indigo	*Baptisia alba*
Wild bergamot	*Monarda fistulosa*
Wild parsnip	*Pastinaca sativa*
Yellow sweet clover	*Melilotus officinalis*