Breeding bird communities and bird-habitat associations on North Dakota Waterfowl Production Areas of three habitat types

by

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Signatures have been redacted for privacy

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GENERAL INTRODUCTION

Waterfowl Production Areas (WPAs) in the northern Great Plains have been purchased by the Department of the Interior to preserve wetland-upland complexes for breeding waterfowl. WPA managers are charged with the responsibility of manipulating the habitat to maintain good waterfowl nesting cover. Some of these manipulation techniques are cattle grazing and planting formerly tilled portions of WPAs with a mixture of introduced grasses and legumes (DNC). Some portions of WPAs have not been burned, mowed, or grazed in several years (idle habitats), and this cover provides a vegetative structure that is different from grazed and DNC habitats.

Much research has focused on waterfowl use of WPAs, or on waterfowl use of vegetation similar to that found on WPAs (Duebbert 1969, Duebbert and Kantrud 1974, Duebbert and Lokemoen 1976, Higgins 1977, Cowardin and Johnson 1979, Kaiser et al. 1979, Duebbert and Lokemoen 1980), but only a few workers have documented non-game bird use of WPAs (Duebbert 1981, Johnson et al. 1982, and previous breeding bird surveys).

The amount of native habitat on private lands has decreased due to increased agriculturalization. As this happens, WPAs gain importance as pockets of native habitat for birds of the eastern mixed-grass prairie. In future management plans, WPA managers may have to consider the habitat needs of non-target bird species as well as waterfowl.

In order to manage the WPAs wisely for non-game birds, managers need to know what bird species and how many birds are using WPAs. Additionally, because vegetative structure largely determines what birds will be present on an area (Hilden 1965, Wiens 1969), managers need to know what habitat features are associated with the presence and density of a species. This information should help managers anticipate what bird communities will occur on WPAs as the result of habitat manipulation.

I conducted this study to determine the species composition and density of bird communities inhabiting upland portions of WPAs of three habitat types; idle native prairie, grazed native prairie, and dense nesting cover (DNC). In addition, I determined bird-vegetative structure associations for the species inhabiting those habitats. With this information, WPA managers will know what non-game birds use WPAs and will better understand the effects of different management techniques on those species.

This thesis is composed of two papers that will be submitted to scientific journals for publication. The first paper is titled "Non-game bird communities associated with three habitat types on North Dakota Waterfowl Production

Areas." The second is titled "Habitat use patterns of non-game birds associated with three habitat types on North Dakota Waterfowl Production Areas." I will be the first author on both publications.

NON-GAME BIRD COMMUNITIES ASSOCIATED WITH THREE HABITAT TYPES ON NORTH DAKOTA WATERFOWL PRODUCTION AREAS

Introduction

Since the 1960s, the U.S. Fish and Wildlife Service has purchased Waterfowl Production Areas (WPAs) to protect wetland-upland complexes for breeding waterfowl in the northern prairie states. Much research has focused on waterfowl use of these areas or of vegetation similar to that found on WPAs (Duebbert 1969, Duebbert and Kantrud 1974, Duebbert and Lokemoen 1976, Higgins 1977, Cowardin and Johnson 1979, Kaiser et al. 1979, Duebbert and Lokemoen 1980), but only a few workers have documented non-game bird use of WPAs (Duebbert 1981, Johnson et al. 1982 and previous breeding bird surveys).

The vegetation on WPAs is manipulated by burning, mowing, or grazing to make it attractive to nesting waterfowl. On formerly tilled portions of WPAs, managers have planted a mixture of introduced grasses and legumes called dense nesting cover (DNC). On some portions of WPAs, managers have not manipulated the vegetation for years, and these idle portions provide a habitat different from that on manipulated areas.

Each year more native habitat on private lands in the Prairie Pothole Region is plowed for agricultural purposes.

With the increased loss of private rangelands and hayfields, WPAs serve as pockets of habitat for the native birds of the mixed-grass prairie. WPA managers may need to take into consideration the habitat needs of non-target species as well as waterfowl to compensate for the loss of native habitats on private lands and to provide the habitat needed by all bird species of the mixed-grass prairie. Because little is known about what non-game bird communities inhabit various habitat types on WPAs, and because this information may help managers make knowledgeable and wise resource use decisions, I conducted this study to determine the species composition and density of bird communities associated with idle native prairie, grazed native prairie, and DNC habitats of North Dakota Waterfowl Production Areas.

Methods and Study Areas

In 1981 and 1982, I worked on 12 different WPAs located on the Missouri Coteau geological formation in Stutsman and McIntosh counties, North Dakota. I established 4, 6-ha (15 acre) study plots for each habitat type: idle native prairie, grazed native prairie, and dense nesting cover. Bird counts were conducted using the spot map method (Kendeigh 1944) to determine the species composition and density of birds on the plots. I usually was able to make three or four counts a morning. Counts usually were started a half hour before sunrise but never later than 10:00, because bird activity dramatically decreased after that time. I walked through the gridded (25 x 25m) plots, mapping the locations of singing males, and noting the flight direction and movements of birds. In 1981 and 1982, I completed 9 and 15 rounds of counts from early May to late June. In that same period, I randomly sampled the plot vegetation using the point-quadrat method (Brown 1954) to determine the percentage cover grass, forb, litter, and shrub, the percentage bare ground, and the vertical density of the vegetation (Wiens 1969). I directly measured litter depth and used a modified Robel pole (Robel et al. 1970) to measure the effective height of the vegetation. I sampled 48 points per plot. (For details on vegetation sampling methods, see Appendix 1.)

WPAs on which idle prairie plots were placed had not been grazed, burned, or mowed for 5 to 19 years before this study. Vegetation on these plots generally was matted and all idle plots had a significant amount of shrub cover. Most of the shrub cover consisted of wolfberry (Symphoricarpos occidentalis), but there were scattered stands of silverberry (Eleagnus commutata) and choke cherry (Prunus virginiana) on a few plots. The herbaceous cover of the idle habitats was dominated by green needlegrass (Stipa viridula), needle and thread (Stipa comata), blue grama

(Bouteloua gracilis), little bluestem (Andropogon scoparius), and Kentucky bluegrass (Poa pratensis).

The homogeneous stands of DNC I worked on had been established 6 to 9 years prior to my study. The vegetation was a mixture of alfalfa (Medicago sativa) and western wheatgrass (Agropyron smithii).

Grazed WPAs had not been grazed 3 to 4 years prior to the study, and the vegetation was dominated by the same plant species as the idle plots. The usual grazing regime used on WPAs consists of 1 month of crowd grazing in the spring (generally in May), then 2 to 3 years of rest. For this study, I requested that the WPAs be grazed for 2 consecutive years. The grazing pressure applied to these areas ranged from 0.7 to 1.5 animal unit months per acre.

In 1982, yearlings were placed on one grazed plot instead of the usual cows with calves. The yearlings were not placed on the WPA until mid-May, and they did not reduce the vegetation on the plot. As a result, the bird community on this plot was unlike the communities on the other grazed plots. Consequently, I have considered this plot to be an example of a plot in its first year of rest after grazing (FYAG). I was not able to statistically analyze the data from this single plot so I will not make inferences about the data beyond reporting what birds were found on that plot and their densities.

Results

The bird communities supported by the three habitat types for the combined years differed in the number of birds and the number of species (Table 1). Idle plots had more birds and more species of birds than grazed or DNC plots. Grazed plots had the fewest number of birds, but had about the same number of species as DNC plots.

Ten species of birds were common to every habitat type (Table 1). Seven others were found in two habitat types, but not in the third. Finally, 13 species were unique to a habitat type. Of the species unique to the idle habitat, the mourning dove (for scientific names, see Appendix 2), least flycatcher, gray catbird, brown thrasher, and yellow warbler were found on only one plot. This plot had a greater amount of shrub cover (30%) than the other plots (19%, 12%, and 11%) and some of the shrubs were choke cherry and silverberry which are generally taller and more dense than the more common wolfberry. These shrub-nesting bird species (Graber and Graber 1963, Stauffer 1978) apparently are attracted to this taller, more dense shrub cover. Sharp-tailed sparrows and Le Conte's sparrows also were found on only one DNC plot. This plot had taller and more dense cover (effective height = 4.1 dcm; vertical density = 9.4 vegetation contacts in 10-cm intervals) than the other DNC plots (effective height = 2.2, 2.1, 2.0 dcm; vertical

TABLE 1. Bird species and mean densities (# territorial males/40 ha) found in each habitat type. Means with the same letter are not significantly different

Bird Species	Densities in each habitat type		
Species common to every habitat type	Idle	Grazed	DNC
Upland sandpiper	1.3 A	1.7 A	0.2 B
Eastern kingbird	8.3 A	4.5 A	0.2 A
Common yellowthroat	5.0 A	1.1 A	4.2 A
Clay-colored sparrow	76.9 A	2.8 B	10.0 B
Savannah sparrow	2.7 B	5.6 AB	12.5 A
Grasshopper sparrow	9.6 A	9.7 A	4.4 A
Red-winged blackbird	4.0 A	2.8 A	0.8 A
Western meadowlark	6.3 AB	7.3 A	2.9 B
Brown-headed cowbird[a]	X	X	X
American goldfinch	8.7 A	0.6 A	1.0 A
Species found in 2 of the 3 habitat types			
Killdeer	0.2 A	1.7 A	- A
Willet	0.2 A	1.3 A	- A
Marbled godwit	0.2 AB	0.8 A	- B
Sedge wren	0.8 B	- B	26.9 A
Baird's sparrow	- A	3.8 A	2.1 A
Song sparrow	1.7 A	0.3 A	- A
Bobolink	1.5 B	- B	31.1 A

[a]Densities of brown-headed cowbirds were not recorded. X denotes their presence in that habitat type.

TABLE 1 (continued)

Bird Species	Densities in each habitat type		
Species found in only one habitat type	Idle	Grazed	DNC
Common snipe	1.5	-	-
Wilson's phalarope	0.8	-	-
Mourning dove	5.6	-	-
Willow flycatcher	7.9	-	-
Least flycatcher	0.2	-	-
Horned lark	-	2.2	-
Gray catbird	2.3	-	-
Brown thrasher	0.4	-	-
Yellow warbler	4.6	-	-
Dickcissel	-	-	2.3
Le Conte's sparrow	-	-	1.5
Sharp-tailed sparrow	-	-	2.5
Chestnut-collared longspur	-	5.0	-
Total bird density	150.7	51.2	102.6
Total no. of species	24	17	16

density = 7.3, 7.3, 7.7 vegetation contacts in 10 cm intervals). This cover appeared to be more attractive to these species that are associated with tall and dense *Spartina* and *Scolochloa* beds in wetland basins (Murray 1969). There were no wetlands on or adjacent to this plot.

The FYAG plot had 11 bird species. The upland sandpiper (density = 1.7 territorial males/40 ha), willet (1.7), Wilson's phalarope (20.0), bobolink (11.7), western meadowlark (6.7), red-winged blackbird (16.7), savannah sparrow (21.7), Baird's sparrow (6.7), grasshopper sparrow (18.3), and chestnut-collared longspur (5.0) held territories or portions of territories on this plot. The brown-headed cowbird also was present on this plot.

The vegetation structure differed among the three habitat types. Idle plots had more shrub cover than grazed or DNC plots (Table 2). Grazed plots had less forb cover and more bare ground than idle or DNC plots. DNC plots had more grass and forb cover, and the effective height and the vertical density of the vegetation were greater on DNC plots, although these differences are not statistically significant. The DNC habitat also provided a deeper litter layer than that found on idle and grazed plots.

Discussion

In grasslands, the vegetative structure of a habitat determines what bird species will be found there (Wiens 1969). Each species appears to have adapted to a set of vegetative structure conditions in which all life requirements are met and it is assumed that birds cue in on structural characteristics that identify the proper habitat for that species (Hilden 1965). The differences I saw in composition and density of the bird communities associated with idle, grazed, and DNC habitats are explained by

TABLE 2. Vegetative structure characteristics of the habitat types. Means with the same letter are not significantly different

	Idle	Grazed	DNC
% cover grass	63.2 AB	49.0 A	77.2 B
% cover forb	27.3 A	16.9 B	34.9 A
% cover litter	99.7 A	98.3 A	99.4 A
% cover shrub	18.2 A	0.9 B	0.1 B
% bare ground	0.1 A	1.0 B	0.1 A
Effective Height (dcm)	1.6 AB	0.6 B	2.6 A
Litter Depth (cm)	3.0 A	1.8 B	3.6 A
Vertical Density (Mean no. of vegetation contacts in 10 cm intervals between 0-70 cm)	7.6 A	4.2 B	7.9 A

differences in vegetative structure among the habitats. Idle habitats have a shrub component that attracts shrub-nesting species. Both grazed areas with shorter, less dense vegetation, and DNC with taller, more dense vegetation attract species whose specific requirements are met by those habitats' vegetation structure.

In the following, I discuss specific effects of not manipulating the vegetation, of grazing, and of planting DNC on the bird communities observed.

The effect of no manipulation

Shrubs will invade native prairie if fire is suppressed and grazing is stopped (Kirsch and Kruse 1972). The idle habitats attracted shrub or small tree nesting bird species. Of the 24 breeding species found within the idle habitat type, 6 are known to use shrubs or small trees as nesting sites (common yellowthroat, red-winged blackbird, American goldfinch, clay-colored sparrow, song sparrow, mourning dove, brown thrasher, yellow warbler) and 6 others are obligate users of woody vegetation as a nesting substrate (eastern kingbird, willow flycatcher, least flycatcher, gray catbird, brown thrasher, yellow warbler). Of the 12 remaining non-shrub nesting species, only the Wilson's phalarope and common snipe were unique to the idle habitats.

The vegetative structure of idle habitats is in the middle of the continuum from short and sparse to tall and dense vegetation, making this habitat type attractive to a variety of birds. When a shrub component is added to the vegetative structure of the prairie, shrub-nesting, forest-edge species are then also attracted to this habitat.

Consequently, if managers choose not to burn, mow, or graze the vegetation on WPAs, and thereby encourage shrub growth, a wide variety of bird species will inhabit these areas.

The effect of grazing

Grazing reduces the amount of vegetative cover, reduces the litter depth, and decreases the height and density of vegetation. Of 17 bird species found in the grazed habitats, only the chestnut-collared longspur and horned lark were unique to these habitats, and these species generally are associated with heavily grazed habitats (Maher 1973, Owens and Myres 1973, Karasiuk et al. 1977). Four of 15 species found on other habitat types as well as grazed areas were most numerous on the grazed. Killdeer, marbled godwit, and willet also were found on idle habitats, and these species generally are associated with short and sparse cover (Graber and Graber 1963, Ryan 1982, Ryan unpub. data). Because godwit and willet territories are larger than my sample plots, several different habitat types may be found within their territories, yet their nests are located in the more short, sparse cover. The Baird's sparrow was found in both grazed and DNC habitats, but was more abundant in grazed areas. This species is associated with lightly grazed and ungrazed prairie (Maher 1973, Owens and Myres 1973, Karasiuk et al. 1977, Kantrud 1981).

The grazing regime now used by WPA managers provides a variety of vegetative conditions for birds throughout the season the areas are grazed. Before grazing begins in May, the vegetation is taller and more dense than after grazing.

As the vegetation continues to grow after grazing, the vegetation present is attractive to a different set of species. For instance, before grazing had started in May, I saw savannah sparrows and Baird's sparrows establish territories in the more tall, dense vegetation. As the cattle reduced the amount of cover and the height and density of vegetation, horned larks, chestnut-collared longspurs, and other species associated with short, sparse vegetation moved onto the areas, established territories, and nested. Then as the vegetation grew after grazing had ceased, savannah sparrows and grasshopper sparrows moved back on the plots. I did not see a reinvasion of Baird's sparrows on grazed plots, probably because their nesting season was nearly over by mid-June (the approximate time of reinvasion by savannah sparrows).

<u>The effect of planting introduced grasses and legumes</u>

The tall, dense herbaceous cover of DNC was attractive to birds associated with vegetative structure of retired croplands (Stewart 1975) and old fields (Zimmerman 1971). DNC provides vegetative cover similar to that available in small, natural wetland basins or at the edges of wetlands on idle and grazed habitats. The cover is taller, more dense and provides a deeper litter layer.

Of 16 bird species breeding in DNC, 10 of them were also found on idle and grazed habitats. The savannah sparrow was found in greater densities in the DNC. In idle and grazed habitats, the savannah sparrow occupied dry wetland basins or the edges of wetland basins (zones with vegetative structure similar to DNC). Of the 6 other species found in DNC, 3 also were found in one other habitat type (sedge wren, bobolink, Baird's sparrow) and 3 were found only in DNC (dickcissel, sharp-tailed sparrow, Le Conte's sparrow). Sedge wrens and bobolinks occurred in higher densities in the DNC, suggesting that DNC was most attractive to them. Of the three species found only on DNC, all are associated with habitats that provide thick vegetative cover (Murray 1969, Zimmerman 1971).

Conclusions

With the continued loss of native upland habitat due to increased agriculturalization, WPAs gain increasing importance as pockets of habitat for species unadapted to agricultural lands. WPA managers may need to consider what vegetative conditions are best not only for waterfowl, but they also may want or have to manipulate the vegetation to benefit non-target bird species as well.

Taking all three habitat types together, the bird species found on those habitats represent a major portion (14 of 17 species) of the expected upland bird community of the eastern mixed-grass prairie (Stewart 1975). Surprisingly, I did not see Sprague's pipit, lark bunting, or vesper sparrow on any plots. These 3 are perhaps the only small bird species associated with the eastern mixed-grass prairie that were not represented in the communities I described. Thus, the combination of idle, grazed, and DNC habitats provides the mosaic of habitat necessary to attract nearly all components of the mixed-grass prairie bird community.

If managers want to manage their areas to also attract vesper sparrows, I suggest that there is probably habitat available for vesper sparrows on idle and grazed habitats. This species is found on grazed (Karasiuk et al. 1977, Kantrud 1981), ungrazed (Maher 1973, Karasiuk et al. 1977), and agricultural habitats (Owens and Myres 1973, Rodenhouse and Best in press). The pipit and bunting are associated with shorter grass, moderately grazed communities (Kantrud 1981). In order to provide the habitat required by Sprague's pipit and lark bunting, perhaps more WPAs should be grazed and perhaps long term grazing should be incorporated into the management schemes of WPAs to ensure that as the amount of native habitat decreases outside of federal holdings, WPA managers can provide the habitat required by all members of the mixed grass bird community.

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HABITAT USE PATTERNS OF NON-GAME BIRDS ASSOCIATED WITH THREE HABITAT TYPES ON NORTH DAKOTA WATERFOWL PRODUCTION AREAS

Introduction

In grasslands, the vegetative structure (or physiognomy) of a habitat largely determines what bird species will be present in a community (Wiens 1969). Ecologists have long believed that birds partition (use different portions of) the habitat to avoid competition (Cody 1968) or partition the habitat as a result of past competition. It is thought that specific physiognomic features of the habitat provide cues to a bird that a portion of the available habitat meets their life requirements (Hilden 1965). Many workers have attempted to determine what habitat features birds use or select (see Cody 1968, Wiens 1969, James 1970, and Balda 1975 for a review).

Habitat use information can be used by managers to determine how to manipulate the habitat to attract desired species. If the physiognomy generally associated with a desired species is provided through vegetation manipulation, managers could expect to see that species using the area. With this information, managers can better understand and predict changes in species composition and density in a bird community when vegetative structural components are changed.

Waterfowl Production Area (WPA) managers in the northern Great Plains have the responsibility of manipulating the habitat to attract breeding waterfowl. Due to a continued loss of native habitat on private lands, federally owned WPAs are becoming increasingly important as pockets of native habitat. Managers may become responsible for making WPAs attractive to breeding non-target species, as well as waterfowl. With this added responsibility, managers need to know which bird species and how many birds are found on WPAs. They also need to know what habitat characteristics are associated with each bird species.

This project was undertaken to determine habitat use patterns of non-target breeding bird species on North Dakota WPAs of 3 habitat types; idle native prairie, grazed native prairie, and dense nesting cover (DNC). My objective was to to determine what vegetation structure characteristics were associated with the bird species present. This study provides information on which stucture characteristics must be manipulated to make an area more attractive to desired bird species.

Study Areas and Methods

In 1981 and 1982, I worked on 12 WPAs located on the Missouri Coteau geological formation in Stutsman and McIntosh counties, North Dakota. I established 4, 6-ha (15 acre) study plots (1 study plot per WPA) for each habitat type of idle native prairie, grazed native prairie, and dense nesting cover.

All plots within each habitat type were selected so that the vegetation structure appeared to be similar among them. Idle plots generally were covered by matted herbaceous vegetation and had more shrub cover than grazed or DNC plots. The vegetation on idle plots had not been grazed, burned, or mowed for 5 to 9 years before this study. The herbaceous cover of the idle habitats was dominated by green needlegrass (Stipa viridula), needle and thread (Stipa comata), blue grama (Bouteloua gracilis), little bluestem (Andropogon scoparius), and Kentucky bluegrass (Poa pratensis). Most shrub cover consisted of wolfberry (Symphoicarpos occidentalis), but there were scattered stands of silverberry (Eleagnus commutata) and choke cherry (Prunus virginiana) on a few plots.

DNC plots were homogeneous stands that had been established 6 to 9 years before my study. The vegetation was relatively tall and dense, and composed chiefly of alfalfa (Medicago sativa) and western wheatgrass (Agropyron smithii).

Grazed plots had not been grazed 3 to 4 years prior to this study. The vegetation was dominated by the same plant species as the idle plots. In the usual grazing regime, WPAs undergo 1 month of crowd-grazing in the spring (usually May) and then they are not grazed for 2 or 3 years. For my study, I requested that the WPAs be grazed for 2 consecutive springs. The grazing pressure applied to these areas ranged from 0.7 to 1.5 animal unit months per acre.

In 1982, yearlings were placed on one of the grazed plots instead of the usual cows with calves. The yearlings were not placed on the WPA until mid-May, and they did not reduce the vegetation on the plot. As a result, the bird community on this plot was unlike the communities on the other grazed plots.. Thus, I treated this plot as a 13th sample plot in the analysis, rather than regarding it as the same grazed plot from 1981. I regarded this plot to be an example of a area in its first year of rest after grazing (FYAG).

I used the spot map method (Kendeigh 1944) to determine the species composition and densities of birds within the communities. I usually started counts 30 min before sunrise but never later than 10:00 because bird activity dramatically decreased after that time. I walked through the gridded plots (25 x 25m) and mapped the locations of singing males and non-singing individuals. I also mapped the flight direction and movements of birds on the plot. Twelve rounds of counts were conducted from mid-May to late July in 1981, and 25 rounds of counts were conducted from mid-April to late July in 1982. I used counts from early May to late June to determine bird densities.

In 1982, I used the Wiens flush technique (Wiens 1969) to delineate territory boundaries for the western meadowlark in late April, and for savannah sparrows, grasshopper sparrows, and sedge wrens in May and early June (for scientific names, see Appendix 2).

I also delineated "used portions" within sample plots for the clay-colored sparrow, savannah sparrow, Baird's sparrow, grasshopper sparrow, and chestut-collared longspur. These "used portions" were delimited by compiling spot maps within a month's period of bird counts and drawing boundaries of use for individual birds by connecting the outer points of clusters of singing individual locations and individual movements.

"Used portions" are not the same as territories. Instead, "used portions" outline parts of the habitat birds used in singing and escaping from me as I flushed them during the counts. I define these compiled locations as "used portions" rather than territories because of the limitations of using the spot map method to delimit territory boundaries (Best 1975). I feel confident in outlining "used portions" because on most plots, only one or two individuals of a species occupied portions of a plot (e.g. savannah sparrow, Baird's sparrow, grasshopper sparrow, chestnut-collared longspur), or if more than two individuals occupied a plot, their locations generally were clustered along distinct features of the habitat such as shrub belts (e.g. clay-colored sparrow) or dry wetland basins (e.g. savannah sparrow).

During the same period I conducted bird counts, I also sampled the vegetation at 48 points on each plot. I stratified my sampling such that there were 2 sample points in each 50 x 50m quadrat. Sample sites were located by pacing randomly determined distances from the corners of the 50 x 50m quadrats. The vegetation structure of each plot was sampled at least once in 1981 and each grazed plot was sampled again after the cattle were removed in early June. In 1982, the vegetation on each plot was sampled in April, May, and June to have more timely information to use in habitat use comparisons at the territory and "used portion" level of analysis.

I used the point-quadrat method (Brown 1954) to determine the percentage cover of vegetative forms (grass, forb, litter, shrub), the percentage bare ground, and the vertical density of the vegetation (Wiens 1969), which I designated as the mean number of vegetation contacts in 10 cm intervals. During preliminary analysis, I found no significant differences in vegetative structure above 70 cm in height among the habitat types, so I restricted my analysis to the 0-70 cm range. I measured the litter depth at the sampling point and used a modified Robel pole (Robel et al. 1970) to measure the effective height of the vegetation (for more details on vegetation sampling techniques, see Appendix 1).

As I did not have territory boundary information for all the bird species, I examined habitat characteristics of plots where a species was territorial (used plots) and compared those to characteristics of plots where I did not find that species (unused plots). The mean values for habitat characteristics of used plots and unused plots were compared by analysis of variance. To determine if there was a relationship between vegetative structure characteristics for the plots and species density, I calculated partial correlations between plot vegetative structure values and the species densities on the plots. The significance of this relationship was tested by analysis of variance.

To determine bird species-habitat associations at a finer (within plot) level of examination, I compared habitat characteristics of territories delineated by the Wiens flush technique to vegetation characteristics outside the territories with analysis of variance. The same comparisons were made between habitat characteristics of "used portions" and habitat outside them. Each plot in each year was considered a separate plot in this analysis; therefore, there were 24 possible plots to use in this analysis. By examining trends of within-plot habitat use by savannah sparrows and grasshopper sparrows, I hoped to test the legitimacy of delimiting "used portions." If "used portions" showed similar trends in vegetative structure as Wiens flush technique territories, then I had more confidence in making "used portions" versus outside "used portions" comparisons.

Within a plot, vegetative structure characteristics summarized from sample points within territories and "used portions" were averaged to determine a plot mean. I also calculated plot means for habitat characteristics outside territories and "used portions." These plot means were used to calculate overall means for habitat characteristics within versus outside territories and "used portions." By using plot means, I could have an equal number of samples making up the overall territory versus outside territory (and "used portion") means, and also account for plot variation in the analysis of variance. Within Tables 5-12, the standard error I report for each habitat characteristic is the standard error of the mean of differences between within versus outside territory and "used portion" plot means for a habitat characteristic. The standard error for each habitat characteristic is not a standard error for just a within territory mean or an outside territory (and "used portion") mean.

Results

The species composition and density of birds on each plot and habitat type are presented in Table 1, and vegetative structure values for each plot and habitat type are presented in Table 2.

Used vs. unused plot comparisons

I found at least one significant difference in the vegetative structure between used and unused plots for 21 species (Table 3; for a complete list of comparisons, see Appendix 3). All plots were used by the western meadowlark, so no used versus unused plot comparison was made. The upland sandpiper, marbled godwit, and horned lark held territories on plots with less grass and forb cover, and with less dense vegetation than on unused plots. In contrast, the bobolink used plots with more grass and forb cover. Like the bobolink, sedge wrens used plots with more forb cover. Clay-colored sparrows used plots with more litter cover, whereas the chestnut-collared longspur used plots with less litter cover and more bare ground.

The mourning dove, willow flycatcher, least flycatcher, gray catbird, brown thrasher, yellow warbler, song sparrow, and American goldfinch used plots with more shrub cover. All of these, except the willow flycatcher, song sparrow,

Table 1. Bird species and their mean densities (# of territorial males/ 40 ha) found on each plot and habitat type. Habitat means with the same letter are not significantly different

Species	Idle 1	Idle 2	Idle 3	Idle 4	Idle X̄	Grazed 5	Grazed 6	Grazed 7	Grazed 8	Grazed X̄
Killdeer (s.e.)	–	+[1]	+	0.8	0.2 A (0.4)	+	–	1.7	4.2	1.5 A (2.0)
Willet	+	0.8	–	–	0.2 A (0.4)	+	+	1.7	1.7	0.9 A (1.0)
Upland sandpiper	1.7	1.7	1.7	+	1.3 A (0.9)	1.7	1.7	1.7	1.7	1.7 A (0.0)
Marbled godwit	0.8	–	–	–	0.2 AB (0.4)	0.8	–	0.8	0.8	0.6 A (0.4)
Common snipe	0.8	–	5.0	–	1.5 (2.4)	–	–	–	–	– (–)
Wilson's phalarope	–	–	3.3	–	0.8 (1.7)	–	–	–	–	– (–)
Mourning dove	+	+	+	22.5	5.6 (11.3)	–	–	+	+	– (–)
Willow flycatcher	–	+	0.8	30.8	7.9 (15.3)	–	–	–	–	– (–)
Least flycatcher	–	+	–	0.8	0.2 (0.4)	–	–	–	–	– (–)
Eastern kingbird	2.5	5.8	3.3	21.7	8.3 A (9.0)	2.5	+	10.8	1.7	3.8 A (4.8)
Horned lark	+	–	–	–	– (–)	–	–	1.7	5.8	1.9 (2.7)

[1]Denotes presence on plot; but not believed to be nesting on the plot.

[2]Brown-headed cowbird densities were not recorded, X denotes 3 or more sightings of cowbirds/plot.

DNC					FYAG
9	10	11	12	$\bar{X}$	13
–	–	–	–	– (–)	–
+	–	–	+	– (–)	1.7
0.8	+	–	+	0.2[B] (–)	1.7
+	–	–	–	–[B] (–)	+
–	–	–	–	– (–)	–
–	–	–	–	– (–)	20.0
+	–	–	–	– (–)	–
–	–	–	–	– (–)	–
–	–	–	–	– (–)	–
0.8	–	+	+	0.2[A] (0.4)	–
–	–	–	–	– (–)	–

Table 1 cont.

Species Plot	Idle 1	2	3	4	$\overline{X}$	Grazed 5	6	7	8	$\overline{X}$
Sedge wren	–	3.3	+	+	0.8^{B} (1.7)	–	–	–	–	$-^{B}$ (–)
Gray catbird	–	–	+	9.2	2.3 (4.6)	–	–	–	–	– (–)
Brown thrasher	–	–	+	1.7	0.4 (0.9)	–	–	–	–	– (–)
Yellow warbler	–	–	–	18.3	4.6 (9.2)	–	–	–	–	– (–)
Common yellowthroat	8.3	+	+	11.7	5.0^{A} (5.9)	+	–	+	3.3	0.8^{A} (1.7)
Dickcissel	–	+	+	–	– (–)	–	–	–	–	– (–)
Clay-colored sparrow	56.7	71.7	68.4	110.9	76.9^{A} (23.5)	+	–	0.8	–	0.2^{B} (0.4)
Savannah sparrow	+	3.3	7.5	–	2.7^{B} (3.5)	8.3	1.7	–	10.8	5.2^{AB} (5.2)
Baird's sparrow	–	–	–	–	– (–)	3.3	–	–	10.4	3.3 (4.7)
Grasshopper sparrow	4.2	18.3	12.5	3.3	9.6^{A} (7.1)	1.7	13.3	5.8	20.8	10.4^{A} (8.4)
Le Conte's sparrow	–	–	–	–	– (–)	–	–	–	–	– (–)

DNC					FYAG
9	10	11	12	$\bar{X}$	13
1.7	34.2	33.4	38.4	26.9^{A}	–
				(17.0)	
–	–	–	–	–	–
				(–)	
–	–	–	–	–	–
				(–)	
–	–	–	–	–	–
				(–)	
0.8	+	12.5	3.3	4.2^{A}	–
				(5.7)	
+	–	+	9.2	2.3	–
				(4.6)	
14.2	+	25.8	+	10.0^{B}	–
				(12.5)	
5.8	16.7	8.3	19.2	12.5^{A}	21.7
				(6.5)	
5.0	–	2.5	0.8	2.1	6.7
				(2.2)	
11.7	–	2.5	3.3	4.4^{A}	18.3
				(5.1)	
–	5.8	–	–	1.5	–
				(2.8)	

Table 1 cont.

Species Plot	Idle 1	2	3	4	$\bar{X}$	Grazed 5	6	7	8	$\bar{X}$
Sharp-tailed sparrow	–	–	–	–	– (–)	–	–	–	–	– (–)
Song sparrow	0.8	–	+	5.8	1.7^{A} (2.8)	–	–	0.8	–	0.2^{A} (0.4)
Chestnut-collared longspur	–	–	–	–	– (–)	+	23.3	–	7.5	7.7 (11.0)
Bobolink	+	5.8	+	+	1.5^{B} (2.9)	+	–	+	–	–^{B} (–)
Red-winged blackbird	5.8	3.3	3.3	3.3	4.0^{A} (1.3)	0.8	1.7	7.5	+	2.5^{A} (3.4)
Western meadowlark	6.7	9.2	7.5	1.7	6.3^{AB} (3.2)	6.7	6.7	6.7	8.3	7.1^{A} (0.8)
Brown-headed cowbird	X[2]	X	X	X		X	X	X	X	
American goldfinch	3.3	0.8	10.0	20.8	8.7^{A} (8.9)	–	–	1.7	–	0.4^{A} (0.9)
Total density					150.7					51.2
Total no. of species					24					17

DNC					FYAG
9	10	11	12	$\overline{X}$	13
–	10.0	+	–	2.5 (5.0)	–
–	–	+	–	– (–)	–
–	–	–	–	– (–)	5.0
25.0	55.0	15.8	28.4	31.1^{A} (16.8)	11.7
+	–	–	3.3	0.8^{A} (1.7)	6.7
1.7	1.7	1.7	6.7	3.0^{B} (2.5)	6.7
X	+	X	X		X
4.2	+	+	+	1.1^{A} (2.1)	+
				102.6	110.2
				16	11

Table 2. Mean values for vegetation structure variables for each plot and habitat type. Habitat means with the same letter are not significantly different

Habitat Characteristics / Plot	Idle 1	2	3	4	$\overline{X}$
% cover grass (s.e.)	51.3	60.7	59.9	80.7	63.2^{AB} (12.4)
% cover forb	22.1	28.1	21.9	37.0	27.3^{A} (7.1)
% cover litter	99.5	99.5	100.0	99.7	99.7^{A} (0.2)
% cover shrub	19.0	12.2	11.2	30.5	18.2^{A} (8.9)
% bare ground	0.3	0.0	0.0	0.0	0.1^{A} (0.2)
Effective height dcm	1.2	1.2	1.4	2.6	1.6^{AB} (0.7)
Litter depth cm	2.6	2.8	3.0	3.4	3.0^{A} (0.3)
Vertical density, mean no. of vegetation contacts in 10 cm intervals between 0-70 cm	6.0	6.3	7.9	10.1	7.6^{A} (1.9)

Table 2 cont.

Grazed					DNC					FYAG
5	6	7	8	$\overline{X}$	9	10	11	12	$\overline{X}$	13
58.1	46.4	47.9	47.4	49.0^{B} (6.7)	73.7	88.8	70.1	76.3	77.2^{A} (8.1)	83.9
27.1	12.5	14.6	11.3	16.9^{B} (7.3)	38.8	35.4	38.3	27.1	34.9^{A} (5.4)	35.4
99.2	95.3	99.5	97.6	97.9^{A} (1.9)	98.7	99.0	100.0	100.0	99.4^{A} (0.7)	97.9
1.8	0.0	1.3	0.0	0.8^{B} (0.9)	0.0	0.0	0.0	0.3	0.1^{B} (0.2)	0.0
0.5	2.1	0.5	1.6	1.2^{B} (0.8)	0.3	0.3	0.0	0.0	0.2^{A} (0.2)	0.0
0.7	0.5	0.5	0.6	0.6^{B} (0.1)	2.2	4.1	2.1	2.0	2.6^{A} (1.0)	0.9
2.1	1.8	1.5	1.8	1.8^{B} (0.2)	3.1	2.4	4.3	4.7	3.6^{A} (1.1)	0.8
4.9	3.6	4.1	4.0	4.2^{B} (0.5)	7.3	9.4	7.3	7.7	7.9^{A} (1.0)	5.9

Table 3. Bird species for which mean values for (a) habitat characteristic(s) of used plots differed significantly (P=0.05) from (a) characteristic(s) of unused plots. (n)= number of used plots

Species	% cover grass	% cover forb	% cover litter	% cover shrub
Willet	—	—	—	—
Upland sandpiper	U- 57.4[d] N- 79.0	U- 23.5 N- 34.4	—	—
Marbled godwit	U- 49.9 N- 71.9	U- 18.8 N- 31.3	—	—
Mourning dove	—	—	—	U- 30.5 N- 4.2
Willow flycatcher	—	—	—	U- 20.8 N- 3.5
Least flycatcher	—	—	—	U- 30.5 N- 4.2
Horned lark	U- 45.2 N- 68.5	U- 13.0 N- 30.0	—	—
Sedge wren	—	U- 33.5 N- 22.6	—	—
Gray catbird	—	—	—	U- 30.5 N- 4.2
Brown thrasher	—	—	—	U- 30.5 N- 4.2
Yellow warbler	—	—	—	U- 30.5 N- 4.2

[a]Effective height readings are in dcm.

[b]Litter depth measurements are in cm.

[c]MVC = mean number of vegetation contacts in 10 cm intervals between 0-70 cm.

[d]U = used plots, N = unused plots.

% bare ground	Effective Height [a]	Litter Depth [b]	MVC [c]	(n)
—	—	U- 1.8 N- 3.1	—	(4)
—	U- 1.1 N- 2.7	U- 2.3 N- 3.7	U- 5.8 N- 9.0	(9)
—	U- 0.7 N- 2.0	—	U- 4.8 N- 7.9	(4)
—	—	—	—	(1)
—	—	—	—	(2)
—	—	—	—	(1)
—	—	—	U- 4.1 N- 7.4	(2)
—	U- 2.3 N- 1.1	U- 3.5 N- 2.3	—	(5)
—	—	—	—	(1)
—	—	—	—	(1)
—	—	—	—	(1)

Table 3 cont.

Species	% cover grass	% cover forb	% cover litter	% cover shrub
Dickcissel	—	—	—	—
Clay-colored sparrow	—	—	U- 99.6 N- 98.5	—
Savannah sparrow	—	—	—	U- 2.8 N- 12.9
Grasshopper sparrow	—	—	—	—
Le Conte's sparrow	—	—	—	—
Sharp-tailed sparrow	—	—	—	—
Song sparrow	—	—	—	U- 16.9 N- 2.8
Chestnut-collared longspur	—	—	U- 97.1 N- 99.5	—
Bobolink	U- 74.8 N- 55.9	U- 33.7 N- 21.6	—	—
Brown-headed cowbird	—	—	—	—

% bare ground	Effective Height	Litter Depth	MVC	(n)
—	—	U- 4.7 N- 2.6	—	(1)
—	—	—	—	(8)
—	—	—	—	(10)
—	U- 1.4 N- 4.1	—	—	(12)
—	U- 4.1 N- 1.4	—	—	(1)
—	U- 4.1 N- 1.4	—	—	(1)
—	—	—	—	(3)
U- 1.3 N- 0.2	—	—	—	(3)
—	—	—	—	(6)
—	U- 1.4 N- 4.1	—	—	(12)

and American goldfinch were found on only one plot, and this plot had the greatest amount of shrub cover. Only the savannah sparrow used plots which had significantly less shrub cover than unused plots.

The upland sandpiper and marbled godwit used plots with vegetation that was less tall and dense (shorter effective height, less dense vertically), and the brown-headed cowbird and grasshopper sparrow used plots with shorter vegetation. In contrast, the sedge wren, Le Conte's sparrow, and sharp-tailed sparrow used plots with taller vegetation. The Le Conte's sparrow and sharp-tailed sparrow also were found on only one plot, and the vegetation on that plot was taller and more dense than on other plots.

Plots used by the willet and upland sandpiper had a thinner litter layer than unused plots. In contrast, the sedge wren and dickcissel used plots with a deeper litter layer.

<u>Partial correlations</u>

Only 10 species displayed significant ($P \leq 0.05$) partial correlations between their densities and vegetative structure characteristics of the plots (Table 4). Savannah sparrow densities were positively correlated with grass cover. Bobolink and American goldfinch densities were positively correlated with the effective height and vegetation vertical density, respectively. Eastern kingbird, clay-colored sparrow, song sparrow, and American goldfinch densities were all positively correlated to shrub cover.

Negative relationships were observed between western meadowlark densities and vegetation effective height, Baird's sparrow and grasshopper sparrow densities and litter depth, and chestnut-collared longspur densities and percentage litter cover.

I noted other suggestive, but non-significant relationships between bird densities and vegetative structure. Forb cover was negatively associated with western meadowlark densities (PCORR= -0.53, P= 0.06), and upland sandpiper and grasshopper sparrow densities were negatively related to vegetation effective height (both with a PCORR= -0.56, P= 0.06)

Habitat characteristics of territories

Over all habitat types, clay-colored sparrow "used portions" tended to have a deeper litter layer and taller vegetation (of greater effective height) than that outside "used portions" (Table 5). I further divided "used portions" into 2 categories, those within idle habitats and those within DNC habitats. I felt that because DNC had a negligible amount of shrub cover, the strong overall difference in shrub cover between "used portions" and vegetation outside "used portions" would not be true for

Table 4. Partial correlations between vegetative structure characteristics of the plots and individual species densities on the plots. Probability values for the correlations are in parentheses. Accepted level of significance = 0.05

Bird species	% cover grass	% cover litter	% cover shrub	Effective height[a]	Litter depth[b]	MVC[c]
Eastern kingbird	—	—	.68 (P=.02)	—	—	—
Clay-colored sparrow	—	—	.66 (P=.02)	—	—	—
Savannah sparrow	.59 (P=.04)	—	—	—	—	—
Baird's sparrow	—	—	—	—	-.68 (P=.01)	—
Grasshopper sparrow	—	—	—	—	-.62 (P=.03)	—
Song sparrow	—	—	.65 (P=.02)	—	—	—
Chestnut-collared longspur	—	-.83 (P=.001)	—	—	—	—
Bobolink	—	—	—	.76 (P=.004)	—	—
Western meadowlark	—	—	—	-.67 (P=.01)	—	—
American goldfinch	—	—	.73 (P=.02)	—	—	.58 (P=.05)

[a]Effective height measurements are in dcm.

[b]Litter depth measurements are in cm.

[c]MVC = mean number of vegetation contacts in 10 cm intervals between 0-70 cm.

clay-colored sparrow "used portions" in DNC. "Used portions" in idle habitats (Table 6) again showed a strong shrub component, were of greater effective height, and tended to have a slightly deeper litter layer. Habitat characteristics within "used portions" in DNC did not differ from that outside "used portions" (Table 6).

The vegetative structure within chestnut-collared longspur "used portions" differed from that outside in several characteristics (Table 7). "Used portions" had a thinner litter layer, a less dense cover (vertical vegetation density), and tended to have a less deep litter cover than samples outside "used portions."

Within sedge wren territories, there tended to be less forb cover (Table 8).

Savannah sparrow territories tended to have a slightly deeper litter layer and less forb cover (Table 9). In savannah sparrow "used portions", I saw the same trends in differences of within versus outside habitat characteristics as observed in Wiens flush technique territories (Table 9). In addition, within savannah sparrow "used portions", there was less shrub cover and the litter layer was deeper. The vegetation within "used portions" also tended to be slightly more dense.

Within grasshopper sparrow territories, the vegetation tended to be slightly more dense (of greater vertical

TABLE 5. Mean values for habitat characteristics of clay-colored sparrow "used portions" and habitat outside "used portions." Unless labeled otherwise, P > 0.05

	Within		Outside
% cover grass (s.e.= 3.3)	66.0		68.0
% cover forb (4.6)	32.2		31.6
% cover litter (0.3)	99.6		99.5
% cover shrubs (2.3)	21.3	(P=.01)	11.1
% bare ground (0.05)	0.0		0.1
Effective height (dcm) (0.1)	2.2	(P=.05)	1.8
Litter Depth (cm) (0.3)	3.6	(P=.1)	3.0
Mean no. of vegetation contacts in 10 cm intervals between 0-70 cm (0.2)	8.2		8.0

Number of plots= 11; Number of sample points= 107

TABLE 6. Means for habitat characteristics of clay-colored sparrow "used portions" and habitat outside "used portions" in idle and DNC plots. Unless labeled otherwise, P > 0.05

	IDLE			DNC	
	Within		Outside	Within	Outside
% cover grass (s.e.= 2.9, 9.8)	64.6		62.9	69.7	81.0
% cover forb (2.2, 18.2)	25.7		27.6	48.9	42.7
% cover litter (0.4, 0.6)	99.5		99.6	100.0	99.1
% cover shrubs (2.6, 0.0)	29.4	(P=.006)	15.0	0.0	0.0
% bare ground (0.1, 0.1)	0.0		0.1	0.0	0.2
Effective Height (dcm) (0.2, 0.1)	2.0	(P=.05)	1.5	2.9	2.8
Litter Depth (cm) (0.1, 0.9)	3.2	(P=.08)	2.9	4.8	3.2
Mean no. of vegetation contacts in 10 cm intervals between 0-70 cm (0.2, 0.4)	7.8		7.8	9.4	8.7
	Plots (n=8) Sample pts. (n= 93)			Plots (n=3) Sample pts. (n= 14)	

TABLE 7. Mean values for habitat characteristics of chestnut-collared longspur "used portions" and habitat outside "used portions." Unless labeled otherwise, P > 0.05

	Within		Outside
% cover grass (s.e.= 3.3)	65.0		61.8
% cover forb (2.4)	20.6		18.8
% cover litter (1.5)	91.4	(P=.08)	95.9
% cover shrubs (0.6)	1.1		0.3
% bare ground (1.1)	3.7		2.0
Effective Height (dcm) (0.06)	0.4		0.6
Litter Depth (cm) (0.2)	0.7	(P=.03)	1.4
Mean no. of vegetation contacts in 10 cm intervals between 0-70 cm (0.2)	3.1	(P=.008)	4.1

Plots (n= 7); Sample Pts. (n= 46)

TABLE 8. Mean values for habitat characteristics of sedge wren territories and habitat outside the territories. Unless labeled otherwise, P > 0.05

	Within		Outside
% cover grass (s.e.= 3.9)	73.6		69.7
% cover forb (3.3)	10.6	(P= .07)	27.0
% cover litter (0.2)	99.1		99.4
% cover shrubs (0.2)	0.0		0.2
% bare ground (0.2)	0.0		0.2
Effective Height (dcm) (0.09)	1.8		1.9
Litter Depth (cm) (0.17)	2.2		2.2
Mean no. of vegetation contacts in 10 cm intervals between 0-70 cm (0.17)	8.2		7.7

Plots (n= 3); Sample pts. (n= 29)

TABLE 9. Mean values for habitat characteristics of savannah sparrow territories and "used portions", and habitat outside them. Unless labeled otherwise, P > 0.05

	Wien's Flush Terr.			"Used Portions"		
	W/in		Out	W/in		Out
% cover grass (s.e.= 3.0, 2.4)	60.8		63.4	59.9		65.5
% cover forb (1.7, 1.8)	22.6	(P=.06)	28.2	22.8	(P=.09)	27.4
% cover litter (0.7, 1.1)	98.8		99.2	97.9		98.7
% cover shrubs (1.9, 0.7)	0.0	(P=.16)	4.2	0.8	(P=.05)	2.9
% bare ground (0.3, 0.2)	0.4		0.2	0.4		0.6
Effective Ht. (dcm) (0.1, 0.06)	1.1		1.1	1.4		1.4
Litter Depth (cm) (0.2, 0.3)	2.0	(P=.09)	1.5	3.6	(P=.03)	2.6
Mean no. of vegetation contacts in 10 cm intervals between 0-70 cm (0.3, 0.2)	7.2	(P=.14)	6.4	6.9	(P=.07)	6.4
	Plots (n= 7) Sample pts. (n= 72)			Plots (n= 17) Sample pts. (n= 131)		

vegetation density) than the vegetation outside territories (Table 10). In grasshopper sparrow "used portions", the vegetative structure within did not differ from that outside (Table 10).

Baird's sparrow "used portions" had greater litter cover than areas outside "used portions" (Table 11).

The vegetative structure within western meadowlark territories differed little numerically from the vegetative structure outside the territories, but some values did statistically differ (Table 12). Territories had a deeper litter layer and the vegetation was more dense, but I hesitate to say that meadowlarks can distinguish a few tenths of a unit difference in litter depth and vegetation density.

Discussion

In this section, I summarize the bird-habitat relationships observed in this study for each species and compare my observations to those previously published. I separate the species into those for which no finer level bird-habitat relationships were observed, those associated with shrubby cover, short and sparse cover, taller and more dense cover, and those associated with a wide range of cover values or those that occupy an intermediate position in the range of short and sparse to tall and dense vegetation.

TABLE 10. Mean values for habitat characteristics of grasshopper sparrow territories and "used portions", and habitat outside them. Unless otherwise labeled, P > 0.05

	Wien's Flush Terr.		"Used Portions"	
	W/in	Out	W/in	Out
% cover grass (s.e.= 1.0, 2.3)	82.9	83.6	70.8	72.4
% cover forb (4.2, 3.1)	40.0	33.0	31.3	30.4
% cover litter (1.2, 0.4)	98.7	97.5	99.0	98.5
% cover shrubs (1.3, 1.9)	2.6	3.9	9.4	8.7
% bare ground (0.5, 0.3)	0.0	0.7	0.6	0.5
Effective Ht. (dcm) (0.05, 0.09)	1.1	1.2	1.5	1.6
Litter Depth (cm) (0.09, 0.3)	0.9	0.8	2.1	2.5
Mean no. of vegetation contacts in 10 cm interval between 0-70 cm (0.1, 0.2)	6.8 (P=.08)	6.4	6.7	6.6
	Plots (n= 4) Sample pts. (n= 68)		Plots (n= 15) Sample pts. (n= 122)	

TABLE 11. Mean values for habitat characteristics of Baird's sparrow "used portions" and habitat outside the "used portions." Unless labeled otherwise, P > 0.05

	Within		Outside
% cover grass (s.e.= 6.5)	57.7		62.5
% cover forb (4.3)	23.8		24.2
% cover litter (0.4)	99.7	(P= .05)	98.3
% cover shrubs (0.3)	0.9		0.4
% bare ground (0.2)	0.3		0.7
Effective Height (dcm) (0.06)	1.3		1.3
Litter Depth (cm) (0.3)	3.6		3.2
Mean no. of vegetation contacts in 10 cm intervals between 0-70 cm (0.5)	6.1		5.9

Plots (n= 7); Sample pts. (n= 43)

TABLE 12. Mean values for habitat characteristics of western meadowlark territories and habitat outside the territories. Unless labeled otherwise, P > 0.05

	Within		Outside
% cover grass (s.e.= 1.0)	11.9		12.9
% cover forb (1.9)	22.1		25.1
% cover litter (0.7)	99.5		99.1
% cover shrubs (1.3)	4.0		4.0
% bare ground (0.1)	0.1		0.2
Effective Height (dcm) (0.03)	1.0		1.0
Litter Depth (cm) (0.12)	2.8	(P=.01)	2.3
Mean no. of vegetation (10.9)	6.3	(P=.05)	6.0

Plots (n= 11); Sample pts. (n= 281)

Species for which finer level habitat associations were not observed

I was unable to detect between and within plot level bird-vegetative structure associations for only 5 species: killdeer, common snipe, Wilson's phalarope, common yellowthroat, and red-winged blackbird.

Killdeer were more common in grazed habitats (Table 1) and are generally associated with short and sparse vegetation, or unvegetated sites (Graber and Graber 1963). I think that the killdeer found on an idle plot (only one plot in one year) probably held a major portion of its territory in a moderately grazed pasture about 75 m from the plot and only a small portion of its territory extended to a small wetland in the corner of the plot.

The common snipe was found only in idle habitats and Wilson's phalaropes were most abundant in idle habitats (Table 1). Common snipe are closely associated with sedge bogs and swamps, and nest in hummocky portions of wetlands or at the edges of wetlands (Tuck 1972). Wilson's phalaropes are primarily associated with class III and IV wetlands (Stewart 1975). I suspect I saw snipe on the idle habitats and Wilson's phalaropes on idle and FYAG habitats due to the presence of class II and III wetlands (Stewart and Kantrud 1971) on a few plots.

Common yellowthroats generally are associated with habitats with low shrubs and dense vegetation (Graber and Graber 1963, Stauffer and Best 1980). In my work, I found yellowthroats in every habitat type, but they were most numerous in the idle and DNC habitats (Table 1), both of which have taller, denser vegetation (Table 2). The idle plots also have a low shrub component that appears to be attractive to yellowthroats.

All habitat types were used by the red-winged blackbird, but they were more abundant in the idle habitats (Table 1). This suggests that red-winged blackbirds are habitat generalists, but they may be associated with shrubby habitats. Stauffer and Best (1980) most often found red-winged blackbirds in herbaceous cover, but blackbirds were also abundant in scrub and wooded edge habitats. They felt red-winged blackbirds preferred herbaceous, open habitats.

Species associated with shrubby habitats

Nine species showed some association with shrub cover. Of these, the mourning dove, willow flycatcher, least flycatcher, gray catbird, brown thrasher, and yellow warbler showed a strong association for the dense shrub and small tree cover. Other workers have documented that these species are associated with shrub and deciduous forest cover (Graber and Graber 1963, Hespenheide 1971, Stauffer 1978, Stauffer and Best 1980). These species were found only on one plot of the idle habitats, and this plot was characterized by a greater amount of shrub cover. Some of these shrubs were choke cherry and silverberry which are taller and more dense than the more common wolfberry.

There were no significant differences in habitat characteristics between used and unused plots for the eastern kingbird (Appendix 3). However, there was a positive relationship between eastern kingbird densities and shrub cover (Table 4). The eastern kingbird nests in trees or low shrubs (MacKenzie and Sealy 1981), so as the amount of shrub cover increases I would expect to see a corresponding increase in the number of eastern kingbirds. On grazed plots, which typically had very little shrub cover (Table 2), eastern kingbird territories stretched over these plots, but the birds were present solely because a tall shrub or small tree was located at the edge or just off of the plot. Kingbird movements on the plots were probably foraging and territory defense flights.

Clay-colored sparrow habitat, on the plot level of analysis, was characterized by slightly greater litter cover (Table 3) and tended to have more shrub cover (Appendix 3). Clay-colored sparrow densities were positively correlated with shrub cover (Table 4), and clay-colored "used portions" had taller, shrubby cover and a slightly deeper litter layer (Table 5). "Used portions" within idle habitats again had taller, shrubby cover, and tended to have a deeper litter layer (Table 6). In DNC, "used portions" were not different from the habitat outside (Table 6). Apparently, clay-colored sparrows are highly attracted to shrub cover, at least in native grassland habitats.

Other workers have noted that clay-colored sparrow territories are closely associated with low shrubs like *Symphoricarpos* and *Salix* (Owens and Myres 1973, Kantrud 1981). Nests generally are supported by tufts of dead grass at the base of a shrub, at the base of herbaceous plants, or on low shrub branches (Root 1968).

On DNC plots, I noticed that clay-colored sparrows tended to concentrate their activities in areas with wormwood, (*Artemisia absinthium*), a tall invading forb. In the absence of shrub cover, I suspect clay-colored sparrows are using taller, more dense grass and forb cover, and concentrating in areas with tall forbs, which perhaps serve as song perches or are used for nest support.

Species associated with short and sparse cover

The willet and marbled godwit are associated with habitats characterized by greatly reduced vegetative cover (Kantrud 1981, Ryan 1982). The willet used plots with a thinner litter layer (also a characteristic of grazed areas, Table 3). Godwits used plots with less grass and forb cover, and with shorter, sparser cover (shorter effective height and less dense in a vertical plane).

Horned larks used plots that had less grass and forb cover than unused plots. In general, horned larks are associated with heavily grazed habitats (Kantrud 1981) and agricultural habitats (Owens and Myres 1973, Rodenhouse and Best in press).

The chestnut-collared longspur is generally associated with grazed habitats (Maher 1973, Owens and Myres 1973, Kantrud 1981). In my work it appears the longspur is attracted to areas of sparse cover and little litter. Like the horned lark, the chestnut-collared longspur was found only on grazed plots of the 3 major habitat types (Table 1). Plots used by them had less litter cover and more bare ground than unused plots (Table 3), and longspur densities were highly negatively correlated with plot litter cover (Table 4). The vegetative structure within "used portions" differed from unoccupied portions of the plots in several aspects (Table 7). "Used portions" tended to have less litter cover, a thinner litter layer, and sparser vegetation.

Species associated with taller, more dense vegetation

Sedge wrens seem to be using taller, herbaceous cover. Plots with greater forb cover, taller vegetation, and a deeper litter layer were used by the sedge wren (Table 3). Also, used plots tended to have greater grass cover and the vegetation tended to be more dense (Appendix 3). Within sedge wren territories, there was less forb cover (Table 8). All of these habitat characteristics of areas used by the sedge wren perhaps are structurally similar to the sedge meadow habitat they generally occupy (Meanley 1952, Burns 1982).

The dickcissel was found only in DNC. The plot used by dickcissels differed from others in having a thicker, deeper litter layer (Table 3). Zimmerman (1971) found that the density of dickcissels was positively related to the volume of vegetation on an area. He also found that within a habitat, dickcissels selected tall and dense herbaceous cover. Zimmerman concluded that dickcissels were characteristic of old field habitats and were generally absent from true grasslands. Like the old field habitat, DNC provides a taller, more dense cover. I suspect the deeper litter layer of the plot used by dickcissels was just a plot characteristic and the dickcissels probably were cuing in on the total structure of the DNC.

Savannah sparrows seem to use habitats and portions of habitats that have grassy cover, a deeper litter layer, and are without shrubs. Plots used by the savannah sparrow had less shrub cover (Table 9), and savannah sparrow densities were positively related to the amount of grass cover (Table 9). Within savannah sparrow territories and "used portions", the litter layer was slightly deeper, there tended to be less forb cover, and there also tended to be less shrub cover (Table 9). Savannah sparrows were most numerous in habitats with the greater amount of grass cover (Table 1 and 2).

Unlike what I observed, Wiens (1969) reported that the savannah sparrow occupied portions of habitat of intermediate vegetation density, and the litter layer within territories was less deep than in unoccupied portions. Other workers (Maher 1973, Owens and Myres 1973) have found that the savannah sparrow was most numerous in undisturbed grasslands, and these observations agree with mine, except in idle habitats, where I suspect that shrubs may make the habitat less attractive to savannah sparrows.

Stewart (1975) regards the savannah sparrow to be a primary inhabitant of wet-meadow swales. I noticed that in idle and grazed habitats, the savannah sparrow occupied dry wetland basins or the edges of wetland basins, which are characterized by dense wet-meadow vegetation, with a deep litter layer, and no shrub cover. This vegetative structure is similar to that of DNC (Table 2).

The sharp-tailed sparrow and Le Conte's sparrow used only a DNC plot which had tall and dense herbaceous cover. Both species are associated with thick, dense beds of Spartina and Scolochloa in wetland basins (Murray 1969). There were no wetlands on or adjacent to this plot so it appears the tall and dense DNC alone attracted these species.

Bobolinks appear to be attracted to a more tall and dense herbaceous cover. Bobolinks used plots which had a greater amount of grass and forb cover, and bobolink densities were positively correlated with vegetation effective height. The bobolink was most numerous on DNC plots, which had the tallest and most dense herbaceous cover available in this study. Other workers have noted that bobolinks appear to prefer hay and clover habitats (Graber and Graber 1963).

Species associated with a wide range of vegetative cover types or with cover intermediate in the range from short and sparse to tall and dense vegetation

The upland sandpiper used plots that had less grass and forb cover, were less tall and dense, and had a thinner litter layer (Table 3). Upland sandpipers generally are associated with moderately dense vegetation of undisturbed and occasionally burned grasslands about 1.5-3.1 dcm tall (Higgins et al. 1969, Kirsch and Higgins 1976). In my work, upland sandpipers were least numerous in DNC (Table 1) and there was no significant difference between sandpiper densities in grazed and idle habitats. This suggests that upland sandpiper habitat can be characterized as vegetation ranging from moderately to less tall and dense cover, and it appears the upland sandpiper would less likely be found in the tallest and densest habitats available.

Habitat characteristics associated with the Baird's sparrow were not easily delimited. Plots used by Baird's sparrows did not differ in any structural characteristics from plots not used, although the Baird's sparrow tended to use plots with less shrub cover than unused plots (Appendix 3). Also, the vegetative structure within "used portions" differed from habitat outside "used portions" only in having a slightly deeper litter layer. Baird's sparrow densities also were negatively correlated with litter depth (Table 4).

Baird's sparrows tended to be slightly more numerous on grazed habitats and were never seen on idle plots. Because they established territories on grazed plots before the cattle were placed on the areas, I suspect the Baird's sparrow was attracted to the moderately tall and dense vegetation present before grazing. The lack of shrub cover on grazed and DNC areas may have also been more attractive to the Baird's sparrow. Lane (1968) reported that the Baird's sparrow was attracted to longer grass habitats with patches of shrubs. In other studies, Baird's sparrows were most numerous in hayland, moderately grazed rangelands, and undisturbed grasslands (Owens and Myres 1973, Kantrud 1981). I agree that the Baird's sparrow may be attracted to sites with moderately tall and dense cover, but I suggest that shrub cover is not associated with breeding Baird's sparrows.

The grasshopper sparrow appears to be a generalist in habitat use patterns. Grasshopper sparrows were equally numerous in the 3 major habitat types (Table 1) and were found on almost every plot (12 of 13). Used plots differed from the unused in generally having shorter vegetation (of shorter effective height, Table 3). Grasshopper sparrow densities were negatively correlated with litter depth and tended to be negatively related to the effective height of the vegetation (Table 4). Within grasshopper sparrow territories and "used portions", the habitat did not differ from unoccupied portions (Table 10). Wiens (1969) found that the vegetation within grasshopper sparrow territories was less dense, shorter, and possessed a thinner litter layer than unoccupied portions. The only trend I notice is that the grasshopper sparrow is probably attracted to vegetation of low to intermediate height.

The western meadowlark appears to be another habitat generalist. They used all plots and were equally numerous in idle and grazed habitats (Table 1). Meadowlark densities were negatively correlated with vegetation effective height and also tended to be negatively correlated with forb cover (Table 2). Within western meadowlark territories, the litter layer tended to be slightly deeper and the vegetation was slightly more dense (Table 11). However, I do not think that those within versus outside territory differences are real, because the mean values for litter depth and vertical vegetation density differ so little (a few tenths of a cm).

I think there is a trend for western meadowlark densities to increase with decreasing cover. It seems the taller and most dense cover available in this study was unattractive to western meadowlarks. Conflicting information exists on western meadowlark densities in grazed versus undisturbed habitats. Most workers have found western meadowlarks to be most numerous in ungrazed prairie habitats (Maher 1973, Owens and Myres 1973, Karasiuk et al. 1977). However, Karasiuk et al. (1977) also presented evidence that meadowlarks were more numerous on grazed rather than ungrazed plots. It appears the western meadowlark uses vegetative structure of low to intermediate height and density, and that habitats with very tall and dense vegetative structure seem to be less attractive to them.

The brown-headed cowbird was found in every habitat type and on nearly every plot (Table 1). The plot the species did not use was of greater effective height than used plots (Table 3). Cowbirds also are habitat generalists and have no marked preferences for any habitat type, although they often are more abundant in shrubby and wooded edge habitats (Graber and Graber 1963, Stauffer and Best 1980). Stauffer and Best (1980) also found that cowbirds were positively associated with the vertical stratification of vegetation less than 3 m tall. I suggest that cowbirds might be more abundant in less tall and dense habitats where it may be easier for them to watch potential host movements.

Conclusions

When we understand what features of the habitat are associated with the presence and densities of a bird species, we should be able to anticipate what bird species might be attracted to management units as we manipulate the habitat.

If shrubs are removed from an area, shrub-nesting species like the willow flycatcher, eastern kingbird, clay-colored sparrow, and song sparrow will not be found there. Yet, if shrubs are removed, we may encourage use of the area by other bird species like the savannah sparrow and Baird's sparrow, which show a negative association with shrub cover.

If the vegetative cover and litter layer are reduced by grazing and perhaps mowing, willets, marbled godwits, horned larks, and chestnut-collared longspurs might be attracted to the area. In contrast, if herbaceous cover is manipulated to result in a taller, more dense cover, the sedge wren, dickcissel, savannah sparrow, Le Conte's sparrow, sharp-tailed sparrow, and bobolink may nest on those units.

Baird's sparrows and upland sandpipers may be attracted to areas where the herbaceous cover is maintained at an intermediate height and density.

The common yellowthroat, red-winged blackbird, and American goldfinch appear to use habitats with either shrub or tall herbaceous cover. Other species, like the grasshopper sparrow and western meadowlark appear to be habitat generalists and may be present under any habitat manipulation scheme.

WPA managers may need to include the habitat needs of non-target species in their management considerations because of the continued loss of native habitat on private lands. If they do so, I think the information I have presented on bird-habitat associations can be used to predict what birds will be present on areas under different vegetation manipulation schemes. I also feel these results may allow managers to focus in on specific habitat features that may be manipulated to encourage use of an area by a desired species.

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SUMMARY

On North Dakota WPAs, the 3 major habitat types of idle native prairie, grazed native prairie, and dense nesting cover (DNC) differed in vegetation structure (except for percentage litter cover) and tended to have different bird communities. In all, 30 bird species were found on the 3 habitat types.

Idle habitats had more shrub cover than grazed and DNC habitats, and idle areas attracted 12 shrub-nesting bird species. If shrubs are removed from these areas, 5 of these 12 species (the willow flycatcher, least flycatcher, gray catbird, brown thrasher, and yellow warbler) probably would be eliminated from idle native prairie habitats. Within idle habitats, a wide variety of vegetative structural components were available to birds, and the habitat structure of idle areas tended to be intermediate within the range of short and sparse cover to tall and dense cover. This structural variety probably explains why idle habitats held more birds and more species of birds than grazed or DNC habitats.

Grazed habitats are characterized by the least amount of grass and forb cover, have more bare ground, a thinner litter layer, and a less dense vegetation. This habitat attracts species like the willet, marbled godwit, horned lark, and chestnut-collared longspur, which are generally

associated with short and sparse cover. If cattle grazing is not used as a habitat manipulation tool on WPAs, I believe the horned lark, chestnut-collared longspur, and perhaps the willet and marbled godwit would be excluded from the bird communities.

DNC habitats tended to be characterized by more grass and forb cover, a deeper litter layer, and taller and denser vegetation. DNC provided vegetative cover that attracted birds that were associated with taller, thicker herbaceous cover. Sedge wrens, dickcissels, Le Conte's sparrows, and sharp-tailed sparrows appeared to be attracted to DNC. Savannah sparrows also appeared to be greatly attracted to DNC, because they were most numerous in the DNC, and in analyses, tended to show a positive association with denser, shrubless cover.

Other bird species, like the upland sandpiper, common yellowthroat, grasshopper sparrow, red-winged blackbird, western meadowlark, and brown-headed cowbird, tended to be habitat generalists and were found on every major habitat type. However, the upland sandpiper and western meadowlark tended to be more attracted to the less tall and dense cover, and the red-winged blackbird tended to be attracted to shrub cover.

As more native grassland habitat on private lands is plowed for agricultural purposes, WPAs gain increasing importance as pockets of native habitat for non-game birds. Hopefully, this study has contributed to our knowledge of the composition of non-game bird communities and of bird-habitat associations on WPAs. When non-game bird habitat needs are considered in WPA management plans, this knowledge should allow WPA managers to better understand the effects of different habitat manipulation regimes on non-game birds and should lead to more ecologically sound resource use decisions.

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APPENDIX 1

In the point-quadrat sampling technique a thin metal rod was pushed vertically through the vegetation at the 4 outer points of 2 intersecting meter sticks (Brown 1954). Percentage cover grass, forb, litter, and shrub were defined as the number of times the metal rod is in contact with a life form divided by the number of times the rod is pushed through the vegetation, times 100.

To determine how dense the vegetation was in a vertical plane (vertical vegetation density), I used the modified point-quadrat technique as used by Wiens (1969). While I sampled for percentage cover, I also counted the number of rod-vegetation contacts in 10-cm intervals along the rod. I defined vertical vegetation density as the number of rod-vegetation contacts in 10-cm intervals. In preliminary analyses, I found no significant differences in vertical vegetation density above 70 cm between habitat types, so in this report I let MVC represent the mean number of vegetation contacts in 10-cm intervals between 0-70 cm. This technique gave me a quantified measure of vegetation density that would be easier to analyze than a subjective measure such as sparse or thick.

Effective height measurements were obtained by averaging the 4 readings of vegetative cover from the Robel pole at a sample point (Robel et al. 1970). I define vegetation effective height as the height at which the vegetative cover totally obstructs the horizon, and technically, the height at which a pole, viewed from 1 m above the ground, is totally obstructed. I believe effective height measurements better represent the height of the vegetative cover as birds might view it, rather than measurements of absolute height (measurements of the tallest plant at the sample point).

APPENDIX 2

Common Name	Scientific Name
Killdeer	*Charadrius vociferus*
Willet	*Catoptrophorus semipalmatus*
Upland Sandpiper	*Bartramia longicauda*
Marbled Godwit	*Limosa fedoa*
Common Snipe	*Gallinago gallinago*
Wilson's Phalarope	*Phalaropus tricolor*
Mourning Dove	*Zenaida macroura*
Willow Flycatcher	*Empidonax traillii*
Least Flycatcher	*Empidonax minimus*
Eastern Kingbird	*Tyrannus tyrannus*
Horned Lark	*Eremophila alpestris*
Sedge Wren	*Cistothorus platensis*
Gray Catbird	*Dumetella carolinensis*
Brown Thrasher	*Toxostoma rufum*
Yellow Warbler	*Dendroica petechia*
Common Yellowthroat	*Geothlypis trichas*
Dickcissel	*Spiza americana*
Clay-colored Sparrow	*Spizella pallida*
Vesper Sparrow	*Pooecoetes gramineus*
Lark Bunting	*Calamospiza melanocorys*

Savannah Sparrow	*Passerculus sandwichensis*
Baird's Sparrow	*Ammodramus bairdii*
Grasshopper Sparrow	*Ammodramus savannarum*
Le Conte's Sparrow	*Ammodramus leconteii*
Sharp-tailed Sparrow	*Ammodramus caudacutus*
Song Sparrow	*Melospiza melodia*
Chestnut-collared Longspur	*Calcarius ornatus*
Bobolink	*Dolichonyx oryzivorus*
Red-winged Blackbird	*Agelaius phoeniceus*
Western Meadowlark	*Sturnella neglecta*
Brown-headed Cowbird	*Molothrus ater*
American Goldfinch	*Carduelis tristis*

APPENDIX 3

Habitat characteristics of used and unused plots for each bird species. The number of plots contributing to the used plot mean = n. MVC = mean number of vegetation contacts between 0-70 cm

Species	Habitat Characteristic	Used	Unused	Prob.
Killdeer	% cover grass	57.1	67.1	0.33
n=3	% cover forb	21.0	29.2	0.23
	% cover litter	99.0	99.2	0.95
	% cover shrub	10.6	4.9	0.36
	% bare ground	0.7	0.3	0.35
	Effective height (dcm)	1.2	1.7	0.57
	Litter depth (cm)	2.2	2.9	0.44
	MVC/10 cm intervals	6.3	7.1	0.67

		Used	Unused	Prob.
Upland	% cover grass	57.4	79.0	0.01
sandpiper	% cover forb	23.5	34.4	0.05
n=9	% cover litter	98.8	99.7	0.11
	% cover shrub	5.7	7.7	0.68
	% bare ground	0.5	0.1	0.15

	Effective height (dcm)	1.1	2.7	0.002
	Litter depth (cm)	2.3	3.7	0.01
	MVC/10 cm intervals	5.8	9.0	0.004

		Used	Unused	Prob.
Willet	% cover grass	55.1	68.5	0.36
n=4	% cover forb	20.5	29.9	0.27
	% cover litter	98.7	99.3	0.57
	% cover shrub	3.9	7.4	0.59
	% bare ground	0.6	0.3	0.70
	Effective height (dcm)	0.8	1.9	0.10
	Litter depth (cm)	1.8	3.1	0.04
	MVC/10 cm intervals	5.0	7.6	0.09

		Used	Unused	Prob.
Marbled godwit n=4	% cover grass	49.9	71.9	0.007
	% cover forb	18.8	31.3	0.03
	% cover litter	99.0	99.2	0.94
	% cover shrub	5.5	6.8	0.94
	% bare ground	0.7	0.2	0.21
	Effective height (dcm)	0.7	2.0	0.05
	Litter depth (cm)	2.0	3.1	0.12
	MVC/10 cm intervals	4.8	7.9	0.02

		Used	Unused	Prob.

Common	% cover grass	55.6	66.4	0.36
snipe	% cover forb	22.0	28.2	0.45
n=2	% cover litter	99.7	99.0	0.27
	% cover shrub	15.1	4.6	0.15
	% bare ground	0.1	0.4	0.46
	Effective height (dcm)	1.3	1.7	0.73
	Litter depth (cm)	2.8	2.7	0.79
	MVC/10 cm intervals	7.1	6.8	0.78

		Used	Unused	Prob.
Wilson's	% cover grass	67.9	64.1	0.55
phalarope	% cover forb	26.4	27.3	0.82
n=2	% cover litter	99.3	99.1	0.96
	% cover shrub	7.5	6.2	0.97
	% bare ground	0.0	0.4	0.36
	Effective height (dcm)	1.2	1.7	0.64
	Litter depth (cm)	2.3	2.8	0.40
	MVC/10 cm intervals	7.4	6.8	0.87

		Used	Unused	Prob.
Mourning	% cover grass	80.7	63.1	0.26
dove	% cover forb	37.0	26.3	0.28
n=1	% cover litter	99.7	99.1	0.45
	% cover shrub	30.5	4.2	0.002
	% bare ground	0.0	0.4	0.46

	Effective height (dcm)	2.6	1.5	0.30
	Litter depth (cm)	3.4	2.7	0.46
	MVC/10 cm intervals	10.5	6.5	0.06

		Used	Unused	Prob.
Willow	% cover grass	70.3	63.5	0.57
flycatcher	% cover forb	29.4	26.7	0.70
n=2	% cover litter	99.9	99.0	0.20
	% cover shrub	20.8	3.5	0.01
	Effective height (dcm)	2.0	1.5	0.53
	Litter depth (cm)	3.2	2.7	0.41
	MVC/10 cm intervals	9.3	6.4	0.06

Least flycatcher n=1, see mourning dove entry, least flycatchers were seen on only one plot, the plot mourning doves used

		Used	Unused	Prob.
Eastern	% cover grass	59.4	75.1	0.12
kingbird	% cover forb	25.1	31.2	0.45
n=8	% cover litter	99.2	98.9	0.29
	% cover shrub	9.5	0.1	0.12
	% bare ground	0.4	0.3	0.84
	Effective height (dcm)	1.3	2.2	0.31
	Litter depth (cm)	2.5	3.2	0.71

	MVC/10 cm intervals	6.5	7.6	0.69

		Used	Unused	Prob.
Horned lark	% cover grass	45.2	68.5	0.03
	% cover forb	13.0	30.0	0.01
	% cover litter	98.6	99.2	0.62
	% cover shrub	0.7	7.5	0.43
	% bare ground	1.0	0.2	0.08
	Effective height (dcm)	0.5	1.8	0.13
	Litter depth (cm)	1.6	3.0	0.12
	MVC/10 cm intervals	4.1	7.4	0.04

		Used	Unused	Prob.
Sedge wren	% cover grass	73.9	57.9	0.07
	% cover forb	33.5	22.6	0.04
	% cover litter	99.4	98.9	0.22
	% cover shrub	2.5	9.1	0.35
	Effective height (dcm)	2.3	1.1	0.03
	Litter depth (cm)	3.5	2.3	0.02
	MVC/10 cm intervals	8.0	6.1	0.11

Gray catbird n=1, see mourning dove entry, gray catbirds were seen on only one plot, the plot mourning doves used

Brown thrasher n=1, see mourning dove entry, brown thrashers were seen on only one plot, the plot mourning doves used

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Yellow warbler n=1, see mourning dove entry, yellow warblers were seen on only one plot, the plot mourning doves used

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		Used	Unused	Prob.
Common	% cover grass	65.8	63.4	0.82
yellow-	% cover forb	29.1	25.2	0.48
throat	% cover litter	99.3	99.0	0.35
n=6	% cover shrub	8.3	4.4	0.45
	% bare ground	0.3	0.4	0.71
	Effective height (dcm)	1.8	1.4	0.45
	Litter depth (cm)	3.3	2.2	0.36
	MVC/10 cm intervals	7.4	6.4	0.36

		Used	Unused	Prob.
Dickcissel	% cover grass	76.3	63.5	0.42
n=1	% cover forb	27.1	27.2	0.98
	% cover litter	100.0	99.0	0.32
	% cover shrub	0.3	6.9	0.56
	% bare ground	0.0	0.4	0.46
	Effective height (dcm)	2.0	1.6	0.64
	Litter depth (cm)	4.7	2.6	0.03
	MVC/10 cm intervals	8.1	6.8	0.53

		Used	Unused	Prob.
Clay-	% cover grass	63.5	66.2	0.79
colored	% cover forb	28.7	25.0	0.51
sparrow	% cover litter	99.6	98.5	0.04
n=7	% cover shrub	10.6	0.4	0.07
	% bare ground	0.1	0.7	0.08
	Effective height (dcm)	1.6	1.6	0.83
	Litter depth (cm)	3.0	2.5	0.27
	MVC/10 cm intervals	7.2	6.4	0.39

		Used	Unused	Prob.
Savannah	% cover grass	66.1	60.0	0.56
sparrow	% cover forb	28.0	24.6	0.65
n=10	% cover litter	99.0	99.6	0.27
	% cover shrub	2.8	16.9	0.02
	% bare ground	0.4	0.3	0.60
	Effective height (dcm)	1.7	1.4	0.86
	Litter depth (cm)	2.8	2.5	0.80
	MVC/10 cm intervals	6.9	6.9	0.85

		Used	Unused	Prob.
Baird's	% cover grass	65.9	63.5	0.58
sparrow	% cover forb	29.2	25.4	0.38
n=6	% cover litter	99.0	99.2	0.99

	% cover shrub	0.4	11.4	0.06
	% bare ground	0.4	0.3	0.88
	Effective height (dcm)	1.5	2.6	0.63
	Litter depth (cm)	3.0	2.6	0.63
	MVC/10 cm intervals	6.4	7.2	0.65

		Used	Unused	Prob.
Grass-hopper sparrow n=12	% cover grass	62.4	88.8	0.08
	% cover forb	26.4	35.4	0.36
	% cover litter	99.1	99.0	0.97
	% cover shrub	6.9	0.0	0.55
	% bare ground	0.4	0.3	0.78
	Effective height (dcm)	.4	4.1	0.004
	Litter depth (cm)	2.8	2.4	0.78
	MVC/10 cm intervals	6.6	9.9	0.12

		Used	Unused	Prob.
Le Conte's sparrow n=1	% cover grass	88.8	62.4	0.08
	% cover forb	35.4	26.4	0.36
	% cover litter	99.0	99.1	0.97
	% cover shrub	0.0	6.9	0.55
	% bare ground	0.3	0.4	0.78
	Effective height (dcm)	4.1	1.4	0.004
	Litter depth (cm)	2.4	2.8	0.78
	MVC/10 cm intervals	9.9	6.6	0.12

Sharp-tailed sparrow n=1, see Le Conte's sparrow entry, sharp-tailed sparrows used only one plot, the same plot Le Conte's sparrows used

		Used	Unused	Prob.
Song	% cover grass	60.0	66.1	0.56
sparrow	% cover forb	24.6	28.0	0.65
n=3	% cover litter	99.6	99.0	0.27
	% cover shrub	16.9	2.8	0.02
	% bare ground	0.3	0.4	0.60
	Effective height (dcm)	1.4	1.7	0.86
	Litter depth (cm)	2.5	2.8	0.80
	MVC/10 cm intervals	7.0	6.9	0.85

		Used	Unused	Prob.
Chestnut-	% cover grass	53.9	66.7	0.44
collared	% cover forb	17.7	29.0	0.21
longspur	% cover litter	97.1	99.5	0.003
n=3	% cover shrub	0.0	7.6	0.34
	% bare ground	1.3	0.2	0.007
	Effective height (dcm)	0.6	1.8	0.17
	Litter depth (cm)	1.5	3.0	0.06
	MVC/10 cm intervals	4.4	7.4	0.09

		Used	Unused	Prob.
Bobolink	% cover grass	74.8	55.9	0.01
n=6	% cover forb	33.7	21.6	0.01
	% cover litter	99.3	99.0	0.48
	% cover shrub	2.3	9.8	0.22
	% bare ground	0.1	0.6	0.07
	Effective height (dcm)	2.2	1.1	0.08
	Litter depth (cm)	3.2	2.4	0.25
	MVC/10 cm intervals	7.8	6.1	0.18

		Used	Unused	Prob.
Red-winged	% cover grass	62.5	68.8	0.53
blackbird	% cover forb	25.2	31.0	0.33
n=9	% cover litter	99.3	98.8	0.84
	% cover shrub	9.5	0.0	0.15
	% bare ground	0.3	0.5	0.68
	Effective height (dcm)	1.3	2.3	0.11
	Litter depth (cm)	2.7	2.9	0.58
	MVC/10 cm intervals	6.6	7.3	0.51

		Used	Unused	Prob.
Brown-	% cover grass	62.4	88.8	0.08
headed	% cover forb	26.4	35.4	0.36
cowbird	% cover litter	99.1	99.0	0.97
n=12	% cover shrub	6.9	0.0	0.55

	% bare ground	0.4	0.3	0.78
	Effective height (dcm)	1.4	4.1	0.004
	Litter depth (cm)	2.8	2.4	0.78
	MVC/10 cm intervals	6.6	9.9	0.12

		Used	Unused	Prob.
American	% cover grass	62.4	66.8	0.64
goldfinch	% cover forb	27.1	27.2	0.95
n=6	% cover litter	99.5	98.7	0.12
	% cover shrub	12.4	0.3	0.02
	% bare ground	0.2	0.6	0.18
	Effective height (dcm)	1.5	1.7	0.95
	Litter depth (cm)	2.7	2.8	0.76
	MVC/10 cm intervals	7.2	6.6	0.52