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Relationships Between Breeding Birds and Vegetation in Four Woodland Types of the Little Missouri National Grasslands

Rick B. Hopkins, J. Frank Cassel, and Ardell J. Bjugstad

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Relationships Between Breeding Birds and Vegetation in Four Woodland Types of the Little Missouri National Grasslands[1]

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Abstract

Bird species richness was greater in the cottonwood woodland type than in the juniper, pine, and ash woodland types. Total breeding bird densities were greatest in the green ash woodland type. The densities of 25 bird species were significantly different among the four woodland types. The densities of birds in five foraging guilds and four nesting guilds were significantly different among the four woodland types. The influence of vegetation on bird community structure is discussed and suggestions are made for preserving and reestablishing woodlands threatened by the strip-mining of lignite coal.

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MANAGEMENT IMPLICATIONS

In western North Dakota, surface mining for lignite coal is likely to increase during the next 50 years. This expanding energy industry could adversely affect woodland communities. Breeding birds in natural woodlands might not only be directly impacted by woodland destruction but also indirectly by blasting, road building, dust, and noise. Using current technology, cropland and rangeland can be reclaimed to premining conditions. However, it has not been demonstrated that natural woodlands can be restored to premining condtions, as required by current laws. Compared to cropland and rangeland, successful woodland reclamation will be hampered by the physical environment, variety of species involved, prolonged time of development, and expense. (Clambey 1979).[3]

Planted woodlands (i.e., shelterbelts) might mitigate woodland loss (fig. 1). Cassel et al.,[4] Fleckenstein (1981), and Hiemenz (1981) reported that bird species richness and density increased with shelterbelt age and area in western North Dakota. Compared to natural woodland types, shelterbelts in west-central and western North Dakota support greater bird densities. In contrast, bird species richness in shelterbelts tends to be less than in large cottonwood woodlands, greater than in juniper and pine woods of comparable area, and nearly the same as larger pine woods and in ash woods of comparable area.

Although shelterbelts apparently can support more species than pine woodlands, they probably have little potential to support birds with strong affinities for the pines (i.e., Red-breasted Nuthatch and Yellow-rumped Warbler). The low number of species supported in the juniper woods and the apparent lack of species with strong affinities for this woodland type suggests that shelterbelts might have greater habitat value for birds than juniper woods. The small area of shelterbelts and lack of vegetation diversity will preclude shelterbelts from supporting the large variety of birds found in cottonwood woodlands and some species characteristic of ash woodlands. Although shelterbelts support bird communities more similar to natural deciduous woodlands than other woodland habitat types (Fleckenstein 1981, Hiemenz 1981), there are some species characteristic of natural woodlands not supported in shelterbelts.

[3]*Clambey, G.K. 1979. A literature review pertaining to hardwood draws in the northern Great Plains and their possible reclamation after strip-mining. Unpublished Report. Botany Department, North Dakota State University, Fargo, 25 p.*

[4]*Cassel, J.F., L. Vorhees, and W.C. Whitman. 1976. Wildlife resources of the Dunn County coal gasification project study area. Unpublished Report. Zoology Department, North Dakota State University, Fargo. 131 p.*

Figure 1.—Planted woodlands (shelterbelts) have the potential to mitigate woodland losses to strip-mining lignite. Shelterbelts of multiple-rows and multiple vegetation strata should benefit birds most.

Shelterbelts have little potential to support birds characteristic of woodland interiors, that is, species that forage and nest in a mature tree canopy (e.g., vireos) or forage on bark surfaces and nest in cavities (e.g., woodpeckers and nuthatches).

Current technologies to mitigate woodland losses seem inadequate, especially in this region. More information is needed to evaluate the potential for using shelterbelts to replace natural woodlands lost to strip-mining. If planted woodlands are used, they should consist mainly of deciduous trees and shrubs arranged to provide a closed canopy and a multilayered community, and should be protected from grazing which would reduce the understory vegetation diversity.

INTRODUCTION

Although woodlands cover only about 1% of the northern High Plains (Boldt et al. 1978), they provide valuable habitat for wildlife and livestock and contribute a unique element to the regional landscape diversity. Increasing pressure from agricultural, industrial, and energy developments threaten to reduce the acreage of woodlands. To understand the effects of energy developments on bird communities it is necessary to know what habitat characteristics are important in determining bird distribution. Once these characteristics are identified and the bird species associated with them known, predictions can be made regarding the effects of habitat disturbance on bird populations in an area.

This study was started in 1979 to (1) describe the vegetation structure of the four principal woodland bird habitats of the Little Missouri National Grasslands; (2) describe the relationship between vegetation and bird community structure in those woodland types; and (3) use these data as a basis for recommending preservation and reestablishment of woodlands threatened by strip-mining lignite coal.

STUDY AREA

Location and Status

The Little Missouri National Grasslands (LMNG) cover about 500,000 ha in western North Dakota and are managed for multiple use. Although livestock grazing is a primary use, the maintenance and improvement of wildlife habitat is also a major concern. Oil and gas development has become an important activity on the LMNG; nearly all of the region is underlaid by lignite coal.

Physiography, Geology, and Soils

The LMNG are part of the Missouri River Plateau and are largely unglaciated. The substrates are stratified beds of sands, silts, and clays of the Fort Union Group, Tongue River formation (Leonard 1930). The soils, derived from soft clayey shales and sandstones, are unstable and highly susceptible to erosion. Gently rolling prairie typifies much of the LMNG. Where the soft substrates have been severely dissected by the Little Missouri River and its tributaries, the general topography is that of "badlands."

Climate

The climate of southwestern North Dakota is semiarid, characterized by short, hot summers and cold winters. Temperatures average –9° C for January and 21° C for July. The growing season averages 110 days. The average annual precipitation is 31 cm, with one-half of that falling during the growing season. Evaporation considerably exceeds precipitation (Visher 1966).

Vegetation

The climax vegetation of the northern Great Plains is grassland, principally mixed grass prairie. Woodland development occurs where sufficient moisture is available or other edaphic characteristics are suitable. The principal woodland types of the LMNG are dominated by Rocky Mountain juniper (*Juniperus scopulorum*), ponderosa pine (*Pinus ponderosa*), cottonwood (*Populus deltoides*), and green ash (*Fraxinus pennsylvanica*). Woodlands cover about 5% of the LMNG (Jakes and Smith 1982).

The woodlands of the LMNG occur as wooded habitat "islands" in a "sea" of grass. The woodlands are derived from a western extension of the North America eastern deciduous forest, an eastern extension of the western coniferous forest, and a northeastern extension of the pinyon-juniper woodland (Rudd 1951). The principal woodland types of the LMNG differ in dominant life form, species composition, physiognomy, and area. These factors present different foliage configurations and combinations of substrates for exploitation by breeding birds.

METHODS

Eight woodlands were studied, two in each of the four principal woodland types. All woodlands were in central Billings and northern Slope counties, North Dakota (fig. 2). All study areas occurred as wooded habitat "islands" grazed by native herbivores and/or cattle.

Vegetation Structure

Data on tree species composition, size classes, and densities were obtained by the point-quarter method (Cottam and Curtis 1956). Sample points were randomly located along transects that traversed the study areas. A total of 80 trees (≥7.5 cm d.b.h.) were sampled in the smaller woodlands (≤4 ha), and 120 trees were sampled in the large woodlands (>12 ha). Tree heights were determined with an Abney Level.

The overstory canopy coverage was estimated visually with a device similar to that described by Emlen (1967). The presence or absence of tree canopy was determined at 400 points in the small woodlands and 600 points in the large woodlands. Sample points were every 2 m along randomly placed 50-m transects. Canopy cover was expressed as the proportion of sample points with canopy present.

The composition of the understory vegetation was determined in 30 randomly placed 1-m^2 quadrats. For plant species occurring within the quadrat, the percent coverage and relative percent coverage were estimated. Estimates were made for all plants that were ≤1.5 m height. Plant nomenclature follows Stevens (1950).

Bird Populations

From mid-May through mid-July of 1979, 1980, and 1981, breeding birds were censused by the spot-mapping method following the guidelines of the International Bird Census Committee (Robbins 1970). Each study area was visited 12 times during the nesting season. A minimum of six early morning visits were supplemented with midday or evening visits to detect birds active at those times. For each visit, all bird activity (all visual and sound contacts) was recorded on a map of the study area. Locating activity was facilitated by grid intersections at 63 m and by landmarks.

For each species, the density of nesting pairs was based on the number of territories or portions of territories in each woodland and expressed as pairs per 40 ha. Censuses were conducted from 0400–0800, 1000–1400, and 1800–2200 hours. Generally, 2 hours were necessary to census the small woodlands and 4 hours for the large woodlands. Each year, 12 hours were spent censusing the small woodlands and 50 hours censusing the large woodlands. Bird names follow the A.O.U. (1982) checklist (Appendix).

Avian Guilds

The assignment of a bird to foraging and nesting guilds (table 1) was based on personal observations or published accounts of foraging and nesting behavior (Hamel et al. 1982). When a bird occupied two guilds, one-half the value for density was assigned to each guild.

Foraging guilds included ground, shrub-sapling, tree canopy, bark surface, aerial, and predator. Species that might forage on herbaceous vegetation were included in the ground foraging guild. The acquisition of food by predators such as hawks and owls might take place not only in the wooded areas but also in adjacent prairies. Four nesting guilds were recognized, including ground, shrub-sapling, tree canopy, and cavity.

Analysis of Data

Differences in bird species richness, bird populations, and densities of birds in foraging and nesting guilds among woodland types were tested for significance ($\alpha = 0.05$) by two-way analysis of variance (woodland type x time) and Tukey's multiple comparison test ($\alpha = 0.10$). Pearson's product-moment correlation coefficients (r) were calculated to examine the strength of associations between bird community attributes and vegetation structural features. When a pair of vegetation variables was highly correlated ($r > 0.7$) the pair was reduced to a single variable.

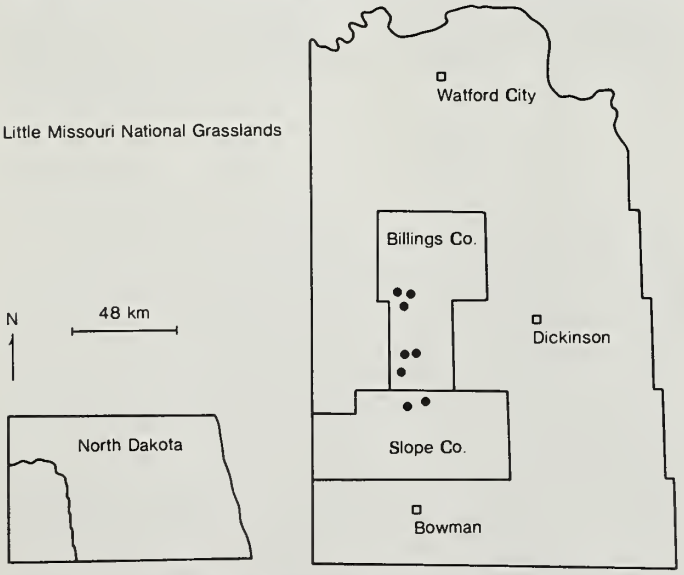

Figure 2.—Little Missouri National Grasslands study area. Study sites are indicated by dots.

RESULTS

Woodland Vegetation

Juniper Woodlands

These woodlands were on moderately to severely eroded hillsides with mixed grass prairie all around (figs. 3–5). Rocky Mountain juniper was the dominant tree in both woodlands, although some green ash was also present (table 2). Total tree density was highest in the juniper woodlands (table 3). Canopy coverage in the juniper woodlands was similar to that in the pine woodlands (table 3). Total ground cover was 10% in the Juniper I woodland and 15% in the Juniper II woodland. Coverage of grasses and shrubs was relatively high in both woodlands compared to forbs, which was less (table 3). The most common grasses were western wheatgrass (*Agropyron smithii*), little bluestem (*Andropogon scoparius*), and little ricegrass (*Oryzopsis micrantha*). Prominent shrubs were skunkbush (*Rhus trilobata*), wolfberry (*Symphoricarpos occidentalis*), and dwarf juniper (*Juniperus communis*).

Pine Woodlands

Ponderosa pine woodland covers about 1,800 ha in northern Slope County (Potter and Green 1964). This woodland type is a mosaic of woodland and prairie and is often park-like in appearance (figs. 6–8). The tree canopy was dominated by ponderosa pine; other trees were of little importance (table 2). Tree density in the pine woodlands was similar to the ash woodlands, higher than in the cottonwood woodlands, and less than in the juniper woodlands (table 3). Canopy coverage was about the same as in the juniper woodlands and less than in the cottonwood and ash woodlands (table 3). Total ground cover was 30% in the Pine I woodland and 25% in the Pine II woodland. The understory in the Pine I woodland was dominated by grasses, whereas shrubs were dominant in the Pine II woodland (table 3). In both pine woodlands, the most common grasses were little bluestem and western wheatgrass. Common shrubs were wolfberry and dwarf juniper.

Cottonwood Woodlands

Both woodlands were on the floodplain of the Little Missouri River (figs. 9–11) surrounded mostly by a shrub community dominated by silver sagebrush (*Artemisia cana*). The canopy of these woodlands was dominated by cottonwoods (table 2). Other trees in the understory were green ash and Rocky Mountain juniper. Cottonwood woodlands had lower total tree density compared to the other woodland types (table 3). Canopy coverage

Table 1.—Ecological attributes of nesting birds and principal woodland types occupied.

Species	Distribution		Primary substrate(s) utilized[3]							Woodland type(s) occupied			
	Seasonal[1]	Geographical[2]	Ground	Shrub-Sapling	Tree Canopy	Bark	Cavity	Aerial	Predator	Cottonwood	Ash	Juniper	Pine
Cooper's Hawk	S	P			N				F		X		
Red-tailed Hawk	S	P			N				F	X			
Northern Harrier*	S	P	N						F				X
American Kestrel	S	E	F				N			X	X		X
Ring-necked Pheasant	P	I	FN							X			X
Wild Turkey	P	P	FN							X	X		X
Mourning Dove*	S	P	F		N					X	X	X	X
Black-billed Cuckoo	S	E		N	FN					X			
Great Horned Owl	P	P			N				F	X			
Long-eared Owl	S	P			N				F		X		
Common Nighthawk*	S	P	N					F					X
Northern Flicker	S	P	F			F	N			X	X		
Red-headed Woodpecker	S	E				F	N			X			
Hairy Woodpecker	P	P				F	N			X			
Downy Woodpecker	P	P				F	N			X			
Eastern Kingbird	S	E			N			F		X			
Blue Jay	P	E			FN					X			
Black-billed Magpie	P	W	F		N					X		X	
Common Crow	P	P	F		N					X	X		
Black-capped Chickadee	P	P			F		N			X	X		X
White-breasted Nuthatch	P	P				F	N			X			
Red-breasted Nuthatch	P	W			F	F	N						X
House Wren	S	P		F			N			X	X		X
Gray Catbird	S	E		FN						X			
Brown Thrasher	S	E	FN	FN						X			
American Robin	S	P	F		N					X	X		
Mountain Bluebird	S	W	F				N				X		
Starling	P	P	F				N			X			
Red-eyed Vireo	S	E			FN					X	X		X
Warbling Vireo	S	P			FN					X			
Black-and-White Warbler	S	E	N			F				X	X	X	X
Yellow Warbler	S	P		FN						X			
Yellow-rumped Warbler	S	N			FN								X
Ovenbird	S	E	FN							X	X		X
Common Yellowthroat	S	P	FN	FN						X			X
Yellow-breasted Chat	S	P		FN						X	X		X
American Redstart	S	E			FN					X	X		
Black-headed Grosbeak	S	W			FN					X			
Lazuli Bunting	S	W	F	N						X	X		
Rufous-sided Towhee	S	P	FN	N						X	X	X	X
Vesper Sparrow*	S	P	FN								X	X	
Lark Sparrow*	S	W	FN								X		
Chipping Sparrow	S	P	F	N	N					X	X	X	X
Field Sparrow	S	E	FN	N						X	X	X	
Western Meadowlark*	S	W	FN							X		X	
Orchard Oriole	S	E			FN					X			
Northern Oriole	S	P			FN					X			
Common Grackle	S	E	F	N	N					X			
Brown-headed Cowbird	S	P	F	N	N					X	X		
American Goldfinch	P	P	F	N	N					X	X		

[1]*S = Summer Resident and P = Permanant Resident.*
[2]*E = Eastern: W = Western; N = Northern; P = Pandemic; and I = Introduced.*
[3]*F = Foraging and N = Nesting.*
**Denotes species that also nest in grasslands.*

Table 2.—Tree species composition (importance values).[1]

Woodland	*P. ponderosa*	*J. scopulorum*	*P. deltoides*	*P. trichocarpa*	*U. americana*	*A. negundo*	*F. pennsylvanica*
Cottonwood I		90.0	202.4				6.7
Cottonwood II		96.7	196.5				6.8
Ash I		28.0		163.9		12.3	95.0
Ash II		3.2			103.3		191.5
Juniper I		268.0					32.0
Juniper II		260.3					39.7
Pine I	278.3	4.0					17.7
Pine II	296.0						4.0

[1]*Importance Value = Relative Density + Relative Dominance + Relative Frequency*

Table 3.—Characteristics of the study areas.

Woodland	Area (ha)	Basal area (m^2/ha)	Mean canopy height (m)	Canopy coverage (%)	Trees per hectare 7.5-23.0 cm d.b.h.	Trees per hectare 23.1-54.0 cm d.b.h.	Trees per hectare >54.0 cm d.b.h.	Relative cover (%) Grasses	Relative cover (%) Forbs	Relative cover (%) Shrubs
Cottonwood I	19.0	18.5	21.0	85.0	79.0	103.7	14.8	40.0	40.0	20.0
Cottonwood II	12.9	15.3	20.0	70.0	82.0	95.8	7.7	15.0	25.0	60.0
Ash I	2.8	17.1	13.5	90.0	254.4	65.7	0.0	15.0	15.0	70.0
Ash II	2.8	18.8	9.0	70.0	388.5	137.0	4.4	10.0	10.0	80.0
Juniper I	2.4	22.5	7.0	65.0	1011.9	66.9	0.0	30.0	10.0	60.0
Juniper II	2.6	14.8	6.1	60.0	918.6	20.7	0.0	50.0	5.0	45.0
Pine I	20.2	11.2	12.1	35.0	161.1	97.8	2.0	75.0	5.0	20.0
Pine II	4.0	13.1	9.0	50.0	265.8	46.1	0.0	35.0	5.0	60.0

was greater in the cottonwood woodlands compared to the juniper and pine woodlands, and about the same as in the ash woodlands (table 3). Total ground cover was 20% in the Cottonwood I woodland and 25% in the Cottonwood II woodland. While grasses were the dominant ground cover in the Cottonwood I woodland, shrubs were more important in the Cottonwood II woodland (table 3). The herbaceous vegetation was dominated by prairie sandreed (*Calamovilfa longifolia*), Kentucky bluegrass (*Poa pratensis*), and yellow sweetclover (*Melilotus officinalis*). Common shrubs were wolfberry and skunkbush.

Ash Woodlands

Both woodlands were in upland draws surrounded on all sides by mixed grass prairie (figs. 12–14). The overstory in the Ash I woodland was dominated by green ash and black cottonwood (*Populus trichocarpa*) (table 2). In the Ash II woodland, green ash and American elm (*Ulmus americana*) were the dominant trees. Total tree density in the ash woodlands was similar to that in the pine woodlands (table 3). Canopy coverage was greater in the ash woodlands than in the pine or juniper woodlands and about the same as in the cottonwood woodlands (table 3). Total ground cover was 20% in the Ash I woodland and 30% in the Ash II woodland. In both ash woodlands, the relative importance of understory life forms was similar (table 3). Shrub cover was important in both woodlands. The prominent herbaceous species were little ricegrass, Kentucky bluegrass, and northern bedstraw (*Galium boreale*). The most common shrubs were western Woods rose (*Rosa woodsii*) and wolfberry.

Bird Populations

Species Richness and Densities

In any year, the number of species in the woodlands ranged from three in the juniper type to 28 in the cottonwood type. Species richness was greatest in the cottonwood woodland type (table 4).

In any year, the total density of nesting pairs ranged from 65 per 40 ha in the juniper type to 531 per 40 ha in the ash type. Densities of breeding birds were highest

Table 4.—Summary (means) of breeding bird censuses in juniper, pine, cottonwood, and ash woodland types, 1979–1981.[1]

	Woodland type Juniper	Pine	Cottonwood	Ash
Species Richness	4.0 c	8.1 bc	26.0 a	11.6 b
Pairs/40 ha	170.1 c	125.0 c	296.3 b	465.3 a

[1]*Common letter denotes no significant difference among means according to Tukey's multiple comparison test (α = .10).*

Figure 3.—The juniper woodland type is common on northfacing slopes and escarpments.

Figure 4.—Trees and foliage are dense in the "interior" of juniper woodlands. Few birds utilize the "interior" of the juniper woodlands except the Black-billed Magpie which places its nest in the tops of the junipers.

Figure 5.—Rufous-sided Towhees and Chipping Sparrows forage and place their nests in the edges of the juniper woods.

Figure 6.—Ponderosa pine woodland covers about 1,800 ha in northern Slope County, North Dakota.

Figure 7.—In the ponderosa pine woodland, the Blackcapped Chickadee, Black-and-White Warbler, Ovenbird, and Rufous-sided Towhee, are common where the pines are dense and the shrub stratum well developed.

Figure 8.—Yellow-rumped (Audubon's) Warblers and Chipping Sparrows are common in the edges of the ponderosa pine woodlands.

Figure 9.—The cottonwood woodland type occurs as discontinuous stands along the Little Missouri River.

Figure 10.—In cottonwood woodlands, the Red-eyed Vireo and Ovenbird are common woodland "interior" species where the canopy is dense and the understory vegetation is diverse.

Figure 11.—The Mourning Dove, Northern Flicker, House Wren, American Robin, Warbling Vireo, Rufous-sided Towhee, and Chipping Sparrow are common in the edges and clearings of the cottonwood woodlands.

Figure 12.—The green ash woodland type generally occurs in upland draws and coulees.

Figure 13.—Grazing by cattle reduces the understory vegetation in some green ash woodlands. Nevertheless, the Black-capped Chickadee, Red-eyed Vireo, and Black-and-White Warbler, are common in the "interior" of ash woodlands.

Figure 14.—Shrubs are often dense in the edges of green ash woodlands. The Lazuli Bunting, Rufous-sided Towhee, and Chipping Sparrow are common there.

in the ash type (table 4). Deciduous woodland types supported higher densities of birds than coniferous types.

Eighteen birds nested only in the cottonwood woodlands, three nested only in the ash woodlands, and three nested only in the pine woodlands (table 1). No species nested exclusively in the juniper woodlands. The densities of 25 birds were significantly different among the woodland types (table 5). Six species had highest densities in the ash type, 15 in the cottonwood type, one in the juniper type, and one in the pine type. Two species had densities that differed significantly among the woodlands; however, the highest densities were in more than one woodland type. Some rare birds that occurred within a single woodland type may prefer that type, even though their densities did not differ significantly among woodland types.

There was significant interaction between woodland type and time in the mean densities of eight species populations (table 5). Of these species, all except the Hairy Woodpecker had densities that differed signifi-

Table 5.— Mean densities (pairs per 40 ha) of birds in juniper, pine, cottonwood, and ash woodland types, 1979–1981.[1]

Species	Woodland Type			
	Juniper	Pine	Cottonwood	Ash
Cooper's Hawk	0.0	0.0	0.0	4.6
Red-tailed Hawk	0.0 b	0.0 b	1.5 a	0.0 b
Marsh Hawk	0.0	0.3	0.0	0.0
American Kestrel	0.0	0.6	2.6	1.8
Ring-necked Pheasant	0.0	0.1	1.3	0.0
Wild Turkey	0.0	3.6	1.1	4.6
Mourning Dove	6.8 b	8.3 b	28.0 a	6.8 b
Black-billed Cuckoo	0.0	0.0	0.3	0.0
Great Horned Owl	0.0	0.0	0.6	0.0
Long-eared Owl	0.0	0.0	0.0	2.3
Common Nighthawk	0.0	0.8	0.0	0.0
Common Flicker	0.0 b	0.0 b	18.8 a	6.8 b
Red-headed Woodpecker	0.0 b	0.0 b	4.3 a	0.0 b
Hairy Woodpecker[2]	0.0 b	0.0 b	3.6 a	0.0 b
Downy Woodpecker	0.0 b	0.0 b	2.1 a	0.0 b
Eastern Kingbird	0.0 b	0.0 b	10.6 a	0.0 b
Blue Jay	0.0 b	0.0 b	2.6 a	0.0 b
Black-billed Magpie	20.0 a	0.0 b	0.5 b	0.0 b
American Crow	0.0	0.0	0.5	2.3
Black-capped Chickadee	0.0 c	7.1 b	4.6 bc	16.6 a
White-breasted Nuthatch[2]	0.0 b	0.0 b	1.1 a	0.0 b
Red-breasted Nuthatch	0.0	2.8	0.0	0.0
House Wren[2]	0.0 c	0.3 c	33.8 a	12.6 b
Gray Catbird	0.0	0.0	0.3	0.0
Brown Thrasher	0.0	0.0	0.6	0.0
American Robin	0.0 b	0.0 b	19.1 a	16.3 a
Mountain Bluebird	0.0	0.0	0.0	2.3
Starling	0.0 b	0.0 b	3.3 a	0.0 b
Red-eyed Vireo	0.0 c	0.3 c	31.0 b	42.0 a
Warbling Vireo	0.0 b	0.0 b	11.8 a	0.0 b
Black-and-White Warbler	4.3 b	6.0 b	2.1 b	32.8 a
Yellow Warbler	0.0 b	0.0 b	1.1 a	0.0 b
Yellow-rumped Warbler[2]	0.0 b	6.6 a	0.0 b	0.0 b
Ovenbird	0.0	12.5	22.8	25.1
Common Yellowthroat	0.0 b	4.6 ab	12.3 a	0.0 b
Yellow-breasted Chat	0.0	0.1	0.6	4.6
American Redstart[2]	0.0 b	0.0 b	1.5 b	13.8 a
Black-headed Grosbeak[2]	0.0 b	0.0 b	9.0 a	0.0 b
Lazuli Bunting[2]	0.0 b	0.0 b	4.0 b	35.1 a
Rufous-sided Towhee	80.5 ab	22.1 c	25.1 bc	132.8 a
Vesper Sparrow	2.6	0.0	0.0	2.3
Lark Sparrow	0.0	0.0	0.0	9.3
Chipping Sparrow	45.1 a	48.1 a	21.3 b	56.0 a
Field Sparrow	9.3	0.0	2.5	14.0
Western Meadowlark	0.0	0.0	0.1	0.0
Orchard Oriole	0.0	0.0	0.3	0.0
Northern Oriole	0.0	0.0	3.5	0.0
Common Grackle[2]	0.0 b	0.0 b	1.1 a	0.0 b
Brown-headed Cowbird	0.0	0.0	2.0	2.3
American Goldfinch	0.0	0.0	1.0	4.6

[1]*Common letter denotes no significant difference among means according to Tukey's multiple comparison test ($\alpha = 0.10$).*

[2]*Denotes significant interaction (woodland type x time)*

cantly among years. Five of the eight species occurred in only one woodland type. The remaining three species occurred in up to three woodland types; however, the species generally showed a strong preference for one woodland type. Two species populations (i.e., White-breasted Nuthatch and American Redstart) increased between 1979 and 1980 and decreased in 1981. Two species populations (i.e., House Wren and Black-headed Grosbeak) decreased between 1979 and 1980 and also between 1980 and 1981. The Yellow-rumped Warbler increased in abundance in 1980 and in 1981. The Common Grackle decreased in abundance between 1979 and 1980 and increased in 1981.

Ecological Relationships

Deciduous woodland types typically supported more foraging guilds than did coniferous types. In any year, the number of foraging guilds exploiting the woodlands ranged from one in the juniper type to six in the cottonwood type. The highest densities of ground foragers were in the ash type (table 6). Aerial foragers were most abundant in the cottonwood type. The densities of shrub-sapling foragers were highest in the cottonwood type. Tree canopy foragers were more abundant in the ash and cottonwood types than in the juniper and pine types. The highest densities of bark foragers were in the ash and cottonwood woodland types.

There was significant interaction between woodland type and time in the mean densities of birds in the shrub-sapling and tree canopy foraging guilds (table 6). There was a significant difference in the abundance of shrub-sapling foragers among years, but not the abundance of tree-canopy foragers. Shrub-sapling foragers were more abundant in 1979 than in 1980 and 1981. The greatest change in abundance of shrub-sapling foragers occurred in the ash type, where mean densities decreased from 52 pairs per 40 ha in 1979 to 0 pairs per 40 ha in 1980 and 1981. During the same times, densities of shrub-sapling foragers generally increased in the cottonwood and pine woodland types. No shrub-sapling foragers occurred in the juniper type. Between 1979 and 1980, the mean densities of tree-canopy foragers increased in the ash type (50%) and pine type (333%), and decreased in the cottonwood type (44%). In 1981, there was a decrease in the mean densities of tree canopy foragers in the ash type (6%) and pine type (14%), and an increase in the cottonwood type (13%). No tree canopy foragers were found in the juniper type.

Table 6.—Mean densities (pairs per 40 ha) of birds in foraging guilds, 1979–1981.[1]

Guild	Woodland type			
	Juniper	Pine	Cottonwood	Ash
Ground	165.8 b	98.0 c	152.0 bc	332.2 a
Shrub-Sapling[2]	0.0 c	6.8 bc	42.5 a	17.3 b
Tree Canopy[2]	0.0 c	15.5 b	63.0 a	72.5 a
Bark	4.3 b	7.4 b	22.9 a	36.2 a
Aerial	0.0 b	0.8 b	10.6 a	0.0 b
Predator	0.0	0.3	3.8	7.0

[1]*Common letter denotes no significant difference among means according to Tukey's multiple comparison test (α = .10).*
[2]*Denotes significant interaction (woodland type x time).*

Table 7.—Mean densities (pairs per 40 ha) of birds in nesting guilds, 1979–1981.[1]

Guild	Woodland type			
	Juniper	Pine	Cottonwood	Ash
Ground	53.2 b	36.9 b	58.4 b	186.9 a
Shrub-Sapling	67.5 b	37.6 b	29.6 b	141.2 a
Tree Canopy	48.9 b	39.4 b	131.9 a	119.8 a
Cavity	0.0 c	11.0 c	74.6 a	41.1 b

[1]*Common letter denotes no significant difference among means according to Tukey's multiple comparison test (α = .10).*

In 1981, there was a decrease in the mean densities of tree canopy foragers in the ash type (6%) and pine type (14%), and an increase in the cottonwood type (13%). No tree canopy foragers were found in the juniper type.

All nesting guilds were represented in the cottonwood, ash, and pine woodlands in all years of study. All nesting guilds, except cavity nesters, occurred in the juniper type. The highest densities of ground and shrub-sapling nesters were in ash woodland type (table 7). Tree canopy nesters were more abundant in ash and cottonwood woodland types than in juniper and pine types. Cavity nesters were most abundant in the cottonwood type.

Habitat Associations

Species richness was positively associated with canopy height and negatively associated with the density of small trees and dominance of conifers (table 8). The total density of birds was negatively associated with dominance of conifers.

The densities of birds in four foraging guilds (ground, shrub-sapling, tree canopy, and bark) were negatively associated with dominance of conifers (table 8). The densities of birds in two foraging guilds (tree canopy and predator) were positively associated with the density of medium size trees. The densities of birds in two foraging guilds (shrub-sapling and aerial) were positively associated with canopy height. The densities of bark foragers were positively associated with canopy cover.

The densities of ground and shrub-sapling nesters were not significantly associated with any vegetation characteristics (table 8). The densities of tree canopy nesters were positively associated with canopy height and cover and negatively associated with dominance of conifers. The densities of cavity nesters were positively associated with canopy height and negatively associated with the densities of small trees and dominance of conifers.

DISCUSSION

Bird species richness and total population density tended to be higher in woodlands characterized by a high canopy and a low density of small trees and low dominance of conifers (table 8). This pattern of species

Table 8.—Significant correlations between bird community attributes and vegetation structural features.

Vegetation characteristic	Species Richness	Total Pairs/40 ha	Pairs per 40 ha in foraging guilds						Pairs per 40 ha in nesting guilds			
			Ground	Shrub-Sapling	Tree Canopy	Bark	Aerial	Predator	Ground	Shrub-Sapling	Tree Canopy	Cavity
Trees/ha 7.5–23 cm d.b.h.	-.71*											-.71*
Trees/ha 33.1–54.0 cm d.b.h.					.70*			.74*				
Canopy height (m)	.94***			.89**			.88**				.73*	.92***
Canopy cover (%)						.72*					.83***	
Dominance by conifer (%)	-.70*	-.89**	-.69*	-.78*	-.94***	-.85***					-.95***	-.85***

* $P < 0.95$
** $P < 0.01$
*** $P < 0.001$

abundance also was reported by James and Wamer (1982). They reported that bird species richness and population density were highest in mature deciduous woodlands, while species richness and population density were lower in coniferous woodlands characterized by high tree density and few tree species.

The geographic location of the LMNG could have an important influence on bird species composition and abundance. Woodlands derived from western forests (i.e., juniper and pine) are limited in extent in the LMNG and lack corridors to the extensive forests of the west. An undisturbed 15-ha ponderosa pine woodland studied by Szaro and Balda (1979) supported up to twice as many species as the large (20-ha) pine woodland in this study. The juniper woodlands of western North Dakota also appear to support fewer species than juniper woodlands to the west (Balda and Masters 1980). The greater number of eastern-deciduous birds in the cottonwood type (table 1) compared to the other woodland types, possibly reflects the importance of that type as a corridor for bird dispersion from eastern forests. Hopkins (1983) reported that the Ovenbird, a common bird of eastern deciduous forests, had lower breeding densities in the LMNG than in eastern portions of its range. This suggests that other bird species populations at the periphery of their range might occur at lower densities in the LMNG.

Bird species richness has been shown to be influenced by woodland area (Galli et al. 1976), and the species composition of wooded "islands" does not represent a random subset of the regional avifauna (Blake 1983). Hopkins (1980) reported that larger areas of juniper woodlands supported more species. Fleckenstein (1981), Hiemenz (1981), and Hopkins (1980) also showed increasing species richness in larger stands of green ash woodlands. The comparatively large number of species restricted to the large cottonwood woodlands indicates these woodlands meet the minimum area requirements for more species (Galli et al. 1976).

The apparent influence of interaction between woodland type and time on the densities of eight species populations and the densities of birds in two foraging guilds, might reflect the influence of factors (e.g., weather, predation, and hazards) elsewhere within the species ranges and not only within the study area (Fretwell 1972). Although weather changes between years can interact with vegetation structure (Balda et al. 1983) to influence bird populations, the weather during this study was similar between years. Therefore, it is unlikely that any significant changes in the habitat or food resource base occurred during the study.

The variety of birds that may ultimately occupy an environment is partly influenced by the species composition and growth form of plants that provide foraging and nesting substrates. Differences in bird community composition in the woodland types of the LMNG probably are influenced by the physical structure of vegetation, kinds and distribution of foraging and nesting substrates, and the availability and abundances of insect resources, all of which are influenced by plant species composition.

A pattern of lower bird species richness and population density in coniferous woodland types (i.e., juniper and pine) compared to deciduous types (i.e., cottonwood and ash), might result from substrates and foliage surfaces being less accessible in the coniferous woods. Foliage substrates also support lower prey populations in coniferous woodlands (Jackson 1979). Insect abundance may have been lower in the coniferous woodland types which occupied drier sites than the deciduous types (Whittaker 1952). Bird species densities are presumably highest in their preferred habitat. The small number of birds (2) to attain their highest densities in the coniferous woods, suggests a lack of birds that efficiently exploit the resources of those woodlands.

Compared to coniferous trees (i.e., juniper and pine), deciduous trees (i.e., cottonwood and ash) have broad leaves and generally have larger branches, deeper furrowed bark, and greater crown closure, all of which provide more opportunities for exploitation of tree surfaces by birds. A deciduous canopy along with local topographic and moisture variation might influence the composition of the understory vegetation strata and the variety of birds that can potentially utilize those substrates.

In these deciduous woods, the understory vegetation usually was dominated by a mixture of tall and short shrubs. In contrast, the understory vegetation in the coniferous woods generally was dominated by grasses or short shrubs. The deciduous woods also were characterized by a greater variety of important tree species, whereas the coniferous woods usually were strongly dominated by a single species. An understory mainly of grass could have a negative effect on the abundance of ground and shrub-sapling foragers. James and Wamer (1982) reported bird species richness was positively associated with tree species richness. Some characteristics of deciduous trees (i.e., higher canopies and larger branches) also provide more nesting substrates for birds, particularly canopy and cavity nesters.

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Appendix

Common and Scientific Names of Birds

Cooper's Hawk	*Accipiter cooperii*
Red-tailed Hawk	*Buteo jamaicensis*
Northern Harrier	*Circus cyaneus*
American Kestrel	*Falco sparverius*
Ring-necked Pheasant	*Phasianus colchicus*
Wild Turkey	*Meleagris gallopavo*
Mourning Dove	*Zenaidura macroura*
Black-billed Cuckoo	*Coccyzus erythropthalmus*
Great Horned Owl	*Bubo virginianus*
Long-eared Owl	*Asio otus*
Common Nighthawk	*Chordeiles minor*
Northern Flicker	*Colaptes auratus*
Red-headed Woodpecker	*Melanerpes erythrocephalus*
Hairy Woodpecker	*Picoides villosus*
Downy Woodpecker	*Picoides pubescens*
Eastern Kingbird	*Tryannus tyrannus*
Blue Jay	*Cyanocitta cristata*
Black-billed Magpie	*Pica pica*
Common Crow	*Corvus brachyrhynchos*
Black-capped Chickadee	*Parus atricapillus*
White-breasted Nuthatch	*Sitta carolinensis*
Red-breasted Nuthatch	*Sitta canadensdsis*
House Wren	*Troglodytes aedon*
Gray Catbird	*Dumetella carolinensis*
Brown Thrasher	*Toxostoma rufum*
American Robin	*Turdus migratorius*
Mountain Bluebird	*Sialia currucoides*
Starling	*Sturnus vulgaris*
Red-eyed Vireo	*Vireo olivaceus*
Warbling Vireo	*Vireo gilvus*
Black-and-White Warbler	*Mniotilta varia*
Yellow Warbler	*Dendroica petechia*
Yellow-rumped (Audubon's) Warbler	*Dendroica coronata*
Ovenbird	*Seiurus aurocapillus*
Common Yellowthroat	*Geothlypis trichas*
Yellow-breasted Chat	*Icteria virens*
American Redstart	*Setophaga ruticilla*
Black-headed Grosbeak	*Pheucticus melanocephalus*
Lazuli Bunting	*Passerina amoena*
Rufous-sided Towhee	*Pipilo erythropthalamus*
Vesper Sparrow	*Pooecetes gramineus*
Lark Sparrow	*Chondestes grammacus*
Chipping Sparrow	*Spizella passerina*
Field Sparrow	*Spizella pusilla*
Western Meadowlark	*Sturnella neglecta*
Orchard Oriole	*Icterus spurius*
Northern Oriole	*Icterus galbula*
Common Grackle	*Quiscalus quiscula*
Brown-headed Cowbird	*Molothrus ater*
American Goldfinch	*Spinus tristis*

Hopkins, Rick B., J. Frank Cassel, and Ardell J. Bjugstad. 1986. Relationships between breeding birds and vegetation in four woodland types of the Little Missouri National Grasslands. USDA Forest Service Research Paper RM–270, 12 p. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.

Bird species richness was greater in the cottonwood woodland type than in the juniper, pine, and ash woodland types. Total breeding bird densities were greatest in the green ash woodland type. The densities of 25 bird species were significantly different among the four woodland types. The densities of birds in five foraging guilds and four nesting guilds were significantly different among the four woodland types. The influence of vegetation on bird community structure is discussed and suggestions are made for preserving and reestablishing woodlands threatened by the strip-mining of lignite coal.

Keywords: Breeding birds, woodlands, wooded draws, Great Plains

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Rocky Mountains

Southwest

Great Plains

U.S. Department of Agriculture
Forest Service

Rocky Mountain Forest and Range Experiment Station

The Rocky Mountain Station is one of eight regional experiment stations, plus the Forest Products Laboratory and the Washington Office Staff, that make up the Forest Service research organization.

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Research programs at the Rocky Mountain Station are coordinated with area universities and with other institutions. Many studies are conducted on a cooperative basis to accelerate solutions to problems involving range, water, wildlife and fish habitat, human and community development, timber, recreation, protection, and multiresource evaluation.

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