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Evaluation of the Bird Conservation Area Concept in the Northern Tallgrass Prairie: Annual Report 2001

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U.S. Department of the Interior
U.S. Geological Survey
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Jamestown, North Dakota

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Cover Photo: Sacha Mkheidze (left) and Annika Samuelson (right) check the charge on a battery and replace a video tape used to monitor grassland bird nests with miniature video camera. Photo by Jill A. Dechant.

Executive Summary

In 1998 we initiated a test of the concept that Bird Conservation Areas (BCA's) can maintain populations of breeding grassland birds. The underlying hypothesis is that large core areas of quality habitat (such as native prairie) that are surrounded by neutral habitats (such as small-grain fields), and that are isolated from hostile habitats (such as woody vegetation) will result in avian densities and reproductive rates sufficient to at least maintain population levels of breeding birds. This concept was proposed by the Midwest Working Group of Partners In Flight (e.g., Pashley and Fitzgerald 1996) and endorsed also by the Prairie Pothole Joint Venture of the North American Waterfowl Management Plan. This evaluation is being conducted in the northern tallgrass prairie, but the concept may be more generally applicable.

In 1999, we added 11 study plots in Sheyenne National Grassland in southeastern North Dakota to the existing 33 study plots in northwestern Minnesota. All study plots were assigned to one of four categories: 1) small core area surrounded by neutral landscape, 2) small core area surrounded by hostile landscape, 3) large core area surrounded by neutral landscape, and 4) large core area surrounded by hostile landscape. This year, four of the study plots could not be censused or nest-searched because prairies received prescribed burning. On each of the remaining 40 study plots we collected data on population density of breeding birds by censusing each plot twice during the field season. Data on nesting success, predation, and brood parasitism were obtained from a subset of 29 study plots. In addition, we color-banded birds on four of the study plots, focusing on Clay-colored Sparrow, Savannah Sparrow, and Bobolink. In 2001, we recorded 58 species on our census plots (compared with 41, 53, and 54 in 1998, 1999, and 2000 respectively), found 838 nests of 41 species (compared with 293 of 19 species, 793 of 34 species, and 679 of 39 species in 1998, 1999, and 2000), and color-banded 318 birds (compared with 263 and 334 in 1999 and 2000).

Background and Justification

Grasslands are recognized by many as the most imperiled ecosystem worldwide (Samson and Knopf 1994, Noss et al. 1995). The avian assemblages associated with grasslands also are at risk—grassland bird populations have shown steeper, more consistent, and more geographically widespread declines than any other guild of North American species (Department of the Interior 1996). Breeding Bird Survey data from 1966-1993 indicate that almost 70 percent of 29 grassland bird species adequately surveyed by BBS data had negative population trends; more than half of these were statistically significant.

In addition to range-wide population declines, the distribution and abundance of many grassland species are highly variable in space and time (Igl and Johnson 1999), which complicates conservation plans for grassland bird species. At both local and regional scales, variation in numbers from year to year may be driven by (1) climate patterns, which may significantly alter vegetation characteristics of the site and hence habitat cues used by birds in selecting breeding territories (Price 1995, Igl and Johnson 1999); (2) changes in the habitat caused by management actions or natural disturbances; (3) success of birds in raising young at that location in previous years, which may influence return rates and hence population stability at a site; (4) changes in landscape structure caused by agriculture, urban sprawl, or other human activities, or (5) random settlement patterns. The relative importance of each of these factors has not been well established for grassland species, yet such knowledge is crucial to understanding patterns of range-wide population declines and local-scale fluctuations in grassland bird populations.

In an attempt to reverse population declines of grassland birds, the management concept of Bird Conservation Areas (BCA's) was suggested as a means to conserve grassland songbird populations (Pashley and Fitzgerald 1996). The notion behind BCA's is that core areas of quality habitat (such as native prairies) that are isolated from hostile habitats (such as woody vegetation) will result in reproductive rates sufficient to maintain population levels of breeding birds (Henderson and Sample 1995). The BCA concept implies that the value of high-quality core areas depends on the habitat composition of the landscape matrix in which the core areas are embedded. This concept is being promoted

despite the absence of data that validate its usefulness in maintaining viable populations of grassland songbirds.

Moreover, the U.S. Department of the Interior (DOI) Conservation Strategy for declining birds in grassland ecosystems (DOI 1996) calls for information on the effects of habitat and landscape features on population viability of grassland birds. High-priority information needs identified by the DOI include effects of habitat structure and composition on avian communities and effects of landscape context (e.g., patch distribution, surrounding land use, and proximity to hostile environments) on avian numbers and nesting success. Furthermore, factors associated with highly variable population numbers (climate, habitat changes, nesting success) need to be understood to determine causes of population stability or instability over time. This information is critical for developing long-term conservation objectives that will benefit grassland birds but is lacking for many grassland bird species.

The BCA concept was proposed by the Midwest Working Group of Partners In Flight and supported also by the Prairie Pothole Joint Venture. It was included in the draft of the Landbird Conservation Plan for Physiographic Area 40: the Northern Tallgrass Prairie. This evaluation of the BCA concept in the northern tallgrass prairie is intended to determine whether BCA's do, in fact, meet their intended objectives. The effort addresses needs identified in the Landbird Conservation Plan by evaluating its assumptions.

For this evaluation, we consider native prairie (parts of which may have been restored) to be high-quality habitat; heavily wooded vegetation, which can harbor high numbers of predators and brood parasites, to constitute hostile habitat; and small-grain and hayfields to be neutral habitats.

Objectives

1. To estimate the distribution, abundance, and reproductive success of grassland bird species in large and small core habitats embedded within hostile and neutral landscape matrices.
2. To estimate between-year site fidelity of grassland songbirds and factors that influence site fidelity.

Study Areas

The study was conducted in three areas in the northern tallgrass prairie: (1) east of Moorhead, MN, in Becker, Mahnomen, and Clay counties; (2) east of Crookston, MN, in Polk County; and (3) in southeastern North Dakota at the Sheyenne National Grassland in Richland and Ransom counties. Study sites include tracts owned by the U.S. Fish and Wildlife Service, U.S. Forest Service, Minnesota Department of Natural Resources, and The Nature Conservancy (Table 1).

Methods

Study Design.--We are using a two-way factorial experimental design to address three major questions: (1) Does size of core habitat patch influence density and nesting success of birds? (2) Does landscape matrix (extent of woody vegetation surrounding the core habitat) influence density and nesting success of birds? and (3) Do patch size and landscape matrix show interactive effects? Main effects in the design are habitat patch size and landscape matrix, with several replicate plots within each size x landscape combination. All study plots were within native or restored prairie of similar vegetation structure and composition and ranged between 1.5 and 16 ha in size.

In total, 21 study plots were established within core areas that are "small" in size (<50 ha), and 23 study plots were established within core areas that are "large" in size (>250 ha). We searched for nests in 15 study plots within small core areas and in 13 study plots within large core areas. In 2001 four study plots in the Glyndon region could not be censused or nest-searched because management required prescribed burning (one large neutral plot and two large hostile plots) or plots were inaccessible (one small neutral plot). In addition, two plots in the Crookston region (one large neutral and one large hostile plot) were burned early during the field season such that census could be conducted, but nest-searching could not. To partly compensate for the lost plots, we included three plots for nest-searching that previously had been only censused (Chicog West, Margherita, and Fuglie; see Table 1). In addition, one census-only plot (Southeast) at Sheyenne National Grassland was added as nest-search plot, because a large number of nests had been found by chance during plot set-up, census, and nest-monitoring. Thus, in 2001, 19 study plots (11 in small core areas and eight in large core areas) were

established within hostile landscapes. Hostile landscapes include landscapes that contain large areas of woodland habitat within 5 km of the core habitat. Twenty-one study plots (nine in small core areas and 12 in large core areas) were established within neutral landscapes. Neutral landscapes include landscapes that consist of habitats that are thought to have little or no negative impact on bird populations within the core areas, such as small-grain fields, hay meadows, or Conservation Reserve Program fields.

Field methods.--We measured vegetation characteristics and bird abundance on all 40 study plots. Nesting success was investigated on a subset of 29 of the study plots (Table 1). Study plots were marked with flags or wooden laths at 50-m intervals along transects that were 100 m apart. Vegetation was assessed at 10 to 34 measuring points within each study plot, systematically located throughout each plot. The number of measuring points taken within a plot varied with the size of the study plot. Vegetation was measured once, in early to mid July. Measurements included vegetation height, percentage cover by growth form (grass, forb, woody, bare ground, litter, and standing residual) based on a 20x50 cm Daubenmire frame, height-density (Robel readings), number of small (≤ 30 cm tall) and large (>30 cm tall) woody stems, and litter depth. Vegetation characteristics in each study plot were evaluated to determine the associations between habitat characteristics, local (patch size) features, landscape features, and density of each species.

Abundance of breeding birds of all species was determined on each study plot by strip-transect censuses (Stewart and Kantrud 1972). Censuses were conducted twice between 21 May and 6 July. The maximum count of a species was used to determine density (number of males/100 ha).

We assessed reproductive success of birds by searching for nests and monitoring eggs and young until fledging. The observers located nests by walking through fields with or without flushing-sticks and looking for nests after flushing or observing birds. Nests were marked with a flag 5 m to the north of the nest and were revisited every 3 days to ascertain its status and the incidence of brood parasitism. Nest success was determined using the Mayfield method (Mayfield 1961). A nest was considered successful if it fledged at least one young of the parental species, and it was considered parasitized if it contained at least one Brown-headed Cowbird egg or chick. We focused our nest

searching efforts on three species: Savannah Sparrow, Clay-colored Sparrow, and Bobolink.

Nest vegetation was characterized within one week after activity at a nest had ceased. Vegetation was measured at five sites near each nest: directly at the nest and at a distance of 0.5 m from the nest in each cardinal direction. At each of the five points we measured vegetation in the same manner as described above for plot vegetation. Vegetation characteristics at the nest were evaluated to determine the associations between reproductive success by species and microhabitat (vegetation), local (patch size), and landscape features.

Four of the 40 study plots (two plots in large core areas surrounded by neutral landscape, and two plots in small core areas surrounded by hostile landscape) were designated as intensive sampling plots. On these we captured and marked birds to assess factors associated with population stability at a local site over time, again focusing on Savannah Sparrows, Clay-colored Sparrows, and Bobolinks. Birds were banded with an federal aluminum band and a combination of three color-bands. Since the 1999 field season, the four sites were monitored throughout the season to determine the number and identity of individuals that returned from previous nesting seasons. Unbanded birds nesting on the plot were targeted for banding. We focused on monitoring banded birds to determine their season-long fecundity and movements within a plot. The goal of the intensive-sampling plots was to evaluate the number of young fledged per year and site fidelity for each adult of the three focal species. Site fidelity was measured in terms of returning to a site between years.

As in 2000, we employed miniature videocameras (Pietz and Granfors 2000) at nest sites of the three focal species to determine the types of nest predators that affect nests in our study area. Cameras were employed within and close to study sites in the Crookston area at nests of our focal species: Savannah Sparrows, Clay-colored Sparrows, and Bobolinks.

Results

In 2001, we recorded 58 species of birds on our study sites (Table 2). The three most common species were Savannah Sparrow, Bobolink, and Clay-colored Sparrow.

Savannah and Clay-colored sparrows seemed to be affected by both patch size and landscape structure. Savannah Sparrows were consistently most abundant in large neutral plots, and least abundant in small hostile plots. Clay-colored sparrows showed the opposite patterns, with highest densities in small hostile plots, and lowest densities in large neutral plots. Bobolinks seemed to be affected primarily by landscape structure; densities were lowest in hostile landscapes, independent of patch size. However, this pattern did not manifest at Sheyenne National Grassland, where Bobolinks were common in both neutral and hostile landscapes. Greater Prairie-Chickens and Marbled Godwits were found only in large prairie patches surrounded by neutral landscape; this pattern was true for all regions (Table 2).

As in previous years, species composition differed among the three regions (Table 2). Some species were detected in only one of the three regions, such as certain duck species, Wilson's Phalarope, and Field Sparrow, all of which were found only at Sheyenne National Grassland. Further, species' densities varied among regions (Table 2); for example, Savannah and Le Conte's sparrows reached highest densities in the Crookston region, whereas Clay-colored Sparrows were recorded most frequently at the Glyndon region, and Western Meadowlarks and Grasshopper Sparrows were recorded most frequently at Sheyenne National Grassland. Bobolinks had similar densities across the three regions.

We found 838 nests of 41 species, resulting in a total of 2605 nests of 49 species over the course of the study (Table 3). Most of the nests found belonged to the three focal species, Savannah Sparrow, Clay-colored Sparrow, and Bobolink (Table 3), bringing to 1757 the total number of nests belonging to one of the focal species. The most unusual finding this year was of a Henslow's Sparrow nest at Sheyenne National Grassland. This nest is the first breeding record of Henslow's Sparrows in the state (Dechant et al. in prep.).

Nesting success of the focal species was highest for Savannah Sparrows and lowest for Clay-colored Sparrows. For nests pooled over all plots, the probability that a nest would survive the incubation and nestling periods were 28.1% for Savannah Sparrows (Mayfield probability of daily nest survival: 0.94 ± 0.006; $N = 187$), 22.6% for

Bobolinks (0.94 ± 0.007; N = 148), and 20.5% for Clay-colored Sparrows (0.92 ± 0.006; N = 242).

Nesting success varied greatly among regions and species, as did patterns in relation to patch size and landscape (Table 4). In the Crookston regions, nesting success of Savannah Sparrows and Bobolinks was highest in small patches, whereas Clay-colored Sparrow nesting success tended to be higher in large patches. Nesting success of the three focal species did not seem to be affected by either patch size or landscape structure in the Glyndon region or at Sheyenne National Grassland.

The main cause of nest failure was depredation (Table 5). Other causes of nest failure included 1) cowbird depredation, 2) weather-related factors (mainly drowning in the nest due to heavy rain), 3) trampling (mainly by cattle), 4) burnt by prescribed fire, 5) unknown causes, and 6) nest abandonment due to partial depredation, cowbird parasitism, camera setup, or unknown reasons.

Cowbird parasitism was low; only 7.0% of all (685) grassland passerine nests were parasitized (Table 6). The most heavily parasitized species were Grasshopper Sparrow, Lark Sparrow, Western Meadowlark, Bobolink, Clay-colored Sparrow, and Savannah Sparrow. All other grassland passerines had overall parasitism rates below 5%, even though parasitism rates were higher for some species in a single region.

We deployed cameras at 28 nests, eight of which eventually were depredated. Nest predators were of a wide array of species: garter snake, Franklin's ground squirrel, white-tailed deer (twice), striped skunk (twice), Northern Harrier, Brown-headed Cowbird, and one unidentified predator. As in 2000, no single predator species prevailed for any bird species, or in any patch size/landscape configuration. On small neutral plots, 12 nests were videotaped; of those, two nests were depredated, one each by striped skunk and Franklin's ground squirrel. On small hostile plots, seven nests were videotaped; of those, three were depredated: one by a white-tailed deer, one by a Brown-headed Cowbird, and one by both a Northern Harrier and a striped skunk. On large hostile plots, cameras were employed at nine nests, three of which got depredated, one each by a garter snake, a white-tailed deer, and an unidentified predator. Cameras were not set up on large neutral plots.

We color-banded 318 birds, 275 of which were focal species: 134 Savannah Sparrows, 90 Clay-colored Sparrows, and 51 Bobolinks. We found 117 nests for which at least one of the two parents was banded (55 Savannah Sparrows, 41 Clay-colored Sparrows, 21 Bobolinks). Both parents were banded at 80 of these nests.

Discussion and Future Plans

This study demonstrates the dynamic nature of grasslands and their avifauna. Not only do densities of breeding birds vary regionally and temporally, but so do interactions with their predators and brood parasites. This variability is reflected in the effects associated with habitat patch size and landscape features. After the fourth and final field season we have studied more than 2600 nests. However, we found that most of the patterns related to density and nesting success of our focal species did not hold consistently from year to year. Although the predicted patterns often emerged, they were not nearly as consistent among regions, years, or species as we had anticipated. These results suggest that 1) we cannot use patch size or landscape data to reliably predict bird assemblages and habitat quality, 2) we cannot readily generalize about patterns in density and nesting success of grassland-nesting birds within and across regions, and 3) we need detailed studies to understand mechanisms that affect abundance of birds and their reproductive success, as well as long-term and spatially extensive studies to discern patterns in those factors.

In the near future we will be conducting more detailed analyses to prepare scientific publications on the following topics:

1) How patch size and landscape structure affect density and nesting success
2) How patch size and landscape structure affect rates of cowbird parasitism
3) How patch size and landscape structure affect site fidelity
4) Nesting phenology of the three focal species
5) Annual variation in density, nest success, and cowbird parasitism of grassland passerine nests
6) How to find nests of grassland birds
7) Nest predators of grassland passerines in the northern tallgrass prairie.

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Table 1. Study sites in northwestern Minnesota and southeastern North Dakota tallgrass prairie patches.

Prairie	Size category	Landscape	Plot size (ha)	Nest search?	Ownership
Crookston Region **(Minnesota)**					
Foxboro	small	neutral	6.00	Yes	SNA[1]
Mentor SN	small	neutral	9.00	Yes	WMA[2]
Shypoke	small	neutral	6.00	Yes	WMA
Dugdale	small	neutral	6.00	No	WMA
Chicog NW	small	hostile	3.75	Yes	WMA
Mentor W	small	hostile	8.75	Yes	WMA
Tilden	small	hostile	8.25	Yes	WMA
Mentor NW	small	hostile	3.00	No	WMA
Pankratz S	large	neutral	16.00	Yes	TNC[3]
Tympanuchus	large	neutral	16.00	Yes	WMA
Pankratz N	large	neutral	16.00	No[7]	TNC
Pembina Trail	large	neutral	16.00	No	TNC
Burnham Creek	large	hostile	12.00	No[7]	WMA
Pankratz/Kertzonville	large	hostile	15.00	Yes	TNC/WMA
Chicog W	large	hostile	12.00	Yes[8]	WMA
Glyndon Region **(Minnesota)**					
Hoykens	small	neutral	5.75	Yes	WPA[4]
"Refuge"[5]	small	neutral	10.50	Yes	State Game Refuge
Spring Creek	small	neutral	12.00	Yes	WPA
Zimmerman	small	neutral	6.00	No	TNC
Eide	small	neutral	1.00	No[9]	WPA
Sagebraaten	small	neutral	3.00	No	WPA
"Private"[6]	small	hostile	4.50	Yes	WPA
Ulen	small	hostile	5.50	Yes	WMA
Buffalo E	small	hostile	3.00	No	State Park
Bicentennial	large	neutral	16.00	Yes	SNA
Bluestem N	large	neutral	15.25	Yes[7]	TNC
Margherita	large	neutral	12.00	Yes[8]	TNC
Blazing Star	large	neutral	16.00	No	TNC
Rice-Elliott	large	neutral	16.00	No	TNC
Bluestem S	large	hostile	15.00	Yes[7]	TNC
Buffalo W	large	hostile	16.00	Yes	State Park
Flickertail	large	hostile	12.00	Yes[8]	WPA
Fuglie	large	hostile	16.00	Yes[7]	WPA

Table 1. cont.

Prairie	Size category	Landscape	Plot size (ha)	Nest search?	Ownership
Sheyenne National Grassland **(North Dakota)**					
Shrike	small	hostile	2.75	Yes	USFS
Pileated	small	hostile	7.00	Yes	USFS
Camp	small	hostile	7.25	Yes	USFS
Surprise	small	hostile	1.50	No	USFS
North	large	neutral	16.00	Yes	USFS
Highway	large	neutral	16.00	Yes	USFS
Plum	large	neutral	16.00	Yes	USFS
Southeast	large	neutral	16.00	Yes[10]	USFS
Savannah	large	hostile	16.00	Yes	USFS
Eagle Point	large	hostile	14.00	Yes	USFS
Hammock	large	hostile	16.00	No	USFS

[1] Scientific and Natural Area

[2] Wildlife Management Area

[3] The Nature Conservancy

[4] Waterfowl Production Area

[5] State Game Refuge on north side of Hwy 26 at large rock pile, east of Hwy 9.

[6] State Game Refuge immediately south of the Shrike Unit

[7] Not used for nest-searching due to prescribed burning. Most plots could be censused before the burn, except for Fuglie and Bluestem prairies.

[8] Added as nest-search plot as a replacement for burnt plots.

[9] Not used for census due to bad condition of the road

[10] Added as nest-search plot because crew found many nests by chance while setting up the census plot.

Table 2. Mean bird density/ 100 ha (± standard error) in small and large plots in neutral and hostile landscapes, by region, in 2001. Species are in taxonomic order.

	Crookston				Glyndon				Sheyenne		
	Small		Large		Small		Large		Small	Large	
	Neutral N= 4	Hostile N= 4	Neutral N= 4	Hostile N= 3	Neutral N= 5	Hostile N= 3	Neutral N= 4	Hostile N= 2	Hostile N=4	Neutral N=4	Hostile N=3
Mallard	0	0	1.6 ± 1.6	0	10.1 ± 6.7	0	4.7 ± 4.7	3.1 ± 3.1	3.4 ± 3.4	12.5 ± 5.7	2.1 ± 2.1
Gadwall	0	0	0	0	0	0	0	0	0	6.3 ± 4.4	0
Northern Shoveler	0	0	0	0	0	0	0	0	0	7.8 ± 5.9	6.3 ± 3.6
Blue-winged Teal	0	0	0	0	3.5 ± 3.5	0	1.6 ± 1.6	0	0	21.9 ± 21.9	11.0 ± 2.4
Green-winged Teal	0	0	0	0	0	0	0	0	0	3.1 ± 3.1	2.1 ± 2.1
Redhead	0	0	0	0	3.5 ± 3.5	0	0	0	0	0	0
Ring-necked Duck	0	0	0	0	3.5 ± 3.5	0	0	0	0	0	0
Northern Pintail	0	0	0	0	0	0	1.6 ± 1.6	0	0	4.7 ± 3.0	0
Northern Harrier	0	0	3.1 ± 3.1	0	1.9 ± 1.9	0	1.6 ± 1.6	0	0	0	0
Sharp-tailed Grouse	0	0	0	0	0	0	0	0	0	1.6 ± 1.6	0
Greater Prairie-Chicken	0	0	12.5 ± 8.5	0	0	0	9.4 ± 4.0	0	0	1.6 ± 1.6	0
American Coot	0	0	0	0	0	0	0	0	0	4.7 ± 3.0	0
Sora	0	0	0	0	9.8 ± 6.8	0	1.6 ± 1.6	0	0	0	4.5 ± 2.2
Killdeer	0	0	3.1 ± 3.1	0	0	0	1.6 ± 1.6	0	0	4.7 ± 4.7	0
Upland Sandpiper	2.8 ± 2.8	0	0	5.3 ± 5.3	4.8 ± 3.0	0	4.7 ± 3.0	0	0	7.8 ± 3.0	10.4 ± 5.5
Marbled Godwit	0	0	1.6 ± 1.6	0	0	0	4.7 ± 3.0	0	0	3.1 ± 1.8	0
Common Snipe	2.8 ± 2.8	0	7.8 ± 3.9	0	0	0	2.1 ± 2.1	3.1 ± 3.1	0	9.4 ± 7.4	2.1 ± 2.1
Wilson's Phalarope	0	0	0	0	0	0	0	0	0	21.9 ± 12.6	6.3 ± 6.3
Black Tern	0	0	0	0	0	0	0	0	0	18.8 ± 9.2	2.1 ± 2.1
Mourning Dove	5.6 ± 5.6	0	0	0	8.6 ± 8.6	0	1.6 ± 1.6	0	0	1.6 ± 1.6	2.1 ± 2.1
Black-billed Cuckoo	0	0	0	0	0	7.4 ± 7.4	0	0	0	0	0
Short-eared Owl	0	0	0	0	1.9 ± 1.9	0	0	0	0	0	0
Ruby-throated Hummingbird	0	0	0	0	0	0	0	0	20.1 ± 15.9	0	0
Northern Flicker	0	0	0	0	0	7.4 ± 7.4	1.6 ± 1.6	0	0	0	2.1 ± 2.1
Alder Flycatcher	0	0	0	0	0	11.1 ± 11.1	1.6 ± 1.6	0	0	0	0
Eastern Phoebe	0	0	0	0	0	0	0	0	0	0	0
Eastern Kingbird	4.2 ± 4.2	2.9 ± 2.9	1.6 ± 1.6	5.6 ± 2.8	2.9 ± 2.9	6.1 ± 6.1	3.1 ± 1.8	15.6 ± 9.4	12.5 ± 8.6	1.6 ± 1.6	6.8 ± 4.1
Northern Rough-winged Swallow	0	0	0	0	0	0	0	0	3.6 ± 3.6	0	0
Bank Swallow	0	3.0 ± 3.0	1.6 ± 1.6	0	0	0	6.3 ± 6.3	3.1 ± 3.1	0	1.6 ± 1.6	4.2 ± 4.2
Tree Swallow	2.8 ± 2.8	0	0	0	10.1 ± 6.7	17.2 ± 9.6	1.6 ± 1.6	7.3 ± 1.0	0	0	0
Cliff Swallow	5.6 ± 5.6	0	1.6 ± 1.6	24.0 ± 24.0	0	0	0	6.3 ± 6.3	0	0	0
Barn Swallow	11.1 ± 3.9	3.0 ± 3.0	6.3 ± 6.3	8.1 ± 4.6	9.2 ± 5.9	0	4.7 ± 3.0	0	0	4.7 ± 3.0	2.1 ± 2.1
Sedge Wren	45.8 ± 26.7	60.0 ± 35.1	17.2 ± 5.9	11.1 ± 11.1	5.2 ± 3.2	22.2 ± 22.2	22.4 ± 12.4	37.5 ± 37.5	0	0	0

Table 2. cont. Mean bird density/ 100 ha (± standard error) in small and large plots in neutral and hostile landscapes, by region, in 2001. Species are in taxonomic order.

	Crookston				Glyndon				Sheyenne		
	Small		Large		Small		Large		Small	Large	
	Neutral N= 4	Hostile N= 4	Neutral N= 3	Hostile N= 3	Neutral N= 5	Hostile N= 3	Neutral N= 4	Hostile N= 2	Hostile N=4	Neutral N=4	Hostile N=3
Marsh Wren	0	0	0	0	5.7 ± 5.7	0	0	0	0	1.6 ± 1.6	0
American Robin	4.2 ± 4.2	0	0	2.7 ± 2.7	0	0	0	0	27.3 ± 27.3	0	2.4 ± 2.4
Gray Catbird	0	0	0	0	0	11.1 ± 11.1	0	0	0	0	2.4 ± 2.4
European Starling	0	0	0	5.6 ± 5.6	0	0	0	0	0	0	0
Yellow Warbler	4.2 ± 4.2	0	0	2.8 ± 2.8	6.3 ± 3.9	28.3 ± 19.9	3.1 ± 1.8	11.5 ± 5.2	0	0	2.4 ± 2.4
Common Yellowthroat	20.8 ± 8.0	15.0 ± 8.8	3.1 ± 1.8	5.6 ± 2.8	16.9 ± 6.4	20.9 ± 12.9	4.7 ± 3.0	59.4 ± 34.4	27.1 ± 14.3	3.1 ± 3.1	2.4 ± 2.4
Field Sparrow	0	0	0	0	0	0	0	0	7.0 ± 4.1	0	0
Clay-colored Sparrow	44.4 ± 17.1	67.6 ± 11.6	25.0 ± 17.1	38.2 ± 15.2	49.3 ± 6.2	118.9 ± 13.7	12.5 ± 7.7	78.1 ± 3.1	67.2 ± 23.7	0	21.4 ± 21.4
Chipping Sparrow	0	0	0	0	0	0	0	0	12.7 ± 8.6	0	0
Grasshopper Sparrow	0	9.1 ± 9.1	3.1 ± 3.1	0	5.7 ± 5.7	0	9.9 ± 3.9	12.5 ± 12.5	45.3 ± 29.5	64.1 ± 23.2	81.0 ± 12.4
LeConte's Sparrow	38.9 ± 9.6	58.3 ± 21.7	42.2 ± 19.3	11.1 ± 5.6	1.9 ± 1.9	7.4 ± 7.4	19.8 ± 14.8	9.4 ± 9.4	0	4.7 ± 1.6	0
Henslow's Sparrow	0	0	0	0	0	0	0	0	0	0	2.4 ± 2.4
Nelson's Sharp-tailed Sparrow	4.2 ± 4.2	0	0	0	0	0	0	0	0	0	0
Savannah Sparrow	145.8 ± 28.4	66.8 ± 22.0	157.8 ± 20.0	90.7 ± 21.4	90.3 ± 36.9	12.1 ± 12.1	153.6 ± 59.8	18.8 ± 6.3	3.6 ± 3.6	123.4 ± 12.9	17.6 ± 2.6
Vesper Sparrow	0	0	0	8.1 ± 4.6	0	0	1.6 ± 1.6	0	7.0 ± 4.1	0	2.1 ± 2.1
Lark Sparrow	0	0	0	0	0	0	0	0	7.0 ± 4.1	0	2.4 ± 2.4
Song Sparrow	0	0	0	2.8 ± 2.8	2.9 ± 2.9	0	0	8.3 ± 8.3	0	0	0
Swamp Sparrow	8.3 ± 8.3	0	0	0	12.8 ± 10.1	0	0	0	0	0	0
Western Meadowlark	6.9 ± 4.2	0	3.1 ± 3.1	0	1.9 ± 1.9	0	8.9 ± 2.6	0	3.6 ± 3.6	28.1 ± 7.4	17.3 ± 3.9
Bobolink male	45.8 ± 12.5	15.6 ± 6.2	51.6 ± 11.2	19.1 ± 9.9	91.4 ± 24.3	33.0 ± 16.8	44.3 ± 12.9	17.7 ± 1.0	87.9 ± 51.7	42.2 ± 13.1	58.3 ± 8.3
Bobolink female	19.4 ± 16.0	9.7 ± 6.3	21.9 ± 5.4	0	46.0 ± 9.9	25.6 ± 15.8	22.4 ± 8.5	13.5 ± 5.2	33.9 ± 19.6	15.6 ± 5.4	21.4 ± 3.6
Brown-headed cowbird	2.8 ± 2.8	0	7.8 ± 5.9	2.8 ± 2.8	0	0	0	0	0	4.7 ± 3.0	0
Red-winged Blackbird	13.9 ± 8.3	0	7.8 ± 3.9	0	66.3 ± 17.9	0	14.6 ± 9.9	0	10.3 ± 10.3	45.3 ± 24.9	28.3 ± 12.6
Brewer's Blackbird	9.7 ± 5.7	0	0	11.0 ± 7.4	19.3 ± 8.0	0	0	0	0	3.1 ± 3.1	2.1 ± 2.1
Common Grackle	0	0	0	0	16.8 ± 12.9	0	0	0	0	6.3 ± 63	0
American Goldfinch	0	24.8 ± 17.2	3.1 ± 1.8	16.6 ± 4.9	11.5 ± 5.4	22.2 ± 22.2	1.6 ± 1.6	17.7 ± 1.0	34.4 ± 16.2	0	4.5 ± 2.2
Total number of species	22	12	22	18	29	15	30	17	18	31	30

Table 3. Numbers of nests found, by study area, in 1998 - 2001, ordered by the total number.

	Crookston				Glyndon				Sheyenne			Total				
Species	1998	1999	2000	2001	1998	1999	2000	2001	1999	2000	2001	1998	1999	2000	2001	All
Clay-colored Sparrow	20	86	27	125	71	119	93	63	56	66	54	91	261	186	242	780
Savannah Sparrow	41	150	141	148	21	25	25	20	27	44	19	62	202	210	187	661
Bobolink	23	27	24	81	25	20	18	31	9	22	36	48	56	64	148	316
Red-winged Blackbird	6	2	7	6	6	4	4	8	28	13	30	12	34	24	44	114
Mallard	5	8	3	5	11	5	6	11	12	5	4	16	25	14	20	75
Blue-winged Teal	0	0	0	0	3	1	4	13	17	10	25	3	18	14	38	73
Western Meadowlark	1	6	2	0	3	1	2	3	25	17	11	4	32	21	14	71
LeConte's Sparrow	5	21	5	7	2	0	4	2	0	0	0	7	21	9	9	46
Grasshopper Sparrow	0	0	1	2	3	4	0	1	8	8	12	3	12	9	15	39
Brewer's Blackbird	12	8	9	0	4	3	0	0	0	0	1	16	11	9	1	37
Field Sparrow	0	0	0	0	0	0	0	0	13	16	7	0	13	16	7	36
Song Sparrow	2	2	0	1	5	8	10	2	3	0	0	7	13	10	3	33
Upland Sandpiper	0	1	6	1	7	3	2	0	3	1	4	7	7	9	5	28
Vesper Sparrow	0	0	0	0	0	0	0	0	8	10	10	0	8	10	10	28
Lark Sparrow	0	0	0	0	0	0	0	0	16	3	6	0	16	3	6	25
Sedge Wren	0	10	6	1	3	3	1	0	0	0	0	3	13	7	1	24
Eastern Kingbird	0	0	0	4	4	5	2	2	1	4	2	4	6	6	8	24
Mourning Dove	0	0	0	0	2	2	0	2	4	9	2	2	6	9	4	21
American Goldfinch	0	0	5	1	0	4	5	3	0	1	1	0	4	11	5	20
Common Yellowthroat	0	0	0	2	2	4	3	5	0	1	1	2	4	4	8	18
Common Snipe	2	3	0	3	1	1	0	0	1	1	5	3	5	1	8	17
Wilson's Phalarope	0	0	0	0	0	0	0	0	2	1	14	0	2	1	14	17
Greater Prairie-Chicken	2	1	3	1	2	2	2	2	0	0	1	4	3	5	4	16
Northern Shoveler	0	0	0	0	0	0	0	0	1	3	8	0	1	3	8	12
Yellow Warbler	0	1	0	0	0	2	6	0	0	0	3	0	3	6	3	12
American Woodcock	0	1	0	0	0	1	0	1	0	4	1	0	2	4	2	8
Marbled Godwit	0	0	1	0	1	1	0	0	2	1	1	1	3	2	1	7
Northern Harrier	0	2	1	0	0	1	1	1	0	0	0	0	3	2	1	6

Table 3. cont.

Species	Crookston				Glyndon				Sheyenne			Total				
	1998	1999	2000	2001	1998	1999	2000	2001	1999	2000	2001	1998	1999	2000	2001	**All**
Gadwall	0	0	0	0	0	0	0	0	3	0	2	0	3	0	2	5
Killdeer	0	0	0	0	0	0	0	1	0	0	4	0	0	0	5	5
Gray Catbird	0	1	0	0	0	0	2	1	0	0	1	0	1	2	2	5
Green-winged Teal	0	0	0	0	0	0	0	1	0	2	0	0	0	2	1	3
Northern Pintail	0	0	0	0	0	0	0	0	0	0	3	0	0	0	3	3
Swamp Sparrow	0	1	0	0	0	1	1	0	0	0	0	0	2	1	0	3
Sora	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	2
Tree Swallow	0	0	0	0	0	0	1	1	0	0	0	0	0	2	0	2
Brown Thrasher	0	0	0	0	0	1	0	1	0	0	0	0	1	0	1	2
Redhead	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1
Sharp-tailed Grouse	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1
Wild Turkey	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1
American Bittern	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1
Black-billed Cuckoo	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1
Marsh Wren	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1
American Robin	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1
Dickcissel	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1
Chipping Sparrow	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1
Henslow's Sparrow	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1
Yellow-headed Blackbird	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1
Total	119	331	241	389	176	221	195	176	241	243	273	295	793	679	838	2605
Region total—all years				1080				768			757					

Table 4. Mayfield estimates of daily nest survival rate (May), its standard error (SE), percent of nests parasitized by Brown-headed Cowbirds (Cow), and sample size (N) in small and large plots in neutral and hostile landscapes, by region, in 2001.

a) Crookston Region

	Small						Large					
	Neutral			Hostile			Neutral			Hostile		
Species	May ± SE	Cow	N	May ± SE	Cow	N	May ± SE	Cow	N	May ± SE	Cow	N
Clay-colored Sparrow	0.87 ± 0.03	3	22	0.90 ± 0.02	2	39	0.92 ± 0.02	0	23	0.95 ± 0.01	2	41
Savannah Sparrow	0.95 ± 0.01	4	59	0.96 ± 0.02	0	17	0.92 ± 0.02	1	54	0.92 ± 0.03	0	18
Bobolink	0.97 ± 0.01	2	22	0.93 ± 0.03	0	9	0.90 ± 0.02	1	26	0.94 ± 0.02	0	24

b) Glyndon Region

	Small						Large					
	Neutral			Hostile			Neutral			Hostile		
Species	May ± SE	Cow	N	May ± SE	Cow	N	May ± SE	Cow	N	May ± SE	Cow	N
Clay-colored Sparrow	0.93 ± 0.02	0	14	0.92 ± 0.02	1	15	0.95 ± 0.02	0	9	0.89 ± 0.02	0	25
Savannah Sparrow	0.93 ± 0.03	0	7	1.00 ± 0.00	0	1	0.95 ± 0.02	2	12	-	-	0
Bobolink	0.96 ± 0.01	1	16	0.92 ± 0.04	0	7	0.98 ± 0.02	1	6	1.00 ± 0.00	0	2

c) Sheyenne National Grassland

	Small						Large					
	Neutral			Hostile			Neutral			Hostile		
Species	May ± SE	Cow	N	May ± SE	Cow	N	May ± SE	Cow	N	May ± SE	Cow	N
Clay-colored Sparrow	-	-	-	0.94 ± 0.01	3	32	0.87 ± 0.09	1	2	0.91 ± 0.02	4	20
Savannah Sparrow	-	-	-	-	0	0	0.93 ± 0.02	3	17	0.68 ± 0.19	0	2
Bobolink	-	-	-	0.93 ± 0.04	1	7	0.91 ± 0.03	1	15	0.89 ± 0.03	8	14

Table 5. Causes of nest failure in 2001.

	Number of nests	Percent
Depredated:	313	37.4
Egg-laying stage	2	0.2
Incubation stage	162	19.3
Nestling stage	149	17.8
Cowbird predation	18	2.1
Weather-related	6	0.7
Trampled	14	1.7
Burnt by prescribed fire	4	0.5
Unknown	10	1.2
Abandoned:	96	11.5
Partial predation	25	3.0
Cowbird parasitism	10	1.2
Camera	8	1.0
Unknown	53	6.3

Table 6. Percentage of grassland passerine nests that were parasitized by Brown-headed Cowbirds in 2001. Total numbers of nests are shown in parentheses.

	Crookston	Glyndon	Sheyenne	Total
Species	Percentage (N)	Percentage (N)	Percentage (N)	Percentage (N)
Sedge Wren	0.0 (1)	0	0	0.0 (1)
Field Sparrow	0	0	0.0 (7)	0.0 (7)
Clay-colored Sparrow	5.6 (125)	1.6 (63)	14.8 (54)	6.6 (242)
Grasshopper Sparrow	50.0 (2)	0.0 (1)	16.7 (12)	20.0 (15)
Le Conte's Sparrow	0.0 (7)	0.0 (2)	0	0.0 (9)
Henslow's Sparrow	0	0	0.0 (1)	0.0 (1)
Savannah Sparrow	3.4 (148)	10.0 (20)	15.8 (19)	5.3 (187)
Vesper Sparrow	0	0	0.0 (10)	0.0 (10)
Lark Sparrow	0	0	16.7 (6)	16.7 (6)
Western Meadowlark	0	0.0 (3)	18.2 (11)	14.3 (14)
Bobolink	3.7 (81)	6.5 (31)	27.8 (36)	10.1 (148)
Red-winged Blackbird	0.0 (6)	12.5 (8)	0.0 (30)	2.3 (44)
Brewer's Blackbird	0	0	0.0 (1)	0.0 (1)
Total	4.3 (370)	4.7 (128)	13.9 (187)	7.0 (685)