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Non-game Birds in Relation to habitat Variation on South Dakota Wetlands

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NON-GAME BIRDS IN RELATION TO HABITAT VARIATION ON SOUTH DAKOTA WETLANDS

by

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ON SOUTH DAKOTA WETLANDS

This thesis is approved as a creditable and independent investigation by a candidate for the degree, Master of Science, and is acceptable for meeting the thesis requirements for this degree. Acceptance of this thesis does not imply that the conclusions reached by the candidate are necessarily the conclusions of the major department.

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Abstract

MICHAEL J. WEBER

Non-game birds on South Dakota wetlands were surveyed on 476 quarter sections representing the major portion of South Dakota excluding the Missouri River and its impoundments and the Black Hills. Two surveys were conducted, one in May and a second in June, in both 1975 and 1976. The distribution of 13 non-game species was analyzed by physiographic strata and wetland classification: red-winged blackbird (Agelaius phoeniceus), yellow-headed blackbird (Xanthocephalus xanthocephalus), Wilson's phalarope (Steganopus tricolor), black tern (Chlidonias niger), lesser yellowlegs (Totanus flavipes), sora (Porzana carolina), marbled godwit (Limosa fedoa), willet (Catoptrophorus semipalmatus), American avocet (Recurvirostra americana), American bittern (Botaurus lentiginosus), great blue heron (Ardea herodias), black-crowned night heron (Nycticorax nycticorax) and green heron (Butorides virescens).

Glacial pond types received the most use by non-game birds. Red-winged blackbird, yellow-headed blackbird, American bittern and sora had highest frequencies of occurrence on semi-permanent ponds. Lesser yellowlegs, marbled godwit, willet, green heron, and black tern occurred frequently on permanent ponds or lakes; Wilson's phalarope on seasonal ponds; American avocet on ephemeral ponds;

and great blue heron and black-crowned night heron on permanent streams.

A greater variety and abundance of birds generally occurred in the 4 physiographic strata east of the Missouri River. All 13 species occurred in the James River Lowland, and 5 species occurred most frequently in this region: great blue heron, black-crowned night heron, green heron, sora and American avocet. The willet, marbled godwit and Wilson's phalarope occurred most frequently in the Missouri Coteau; red-winged blackbird and lesser yellowlegs in the Southern Plateau Region; black tern and yellow-headed blackbird in the Minnesota River-Red River Lowland and American bittern in the Prairie Coteau.

Multivariate analysis indicated surface water area as the single most common variable explaining the utilization of wetlands by non-game birds. Multiple regression analysis of territorial male red-winged and yellow-headed blackbirds on semi-permanent ponds explained 47 and 57 percent of the variation respectively. Results of discriminant analysis of the presence and absence of the other target species generally explained less than 10 percent of the variation. The best discriminant results were with the American bittern where approximately 13 percent of the variation was explained.

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INTRODUCTION

The objectives of this study were to evaluate the importance of different wetland classes and of associated wetland and upland habitat variables to selected species of wetland non-game birds, and to determine the distribution and relative abundance of these species throughout the major physiographic regions of South Dakota.

Only limited information is available on the behavior and habitat requirements of non-game bird species common to prairie wetlands. Information on habitat relationships, general distribution, and abundance in relation to existing habitat is needed before non-game birds can be included in comprehensive wetland management. Continued existence of prairie wetland birds that could be adversely affected by wetland losses in the prairie pothole region is dependent upon careful management of our remaining natural wetlands and enhancement of man-made wetlands.

The prairie pothole region comprises less than 10 percent of the waterfowl breeding habitat in North America but produces disproportionately large numbers of waterfowl (Smith et al. 1964). Emphasis through federal programs has been preservation of wetlands for waterfowl but non-game species are also dependent on wetland areas. This study is an attempt to provide information useful in management of wetlands for non-game birds.

STUDY AREA

The study was conducted in South Dakota, a northcentral state encompassing 199,552 sq. km.. The Missouri River marks the westward limit of glaciation in South Dakota, divides a western livestock industry from an eastern farming economy (Westin et al. 1967), and provides a natural division of the state into east-river and west-river areas.

Physiography

Eight major physical divisions (strata) (Westin et al. 1967) formed the basis for stratified random sampling of the state (Fig. 1). Wetland densities and composition in these strata were described by Ruwaldt (1975). The east-river region of South Dakota is composed of 2 river valleys and 2 coteaux. The Minnesota River-Red River Lowland is a broad, gently undulating valley with semi-permanent ponds predominant among survey wetlands. The Coteau des Prairies is a highland area between the Minnesota River-Red River Lowland and the James River Lowland to the west; it is drained to the south by the Big Sioux River and is dotted with glacial wetlands of variable permanence. The James River Lowland is a broad lowland plain that spans the state from north to south. Wetlands are comprised primarily of the James River and shallow, natural ponds. The Coteau du Missouri extends from the James River Lowland to the Missouri

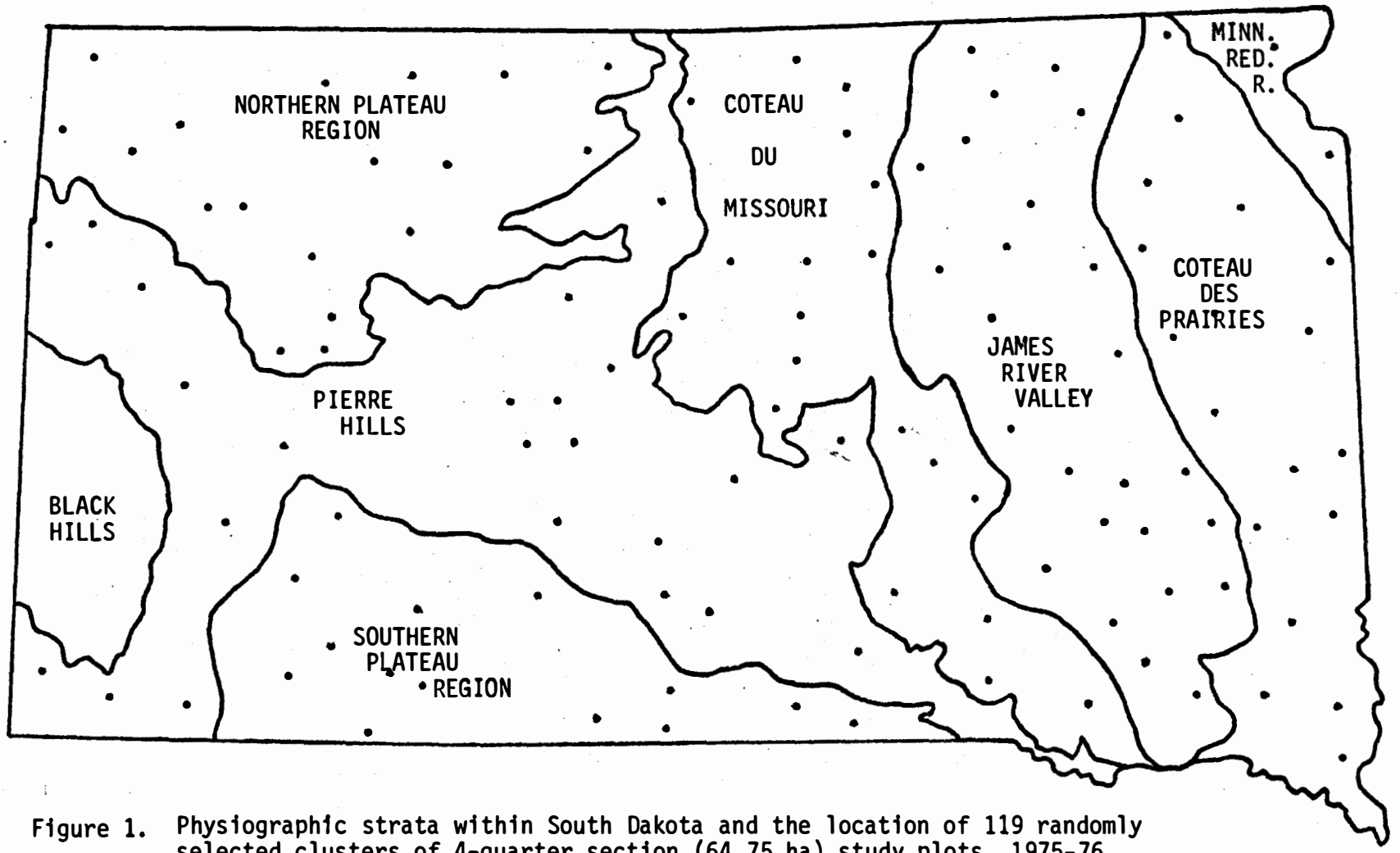

Figure 1. Physiographic strata within South Dakota and the location of 119 randomly selected clusters of 4-quarter section (64.75 ha) study plots, 1975-76.

River. Man-made and glacial wetlands are common among survey wetlands in the Missouri Coteau.

There are 4 major divisions in the unglaciated west-river portion of South Dakota (Fig. 1): The Northern Plateau, an area of plateaux and isolated buttes; the Pierre Hills, a network of rolling hills and ridges lying between the Northern and Southern Plateaux; the Southern Plateau, a series of benches and buttes; and the Black Hills, a mountainous region of rocky terrain and ponderosa pine (Pinus ponderosa) forests. The main wetland types in the western strata are stock ponds (a pond formed by damming a natural drainage, excluding dugouts) and intermittent streams. The White, Cheyenne, Bad, Grand and Moreau rivers, all tributaries of the Missouri River, are part of a well-developed drainage system.

Vegetation

South Dakota lies entirely within the grassland biome (Shelford 1963). Great expanses of nearly treeless prairie were the predominant habitat prior to settlement by the white man. East-river strata were dominated by tall grass and mixed grass prairie while west-river strata were dominated by mixed grass and short grass prairie (Shelford 1963). Most of the major river valleys throughout the state are vegetated with northern flood plain forests (Kuchler 1964); the Black Hills and several buttes in the Southern Plateau and Northern Plateau regions are dominated by ponderosa pine.

Climate

The climate of South Dakota is the cool subhumid or semiarid continental type (Visher 1954). The average annual temperature is approximately 8 C with a mean January temperature of -9 C and a mean July temperature of 22 C. Annual precipitation ranges from 64 cm in the southeast to 33 cm in the northwest (Spuhler et al. 1971). Annual precipitation, however, is highly variable, resulting in alternating wet and dry periods. Approximately 75 percent of the precipitation falls during the growing season which varies from 150 days in the southeast to 120 days in the northwest. Evaporation exceeds precipitation throughout South Dakota and is greatly influenced by the high winds typical of the Great Plains. The prevailing winds are north to northwesterly in winter and south to southeasterly in summer. Average wind speed is 18 km per hour, and humidity is generally low (Spuhler et al. 1971).

METHODS

The opportunity for this investigation was provided by the already existent state-wide waterfowl survey begun in 1973 (Brewster et al. 1976). Study plots and censusing techniques designed for state-wide censusing of waterfowl and waterfowl habitat were expanded to include wetland-associated non-game birds as well.

Sampling Design

Statistical information was obtained from 476 legal quarter sections (64.75 ha) representing 7 physiographic strata in South Dakota. Twenty-four quarter sections located in the Black Hills were eliminated because of the inaccessibility of some of the plots and the presence of few wetlands other than rapidly flowing streams. Study plots were chosen through a combination of stratified random and 2-stage cluster sampling (Steel and Torrie 1960). A detailed description of the sampling scheme and its design was provided by Ruwaldt (1975), Brewster et al. (1976), and McEnroe (1976).

The legal quarter section (64.75 ha) provided a study plot that was easily recognizable in the field by the location of roads, fences or changes in land use. The quarter section was also small enough to enable 2 observers to cover all wetlands on the area in a relatively short period of time.

Census Methods

Three 2-man teams, equipped with binoculars and waders, conducted the avian surveys. Large, open-water wetlands were surveyed with the aid of spotting scopes, and the shoreline was walked to flush birds on or near shore. On wetlands with emergent vegetation, territorial red-winged and yellow-headed blackbirds were counted from a vantage point before censusing the wetland by walking and wading. Counts were made from one-half hour after sunrise until one-half hour before sunset.

Observations of non-game species were recorded as the total number of individuals of each species seen on each wetland visited. Only male red-winged and yellow-headed blackbirds apparently holding a territory were counted because of the inconspicuousness of the females.

Data on non-game species were recorded during the counts of early and late nesting waterfowl. The early censuses were conducted from 12-24 May 1975, and from 10-23 May 1976. Late censuses were from 10-21 June 1975, and from 7-12 June 1976.

Natural wetlands were classified in accordance with the method of Stewart and Kantrud (1971). Fluviatile wetlands were classified as intermittent or permanent streams. Man-made wetlands were categorized as stock ponds, dugouts, ditches and gravel pits. Wetlands with tilled soil bottoms or wetlands in pastures and without aquatic vegetation were classified as tillage ponds and pasture ponds respectively. The type of cover was classified from 1 to 4

representing closed stands of emergents with open water covering less than 5 percent of the wetland area, open water covering 5 to 95 percent of the wetland area with scattered dense patches or diffuse open stands of emergent cover, central expanses of open water comprising more than 5 percent of the wetland area and surrounded by peripheral bands of emergent cover averaging 1.8 meters or more in width, open water covering more than 95 percent of the wetland area, respectively (Steward and Kantrud 1971:10). The percentage of the basin with surface water and height of emergent vegetation were estimated for each wetland. Grazing pressure on the adjacent uplands was rated as none, light, moderate or heavy (0 to 3), and the percentage of each wetland shoreline exposed to grazing was also recorded. Average wetland depth was rated from 1 to 4 on the basis of 0 to 3 dm, 3 to 6 dm, 6 to 10 dm, and greater than 10 dm average depth, respectively. Basin area and shoreline distances were measured from aerial photographs of the study plots using a compensating polar planimeter and map measure, respectively. Aerial photographs were obtained from the South Dakota Agricultural Stabilization and Conservation Service and were enlarged to 1:3960 (1 cm = 39.6 m) to aid in location of study plots and identification of wetland basins. Upland cover and land use were mapped once each summer, and an index to habitat interspersion was determined by the number of habitat changes intersected by a diagonal line drawn across the cover map of each study plot from the northwest corner to the southeast corner.

Selected Species

Thirty-five non-game bird species associated with South Dakota wetlands were recorded during the study (Table 1). Detailed records of presence and numbers of individual birds seen were not kept for all of these species because many of the species were infrequently observed, were not generally considered wetland birds, or could not be accurately censused using the method adopted. Analysis was concentrated on the 13 species indicated in Table 1.

Analysis of Data

Census data were tabulated to analyze the distribution of birds by physiographic strata and the occurrence of individual species and numbers of species by wetland types. Further analysis of wetland and upland habitat variables was attempted using stepwise forward multiple regression analysis (Snedecor and Cochran 1967) and stepwise forward discriminant analysis (Cooley and Lohnes 1971).

Table 1. Non-game bird species recorded in association with wetlands during May and June surveys in South Dakota, 1975-76.

Common name	Scientific name[a]
Belted kingfisher	Megaceryle alcyon
American bittern[b]	Botaurus lentiginosus
Least bittern	Ixobrychus exilis
Green heron[b]	Butorides virescens
Great blue heron[b]	Ardea herodias
Black-crowned night heron[b]	Nycticorax nycticorax
Yellow-crowned night heron	Nyctanassa violacea
Little blue heron	Florida caerulea
Common egret	Casmerodius albus
Eared grebe	Podiceps caspicus
Horned grebe	Podiceps auritus
Pied-billed grebe	Podilymbus podiceps
Western grebe	Aechmophorus occidentalis
Red-winged blackbird[b]	Agelaius phoeniceus
Yellow-headed blackbird[b]	Xanthocephalus xanthocephalus
Common grackel	Quiscalus quiscula
Franklin's gull	Larus pipixcan
Yellowthroat	Geothlypis trichas
White pelican	Pelecanus erythrorhynchos
Double-crested cormorant	Phalacrocorax auritus
Wilson's phalarope[b]	Steganopus tricolor

Table 1. Continued.

Common name	Scientific name[a]
Sora[b]	Porzana carolina
American avocet[b]	Recurvirostra americana
Marbled godwit[b]	Limosa fedoa
Willet[b]	Catoptrophorus semipalmatus
Lesser yellowlegs[b]	Totanus flavipes
Greater yellowlegs	Totanus melanoleucus
Killdeer	Charadrius vociferus
Long-billed dowitcher	Limnodromus scolopaceus
Semipalmated plover	Charadrius semipalmatus
Spotted sandpiper	Actitus macularia
Pectoral sandpiper	Erolia melanotos
Forster's tern	Sterna forsteri
Black tern[b]	Chlidonias niger
Long-billed marsh wren	Telmatodytes palustris

[a]Scientific names according to The A.O.U. Checklist of North American Birds, 1957.

[b]Species selected for census and further analysis.

RESULTS AND DISCUSSION

Stock ponds and dugouts were the predominant man-made wetland types surveyed and the most prominent wetlands overall in the survey (Table 2). Man-made wetlands represented 47 percent of the wetlands (excluding dry basins) surveyed and 25 percent of the total surface water area. Glacial ponds and fluviatile wetlands constituted the principle natural wetlands and represented 49 percent of the wetlands surveyed and 67 percent of the total surface water area. The number of wetland areas and diversity of wetlands were highest in the east-river strata where glacial pond types were the most common wetlands surveyed. The Prairie Coteau had the most survey wetlands overall and the greatest number of glacial ponds. Wetlands in the west-river strata were predominantly man-made stock ponds.

Species Occurrence by Strata

The 13 selected species were observed more often on wetlands in the east-river strata than on wetlands in the west-river strata (Table 3). The more frequent occurrence in the east-river strata is probably due to the presence of glacial ponds and lakes. Eleven of the 13 species occurred most frequently on 1 of the glacial pond categories (Table 4). Red-winged and yellow-headed blackbirds were the only species recorded in all 7 strata surveyed (Table 3). Six species were recorded in all but 1 of the 7 strata: Wilson's phalarope, black tern, lesser yellowlegs, great blue heron, sora and

Table 2. Numbers of wet basins surveyed of each wetland class in each stratum during May and June surveys of wetland non-game birds in South Dakota, 1975-76.

Wetland class	Strata							
	James River Lowland	Coteau des Prairies	Coteau du Missouri	Northern Plateau Region	Southern Plateau Region	Pierre Hills	Minnesota River-Red River Lowland	Total
Dugouts	212	93	103	10	8	16	10	452(0.08)[a]
Intermittent Streams	27	38	19	165	26	58	1	334(0.25)
Temporary ponds[b]	11	23	20	12		4	3	73(0.26)
Seasonal ponds[b]	39	84	134	6	2		1	266(0.49)
Stock ponds	7	8	38	96	49	180		378(0.72)
Tillage and pasture ponds	30	13	15	11	8		14	91(0.67)
Semi-permanent ponds[b]	39	149	41		7		20	256(1.65)
Permanent streams	34	12		21	20	4		91(0.57)
Ephemeral ponds[b]	3	7	6	4				20(0.61)
Permanent ponds or lakes[b]	4	8	4					16(7.75)
Other wetlands	70	55	19	27	5	6		182(0.21)
Total	476	490	399	352	118	275	49	2159(0.58)

[a]Average surface water area in hectares is included in parenthesis.

[b]Glacial pond types are according to the classification system in Classification of Natural Ponds and Lakes in the Glaciated Prairie Region by Stewart and Kantrud, 1971.

American bittern. The green heron had the most limited distribution in the state and was encountered on survey wetlands only in the Prairie Coteau and the James River Lowland.

All 13 species were found on survey wetlands in the James River Lowland (Table 3). The green heron, great blue heron, black-crowned night heron, American avocet and sora were most frequently encountered and were at their highest average densities on wetlands in this region (Table 3, 5). The green heron, great blue heron and black-crowned night heron utilized permanent streams (Table 4). Thirty-seven percent of the study plots with permanent stream habitat were in the James River Lowland (Table 2).

The American avocet had a high frequency and a high density of occurrence in the James River Lowland. Avocets frequently utilized tillage and pasture ponds (Table 4); 33 percent of the tillage and pasture ponds surveyed occurred in the James River Lowland. This statistic may offer a possible explanation for high frequency and density of avocets in the James River Lowland.

Wetlands in the Missouri Coteau had the highest frequencies of occurrence and average densities for marbled godwits and willets (Table 3, 5). The Wilson's phalarope was most frequently recorded on wetlands in the Missouri Coteau (Table 3), but had a higher average density on wetlands in the Northern Plateau Region (Table 5). Lesser yellowlegs and soras had comparatively high frequencies and average densities on Missouri Coteau wetlands, probably reflecting preferences for glacial pond types (Table 3). The green heron was

Table 3. Frequency of occurrence by strata (as the percent of the total number of wet basins surveyed in each stratum) of 13 species of non-game birds recorded during May and June surveys of wetland birds in South Dakota, 1975-76. The number of wet basins in each stratum is included in parenthesis below the stratum name.

Species	James River Lowland (476)	Coteau du Missouri (399)	Coteau des Prairies (490)	Pierre Hills (275)	Northern Plateau Region (352)	Southern Plateau Region (118)	Minnesota River-Red River Lowland (49)	Total (2159)
Red-winged blackbird	34.0(162)[a]	42.0(168)	42.8(210)	37.1(102)	47.9(169)	51.7(61)	36.7(18)	41.2(890)
Yellow-headed blackbird	4.6(22)	7.3(20)	14.5(71)	2.5(7)	1.7(6)	11.0(13)	16.3(8)	7.2(156)
Wilson's phalarope	4.2(20)	9.5(38)	1.6(8)	5.1(14)	5.9(21)	5.1(6)		5.0(107)
Black tern	0.8(4)	3.8(15)	1.6(8)		0.8(3)	0.8(1)	6.1(3)	1.6(34)
Lesser yellowlegs	1.9(9)	2.5(10)	0.8(4)	0.7(2)	0.3(1)	3.4(4)		1.4(30)
Great blue heron	2.7(13)	1.0(4)	0.2(1)	0.4(1)	0.8(3)	0.8(1)		1.1(23)
Sora	2.5(12)	2.0(8)	2.0(10)	1.1(3)	0.8(3)		2.0(1)	1.7(37)
American bittern	1.3(6)	1.0(4)	2.9(14)	0.4(1)	0.3(1)		2.0(1)	1.3(27)
Willet	0.8(4)	8.3(33)	1.2(6)	0.4(1)	0.3(1)			2.1(45)
American avocet	1.7(8)	1.3(5)		0.4(1)	0.6(2)			0.7(16)
Black-crowned night heron	1.0(5)	0.5(2)	0.4(2)	0.4(1)				0.5(10)
Marbled godwit	2.9(14)	5.3(21)		0.4(1)				1.7(36)
Green heron	1.5(7)		0.2(1)					0.4(8)

[a]The number of wetlands each species occurred on within each stratum is included in parenthesis following the frequency of occurrence for each stratum.

Table 4. Frequency of occurrence by wetland classification (as the percent of the total number of wet basins surveyed in each wetland classification) of 13 species of non-game birds recorded during May and June surveys of wetland birds in South Dakota, 1975-76. The numbers in parenthesis below each wetland class designation represent the total number of wet basins for the 4 surveys.

	Wetland Class											
Species	Semi-permanent ponds[a] (256)	Stock ponds[b] (378)	Intermittent streams (334)	Seasonal ponds[a] (266)	Dugouts (452)	Permanent streams (91)	Permanent ponds or lakes[a] (16)	Temporary ponds[a] (73)	Tillage and pasture ponds (91)	Ephemeral ponds[a] (20)	Other wetlands[c] (182)	Total (2159)
Red-winged blackbird	74.2(190)[d]	38.9(147)	59.3(198)	51.9(138)	19.9(90)	52.7(48)	25.0(4)	37.0(27)	6.6(6)		23.1(42)	41.2(890)
Yellow-headed blackbird	37.5(96)	5.6(21)	2.4(8)	6.8(18)	0.7(3)		12.5(2)	2.7(2)	1.1(1)		2.7(5)	7.2(156)
Wilson's phalarope	7.4(19)	8.7(33)	3.0(10)	9.8(26)	1.8(8)		6.3(1)	8.2(6)	2.2(2)	5.0(1)	0.6(1)	5.0(107)
Lesser yellowlegs	1.6(4)	2.1(8)	0.9(3)	1.9(5)	0.9(4)	2.2(2)	6.3(1)	2.7(2)			0.6(1)	1.4(30)
Marbled godwit	2.3(6)	2.4(9)	1.5(5)	1.5(4)	1.5(7)		6.3(1)	4.1(3)	1.1(1)			1.7(36)
Willet	4.7(12)	2.6(10)	1.2(4)	3.4(9)	1.1(5)		6.3(1)	4.1(3)		5.0(1)		2.1(45)
Sora	5.5(14)	0.8(3)	2.1(7)	3.4(9)	0.2(1)	2.2(2)					0.6(1)	1.7(37)
American bittern	6.3(16)	0.5(2)	1.2(4)	0.8(2)	0.2(1)	1.1(1)					0.6(1)	1.3(27)
American avocet		0.8(3)	0.3(1)	0.4(1)	0.2(1)	1.1(1)		1.4(1)	6.6(6)	10.0(2)		0.7(16)
Black tern	6.3(16)	3.2(12)		1.1(3)	0.2(1)		12.5(2)					1.6(34)
Great blue heron	1.2(3)	2.1(8)	0.3(1)			12.1(11)						1.1(23)
Black-crowned night heron	1.2(3)	0.8(3)		0.4(1)		3.3(3)						0.5(10)
Green heron	0.4(1)		0.3(1)			5.5(5)	6.3(1)					0.4(8)

[a]Definition of glacial pond types according to Classification of Natural Ponds and Lakes in the Glaciated Prairie Region by Stewart and Kantrud, 1971.

[b]A stock pond is a pond formed by damming a natural drainage.

[c]Other wetlands include drainage and road ditches, oxbows and gravel pits.

[d]The number of wetlands each species occurred on within each wetland classification is included in parenthesis following the frequency of occurrence for each wetland classification.

Table 5. Average density (birds per hectare of surface water) by strata for 13 species of non-game birds recorded during May and June surveys of wetland birds in South Dakota, 1975-76. The number in parenthesis below each stratum name respresents the total surface water hectares surveyed in each stratum.

Species	James River Lowland (226)	Coteau du Missouri (226)	Coteau des Prairies (458)	Pierre Hills (118)	Northern Plateau Region (120)	Southern Plateau Region (62)	Minnesota River-Red River Lowland (43)	Total (1252)
Red-winged blackbird	2.98(672)[a]	2.30(520)	1.87(855)	2.06(244)	4.84(580)	2.09(129)	1.43(61)	2.45(3061)
Yellow-headed blackbird	0.47(105)	1.10(249)	1.72(789)	0.11(13)	0.11(13)	0.95(59)	2.00(85)	1.05(1313)
Wilson's phalarope	0.44(99)	0.48(109)	0.06(28)	0.72(85)	0.99(118)	0.53(33)		0.38(472)
Black tern	0.08(17)	0.19(42)	0.04(19)		0.17(20)	0.10(6)	0.28(12)	0.09(116)
Lesser yellowlegs	0.17(39)	0.12(28)	0.02(11)	0.02(2)	0.02(2)	0.11(7)		0.07(84)
Great blue heron	0.21(48)	0.05(12)	0.002(1)	0.01(1)	0.03(3)	0.02(1)		0.05(66)
Sora	0.10(22)	0.08(18)	0.03(13)	0.03(3)	0.03(4)		0.05(2)	0.05(62)
American bittern	0.04(9)	0.04(9)	0.09(40)	0.01(1)	0.01(1)		0.02(1)	0.05(61)
Willet	0.03(7)	0.23(52)	0.02(8)	0.01(1)	0.01(1)			0.06(69)
American avocet	0.08(18)	0.02(4)		0.03(3)	0.03(4)			0.02(29)
Black-crowned night heron	0.02(5)	0.01(3)	0.01(3)	0.01(1)				0.01(12)
Marbled godwit	0.14(31)	0.23(51)		0.03(3)				0.07(85)
Green heron	0.04(8)		0.002(1)					0.01(9)

[a]The total number of birds recorded for each species in each stratum is included in parenthesis following the average density for the stratum.

the only species not recorded on study wetlands in the Missouri Coteau; however, the total number of green herons observed in the state was low in relation to other birds.

The American bittern had the highest frequency of occurrence (Table 3) and highest average density (Table 5) on wetlands in the Prairie Coteau. The American bittern utilized semi-permanent wetlands (Table 4), a type that was abundant in the Prairie Coteau (Table 2). Sixty percent of the wetlands where bitterns were observed were classified as semi-permanent, and approximately 42 percent of the semi-permanent wetlands state-wide occur in the Coteau des Prairies (Ruwaldt 1975). The greatest numbers of red-winged and yellow-headed blackbirds were observed in the Prairie Coteau, but frequencies of occurrence and average densities for these species were higher in other strata. Semi-permanent wetlands provided habitat that was frequently utilized by the blackbird species. Red-winged blackbirds were present on 74 percent of the semi-permanent wetlands surveyed, while yellow-headed blackbirds were present on 37.5 percent (Table 5). Wilson's phalarope had a low frequency of occurrence and a low average density on wetlands surveyed in the Prairie Coteau. Seasonal ponds and stock ponds were frequently used by phalaropes (Table 4), but these ponds types occurred in low numbers among survey wetlands in this region (Table 2). The low number of seasonal and stock ponds and the low frequency of occurrence and low average density of phalaropes may be related.

The American avocet and marbled godwit were not observed on study plots in the Prairie Coteau, but were observed in the stratum.

The Minnesota River-Red River Lowland had the highest frequency of occurrence and average density for yellow-headed blackbirds and black terns. Both species had high frequencies of occurrence on semi-permanent ponds, and 41 percent of the wetlands surveyed in this stratum were semi-permanent ponds. The variety of wetland types surveyed was low in this region and may explain the low number of species recorded.

The Southern Plateau Region had the highest frequency of occurrence for red-winged blackbirds and lesser yellowlegs and was probably related to the few wetlands surveyed (Table 2) and the ubiquitous distribution of these species (Table 3). The red-winged blackbird had a higher average density in the Northern Plateau Region, while the lesser yellowlegs had a higher average density in the James River Lowland.

Species Occurrence by Wetland Types

The census data indicate a general association of the selected non-game species with South Dakota wetlands. The highest frequency of occurrence for each of the 13 species was recorded on 1 of the natural wetland types (Table 4). The red-winged blackbird, yellow-headed blackbird, sora and American bittern were most frequently observed on semi-permanent ponds (Table 4); lesser yellowlegs, marbled godwit, willet, black tern and green heron on

permanent ponds; Wilson's phalarope on seasonal ponds; American avocet on ephemeral ponds; and the great blue heron and black-crowned night heron on permanent streams.

The wetland type with the highest frequency of occurrence for each species was not always the wetland where that species also had the highest average density. This may indicate the influence of wetland size (Table 2) on species utilization. The yellow-headed blackbird and American bittern had the highest average density on semi-permanent ponds; lesser yellowlegs and willets on temporary ponds; green heron, great blue heron and black-crowned night heron on permanent streams; red-winged blackbird and sora on intermittent streams; Wilson's phalarope and marbled godwit on dugouts; black tern on stock ponds and American avocet on tillage and pasture ponds (Table 6).

Numbers of Species by Wetland Types

Natural ponds and lakes in general and seasonal and semi-permanent ponds in particular were utilized more by the 13 target species than were other wetland types. One or more of the target species were recorded on 66.3 percent and 2 or more species on 32.4 percent of the seasonal and semi-permanent ponds surveyed (Table 7). Stock ponds had a broader range of species recorded, but only 47.4 percent of the stock ponds surveyed had 1 or more of the target species present and 18.3 percent had 2 or more species present. Fluviatile wetlands had up to 5 of the target species on

Table 6. Average density (birds per hectare of surface water) by wetland classifications for 13 species of non-game birds recorded during May and June surveys of wetland birds in South Dakota, 1975-76. The numbers in parenthesis below each wetland class designation represent the total surface water hectares surveyed.

Species	Wetland Class											
	IV. Semi-permanent ponds[a] (423)	Stock ponds[b] (274)	Intermittent streams (82)	III Seasonal ponds (131)	Dugouts (34)	Permanent streams (52)	V Permanent ponds or lakes (124)	II Temporary ponds (19)	VI Tillage and pasture ponds (61)	I Ephemeral ponds (12)	Other wetlands[c] (40)	Total (1252)
Red-winged blackbird	2.08(879)[d]	1.56(426)	8.79(721)	3.26(428)	4.60(157)	4.66(241)	0.20(25)	1.93(37)	0.25(15)		3.31(132)	2.45(3061)
Yellow-headed blackbird	2.43(1026)	0.65(179)	0.24(20)	0.40(53)			0.02(3)	0.47(9)	0.02(1)		0.55(22)	1.05(1313)
Wilson's phalarope	0.16(68)	0.67(182)	0.32(26)	0.89(117)	1.14(48)		0.01(1)	0.83(16)	0.21(13)		0.03(1)	0.38(472)
Lesser yellowlegs	0.07(30)	0.05(14)	0.09(7)	0.06(8)	0.15(5)	0.10(5)	0.01(1)	0.68(13)			0.03(1)	0.07(84)
Marbled godwit	0.05(21)	0.08(23)	0.15(12)	0.09(12)	0.26(9)		0.02(3)	0.21(4)	0.02(1)			0.07(85)
Willet	0.06(24)	0.05(15)	0.05(4)	0.09(12)	0.15(5)		0.01(1)	0.26(5)	0.03(2)	0.08(1)		0.06(69)
Sora	0.05(23)	0.01(3)	0.21(17)	0.10(13)	0.06(2)	0.04(2)					0.05(2)	0.05(62)
American bittern	0.10(43)	0.03(6)	0.05(4)	0.02(2)	0.06(2)	0.02(1)					0.03(1)	0.05(61)
American avocet		0.02(5)	0.01(1)			0.02(1)		0.05(1)	0.31(19)	0.17(2)		0.02(29)
Black tern	0.11(45)	0.20(56)		0.03(4)	0.03(1)		0.08(10)					0.09(116)
Great blue heron	0.01(5)	0.06(16)	0.01(1)			0.83(43)						0.05(66)
Black-crowned night heron	0.01(4)	0.01(4)		0.01(1)		0.06(3)						0.01(12)
Green heron	0.00(1)		0.01(1)			0.12(6)	0.01(1)					0.01(9)

[a]Definition of glacial pond types according to Classification of Natural Ponds and Lakes in the Glaciated Prairie Region by Stewart and Kantrud, 1971.

[b]A stock pond is a pond formed by damming a natural drainage.

[c]Other wetlands include drainage and road ditches, oxbows and gravel pits.

[d]The total number of birds recorded for each species on the wetland classification indicated is included in parenthesis following the average density for each wetland classification.

Table 7. Numbers of species recorded in relation to wetland categories for May and June surveys of wetland non-game birds in South Dakota, 1975-76. The numbers in parenthesis below each wetland class designation represent the total number of wet basins surveyed.

Number of species recorded	Wetland Categories								
	Stock ponds (378)	Seasonal and semi-permanent ponds (522)	Fluviatile wetlands (425)	Permanent ponds or lakes (16)	Ephemeral and temporary ponds (93)	Dugouts (452)	Tillage and pasture ponds (91)	Other wetlands (182)	Total (2159)
1	29.1[a]	33.9	49.4	18.8	25.8	23.2	13.2	24.2	31.7
2	12.7	19.2	7.8	6.3	8.6	2.2	2.2	2.7	9.8
3	2.6	8.6	2.1	18.8	5.4	0.4			3.5
4	1.1	3.8	0.7					0.5	1.3
5	0.8	0.8	0.5						0.4
6	0.8			6.3					0.2
7									
8									
9									
10	0.3								0.05
Total	47.4	66.3	60.5	50.0	39.8	25.9	15.4	27.4	46.6

[a]The percentage of the total number of wet basins.

a single wetland; 60.5 percent of the fluviatile wetlands surveyed had 1 or more species present, and 11.1 percent had 2 or more species present (Table 7).

The use of seasonal and semi-permanent ponds could be attributable to an apparently greater habitat diversity on these wetland types. Seasonal and semi-permanent ponds had an average surface water area greater than either man-made or fluviatile wetlands (Table 2). This difference in wetland size, combined with characteristic water conditions conducive to presence of emergent vegetation, enables seasonal and semi-permanent ponds to support a variety of vegetative life forms and interspersion of open water with vegetation. Weller and Spatcher (1965) and Weller and Fredrickson (1973) found the greatest density and diversity of marsh birds associated with an interspersion of half emergent vegetation and half open water on marshes in northern Iowa. These characteristics--variety of vegetative life forms and a balance of vegetation to open water, both of which accentuate the edge effect--were best exemplified by seasonal and semi-permanent ponds.

The importance of edge has been expressed by Allen (1934) and Glahn (1974) for the sora, Cuthbert (1954) for the black tern, Orians (1961) and Case and Hewitt (1963) for the red-winged blackbird and Willson (1966) for the yellow-headed blackbird. The amount of edge can influence both the number of bird territories established on a marsh and the diversity and abundance of aquatic invertebrates (Krecher 1939, Griffith 1948, Krull 1970, Voights 1973, Whitman 1976).

High invertebrate populations are also a product of the periodic drying and flooding characteristics of glacial ponds (Kadlec 1962, Krull 1969).

Stock ponds and dugouts were generally deeper than natural wetlands, thus discouraging emergent vegetation and resulting in minimal habitat variation on a single wetland. Stock ponds with extensive shallow water areas supported emergent vegetation and appeared close to or equal to the habitat diversity of natural wetlands. The design of dugouts and intensive use by cattle precluded emergent vegetation from developing.

Intermittent and permanent streams supported a more diverse habitat when compared to man-made wetlands in general, but appeared to be utilized less by the target species (Table 4). Infrequent use of fluviatile wetlands by most target species may have been influenced by the smaller average wetland size and potentially rapid and dramatic water level changes.

Tillage and pasture ponds were characteristically small in size with little or no emergent vegetation and were infrequently used by most of the target species (Table 7).

Multiple Regression Analysis

Red-winged and yellow-headed blackbirds were the most common non-game wetland birds encountered. Both species occurred most frequently on semi-permanent ponds (Table 4). Because of the apparent importance of semi-permanent ponds to the blackbird species,

multiple regression analysis was used to examine possible habitat relationships. The variation in numbers of blackbirds observed on semi-permanent ponds enabled the use of stepwise forward multiple regression analysis (Snedecor and Cochran 1975). The number of territorial males was used as the dependent variable, and the independent variables included the characteristics of each wetland and surrounding quarter section plot (Table 8).

Red-winged blackbird.--Multiple regression analysis of red-winged blackbirds on semi-permanent wetlands yielded an R^2 value of 0.474 ($P<0.05$) suggesting that approximately 47 percent of the variation in numbers of red-winged blackbirds observed on semi-permanent ponds was explainable by the variables measured. Three variables were indicated as significant ($P<0.05$): hectares of surface water, hectares of treeland and percentage of open water (Table 9).

Hectares of surface water was positively correlated with and accounted for most of the variation between numbers of territorial males observed. Wetlands with larger surface water area probably had more habitat suitable for red-winged blackbirds. The variable hectares of treeland was also positively correlated with numbers of territorial males observed. Use of trees by red-winged blackbirds has been noted by Sherman (1932), Nero (1950), Beer and Tibbitts (1950), and Wiens (1965). Wiens (1965) found trees to be important to the birds for insect foraging. Negative correlation with percentage of open water reflects greater use of wetlands with large stands of

Table 8. Independent variables used in multiple regression and discriminant analysis of non-game birds on South Dakota wetlands during May and June surveys, 1975-76.

1	Hectares of surface water
2	Open water (Percentage of surface water without emergent vegetation)
3	Cover type[a] (Classification of the vegetative pattern, used as a dummy variable)
4	Depth rating (Rated 1 to 4 on the basis of 0.3 dm, 3-6 dm, 6-10 dm, >10 dm)
5	Percentage of shoreline grazed
6	Grazing intensity (Intensity of grazing on the shoreline and the immediate upland, rated from 0 to 3)
7	Shoreline distance in meters
8	Average vegetation height in centimeters
9	Wetland type[a] (Used as a dummy variable)
10	Number of ponds surveyed on each study plot
11	Hectares of cultivated land on plot
12	Hectares of alfalfa or hayland on plot
13	Hectares of pasture on plot
14	Hectares of idle grassland on plot
15	Hectares of treeland on plot
16	Hectares of idle cultivated land on plot
17	Habitat interspersion index[b]

[a]Follows classification system in Classification of Natural Ponds and Lakes in the Glaciated Prairie Region by Stewart and Kantrud, 1971.

[b]Determined by the number of habitat changes, intersected by a diagonal line drawn across the cover map of each study plot from the northwest corner to the southeast corner.

Table 9. Stepwise forward multiple regression analyses of red-winged and yellow-headed blackbirds on semi-permanent ponds. Only semi-permanent ponds where each species occurred were included in the analyses.

Dependent variable and sample size	Independent variables[a]	Standardized partial regression coefficients (P<0.05)	Coefficient of determination (R^2)	Change in R^2	Simple correlation coefficient (r)
Red-winged blackbird (181)	Hectares of surface water	+ 0.4560	0.4450	0.4450	+ 0.6671
	Hectares of treeland	+ 0.1397	0.4606	0.0157	+ 0.1739
	Percent open water	- 0.1609	0.4743	0.0137	- 0.1151
Yellow-headed blackbird (92)	Hectares of surface water	+ 0.7008	0.5140	0.5140	+ 0.7169
	Cover type 2[b]	+ 0.3355	0.5615	0.0475	+ 0.2222

[a]Variables listed in order of their ability to explain variance in the dependent variable.
[b]Classification of vegetative pattern according to Stewart and Kantrud (1971).

emergent vegetation as preferred nesting sites. Shoreline distance had a relatively high simple correlation value, but did not enter in the equation, possibly because of a high correlation with hectares of surface water.

Yellow-headed blackbird.--Multiple regression analysis of yellow-headed blackbirds on semi-permanent ponds explained 56 percent of the variation in territorial males ($P<0.05$). Hectares of surface water and cover-type 2 were indicated as significant ($P<0.05$) and were positively correlated with numbers of territorial male yellow-headed blackbirds (Table 9). Hectares of surface water accounted for most of the variance in numbers of territorial males observed. The significance of cover-type 2 indicated a preference for wetlands with open water covering 5 to 95 percent of the wetland area, with scattered dense patches or diffuse open stands of emergent cover present. Other studies have indicated similar preference for emergent vegetation interspersed with open water (Ammann 1938, Weller and Spatcher 1965, Willson 1966). Shoreline distance had a relatively high simple correlation coefficient but was not entered into the equation.

Discriminant Analysis

The target species other than red-winged and yellow-headed blackbirds varied little in numbers of individuals observed between wetlands. Stepwise forward discriminant analysis (Cooley and Lohnes 1971) using the variables listed in Table 8 was applied to identify

important habitat variables influencing the presence or absence of each species on wetlands. A low degree of separation resulted between the 2 groups for most species as indicated by the final values of Wilk's lambda and canonical correlation (Klecka 1975) (Table 10). However, the only non-significant ($P<0.05$) discriminant function resulted with the lesser yellowlegs. The most important discriminating variables, chosen on the basis of change in Rao's V which indicates the significance of each variable as it is included in the analysis (Klecka 1975), are discussed for each species. All of the discriminant functions based on the most important variables were significant ($P<0.01$).

American bittern.--The variables that provided the best discrimination between wetlands where American bitterns were present and where absent in order of decreasing importance were hectares of surface water, cover-type 3, hectares of idle grassland, vegetation height and semi-permanent pond (Table 11). The standardized discriminant function values indicated hectares of surface water was 3 times as important as the second most important variable, cover-type 3 (Table 11). The 5 most important variables were directly related to the presence of the American bittern as evidenced by the indirect or negative discriminant function signs on the variables, along with the negative sign on the group centroid corresponding to ponds with bitterns present. Together those 5 variables correctly classified 33.3 percent of the wetlands where American bitterns were present.

Table 10. Stepwise forward discriminant analyses for 11 non-game species. Discrimination is between presence and absence of each species on wetlands surveyed during May and June surveys of wetland non-game birds in South Dakota, 1975-76.

Species	Canonical correlation[a]	Wilk's lambda[b]	Level of significance	Number of cases[c]	Percent of cases correctly classified
American bittern	0.347	0.8796	P<0.01	27	33.3
Great blue heron	0.273	0.9255	P<0.01	23	39.1
Black tern	0.258	0.9335	P<0.01	34	23.5
Wilson's phalarope	0.230	0.9473	P<0.01	107	2.8
Black-crowned night heron	0.214	0.9541	P<0.01	10	50.0
Green heron	0.211	0.9556	P<0.01	8	37.5
American avocet	0.205	0.9581	P<0.01	16	31.3
Sora	0.191	0.9637	P<0.01	37	5.4
Willet	0.165	0.9727	P<0.01	45	4.4
Marbled godwit	0.137	0.9813	P<0.05	36	2.8
Lesser yellowlegs	0.121	0.9853	P>0.05	30	3.3

[a]The cannonical correlation squared is the proportion of variance in the discriminant function explained by the groups (Klecka 1975).

[b]Wilk's lambda is an inverse measure of the discriminating power in the variables.

[c]The total possible cases is 2159 which is the total number of wetlands surveyed during the 2 years of study.

Table 11. Major independent variables discriminating between wetlands with a species present and wetlands with the species absent as indicated by stepwise forward discriminant analysis.

Group	Number of cases	Percent of total observations	Percent of observations correctly classified	Group centroid[a]	Major discriminating variables[b]	Standardized discriminant functions
American bittern						
Present	27	1.3	33.3	- 2.8518	surface water area	- 0.7817
Absent	2132	98.7	98.3	+ 0.0361	cover-type 2	- 0.2460
Total	2159		97.5		idle grassland	- 0.2057
					vegetation height	- 0.1529
					semi-permanent pond	- 0.1505
Great blue heron						
Present	23	1.0	47.8	- 2.5341	permanent stream	- 0.4374
Absent	2136	99.0	97.5	+ 0.0273	cover-type 3	- 0.3904
Total	2159		96.9		surface water area	- 0.3447
					hectares of trees	- 0.2992
					shoreline distance	- 0.2582
Black tern						
Present	34	1.6	23.5	- 1.8871	surface water area	- 0.6886
Absent	2125	98.4	98.1	+ 0.0302	semi-permanent pond	- 0.4226
Total	2159		96.9		cover-type 3	- 0.3290

Table 11. (Continued)

Group	Number of cases	Percent of total observations	Percent of observations correctly classified	Group centroid[a]	Major discriminating variables[b]	Standardized discriminant functions
Wilson's pharlarope						
Present	107	5.0	4.7	+ 0.9620	vegetation height	- 0.4731
Absent	2052	95.0	99.6	- 0.0502	seasonal pond	+ 0.4649
Total	2159		94.9		cover-type 4	- 0.4525
					stock pond	+ 0.4126
					semi-permanent pond	+ 0.4027
					number of ponds on plot	- 0.3747
					hectares of alfalfa/hayland	+ 0.3467
					surface water area	+ 0.3454
					percent open water	- 0.3008
					intermittent stream	+ 0.2887
					percent of shoreline grazed	+ 0.1940
Black-crowned night heron						
Present	10	0.5	50.0	- 2.8071	surface water area	- 0.6151
Absent	2149	99.5	98.3	+ 0.0131	cover-type 3	- 0.5288
Total	2159		98.1		hectares under cultivation	- 0.3027
					shoreline distance	- 0.2872
					permanent pond	+ 0.2679

Table 11. (Continued)

Group	Number of cases	Percent of total observations	Percent of observations correctly classified	Group centroid[a]	Major discriminating variables[b]	Standardized discriminant functions
Green heron						
Present	8	0.4	50.0	- 3.8897	permanent stream	- 0.5884
Absent	2151	99.6	96.6	+ 0.0132	permanent pond	- 0.3785
Total	2159		96.4		hectares of trees	- 0.3261
					shoreline distance	- 0.2649
American avocet						
Present	16	0.7	37.5	- 2.1085	tillage and pasture pond	- 0.6632
Absent	2143	99.3	97.6	+ 0.0157	ephemeral pond	- 0.5984
Total	2159		97.1		hectares of alfalfa/hayland	- 0.4522
					grazing intensity	- 0.3218
Sora						
Present	37	1.7	5.4	- 1.1847	semi-permanent pond	- 0.5403
Absent	2122	98.3	99.7	+ 0.0207	shoreline distance	- 0.4983
Total	2159		98.1		cover-type 3	- 0.3642
					hectares of cultivation	- 0.3199
					seasonal ponds	- 0.3196
					cover-type 4	+ 0.1861

Table 11. (Continued)

Group	Number of cases	Percent of total observations	Percent of observations correctly classified	Group centroid[a]	Major discriminating variables[b]	Standardized discriminant functions
Willet						
Present	45	2.1	0.0	+ 0.9249	semi-permanent pond	+ 0.7936
Absent	2114	97.9	99.9	- 0.0197	seasonal pond	+ 0.6949
Total	2159		97.8		vegetation height	- 0.5387
					number of ponds on plot	- 0.4994
					temporary pond	+ 0.4747
					hectares of cultivation	- 0.3753
					surface water area	+ 0.3539
Marbled godwit						
Present	36	1.7	0.0	+ 0.6692	hectares of cultivation	- 0.5910
Absent	2123	98.3	100.0	- 0.0114	hectares of alfalfa/hayland	+ 0.7941
Total	2159		98.3			
Lesser yellowlegs						
Present	30	1.4	3.3	- 0.7412	surface water area	- 0.7888
Absent	2129	98.6	99.7	+ 0.0104	vegetation height	+ 0.7129
Total	2159		98.3		cover-type 2	- 0.6183

[a]Centroid in reduced space of the discriminant scores.

[b]Major independent discriminating variables are listed in order of their ability to discriminate between groups. The ability of each variable is dependent on the ability of the variables listed prior to it.

The difference in means of the variable within each group was tested using the univariate F-ratio. The means for 7 variables were significantly different ($P<0.01$) (Table 12) and supported the conclusions from the discriminant function. Percent open water and shoreline distance showed relatively high correlation with vegetation height and hectares of surface water respectively, possibly explaining why they were not among the discriminating variables entering the equation.

Past studies of the American bittern have indicated a nesting preference for dense vegetation, usually in marshes, but also on uplands (Abbott 1907, Lewis 1930, Mousley 1939, Vesall 1940, Middelton 1949, Bent 1963). In this study the high values for hectares of surface water, shoreline distance, vegetation height, cover-type 3, semi-permanent ponds and the low value for percent open water indicated a preference for large semi-permanent wetlands with dense stands of robust emergent vegetation. The high value for hectares of idle grassland may indicate the bittern's use of uplands near water for nesting.

Great blue heron.--Five variables--permanent streams, cover-type 3, hectares of surface water, hectares of treeland and shoreline distance--chosen as the best discriminating variables are all directly related to the presence of great blue herons (Table 11). The difference in the mean of the variable within each group was significant ($P<0.01$) for all 5 (Table 12). Almost 48 percent of the wetlands with great blue herons present were correctly classified by these 5 variables.

Table 12. Significantly different within-group means (percent[a]) of variables that discriminated between wetlands with a species present and wetlands with the species absent.

Species	Variable	Wetlands with species present	Wetlands with species absent	All ponds
American bittern				
	Surface water area[b] (ha)	5.3	0.6	0.6
	Percent open water[b]	44.4	70.6	70.3
	Percent cover-type 3 wetlands[b]	30.0	4.0	4.0
	Shoreline distance[b] (m)	1061.7	446.4	454.1
	Semi-permanent pond[b]	70.0	11.0	12.0
	Idle grassland[b] (ha)	7.5	1.2	1.3
	Vegetation height[b] (cm)	67.5	27.1	27.6
Great blue heron				
	Shoreline distance[b] (m)	1833.0	439.0	454.1
	Percent cover-type 3 wetlands[b]	26.0	4.0	4.0
	Permanent stream[b]	48.0	4.0	4.0
	Surface water area[b] (ha)	3.3	0.6	0.6
	Hectares of trees[b]	4.2	0.6	0.6
Black tern				
	Surface water area[b] (ha)	3.5	0.6	0.6
	Percent cover-type 3 wetlands[b]	24.0	4.0	4.0
	Vegetation height[b] (cm)	54.9	27.2	27.6
	Shoreline distance[b] (m)	830.2	448.0	454.1
	Percent of ponds semi-permanent[b]	50.0	11.0	12.0

Table 12. (Continued)

Species	Variable	Wetlands with species present	Wetlands with species absent	All ponds
Wilson's phalarope				
	Surface water area[b] (ha)	1.4	0.6	0.6
	Percent open water[b]	52.6	71.2	70.3
	Percent cover-type 4 wetlands[b]	29.0	53.0	51.0
	Percent of ponds seasonal[b]	25.0	12.0	12.0
	Alfalfa/hayland[b] (ha)	11.8	6.9	7.2
Black-crowned night heron				
	Surface water area[b] (ha)	4.2	0.6	0.6
	Percent cover-type 3 wetlands[b]	40.0	4.0	4.0
	Shoreline distance[b] (m)	1547.0	449.0	454.1
	Percent of ponds permanent stream[c]	30.0	4.0	4.0
	Hectares of trees[c]	2.5	0.6	0.6
	Hectares of cultivation[c]	24.8	12.0	12.1
Green heron				
	Percent of ponds permanent stream[b]	63.0	4.0	4.0
	Percent of ponds permanent[b]	13.0	1.0	1.0
	Hectares of trees[b]	6.4	0.6	0.6
	Shoreline distance[b] (m)	2296.5	447.2	454.1
	Surface water area[c] (ha)	1.9	0.6	0.6

Table 12. (Continued)

Species	Variable	Wetlands with species present	Wetlands with species absent	All ponds
American avocet				
	Percent of ponds tillage and pasture[b]	31.0	4.0	4.0
	Ephemeral pond[b]	13.0	1.0	1.0
	Alfalfa/hayland[b] (ha)	18.1	7.1	7.2
	Hectares of pasture[b]	19.0	35.4	35.3
Sora				
	Surface water area[b] (ha)	1.7	0.6	0.6
	Percent open water[b]	47.0	70.7	70.3
	Percent cover-type 3 wetlands[b]	16.0	4.0	4.0
	Percent cover-type 4 wetlands[b]	19.0	52.0	51.0
	Vegetation height[b] (cm)	45.0	27.3	27.6
	Shoreline distance[b] (m)	858.9	447.0	454.1
	Percent of ponds semi-permanent[b]	35.0	11.0	12.0
	Hectares of cultivation[c]	17.8	11.9	12.1
Willet				
	Surface water area[b] (ha)	1.3	0.6	0.6
	Percent of ponds temporary[c]	9.0	3.0	3.0
	Percent of ponds seasonal[c]	22.0	12.0	12.0
	Percent of ponds semi-permanent[c]	22.0	12.0	12.0

Table 12. (Continued)

Species	Variable	Wetlands with species present	Wetlands with species absent	All ponds
Marbled godwit				
	Alfalfa/hayland[b] (ha)	14.9	7.0	7.2
	Hectares of cultivation[b]	4.9	12.2	12.1
	Percent cover-type 1 wetlands[c]	28.0	14.0	14.0
Lesser yellowlegs				
	Surface water area[b] (ha)	1.5	0.6	0.6

[a]Dummy variables are represented as the percent of the wetlands within that group that had this variable present.

[b]The difference in means is significant at the $P<0.01$ level.

[c]The difference in means is significant at the $P<0.05$ level.

The significant variables, permanent stream, hectares of surface water, hectares of treeland and shoreline distance, indicated a preference for riparian habitat. Permanent streams characteristically had long shorelines and large surface water area and were generally associated with large areas of treeland. Frequencies of occurrence also indicated the utilization of permanent streams by great blue herons (Table 4). A similar preference for permanent streams by great blue herons was noted in South Dakota by Adolphson and Adolphson (1968).

Black tern.--Three variables--hectares of surface water, semi-permanent pond and cover-type 3 in decreasing order of importance--were the best discriminating variables separating presence and absence of black terns on wetlands (Table 11). Black terns were recorded on 34 wetlands, and 23.5 percent were correctly classified by the 3 most important variables. The 3 variables were directly related to the presence of black terns. The difference in means was significant ($P<0.01$) for hectares of surface water, semi-permanent wetlands, cover-type 3, vegetation height and shoreline distance (Table 12). Vegetation height and shoreline distance had a relatively high correlation value with semi-permanent wetlands and hectares of surface water respectively which may explain why they were not among the top discriminating variables.

Black terns are known to nest in a variety of wet, marshy situations that range from floating vegetation in open water to dense emergent vegetation (Currier 1904, Cuthbert 1954, Bent 1963,

Bergman et al. 1970, Doane 1972). In this study it was apparent that large semi-permanent wetlands with robust emergent vegetation were preferred. Semi-permanent ponds stood out as important in frequency of occurrence (Table 4), in discriminant analysis (Table 11) and in mean differences (Table 12).

Wilson's phalarope.--Wilson's phalarope was present on 5 percent of the wetlands surveyed. Vegetation height, cover-type 4, number of ponds on plot and percent open water were among the most important variables and were negatively correlated with phalarope presence (Table 11). The variables that were positively correlated include seasonal ponds, stock ponds, semi-permanent ponds, hectares of alfalfa/hayland, hectares of surface water, intermittent streams and percentage of shoreline grazed (Table 11). Of the 11 significant variables only surface water area, percent open water, cover-type 4, seasonal ponds and hectares of alfalfa/hayland had means that were significantly different ($P<0.01$) between groups (Table 12).

The significance of hectares of alfalfa/hayland may indicate preference of the phalarope for nesting in this habitat type. Hohn (1967) reported nesting of Wilson's phalarope in hay meadows as much as 45.7 - 91.4 m from water in Alberta, Canada. Other studies have noted nesting on the periphery of shallow grassy ponds or on nearby uplands (Johns 1969, Howe 1975). Seasonal ponds were most frequently used by phalaropes in this study (Table 4) and may best fit the shallow grassy pond description. Wilson's phalarope was also recorded frequently on semi-permanent ponds. The low percentage of

open water (53 percent) and cover-type 4 (29 percent) and the high value for hectares of surface water (1.4 ha) were most characteristic of semi-permanent ponds.

Black-crowned night heron.--Black-crowned night herons were recorded on only 10 wetlands, but 50 percent of them were correctly classified by the 5 most important discriminating variables (Table 11). Hectares of surface water, cover-type 3, hectares of cultivation and shoreline distance were directly related to the presence of night herons; permanent ponds were negatively correlated. Differences between group means were significant ($P<0.05$) for hectares of surface water, cover-type 3, shoreline distance, hectares of cultivation, permanent streams and hectares of treeland (Table 12). Shoreline distance was correlated with permanent streams and with hectares of treeland possibly explaining why the 2 latter were not among the most important variables.

Black-crowned night herons frequently occurred on permanent streams (Table 4). The segments of permanent streams that occurred on study plots characteristically had high values for hectares of surface water and shoreline distance and high values for hectares of treeland on the plot. Cover-type 3 is probably more characteristic of semi-permanent ponds where night herons also occurred, though they most frequently occurred on permanent streams (Table 4). In other studies the black-crowned night heron has been recorded feeding and nesting in marshes, substantiating its use of semi-permanent ponds (Gross 1923; Wolford and Boag 1971a, 1971b; Hammer and Hammer 1970).

Green heron.--Four variables--permanent stream, permanent pond or lake, hectares of treeland and shoreline distance--provided the best discrimination between presence and absence of green herons on survey wetlands (Table 11). Fifty percent of the 8 wetlands on which green herons occurred were correctly classified by the 4 most important variables. Differences between group means were significant ($P<0.05$) for permanent stream, permanent pond or lake, hectares of treeland, shoreline distance and hectares of surface water (Table 12). Hectares of surface water had relatively high correlation with shoreline distance, a possible explanation of why surface water area was not among the entering variables.

Permanent streams represented 63 percent of the wetlands where green herons were observed. The high values for shoreline distance, hectares of surface water and hectares of treeland on plot reflect characteristics of permanent stream habitat. Campbell (1972) found a similar preference for permanent streams by green herons in British Columbia, Canada.

American avocet.--The American avocet occurred on 16 wetlands; 37.5 percent of these wetlands were correctly classified by the top 4 discriminant variables--tillage and pasture pond, ephemeral pond, hectares of alfalfa/hayland and grazing intensity (Table 11)--all directly related to the presence of avocets. Group mean differences were significant ($P<0.01$) for tillage and pasture pond, ephemeral pond, hectares of alfalfa/hayland and hectares of pasture (Table 12). A relatively high correlation between hectares of pasture and

grazing intensity probably explains why hectares of pasture did not enter the equation.

Thirty-one percent of the ponds on which the American avocet occurred were tillage or pasture ponds, and 13 percent were ephemeral ponds. The shallow water feeding habits of the avocet probably explain the attractiveness of these wetland types. Past studies of the American avocet have indicated the use of shorelines, islands and grassy meadows for nesting (Schwilling 1954, Bent 1962, Moriarty 1962, Gibson 1971, Campbell 1972); alfalfa hayland and pasture may be important nesting habitat in South Dakota. The positive correlation of livestock grazing intensity with the presence of American avocets may indicate a preference for open areas. A similar preference for open areas was indicated by Moriarty (1962) who described the preferred nesting habitat of American avocets as open shorelines, bare alkali flats or gravelly or rocky points.

Sora.--Six variables provided the best discrimination between wetlands with soras present and wetlands with soras absent (Table 11). Semi-permanent wetlands, shoreline distance, cover-type 3, hectares of cultivation and seasonal ponds, in order of decreasing importance, were directly related to the presence of soras. Cover-type 4 was least important and was negatively correlated with sora presence. The first 6 variables selected correctly classified 5.4 percent of the 37 wetlands on which soras occurred. Group mean differences were significant ($P<0.05$) for all 6 variables except seasonal ponds (Table 12). Surface water area, percent open water and vegetation

height also had significant ($P<0.01$) differences between group means. Intercorrelations with other variables may explain why these 3 variables were not important to the equation. Correlation was relatively high between surface water area and shoreline distance, vegetation height with cover-type 4.

Soras occurred most frequently on semi-permanent ponds, followed in importance by seasonal ponds (Table 4). These 2 wetland types accounted for 62 percent of the sora observations and had characteristically large hectares of surface water, shoreline distance and cover-type 3, and a low percentage of open water and cover-type 4. This and previous studies of the sora indicate a preference for cattail marshes (Weber 1909, Allen 1934, Mousley 1937, Walkinshaw 1940, Pospichal and Marshall 1954, Tanner and Hendrickson 1956, Glahn 1974, Irish 1974). Semi-permanent wetlands particularly were characterized by the presence of cattail (Typha spp.) as indicated by a positive correlation with vegetation height.

Willet.--Seven variables provided the best separation between the presence and absence of willets on wetlands (Table 11). Semi-permanent ponds, seasonal ponds, temporary ponds and hectares of surface water were directly related to the presence of willets. Vegetation height, number of ponds on plot and hectares of cultivation were negatively correlated. Only surface water area, temporary, seasonal and semi-permanent ponds had group means that were significantly different ($P<0.05$).

Fifty-three percent of the willet observations were on temporary, seasonal or semi-permanent ponds (Table 4), indicating the importance of these wetland types to willet presence. The high value for surface water area probably reflects the high frequency of occurrence on semi-permanent ponds (Table 4). The negative correlation of vegetation height with willet presence may indicate the use of more temporary wetlands such as ephemeral, temporary and seasonal ponds which generally have shorter vegetation than semi-permanent ponds. Willets have been recorded nesting on grassy upland areas near water and in open pastures (Tuft 1925, Tomkins 1955), a possible explanation of the negative correlation of hectares of cultivation with willet presence. No biological explanation is prompted by the negative correlation of number of ponds on plot.

Marbled godwit.--The top discriminating variables for separating wetlands with and without godwits present were hectares of cultivation and hectares of alfalfa/hayland (Table 11). Hectares of alfalfa/hayland was positively correlated with marbled godwit presence, while hectares of cultivation was negatively correlated. Group mean differences were significant ($P<0.05$) for hectares of cultivation, hectares of alfalfa/hayland and cover-type 1 (Table 12).

Twenty-eight percent of the wetlands with marbled godwits present also had cover-type 1 and indicated an association with wetlands having closed stands of emergent vegetation with open water or bare soil covering less than 5 percent of the wetland. The low

mean hectares of cultivation along with the high mean hectares of alfalfa/hayland may reflect the nesting preference of godwits for occassionally flooded grassy plains or meadows (Bent 1907, 1962).

Lesser yellowlegs.--The first 3 entering variables correctly classified 3.3 percent of the 30 wetlands on which lesser yellowlegs occurred (Table 11). Hectares of surface water and cover-type 2 were positively correlated with the presence of lesser yellowlegs, and vegetation height was negatively correlated. The difference between group means was significant ($P<0.01$) for hectares of surface water.

The lesser yellowlegs occurs only as a migrant in South Dakota (Behrens et al. 1956) and is attracted to wetlands for feeding and resting. Large surface water area, low emergent vegetation and cover-type 2 provided the best separation between wetlands utilized by yellowlegs and wetlands not utilized.

CONCLUSIONS

Frequencies of occurrence and average densities were highest for 11 of the 13 species examined intensively in the 4 physiographic regions east of the Missouri River. All 13 species were recorded in the James River Lowland. The higher number of observations may be related to the abundant natural ponds and lakes in eastern South Dakota. Brewster et al. (1976) found a similarly high use of east-river strata by waterfowl in South Dakota.

Natural wetlands, including glacial ponds and lakes and fluviatile wetlands, were commonly utilized by non-game birds. Natural wetlands had greater habitat diversity than man-made wetlands and constituted 67 percent of the total surface water area surveyed in the state. Semi-permanent ponds in particular were individually characterized by a diversity of habitat. Red-winged blackbird, yellow-headed blackbird, sora and American bittern were most frequently observed on semi-permanent ponds. Management for non-game birds should include preservation of natural wetlands.

Some stock ponds were extensively utilized by non-game birds, indicating the potential of this wetland type as non-game bird habitat. Stock ponds should be managed or designed to encourage emergent vegetation; however, in ponds managed as fisheries excessive emergent vegetation may be detrimental to proper balance of game and forage fish populations.

Hectares of surface water was the single-most common variable explaining the utilization of wetlands by non-game birds. McEnroe (1976) found hectares of surface water to be closely associated with wetland utilization by breeding waterfowl in South Dakota. Multiple regression analysis of territorial male red-winged and yellow-headed blackbirds on semi-permanent ponds explained 47 and 56 percent of the variation respectively. Generally less than 10 percent of the variation between presence and absence of the other target species was explainable using discriminant analysis. The greatest amount of variation explained by analysis was 13 percent for the American bittern.

Further indepth study is needed on non-game wetland birds to answer more specific questions about the utilization of wetland types in South Dakota. Certainly other variables than those measured during this study are influencing wetland usage by non-game birds and need to be identified and evaluated. Food availability and abundance, nesting habitat availability and inter- and intra-specific competition are variables that may be important in determining wetland utilization by non-game birds.

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