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Impacts of Agricultural Tillage on Grassland Birds in Western South Dakota

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Abstract

Xeric, mixed-grass landscapes are changing rapidly as native grasslands are converted to cropland. We surveyed birds to compare their use of grassland and cropland habitats and to evaluate whether their abundances were related to grassland fragment size. Surveys were conducted in western South Dakota at 146 sites that were stratified by habitat type, landscape composition and fragment size. The abundances of 13 of 14 species were 1.2–140 times higher in grasslands than in cropland. Greater prairie-chicken, sharp-tailed grouse, burrowing owl, Baird's sparrow, northern harrier, and short-eared owl never occurred in cropland. Abundances of grasshopper sparrow, western meadowlark and chestnut-collared longspur were higher in grassland than in any other habitat type. A positive relationship between grassland fragment size and grasshopper sparrow abundance indicates that it may not be enough to conserve small parcels of habitat even for the most common grassland species. The future of grassland bird populations will depend on grassland habitat conservation practices because most species are grassland specialists.

Keywords: Birds, cropland, fallow, grassland, habitat, South Dakota, tillage

Introduction

Xeric, mixed-grass landscapes of the northern Great Plains are changing rapidly as vast expanses of native grasslands are converted to cropland (Higgins and others 2002). Conversion to cropland has left grasslands as one of the most endangered ecosystems in North America (Samson and others 2004). Not surprisingly, grassland-dependent birds have declined more than any other bird group in North America (Knopf 1994, Vickery and Herkert 2001). Although evidence suggests that some species require large, unfragmented grassland tracts (e.g., Vickery and others 1994, Winter and Faaborg 1999), scientists do not yet fully understand which species are most vulnerable to habitat loss or how well fragmented grassland landscapes function for species that remain. Goals of this study were 1) to compare the frequency and abundance of grassland birds in native prairie and cropland habitats, 2) to identify grassland habitat specialists, and 3) to evaluate whether the size of remaining grassland fragments influences grassland bird abundance.

Study Area

Landscapes of western South Dakota are unglaciated landforms produced by ancient geological processes (Johnson and others 1995). While exotic plant species, such as crested wheatgrass (*Agropyron cristatum* Gaertn) and Kentucky bluegrass (*Poa pratensis* L.), are present, nearly half of western South Dakota is still considered native northern wheatgrass (*Agropyron* spp. Gaertn)–needlegrass (*Stipa* spp. L.) grassland (Johnson and Larson 1999). These native grasslands are used primarily for livestock grazing. Rangeland area in South Dakota has decreased by about 14% in the last 20 years (Higgins and others 2002). Major crops that have replaced native grasslands include wheat (*Triticum aestivum* L.), corn (*Zea mays* L.) and soybeans (*Glycine max* L.). Farmers often fallow fields for one year to conserve soil moisture. Annual weeds grow in fallowed fields for one growing season before they are plowed up and planted back to cropland.

Methods

Survey Design

As part of the Northern Great Plains Steppe Assessment, the U.S. Geological Survey's EROS Data Center, in cooperation with The Nature Conservancy, mapped land use (1:250,000 scale at 30-m resolution) in western South Dakota using 1991–1993 satellite imagery. After excluding the Black Hills and Badlands regions, we overlaid 25.9-km^2 cells on the Northern Great Plains Steppe Assessment map to identify grassland and tillage landscapes. Grassland landscapes were composed of less than 5% cropland within 25.9-km^2 cells, whereas intensively tilled landscapes contained greater than 60% cropland. We randomly selected 101 landscapes in western South Dakota (Figure 1). Within intensively tilled landscapes, we conducted surveys in 101 grassland fragments

and 21 cropland sites to evaluate bird use of grassland and cropland habitats. To evaluate the influence of fragment size on bird use, we stratified grasslands into four size classes: 1) 10–40 ha [n = 25], 2) 41–129 ha [n = 27], 3) 130–258 ha [n = 24], 4) 259–1,033 ha [n = 25]. Lastly, we surveyed 24 sites in grassland landscapes (less than 5% cropland) to compare bird abundances in grassland fragments in intensively tilled landscapes to those in contiguous grassland areas (i.e., unfragmented grasslands).

Bird Surveys

We surveyed birds May 21–July 4 in 1999 and 2000 using belt transects of fixed length and width (150 m x 120 m) (Wakeley 1987, Ralph and others 1993). We located transects greater than 30 m from roads and tree belts to minimize edge effects. We recorded all birds that were seen or heard within the transect area (Wakeley 1987). Birds flying over a transect were not counted. We visited a new set of survey sites in each year. Birds were surveyed using one transect at all sites regardless of their size to avoid passive sampling issues (Horn and others 2001, Johnson and Igl 2001).

Vegetation Sampling

We were interested in quantifying abundances of grassland birds in the most common habitat available to them. Thus, we selected grazed grasslands that had similar vegetative composition and structure to reduce variation among study sites. Some areas contained a mixture of native mixed-grass species and exotic species, such as alfalfa, Kentucky bluegrass or crested wheatgrass. To characterize vegetation structure, vegetation sampling was conducted along each transect at two points, each at one-third the length of each transect (50 m and 100 m). Estimates of visual obstruction were recorded in the four cardinal directions at the highest point above the ground where vegetation limited visibility of the pole by 100% from a sighting height of 1 m and at a sighting distance of 4 m (Robel and others 1970). Tallest forb, tallest grass and leaf height also were estimated to the nearest dm at each sampling point using a modified Robel pole (Higgins and Barker 1982).

Data Analysis

We calculated frequency of occurrence by dividing the number of sites in which the bird species was recorded by the total number sites surveyed. Bird abundance was calculated for each species as the number of individuals per 100 ha. For eight species that occurred in greater than 5% of grasslands surveyed, we used Analysis of Variance (ANOVA) to evaluate whether bird abundance differed among three habitats: grassland, fallow fields, and cropland. We also used ANOVA to evaluate whether bird abundance was associated with size of the grassland fragment. A Tukey's post-hoc test was used to determine where differences in bird abundance occurred among sizes of grassland fragments. For species that exhibited a relationship between abundance and grassland fragment size, we also compared their abundance in the largest grassland fragments to that observed in unfragmented grassland landscapes (less than 5% cropland within 25.9-km^2 cells). Lastly, we used ANOVA to assess whether local vegetative attributes in fragmented and unfragmented grasslands differed.

Results

Six species that used grasslands but never occurred in cropland were the greater prairie-chicken (*Tympanuchus cupido* L.), sharp-tailed grouse (*Tympanuchus phasianellus* L.), burrowing owl (*Athene cunicularia* Molina), Baird's sparrow (*Ammodramus bairdii* Audubon), northern harrier (*Circus cyaneus* L.), and short-eared owl (*Asio flammeus* Pontoppidan) (Table 1). The abundances of 13 of 14 species were 1.2–140 times higher in grasslands than cropland. The two most abundant species, grasshopper sparrow (*Ammodramus savannarum* Gmelin) and western meadowlark (*Sturnella neglecta* Audubon), were present in more than 95% of all grasslands surveyed at an estimated combined abundance of at least 470 birds/100 ha. Abundances of grasshopper sparrow, western meadowlark and chestnut-collared longspur (*Calcarius ornatus* Townsend) were higher ($P \leq 0.10$) in native grasslands than in fallow fields or cropland (Table 1). Abundance of bobolink (*Dolichonyx oryzivorus* L.) was higher in grasslands and fallow fields than in cropland (Table 1). Dickcissels (*Spiza americana* Gmelin) were more abundant in fallow

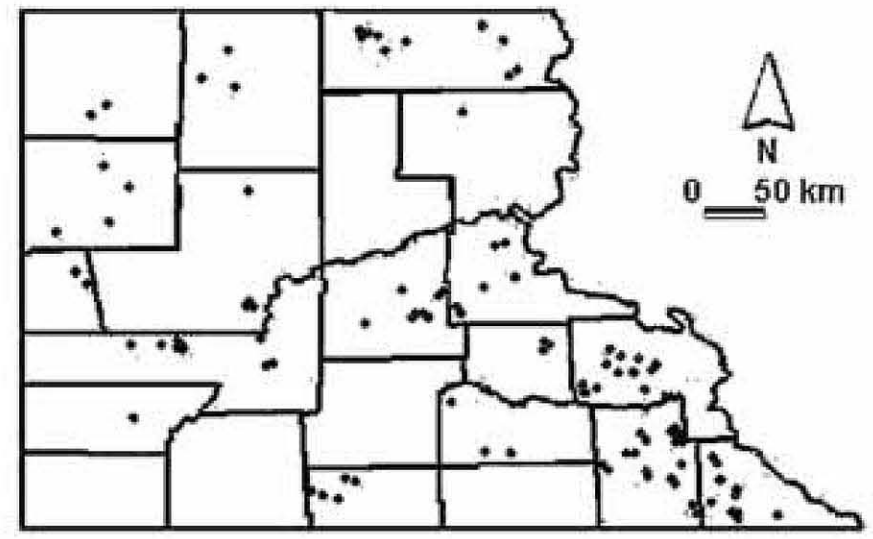

Figure 1. Distribution of 101 landscapes that were surveyed for grassland birds in western South Dakota, 1999–2000. One landscape may depict the location of multiple individual fields.

Table 1. Frequency (%) and abundance (birds/100 ha) of grassland birds in grassland, fallow fields, and cropland in western South Dakota, 1999–2000.

	Grassland (*n* = 125)			Fallow (*n* = 8)			Cropland (*n* = 13)		
Species	%	Birds/ 100ha	SE	%	Birds/ 100ha	SE	%	Birds/ 100ha	SE
Grasshopper sparrow *Ammodramus savannarum* Gmelin	98	280	14	13	7	7	23	17	10
Western meadowlark *Sturnella neglecta* Audubon	96	190	11	38	21	15	15	30	19
Chestnut-collared longspur *Calcarius ornatus* Townsend	30	58	10	13	7	7	8	4	4
Bobolink *Dolichonyx oryzivorus* L.	30	41	7	50	49	27	23	17	10
Dickcissel *Spiza americana* Gmelin	14	13	4	38	42	20	15	9	4
Upland sandpiper *Bartramia longicauda* Bechstein	14	11	3	0	0	0	8	4	4
Lark bunting *Calamospiza melanocorys* Stejneger	12	15	4	25	21	15	54	103	41
Horned lark *Eremophila alpestris* L.	8	8	3	25	49	19	62	86	33
Sharp-tailed grouse *Tympanuchus phasianellus* L.	2	2	0	0	0	0	0	0	0
Greater prairie-chicken *Tympanuchus cupido* L.	2	12	0	0	0	0	0	0	0
Burrowing owl *Athene cunicularia* Molina	2	<1	0	0	0	0	0	0	0
Baird's sparrow *Ammodramus bairdii* Audubon	1	1	0	0	0	0	0	0	0
Northern harrier *Circus cyaneus* L.	1	1	0	0	0	0	0	0	0
Short-eared owl *Asio flammeus* Pontoppidan	1	<1	0	0	0	0	0	0	0

Table 2. Comparison of vegetation attributes in fragmented and unfragmented grassland landscapes in western South Dakota, 1999–2000. All measurements are in decimeters.

Attribute	Grassland fragments (*n* = 101)		Unfragmented grasslands (*n* = 24)		P-value
	Min–Max	Mean (*SE*)	Min–Max	Mean (*SE*)	
Visual obstruction	0.3 – 3.2	1.0 (0.1)	0.5 – 2.4	0.9 (0.1)	0.21
Tallest forb	0.0–12.9	4.7 (0.2)	2.4–10.0	5.4 (0.4)	0.13
Tallest grass	2.3–10.5	5.5 (0.2)	2.7–10.4	5.8 (0.4)	0.36
Leaf height	0.3 – 6.0	0.8 (0.1)	0.4 – 6.5	1.0 (0.3)	0.22

fields than in any other habitat type surveyed (Table 1). Horned lark (*Eremophila alpestris* L.) and lark bunting (*Calamospiza melanocorys* Stejneger) were the only two species that occurred more frequently and in higher abundance ($P < 0.01$) in cropland than in grassland or fallow fields (Table 1). Abundance of grasshopper sparrow was higher in larger than smaller grassland fragments (Figure 2). Abundance of grasshopper sparrow in the largest grassland fragment and in unfragmented grasslands was similar ($P > 0.15$). Four attributes of vegetation structure were similar ($P = 0.13 – 0.36$; Table 2) within fragmented and unfragmented grasslands.

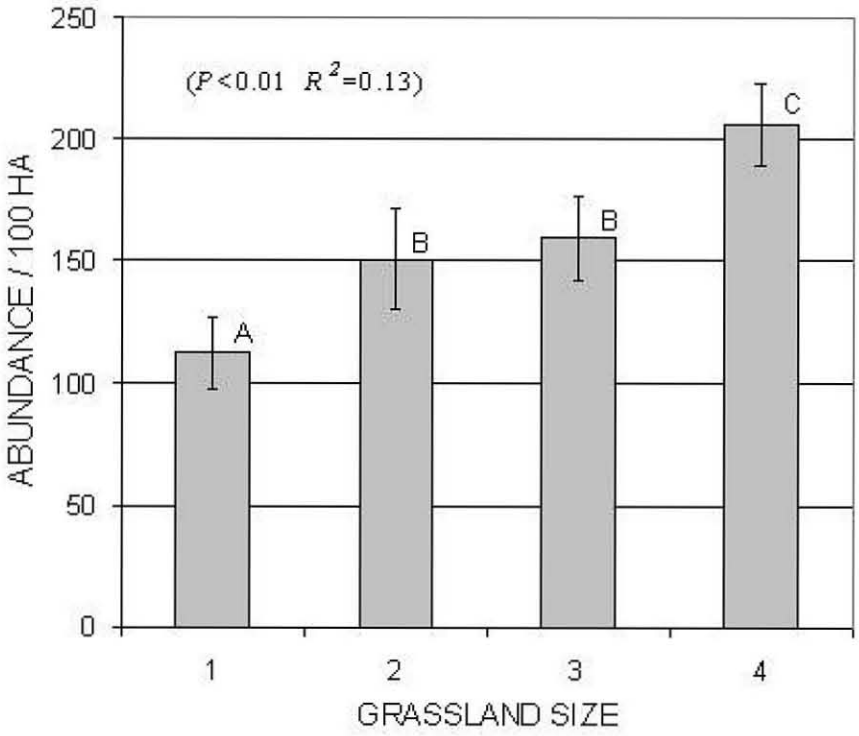

Figure 2. Grasshopper sparrow abundance in grassland fragments in western South Dakota, 1999–2000. Fragment sizes are 1) 10-40 ha, 2) 41-129 ha, 3) 130-258 ha, and 4) 259-1033 ha. Letters above bars denote statistical differences.

We were able to evaluate whether grassland fragment size was related to bird abundance because attributes of vegetation structure within fragmented and unfragmented grasslands were similar. A positive relationship between grassland fragment size and abundance of grasshopper sparrow indicates that it may not be enough to conserve small parcels of habitat even for the most common grassland species. Rather, grassland birds need large tracts of unfragmented grassland habitat if they are to attain their highest abundance. Although we did not evaluate reproductive success in this study, Herkert and others (2003) found that predation of grassland passerine nests was highest in small (less than 247 acres or 100 ha) and lowest in large (more than 2,470 acres or 1,000 ha) grassland fragments in five states in the United States.

These findings highlight the need for a greater landscape focus in grassland bird management and research to place local-level work into perspective. Multi-scale analyses may be necessary where grasslands are still abundant (e.g., western mixed-grass prairie) because human definitions of what constitutes a patch may not capture the influence of the surrounding landscape on density and occupancy rates of some species. In grassland-dominated landscapes, multi-scale analyses can be used to quantify the importance of the surrounding area because there is no single correct scale that describes a system. Working in eastern South Dakota, Bakker and others (2002) found that occupancy rates for sedge wren (*Cistothorus platensis* Latham) and clay-colored sparrow (*Spizella pallida* Swainson) were 12–23% higher in small fragments with less than 60% grassland habitat in the surrounding landscape than in large, isolated fragments with less than 60% grassland habitat. Understanding habitat needs of grassland birds in a landscape context will be a continuing area of research.

Discussion

The future of many grassland birds will depend on habitat conservation practices because most species surveyed use grassland habitat more than cropland during the breeding season. The most simple, yet striking, result from this study was the absence of all six large-bodied grassland species from the cropland habitats. Another species that was found in grassland habitats but never used cropland was Baird's sparrow, a species that warrants special attention due to a small population and restricted breeding range (Dechant and others 2003). Lack of cropland use by these grassland specialists is disturbing because the recent arrival of genetically modified soybeans that grow in drought-prone soils of western South Dakota has further elevated concern over the expansion of tillage agriculture into formally secure grassland habitats (Higgins and others 2002). Concurrent changes in crop types have decreased quality of grassland habitat while bigger and faster farm equipment make farming marginal land less risky (Higgins and others 2002). Data from this study further indicate that, even when species use cropland, their abundances may be too low to support healthy populations. The use of fallow fields by bobolink and dickcissel is encouraging, but this practice only provides temporary habitat that may act as a sink if birds begin to nest in spring before fields are put back to cropland. Unless habitat conservation practices are implemented to stem the loss and degradation of habitat, we will be left with a depauperate grassland bird community.

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