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Breeding Waterfowl Use of Intermittent Streams, McHenry County, North Dakota

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BREEDING WATERFOWL USE OF INTERMITTENT STREAMS

McHENRY COUNTY, NORTH DAKOTA

BY

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McHENRY COUNTY, NORTH DAKOTA

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Thesis Adviser

Date

of Wildlife & Fisheries Sciences

BREEDING WATERFOWL USE OF INTERMITTENT STREAMS

McHENRY COUNTY, NORTH DAKOTA

Abstract

DANIEL E. HUBBARD

Thirty-three 425 m segments of 4 intermittent streams in north central North Dakota were censused for breeding pairs of waterfowl in 1977 and 1978. Pair count data were available for 1976. Emphasis of this study was placed on the narrow meandering portions of the streams. High dabbling duck (*Anas* spp.) densities were observed in 1977 and 1978; 6.11 pairs per ha and 5.60 pairs per ha, respectively, for the first census of each year. Excepting blue-winged teal (A. *discors*), numbers of dabbler pairs were similar in 1976 and 1978. Dry conditions in 1977 caused lower numbers of all species of dabblers except gadwalls (A. *strepera*). Most pothole wetlands in the immediate area were wet in 1976 and dry in 1977 and 1978.

Multiple regression analysis was used to analyze some of the factors which influenced pair use of the narrow portions of the streams. Height of emergent vegetation and growing crops >1.5 dm tall were negatively associated with blue-winged teal pairs while hectares of idle land and percent coverage of submersed vegetation were positively associated. Pasture >1.5 dm tall was positively associated with gadwall pairs and was the most important variable in 2 of 3 analyses. Shoreline/surface area ratio, number of Class IV wetlands, percent bare shoreline, and shoreline distance were negatively associated and surface area of water was positively associated with gadwall pairs. Mallard (A.

platyrhynchos) pairs were positively associated with shoreline distance and pasture >1.5 dm tall, and negatively associated with mulched stubble <1.5 dm tall and surface area of water off the segments. Shoreline distance was the most important variable in each of two analyses for mallards.

It was concluded that these streams were excellent habitat for breeding pairs of dabbling ducks. Stream channelization would severely degrade the waterfowl habitat provided by these streams.

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INTRODUCTION

The prairie pothole region of North America is the most important duck breeding area on the continent. It comprises only 10% of the waterfowl breeding habitat but contributes 50% of the continental duck crop in an average year (Smith et al. 1964). The prairie pothole region covers about 780,000 km^2 in south-central Canada and north central United States. The United States portion covers about 156,000 km^2, mostly in the Dakotas and Minnesota (Harmon 1970). This figure represents approximately half of the original pothole region in the United States (Harmon 1970); the other half was drained prior to 1950. Drainage is continuing. In the Dakotas and Minnesota 50,000 ha of wetlands were drained between 1965 and 1968 (Harmon 1970).

Pothole drainage is not the only threat to waterfowl habitat on the prairies. Stream channelization is threatening waterfowl habitat by destroying stream habitat and increasing pothole drainage by providing an improved outlet (Erickson et al. 1979). It has been estimated that in Minnesota 34,720 km of streams (perennial and intermittent) have been channelized (Funk and Ruhr 1971). The U.S. Soil Conservation Service estimated that 9843 km of stream having intermittent flow have been channelized nationwide by their agency as of 1974 and 12,028 km more of these types of streams were planned to be channelized (Thomas 1975).

In 1976, the U.S. Fish and Wildlife Service (FWS) censused breeding pairs of waterfowl on portions of 4 intermittent streams totaling 162.2 km in McHenry County, North Dakota. This census was intended to provide baseline data on waterfowl use of these streams, which are to be channelized as part of the Garrison Diversion Unit irrigation project (a Pick-Sloan Missouri River Basin Project). The results of this survey showed an average of 16.7 duck pairs per kilometer of stream (U.S. Fish and Wildlife Service 1976). It appeared that waterfowl use of these intermittent streams was high.

Stewart and Kantrud (1973) showed that 16% of the waterfowl breeding pairs in the northwestern drift plain subregion (the area within which these 4 streams lie) were using intermittent streams and oxbows. Their study indicated that streams were an important habitat type for waterfowl, at least in the northwestern drift plain.

The objectives of this study were to document waterfowl breeding pair use in 1977 and 1978 on the 4 intermittent streams censused by the FWS in 1976 and to assess the factors which influenced the use of these streams by breeding waterfowl. The results of this study will be of use to biologists in evaluating the importance of these habitats to breeding waterfowl and in assessing the effects that stream channnelization might have on waterfowl populations using intermittent streams.

STUDY AREA

North Dakota has a cool, subhumid to semiarid continental climate (Dietrich and Hove 1962). McHenry County is in the north central part of the state and has an average annual precipitation of about 38 cm, 50 of which falls in May, June, and July (Dietrich and Hove 1962). McHenry County has an average January temperature of -15.6 C, an average July temperature of 19.4 C, and a 120-day growing season (Dietrich and Hove 1962). Annual evaporation exceeds precipitation (Stewart 1975). The primary land use of the area is agriculture. Wheat, rye, flax, and beef cattle are the major products.

The study area lies in the lake plain of glacial Lake Souris and is surrounded by gently rolling ground moraine (Colton et al. 1963). The area is classified as the northwestern drift plain subregion of the prairie pothole region in North Dakota (Stewart 1975). The characteristic biotic climax community is eastern mixed grass prairie (Stewart 1975).

The streams under study in this investigation were Cut Bank Creek, South Egg Creek, Little Deep Creek, and Spring Coulee. All lie either totally, or in part, in northwestern McHenry County and are tributaries of the Deep River which empties into the Souris River at a point about 8 km north of the city of Upham. At the closest point, J. Clark Salyer National Wildlife Refuge lies 2.2 km east of the study area. The streams are intermittent in flow characteristics. Cut Bank Creek is monitored by a U.S. Geological Survey gauging station. Stream flows for Cut Bank Creek are presented in Appendix A. Cut Bank probably has the largest flow volume of the 4 study streams.

Excellent precipitation in the fall of 1975 (Appendix B), good snowpack in March (Appendix C), and good precipitation in March and April caused high runoff on the study area in the spring of 1976 resulting in excellent water conditions in the streams and surrounding natural basin wetlands (potholes). The dry fall of 1976, poor snowpack conditions at the end of winter, and low precipitation in early spring resulted in low runoff and poor wetland conditions in 1977. Modest precipitation in the fall of 1977, good snowpack in March, and modest precipitation in the early spring resulted in fair water conditions in the streams, but poor pothole conditions in the spring of 1978.

The wetland classification system of Stewart and Kantrud (1971) was developed specifically for pothole basin wetlands; however, I will describe the vegetation of the streams in terms of this system. The habitat consisted of a series of intergradations from Class III A, B, and C, to Class IV A and B, with pockets of Class VII (Stewart and Kantrud 1971). A list of plant species occurring most frequently as dominant or co-dominant within the streams is presented in Appendix D.

A feature of the vegetation of these creeks is the frequent occurrence of marestail (*Hippuris vulgaris*) in pure stands and occasionally intermingled with other submersed aquatics. Marestail is a characteristic plant of Class VII wetlands (fen ponds) which are indicative of seepage inflow from ground water (Stewart and Kantrud 1971). According to David B. Hanson (letter dated 15 July 1977), hydrologist for the U.S. Geological Survey, nearly all of the ground water supplies of northwestern McHenry County are from water table aquifers associated with alluvium deposits in stream valleys. It appears that the streams are associated with ground water flows, although the extent of ground water influence on the water regime of the streams is not known.

METHODS

Waterfowl Census

Aerial photographs of the 4 streams on the study area were obtained from the Fish and Wildlife Service, Bismarck Area Office. The photos were taken on 25 July 1975 at a scale of 1:24000 by the U.S. Army Corps of Engineers and enlarged to a scale of 1:8500 by the photo lab at the U.S. Environmental Protection Agency, Reston, Virginia.

The 162.2 km of stream censused by the FWS in 1976 were divided into 425 m segments and 40 segments were selected by a restricted random sample for purposes of multiple regression analyses of factors influencing pair use. Portions of the streams which in 1976 had expanded to form large marshes with no confined channel were deleted from the sampling procedure because they could not be accurately censused by a single observer. Large marshes constituted 24 km of Cut Bank Creek and 1.5 km of South Egg Creek. The 40 segments were selected using a table of 10,000 random digits (Rohlf and Sokal 1969) and were rejected if there was a large overlap (over 25%) of the area within 800 m around the segment with the area around a previously selected segment (see Independent Variables for Multiple Regression Analysis section, p. 8).

Permission was obtained from all landowners to census the streams during the winter of 1976-1977. Upon arrival on the study area in the spring of 1977, several landowners had reversed their decision to allow access to their land. As a result, 6 segments for multiple regression analysis were dropped. No additional segments were selected due to the difficulty in selecting segments with minimal overlap of land use areas to be mapped.

In 1978, another landowner denied access to his land and another segment for multiple regression analysis had to be dropped. The net result was 34 segments censused in 1977 and 33 segments in 1978 for multiple regression analysis; 5 segments on Cut Bank Creek, 3 on South Egg Creek, and 7 on Spring Coulee for both 1977 and 1978. Nineteen segments on Little Deep Creek were censused in 1977 and 18 in 1978.

In addition to the segments used in the regression analysis, 30.6 km of Cut Bank Creek in 1977 and 1978, 21.8 km of Spring Coulee in 1978, and 8.6 km of South Egg Creek in 1978 (total = 61 km) were censused for waterfowl pairs for comparison with the 1976 data collected by the FWS.

Waterfowl were censused by a single observer in 1977 and 1978 using a walk-wade technique. Most birds were flushed from the streams and watched until they flew out of sight or landed. Birds landing on uncensused portions of the stream were noted and not tabulated when flushed or observed a second time. The census in 1976 by the FWS was conducted using this same technique but with 3 two-man teams. Censusing on the 61 km of stream was conducted during all hours of daylight as were the FWS counts in 1976. However, those segments which were used for multiple regression analysis were only censused between 0900 and 1300 CDT as recommended by Dzubin (1969b). He determined that on his study area in Manitoba and Saskatchewan pairs of most species of ducks were least mobile during this period. Criteria for the determination of pairs and indicated pairs followed those established by Hammond (1969).

All stream segments were censused twice during each breeding season: 14-28 May and 10-30 June 1977 and 5-24 May and 2-27 June 1978. These periods were used under the assumption that the peak of nesting for early nesting species would be accounted for in the first census and the peak of later nesting species in the second census. The FWS census in 1976 was conducted from 24-28 May; within the time period suggested by Stewart and Kantrud (1973) as best for a single census to cover all species of ducks in North Dakota. Scientific names of waterfowl observed in this study are listed in Table 1.

Independent Variables for Multiple Regression Analysis

Using the information presented in Table 2 as a base, it was decided that the area within 800 m of all points along the selected 425 m stream segments would be adequate to cover the home ranges of most pairs found using the segments. Wetland and land use data were recorded for the area encompassed by the 800 m radius on acetate sheets placed over the aerial photographs. Separate land use maps were drawn for each census.

Twenty-eight independent variables were used for multiple regression analysis of both censuses in 1978 (Table 3). However, due to dry conditions in 1977, only 24 segments contained surface water. As a result, only those 24 wet segments were used for multiple regression analysis that year. Since the number of variables (including the

Table 1. Common and scientific names of waterfowl observed in this study.[a]

Common Name	Scientific Name
Dabbling ducks	
Blue-winged teal	*Anas discors*
Gadwall	*A. strepera*
Mallard	*A. platyrhynchos*
Northern pintail	*A. acuta*
Northern shoveler	*A. clypeata*
American wigeon	*A. americana*
Green-winged teal	*A. crecca*
Diving ducks	
Canvasback	*Aythya valisineria*
Lesser scaup	*A. affinis*
Redhead	*A. americana*
Ruddy duck[b]	*Oxyura jamaicensis*

[a] Common and scientific name according to Johnsgard (1975).
[b] Ruddy ducks are actually a stiff-tailed duck but are included with diving ducks here for convenience.

Table 2. Home range sizes of waterfowl.

Location	Species	Home Range Size	Remarks	Author
Utah	gadwalls	mean: 26.8 ha (5 hens) range: 13.6-34.8 ha	Ogden Bay	Gates 1962
Utah	blue-winged teal	less than 8 ha	Ogden Bay	Gates 1962
Utah	northern shovelers	less than 8 ha	Ogden Bay	Gates 1962
South Dakota	blue-winged teal	mean radius: 0.29 km (11 pairs) range: 0-0.7 km	prairie potholes	Evans and Black 1956
South Dakota	blue-winged teal	mean: 67.6 ha (14 pairs) range: 29.6-86 ha (14 pairs)	prairie potholes	Drewien 1968
North Dakota	gadwalls	several hundred acres (as reported)	colonial island nesters	Duebbert 1966
Minnesota	mallards	minimum mean: 240 ha (12 drakes) minimum mean: 210 ha (12 hens)	wooded lakes and marshes	Gilmer et al. 1975
Manitoba	mallards	greater than 280 ha	Aspen Parkland	Dzubin 1955
Manitoba	blue-winged teal	greater than 100 ha	Aspen Parkland	Dzubin 1955

Table 3. Independent variables used in multiple regression analyses.

<u>Land Use Variables</u> (in hectares within 800 m of stream segment)

1. Growing crops >1.5 dm tall
2. Growing crops <1.5 dm tall

3. Standing stubble >1.5 dm tall
4. Standing stubble <1.5 dm tall

5. Mulched stubble >1.5 dm tall
6. Mulched stubble <1.5 dm tall

7. Hay >1.5 dm tall
8. Hay <1.5 dm tall

9. Pasture >1.5 dm tall
10. Pasture <1.5 dm tall

11. Fallow cropland

12. Idle land

<u>Wetlands Variables</u> (within 800 m of stream segment)

13. Number of Class III[a] with ponded water
14. Surface area of Class III with ponded water (ha).

15. Number of Class IV[a] with ponded water
16. Surface area of Class IV with ponded water (ha)

17. Number of dugouts with ponded water
18. Surface area of dugouts with ponded water (ha)

19. Surface area of all wetlands including adjacent stream

<u>Stream Habitat Variables</u>

20. Surface area of water on stream segment (ha)
21. Shoreline distance of stream segment (m)
22. Ratio of shoreline length (m) to surface area of segment (ha)
23. Meanderness index
24. Percent of bare shoreline
25. Percent of surface area covered with emergent vegetation
26. Percent of surface area covered with submergent vegetation
27. Average height of emergent vegetation (decimeters)
28. Percent of stream segment with a depth of less than 1 meter

[a] Classified according to Stewart and Kantrud (1971).

dependent variable) used in a multiple regression analysis must be less than the number of observations (segments censused) some variables had to be deleted. As very few basin wetlands occurring on the study area contained ponded water, it was decided to delete independent variables 13-18 (Table 3); only 2 segments had Class III wetlands near them (range: 1-2), 5 segments had Class IV wetlands near them (range: 1-2), and 4 segments had dugouts near them (range: 1-3). In 1977 surface water in the stream segments was generally discontinuous. As a result, the meanderness index (variable 23) was also deleted from the analysis. Twenty-one independent variables were used for the pooled multiple regression analyses of the first censuses of both years.

Surface area variables were measured from land use maps using a compensating polar planimeter. The exception to this was the surface area of the stream segments for the second census in 1977 when some stream pools were too small to measure. The length and width of these small pools were paced and surface area estimated by assuming that their surface area was equal to a rectangle of the same dimensions. Shoreline distances of the segments were measured with a cartometer.

The land use categories of growing grain, standing stubble, mulched stubble, hay, and pasture were split into 2 variables each (Table 3); those in which the predominant cover was higher than 1.5 dm (6 inches) and those less than 1.5 dm. Cover height was estimated by the observer. Although subjective assessments are not highly accurate, they can be used for comparative purposes if conducted by a single observer (Greig-Smith 1964:2). Variables 24-28 (Table 3) were also assessed subjectively.

For the first censuses of each year, dead emergent vegetation which was inundated was considered "submersed" vegetation.

The idle land category included roadside right-of-ways, abandoned farmsteads, undisturbed field borders, ungrazed shelterbelts, undisturbed dry basin wetlands, and idle lands associated with the streams.

Percent of bare shoreline was the percent of shoreline distance of the segment with vegetation less than 1.5 dm tall for a distance of at least 3 dm from the edge of the water. The ratio of shoreline length to surface area was calculated by dividing the latter into the former.

Meanderness index was the number of times the observer lost sight of one or the other of the stream banks throughout the course of the 425 m segment. This was accomplished by standing at the beginning of a segment and noting the point at which either bank caused the observer to lose sight of the stream. The observer then moved to that point and repeated this procedure until the end of the segment was sighted.

Multiple Regression Analysis

Multiple regression analysis (Snedecor and Cochran 1967) was used to determine which of the independent variables had a statistically significant effect on explaining the variation in the number of duck pairs (the dependent variable) using the stream segments. The computer program used was the Statistical Package for the Social Sciences version (Kim and Kohout 1975) of a stepwise forward multiple regression procedure.

In the stepwise forward multiple regression procedure, the independent variable which explains the greatest amount of variation (the greatest reduction in the sum of squares) of the dependent variable is entered into the multiple regression equation first (Snedecor and Cochran 1967). The variable which explains the greatest additional variation in the dependent variable, after the effect of the previously entered variable is removed, is entered into the equation next. This procedure is repeated until all the variables are included, or the investigator cuts off the analysis at some predetermined point.

The coefficient of determination (R^2) gives the percent reduction in the sum of squares of the dependent variable attributed to the combined effects of all the variables in the equation (Steel and Torrie 1960). In other words, the R^2 value indicates the amount of variation in the dependent variable explained by the independent variables. The standardized partial regression coefficient (b) indicates the importance of each variable in predicting or estimating the dependent variable relative to the other variables in the equation (Steel and Torrie 1960). The sign (+ or -) of b indicates the direction of association between the independent variable and the dependent variable.

The multiple regression program used for the analysis also gives simple correlation coefficients (r) between all pairs of variables in the multiple regression equation. Correlation coefficients are an aid in interpreting the meaning of the multiple regression equation.

Multiple regression can be used in a predictive sense, or merely to rate variables in their order of importance (Snedecor and Cochran 1967). The use of this statistical analysis in the present study will be to rate variables.

RESULTS AND DISCUSSION

Waterfowl Pair Use

Blue-winged teal was the most abundant species using the stream segments and accounted for 50% of the 3-year mean (Table 4). Counts of breeding pairs for 3 years on 30.6 km of Cut Bank Creek and for 2 years on 21.8 km of Spring Coulee and 8.6 km of South Egg Creek also demonstrated that blue-winged teal was the most abundant species using the streams (Table 5). The high percent of diving ducks (13% of the 3-year mean) occurring on Cut Bank Creek was due to the high runoff in 1976 (Appendix A) which caused portions of that stream to form wide marshes. In 1977 and 1978 most of the wide marshes were reduced to a meandering stream channel typical of the rest of the streams. Diving ducks on South Egg used a large marsh formed by a dam on the creek. Wide marshes on the streams and the good water conditions in nearby basin wetlands explains the generally higher numbers of all species in 1976.

Blue-winged teal consistently comprised the greatest proportion of waterfowl pairs censused (Tables 4 and 5). According to Stewart and Kantrud (1974), blue-winged teal were second to northern pintails as the most abundant breeding waterfowl species in the northwestern drift plain from 1967-1969. Apparently, the habitat provided by intermittent streams was attractive to breeding blue-winged teal. Widely fluctuating numbers of blue-winged teal probably reflected the water conditions in the general area. Smith (1971) noted wide fluctuations in numbers of blue-

Table 4. Number of pairs of waterfowl censused on 33 randomly selected 425 m stream segments during 1976, 1977, and 1978.

Species	1976[a]	1977 1st Census[b]	1977 2nd Census[c]	1978 1st Census[d]	1978 2nd Census[e]	Three Year mean[f]	Percent of mean total
Blue-winged teal	118	35	12	61	30	71.3	50%
Gadwall	17	17	8	18	7	17.3	12%
Mallard	14	11	1	19	8	14.7	10%
Northern pintail	14	8	0	12	5	11.3	8%
Northern shoveler	16	5	0	16	3	12.3	9%
American wigeon	10	4	1	10	6	8.0	6%
Green-winged teal	5	0	0	3	2	2.7	2%
Total Dabblers	194	80	22	139	61	137.7	97%
Canvasback	3	0	0	0	2	1.7	1%
Lesser scaup	1	0	0	1	1	0.7	1%
Redhead	0	0	0	4	0	1.3	1%
Ruddy duck	0	0	0	0	0	0	0
Total Divers	4	0	0	5	3	3.7	3%
Total	198	80	22	144	64	141.4	100%

24-28 May. U.S. Fish and Wildlife Service (1976).
14-28 May.
10-30 June.
5-24 May.
2-27 June.
f First censuses in 1977 and 1978 for all species except canvasback (first census 1977 and second census 1978).

Table 5. Waterfowl pairs observed on identical portions of Cut Bank Creek, 24-28 May 1976, 14-28 May 1977 and 5-24 May 1978, and Spring Coulee and South Egg Creek, 24-28 May 1976 and 5-24 May 1978.

	Cut Bank Creek[a]					Spring Coulee[b]				South Egg Creek[c]			
Species	1976[d]	1977	1978	Mean	Percent of mean total	1976[d]	1978	Mean	Percent of mean total	1976[d]	1978	Mean	Percent of mean total
Blue-winged teal	226	96	113	145.0	42%	141	90	115.5	53%	59	23	41.0	47%
Gadwall	50	37	44	43.7	13%	20	14	17.0	8%	6	3	4.5	5%
Mallard	56	34	37	42.3	12%	26	22	24.0	11%	10	6	8.0	9%
Northern pintail	40	7	31	26.0	8%	20	24	22.0	10%	10	6	8.0	9%
Northern shoveler	33	11	23	22.3	6%	22	12	17.0	8%	17	8	12.5	14%
American wigeon	13	12	17	14.0	4%	7	12	9.5	4%	2	2	2.0	2%
Green-winged teal	11	1	2	4.7	1%	7	10	8.5	4%	4	1	2.5	3%
Total Dabblers	429	198	267	298.0	87%	243	184	213.5	99%	108	49	78.5	91%
Canvasback	13	0	2	5.0	1%	2	1	1.5	1%	3	4	3.5	4%
Lesser scaup	17	1	3	6.7	2%	0	1	0.5	Tr	1	0	0.5	Tr
Redhead	91	0	8	33.0	10%	2	0	1.0	Tr	2	3	2.5	3%
Ruddy duck	3	0	0	1.0	Tr[e]	0	0	0	0	3	0	1.5	2%
Total Divers	124	1	13	46.0	13%	4	2	3.0	1%	9	7	8.0	9%
Total Pairs	553	199	280	344.0	100%	247	186	216.5	100%	117	56	86.5	100%

bLength censused 30.6 km.
Length censused 21.8 km.
dLength censused 8.6 km.
U.S. Fish and Wildlife Service (1976).
[e]Tr = less than 0.5%.

winged teal and green-winged teal on his study area in Alberta. He maintained that these 2 species were affected more dramatically by drought than other dabbling duck species.

Number of breeding pairs was highest for all dabbler species in the first census of both 1977 and 1978 (Table 4). Pair densities (Table 6) for the first censuses were probably the most representative of the capabilities of these intermittent streams.

The densities for the first censuses in both years for blue-winged teal, gadwalls, mallards, northern shovelers, and American wigeon were higher than the densities reported by Kantrud and Stewart (1977) for these species on all of the classes of natural basin wetlands in the prairie pothole region of North Dakota. Specifically, the densities reported by Kantrud and Stewart (1977) for Class III and Class IV wetlands (which these streams approximate in vegetation) were, in pairs/ha, respectively: blue-winged teal, 1.224 and 0.737; gadwalls, 0.388 and 0.295; mallards, 0.449 and 0.286; northern shovelers, 0.344 and 0.277; and American wigeon, 0.05 and 0.024. Their calculated densities for total dabbling duck species on Class III and IV wetlands were 3.172 and 1.891 pairs/ha respectively, much lower than the densities of dabbling ducks on the stream segments for the first censuses in both 1977 and 1978.

The high densities found on the stream segments could be explained by the crowding of pairs onto available water due to dry conditions (see review by Dzubin 1969a). While many basin wetlands were apparent on the

Table 6. Average densities of breeding pairs of waterfowl (pairs/ha) by species on 33[a] randomly selected 425 m stream segments during 1977 and 1978.

Species	Pairs/ha 1977 1st Census	1977 2nd Census[c]	1978 1st Census[d]	1978 2nd Census[e]
Blue-winged teal	2.67	1.28	2.46	1.59
Gadwall	1.30	0.85	0.73	0.37
Mallard	0.84	0.11	0.77	0.42
Northern pintail	0.61	0	0.48	0.26
Northern shoveler	0.38	0	0.65	0.16
American wigeon	0.31	0.11	0.40	0.32
Green-winged teal	0	0	0.12	0.11
Total Dabblers	6.11	2.34	5.60	3.23
Canvasback	0	0	0	0
Lesser scaup	0	0	0.04	0.05
Redhead	0	0	0.16	0
Ruddy duck	0	0	0	0
Total Divers	0	0	0.20	0.16
Total	6.11	2.34	5.81	3.39

Densities calculated on wet segments only: 24 in 1977, 32 in 1978.
Total water surface area = 13.1 ha.
Total water surface area = 9.4 ha.
[d]Total water surface area = 24.8 ha.
[e]Total water surface area = 18.0 ha.

aerial photographs of the study area, few were wet. Pair counts on federal waterfowl production areas in counties surrounding the study area indicate that in 1977 and 1978 more pairs were crowding onto less water (Appendix E). The densities presented by Kantrud and Stewart (1977) were averaged over 3 years, in 2 of which excellent water conditions prevailed (Stewart and Kantrud 1973), and may account for the lower densities reported.

The crowding of ducks onto the water available in the stream segments may not adequately explain the high pair densities found in this study. Excluding blue-winged and green-winged teal, the number of pairs of the other dabbling ducks using the stream segments was similar for 1976 and 1978 (Table 4). The number of pairs of gadwall is similar for all 3 years.

Although I have no data on the number of pothole basins containing water in 1976, I believe that most basins on the study area contained water. I estimated from inspection of the aerial photographs that there were at least 286 basins on the area within 800 m of the censused stream segments. In 1978 only 43 of these basins contained water during the first census. In view of the difference in wet basins between 1976 and 1978 and the consistent number of dabbling duck pairs (excepting teals) using the stream segments, I believe that the availability of wet basins had little effect on the numbers of dabbler pairs (excepting teals) using these stream segments.

A more plausable explanation for the high pair densities found during this study centers on the surface area of the stream segments and the permanancy of water. Evans and Black (1956) and Drewien and Springer (1969) maintained that the best distribution of a given amount of water for breeding pairs would be many small, relatively permanent areas available throughout the breeding season. The highest pair densities of blue-winged teal, mallards, and American wigeon observed by Smith (1971) in Alberta occurred on potholes between 0.24 and 0.40 ha in size (Table 7). Stoudt (1971) in Saskatchewan observed the highest densities of blue-winged teal and mallards on potholes from 0.04 to 0.20 ha in size (Table 7). Smith (1971) and Stoudt (1971) calculated breeding pair densities according to pothole type (Table 8) using the classification system described by Shaw and Fredine (1956). Smith (1971) found the highest densities of blue-winged teal and American wigeon on type 4 potholes and mallards on type 3 potholes. Stoudt (1971) found the highest densities of blue-winged teal and mallard on type 3 potholes. The types 3 and 4 of Shaw and Fredine (1956) can be roughly equated to the Class III and Class IV wetlands of Stewart and Kantrud (1971) which the stream segments of this study resembled. Kantrud and Stewart (1977) found 60% of the breeding dabbling ducks in the prairie pothole region of North Dakota using Class III ponds and 30% using Class IV ponds. The average amount of water surface area on the stream segments in 1977 was 0.6 ha (range: 0.1 to 2.6 ha). In 1978, the average was 0.8 ha (range: 0.2 to 2.4 ha). However, the small surface areas of these streams was accentuated

Table 7. Breeding pair densities of blue-winged teal, mallards, and American wigeon by pothole size according to Smith (1971) and Stoudt (1971).

Investigator	Pothole size (ha)	Blue-winged teal	Mallard	American wigeon
Smith (1971)	0.04-0.20	1.08	1.61	0.28
(in pairs/2.6 km^2)	0.24-0.40	1.14	1.62	0.35
	0.44-0.80	0.98	1.17	0.28
	0.84-2.00	0.76	0.83	0.26
	2.04-8.00	0.08	0.20	0.08
Stoudt (1971)	0.04-0.20	1.38	3.20	
(in pairs/ha)	0.24-0.40	1.30	2.10	
	0.44-0.80	0.90	1.45	
	0.84-2.00	0.60	1.23	
	2.04-8.00	0.93	1.23	

Table 8. Breeding pair densities of blue-winged teal, mallards, and American wigeon by pothole type according to Smith (1971) and Stoudt (1971).

Investigator	Pothole type[a]	Blue-winged teal	Mallard	American wigeon
Smith (1971) (in pairs/2.6 km^2)	Type 1	0.00	0.30	0.00
	Type 3	0.03	1.47	0.26
	Type 4	1.04	1.28	0.30
	Type 5	0.54	0.90	0.20
Stoudt (1971) (in pairs/ha)	Type 1	0.63	1.90	
	Type 3	1.28	2.70	
	Type 4	1.25	2.03	
	Type 5	1.13	1.58	

[a] Pothole types are classified according to Shaw and Fredine (1956).

by the lineal configuration of the stream. Drewien and Springer (1969) concluded that the high use of type 1B ponds (i.e., Class III of Stewart and Kantrud 1971) appeared to be related to the larger ratio of shoreline to unit area of water. Thus, if behavioral spacing mechanisms are important in regulating the number of duck pairs that will utilize an area (Hochbaum 1944, Evans and Black 1956, Gates 1962, Dzubin 1969a, Dzubin and Gollop 1972, Patterson 1976) the small surface area of streams combined with their configuration and wetland class designations (III and IV) explains the high densities of pairs observed in this study.

Multiple Regression Analyses of Factors Influencing Pair Use

Multiple regression analysis was performed on each species of dabbling duck and total dabblers for each census period in which the number of pairs exhibited adequate variation in numbers on the 33 randomly selected segments. No analyses were performed on the results of the second census in 1977 as no single species or total dabblers showed adequate variation. Analyses were also performed on the pooled results of the first censuses in both years.

Blue-winged Teal

The variation in numbers of blue-winged teal per segment was 0-6 for the first census 1977, 0-6 for the first census 1978, 0-4 for the second census 1978, and 0-6 for the first censuses 1977 and 1978 combined. As a result, multiple regression analysis was performed on each of these censuses; however, the results of the analyses for the first census 1977 and combined first censuses 1977 and 1978 did not produce statistically significant results ($P>0.05$).

During the first census 1978 (Table 9) height of emergent vegetation and mulched stubble >1.5 dm were negatively associated (according to sign of b) with blue-winged teal pair numbers; idle land and percent coverage of submersed vegetation were positively associated with blue-winged teal pair numbers. These 4 factors accounted for 46% of the variation in pair numbers ($P<0.05$). The sign of the standardized partial regression coefficients (b) of these variables agreed with their simple correlation coefficients (r) in all cases except for mulched stubble >1.5 dm. The r for mulched stubble >1.5 dm and blue-winged teal pair numbers was +0.01638, indicating a small but positive correlation. However, an intercorrelation existed among the independent variables. Mulched stubble >1.5 dm and height of emergent vegetation exhibited a simple correlation of $r = -0.33742$, a much larger r than of that between blue-winged teal pairs and mulched stubble >1.5 dm. One possible explanation for the disagreement of signs between r and b is that as hectares of mulched stubble >1.5 dm increased the height of emergent vegetation increased, which was negatively associated with blue-winged teal pair numbers, resulting in a negative b in the regression equation. The relationship between mulched stubble >1.5 dm and height of emergent vegetation was probably coincidental and I interpret its effect in this analysis as meaningless.

Forty-four percent of all observations recorded as blue-winged teal pairs were lone drakes. These drakes were probably awaiting the return of their hens from the nest site. The negative association between

Table 9. Stepwise forward multiple regression analysis[a] of blue-winged teal pairs and habitat variables for 1st and 2nd census 1978 (n = 32).

Census	Probability level	Independent variable	Std. part. reg. coef. (b)	Coef. of deter. (R^2)	Simple corr. coef. (r)
1978 1st census	P<0.05	Height of emergent vegetation (dm)	-0.57021	0.20133	-0.44869
		Idle land (ha)	+0.44649	0.32689	+0.26723
		Mulched stubble >1.5 dm (ha)	-0.40547	0.38282	+0.01638
		Percent coverage of submersed vegetation	+0.33336	0.46675	+0.29464
1978 2nd census	P<0.025	Growing crops >1.5 dm (ha)	-0.58490	0.34211	-0.58490

[a]Variables listed in order of ability to explain variation in the dependent variable.

height of emergent vegetation and blue-winged teal pairs may reflect a tendency for drakes to select portions of the stream with low vegetation for waiting sites in order to be more visible to their returning hens.

The positive association between hectares of idle land and blue-winged teal pairs probably reflected the nesting habits of the species. Bellrose (1976) summarized the literature on nest sites of blue-winged teal and stated that the average distance of the nest from water was 37.5 m. According to Higgins (1977) untilled uplands were preferred nesting cover. Idle land associated with the streams accounted for 38% of the idle land in this study.

The positive association of blue-winged teal pairs with submersed vegetation reflects the food habits of the species. Most of the "submersed" vegetation during the first census was comprised of inundated dead emergent vegetation and created a condition Swanson et al. (1974) term a "hay infusion". These conditions produce an abundance of aquatic invertebrates which are the main food source for breeding blue-winged teal.

The multiple regression analysis for the second census 1978 (Table 9) showed that only growing crops >1.5 dm tall had a significant ($P<0.025$) effect on explaining the variation in blue-winged teal pairs. This variable accounted for 34% of the variation in pair numbers and was negatively associated. Higgins (1977) found only 6% of all blue-winged teal nests in growing grain, indicating that this cover type was not preferred for nesting.

Gadwalls

Gadwall pairs exhibited a variation of 0-2 on the selected stream segments for all censuses; however, on only 1 segment in the second census 1978 were 2 pairs observed. Therefore, a multiple regression analysis was not performed on the 1978 second census data.

For the first census 1977, 3 variables accounted for 47% of the variation in gadwall pairs (Table 10). Shoreline/surface area ratio explained the most variation in gadwall pairs and was negatively associated. This negative association was expected as gadwall pairs were positively associated with surface area of water on the stream segment. The simple correlation coefficient between shoreline/surface area ratio and surface area of water on the segment was -0.40920. Thus, as the surface area increased, the shoreline/surface area ratio decreased. Roberson (1977) also found gadwalls to be positively correlated with water surface area, $r = +0.17$, in a study of breeding waterfowl on South Dakota stock ponds.

Pasture <1.5 dm was the second most important variable in explaining gadwall pair numbers for the first census in 1977. This variable may reflect a habitat preference for nesting; however, it may have entered into the regression equation due to intercorrelations with another variable. I suspect the latter for 2 reasons. First, pasture >1.5 dm was significant in explaining gadwall variation in the first census 1978 and in the first censuses 1977 and 1978 combined. Secondly, the fourth variable to be entered into the multiple regression equation for the

Table 10. Stepwise forward multiple regression analysis[a] of gadwall pairs and habitat variables for 1st census 1977 (n = 24), 1st census 1978 (n = 32), 1st census 1977 and 1978 combined (n = 56).

Census	Probability level	Independent variable	Std. part. reg. coef. (b)	Coef. of deter. (R^2)	Simple corr. coef. (r)
1977 1st census	$P<0.05$	Shoreline/surface area ratio	-0.37570	0.21761	-0.46648
		Pasture <1.5 dm (ha)	+0.46139	0.35786	+0.30611
		Surface area of water on segment (ha)	+0.37839	0.47027	+0.40640
1978 1st census	$P<0.05$	Pasture >1.5 dm (ha)	+0.54366	0.23838	+0.48824
		Fallow (ha)	+0.67433	0.41040	+0.34850
		Number of Class IV wetlands	-0.49451	0.57675	-0.25820
		Percent bare shoreline	-0.23983	0.62934	-0.00507
1977 and 1978 1st censuses combined	$P<0.05$	Pasture >1.5 dm (ha)	+0.36181	0.12253	+0.35004
		Fallow (ha)	+0.31497	0.19440	+0.30475
		Shoreline distance (m)	-0.31053	0.28667	-0.20620

[a] Variables listed in order of ability to explain variation in the dependent variable.

first census 1977 was mulched stubble >1.5 dm and was negatively associated with gadwall pairs (b = -0.25064, r = -0.34353). However, this association was not statistically significant at the 5% level. The simple correlation coefficient between pasture <1.5 dm and mulched stubble >1.5 dm was r = -0.44408. The absolute value of r between pasture <1.5 dm and mulched stubble >1.5 dm was higher than the r value for either of these 2 variables with gadwall pairs. This is my interpretation of what may have happened in the analysis; other intercorrelations, however, may exist.

The results of the multiple regression analysis for the first census 1978 (Table 10) showed pasture >1.5 dm, fallow, number of Class IV wetlands and percent bare shoreline to be statistically significant (P<0.05) in explaining 63% of the variation in gadwall pairs.

Pasture >1.5 dm was positively associated with gadwall pairs and was the single most important factor in explaining variation. This association was probably due to the preference of gadwall for untilled uplands with dense cover for nest sites. Higgins (1977) found 95% of all gadwall nests located on untilled uplands. Miller and Collins (1954) found 84% of 381 gadwall nests in vegetative cover between 3.25 and 9.00 dm tall.

One possible explanation of why fallow was entered in the analysis as the second most important variable was due to its correlation with number of Class IV wetlands, r = +0.42433, which has an absolute value greater than the correlation coefficient between gadwall pairs and number of Class IV wetlands, r = -0.25820. As the number of Class IV wetlands increased the hectares of fallow increased. The negative association between gadwall pairs and number of Class IV wetlands could mean that gadwalls preferentially used Class IV potholes, when available, over the habitat provided by the streams.

Sixty-one percent of all observations tallied as gadwall pairs were actual pairs, not lone drakes. A gadwall drake is very intolerant of other pairs of gadwalls (Dzubin 1969a) and is most intolerant when his hen is present (Dwyer 1974). The negative effect of bare shoreline on gadwall pairs may be explained by a tendency of the pairs to seek seclusion from other pairs.

The results of the multiple regression analysis for the first censuses 1977 and 1978 combined (Table 10) showed that pasture >1.5 dm, fallow, and shoreline distance explain 29% of the variation in gadwall pairs (P<0.05). This pooled analysis demonstrated the importance of pasture >1.5 dm as it was also the most important variable for the analysis conducted on the first census of 1978.

In 1977, 33% of the pasture on the study area was >1.5 dm during the first census. Pasture >1.5 dm comprised 45% of the pasture during the first census in 1978. Of the total hectares of pasture (both classes) on the study area 80% were in units associated with the streams, i.e., the streams were either adjacent to them or bisected them.

Fallow in the pooled analysis was again intercorrelated with another independent variable; this time possibly with surface area of water on the segment (r = +0.39817), which fell into the regression equation as the fourth most important variable but was not statistically significant ($P>0.05$). The simple correlation coefficient between surface area of water and the segment and gadwall pairs was +0.31774, a value higher than between fallow and gadwall pairs (r = +0.30475). I cannot explain the negative relationship between gadwall pairs and shoreline distance.

Mallards

Variation in numbers of mallard pairs per stream segment was 0-2 for the first census 1977, 0-3 for the first census 1978, and 0-3 for first censuses 1977 and 1978 combined. Multiple regression was not performed on the second census 1978 due to a variation of 0-1 mallard pairs per segment. Analysis of data for the first census 1978 did not produce statistically significant results ($P>0.05$).

The independent variables shoreline distance, pasture >1.5 dm and mulched stubble <1.5 dm accounted for 55% of the variation in mallard pairs during the first census in 1977 (Table 11). Shoreline distance and pasture >1.5 dm were both positively associated with mallard pairs, and mulched stubble <1.5 dm was negatively associated.

Shoreline distance was also positively associated with mallard pairs in South Dakota (McEnroe 1976 and Roberson 1977). Hochbaum (1944) equated shoreline distance with increased opportunities for spacing, thereby reducing aggressive interactions among pairs.

The positive association between mallard pairs and pasture >1.5 dm reflected the preference of pasture for nesting. Higgins (1977) found

Table 11. Stepwise forward multiple regression analysis[a] of mallard pairs and habitat variables for first census 1977 (n = 24), 1st census 1977 and 1978 combined (n = 56).

Census	Probability level	Independent variable	Std. part. reg. coef. (b)	Coef. of deter. (R)	Simple corr. coef. (r)
1977 1st census	P<0.05	Shoreline distance (m)	+0.55565	0.33994	+0.58305
		Pasture >1.5 dm (ha)	+0.35854	0.47472	+0.49089
		Mulched stubble <1.5 dm (ha)	-0.27470	0.54686	-0.17068
1977, 1978 1st censuses combined	P<0.05	Shoreline distance (m)	+0.52613	0.08823	+0.29704
		Surface area of water off segment (ha)	-0.36351	0.16974	-0.15398
		Mulched stubble <1.5 dm (ha)	-0.28851	0.24157	-0.10162

[a] Variables listed in order of ability to explain variation in the dependent variable.

90% of all mallard nests on his study area in untilled uplands. Smith (1971) found 58% of all mallard nests in grass or buckbrush (*Symphoricarpos occidentalis*). Buckbrush was very abundant in the pastures on my study area. Stoudt (1971) found that mallard pairs attained their highest density on his study area in potholes surrounded by ungrazed grassland. Roberson (1977) demonstrated a negative association between mallard pairs and grazing intensity.

The negative relationship between mallard pairs and mulched stubble <1.5 dm was probably because mallards seldom used mulched stubble for nesting (Higgins 1977).

The relationships between mallard pairs and shoreline distance and mulched stubble <1.5 dm were reinforced by the results of the pooled censuses for 1977 and 1978. These 2 variables when combined with surface area of water off the segment accounted for 24% of the variation in mallard pairs.

The negative association between surface area of water off the stream segment and mallard pairs using the segments possibly reflected an increased opportunity for mallard pairs to locate on wetlands elsewhere. However, this should not be construed to imply that mallards preferred wetlands other than the stream. Ninety-one percent of the surface area of water off the selected segments, and within 800 m of them, was composed of intermittent stream contiguous to the segments.

Total Dabbling Ducks

Multiple regression analyses were performed on all censuses (except second census 1977) and the pooled results of the first censuses in both years (Table 12). The first census, 1977, did not yield statistically significant results (P>0.05).

Four variables accounted for 53% of the variation in total dabbling duck pairs for the first census in 1978. Two of these 4 variables, fallow (positively associated) and number of Class IV wetlands (negatively associated), were also statistically significant (P<0.05) in explaining variation in gadwall pairs (Table 10). Gadwall pairs were highly correlated with total dabbler pairs (r = +0.70135). Height of emergent vegetation was negatively associated with total dabbler pairs and was also the most important variable in explaining variation in blue-winged teal numbers (Table 9). Blue-winged teal pairs were highly correlated with total dabbler pairs (r = +0.81507). Both gadwall and blue-winged teal pairs had higher correlations with total dabbler pairs than any other species (next highest correlation was with northern shoveler, r = +0.53270). These high correlations with total dabbler pairs were probably responsible for fallow, height of emergent vegetation, and number of Class IV wetlands entering into the multiple regression equation as statistically significant for total dabbling duck pairs.

Mulched stubble <1.5 dm was the fourth most important variable and was negatively associated with total dabbler pairs for the first census 1978. This was probably due to its poor suitability as a nesting habitat for all species except northern pintail (Higgins 1977).

Table 12. Stepwise forward multiple regression analysis[a] of total waterfowl pairs with habitat variables for 1st and 2nd census 1978 (n = 32), 1st census 1977 and 1978 combined (n = 56).

Census	Probability level	Independent variable	Std. part. reg. coef. (b)	Coef. qf deter. (R^4)	Simple corr. coef. (r)
1978 1st census	P<0.05	Fallow (ha)	+0.59057	0.17994	+0.42419
		Height of emergent vegetation (dm)	-0.38861	0.34019	-0.40754`
		Number of Class IV wetlands	-0.39250	0.43305	-0.15574
		Mulched stubble <1.5 dm (ha)	-0.32560	0.53437	-0.19764
1977 and 1978 1st census combined	P<0.05	Fallow (ha)	+3.0014	0.09008	+0.30014
1978 2nd Census	P<0.05	Growing crops >1.5 dm (ha)	-0.25537	0.27008	-0.51969
		Surface area of water off segment (ha)	+0.42966	0.42068	+0.50414
		Growing crops <1.5 dm (ha)	+0.35897	0.52362	+0.48555

[a] Variables listed in order of ability to explain variation in the dependent variable.

Fallow accounted for 9% of the variation in total dabbler pairs for the multiple regression performed on the first censuses in 1977 and 1978 combined ($P<0.05$). Fallow was also significant ($P<0.05$) in explaining variation in gadwall pairs alone (Table 10) for the combined first censuses in 1977 and 1978. Gadwall pairs were highly correlated with total dabbler pairs ($r = +0.64039$), second only to blue-winged teal, and probably accounted for fallow exhibiting a significant influence on total pairs.

For the second census 1978 3 variables accounted for 52% of the variation in total dabbler pairs. They were growing crops >1.5 dm (negatively associated), surface area of water off the segment (positively associated), and growing crops <1.5 dm (positively associated). The variable growing crops >1.5 dm was also the most important in explaining variation in blue-winged teal pairs (Table 9) for the second census 1978. As blue-winged teal pairs exhibited the highest simple correlation with total dabbler pairs ($r = +0.81312$) it was not surprising that growing crops >1.5 dm showed the greatest ability to account for variation in total dabblers.

There was a 23% reduction of surface area of water on the 33 segments from the first census to the second census in 1978. This reduction in water area probably explains why the surface area of water off the segments had a significantly positive association with total dabbler pairs. As the segments began to dry water available on other portions of the home range became increasingly important. Ninety-four percent of the surface area of water off the segments was composed of adjacent stream during this census period.

The third most important variable in explaining the variation in dabbler pairs was growing crops <1.5 dm. I believe this variable was entered into the multiple **regression equation as** significant (P<0.05) due to its negative correlation with growing crops >1.5 dm (r = -0.44146).

Five of the 8 variables significant (P<0.05) in explaining variation in total dabbler pairs (Table 12) also significantly explained variation in gadwall or blue-winged teal pairs. Thus, the analyses for total pairs reflected, for the most part, those variables which accounted for the variation in the individual species which are the most highly correlated with the total pairs of dabblers. Dzubin (1969a) maintained that pond and breeding pair relationships should be made on a species basis and pairs of all species should not be combined. From the results of the multiple regression analyses of total dabbler pairs, I agree with his assessment and would extend it to include all habitat relationships.

CONCLUSIONS

The emphasis of this study was placed on the narrow, meandering portions of 4 intermittent streams. These stretches of stream were excellent habitat for breeding pairs of dabbling ducks. Due to the high densities of dabbler pairs supported, these streams may be considered optimum pair habitat; they have small surface areas, large amounts of shoreline, and represent an intergradation from Class III to Class IV wetlands.

The streams appeared to constitute their own wetland complex. Over 90% of the surface water area within 800 m of the segments used in multiple regression analysis was accounted for by intermittent stream contiguous to the segments. Due to having large watersheds and the influence of ground water inflow, the streams have a more dependable water supply than surrounding potholes. Except for years with little runoff, as in 1977, the narrow portions of the streams appeared to support a consistent number of breeding pairs of dabbling ducks (excepting blue-winged teal) regardless of the water conditions in the surrounding potholes. During springs with high runoff some reaches of the streams expanded into large marshes and attracted numerous waterfowl of all species, but particularly increased use by diving ducks.

Two factors influencing pair use of the streams were hectares of pasture with an average height of vegetation >1.5 dm and hectares of idle land. Eighty percent of all pasture and 38% of the idle land occurring within 800 m of the censused segments were associated with the streams. Thus, the **streams** offered nesting cover.

Stream channel modification would severely reduce the habitat quality of these streams for breeding waterfowl pairs. Channelization would decrease the surface area of the streams and reduce shoreline distances which would have deleterious effects on pair habitat. The pasture and idle land associated with the stream would become more easily accessible to the plow once the stream channel is straightened and as a result, nesting cover would also be destroyed.

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APPENDICES

Appendix A. Monthly water-discharge records for Cut Bank Creek at Upham, North Dakota, water years 1976-1978.[a]

	Discharge $(m^3) \times 10^{-5}$											
Water year[b]	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1976	5.812	5.984	1.080	0.432	0.629	4.837	219.876	59.596	11.154	1.567	0.0	0.0
1977	0.0	0.0	0.0	0.0	0.0	0.002	0.259	0.407	0.089	0.0	0.0	0.0
1978	0.0	0.0	0.0	0.0	0.0	0.0	1.357	1.592	0.740	0.054	0.0	0.0

[a] Source: U.S. Geological Survey. 1977-1979. Water Resources Data for North Dakota, water years 1976-1978. U.S. Geol. Surv. Water Data Rep. ND-76, 77, 78-1.

[b] A water year begins in October and ends in September, i.e., water year 1976 spans October 1975 to September 1976.

Appendix B. Monthly precipitation (cm) 4.8 km north of Upham North Dakota.[a]

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1975	2.31	0.84	2.82	10.08	4.88	8.56	10.62	4.37	8.05	5.11	1.60	3.30
1976	1.83	1.93	1.52	4.52	1.24	10.74	2.24	4.95	0.15	0.74	0.05	1.02
1977	1.22	0.33	0.25	0.48	8.36	7.75	4.24	4.11	7.85	1.83	2.03	4.17
1978	0.38	0.23	0.81	1.04	7.11	7.98	7.39	5.99	2.69	0.97	1.96	1.80

[a] Source: National Oceanic and Atmospheric Administration. 1975-1978. Climatological data: annual summaries, North Dakota. Vols. 84-87(13).

Appendix C.   Monthly snowpack (cm) 4.8 km north of Upham, North Dakota.[a]

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1975 maximum										7.62	17.78	38.10
end of month											17.78	27.94
1976 maximum	38.10	40.64	45.72	Tr[b]	Tr						Tr	20.32
end of month	30.48	35.56	Tr								Tr	15.24
1977 maximum	30.48	20.32	Tr								20.32	35.56
end of month	20.32	Tr									12.70	30.48
1978 maximum	38.10	40.64	45.72	5.08								
end of month	30.48	40.64										

[a] Source: National Oceanic and Atmospheric Administration. 1975-1978. Climatological data: annual summaries, North Dakota. Vols. 84-87(13).

[b] Tr indicates trace.

Appendix D. Most common dominant or co-dominant plants observed in Cut Bank Creek, Little Deep Creek, South Egg Creek, and Spring Coulee, McHenry County, North Dakota.

Emergents	Submergents
Alisma trivale	Callitriche hermaphroditica
Beckmannia syzigachne	Chara spp.
Eleocharis spp.	Hippuris vulgaris
Phalaris arundinacea	Lemna trisulca
Polygonum amphibium	Miriophyllum exalbescens
Polygonum coccineum	Potamogeton pectinatus
Ranunculus septentrionalis	Potamogeton richardsonii
Sagittaria cuneata	Ranunculus trichophyllus
Scirpus acutus	
Scirpus americanus	
Scirpus fluviatilis	
Scirpus validus	
Scolochloa festucacea	
Sium suave	
Sparganium eurycarpum	
Typha "glauca"	
Typha latifolia	

Appendix E. Waterfowl pair censuses (all species) of a sample of waterfowl production areas in Bottineau, McHenry, Pierce, Renville, and Rolette Counties, North Dakota. [a]

Year	Basin[b] hectares	Wet hectares	Total pairs	Pairs per wet hectare
1974	234.4	238.4	369	1.55
1975	234.4	221.2	387	1.75
1976	234.4	226.4	373	1.65
1977	234.4	133.6	463	3.47
1978	234.4	188.0	508	2.70

[a] Data provided by J. Clark Salyer National Wildlife Refuge, Upham, North Dakota.

[b] Basins are Class IV and Class V according to Stewart, R. E., and H. A. Kantrud. 1971. Classification of natural ponds and lakes in the glaciated prairie region. U.S. Fish Wildl. Serv. Resour. Publ. 92. 57 pp.

Appendix F. Waterfowl broods observed during the course of censusing for pairs and mapping of water on the streams 2-27 June 1978.

	Cut Bank	Spring	South Egg r–„–d,	Little Deep rraale
Blue-winged teal	15	1	-	42
Gadwall	-	-	-	6
Mallard	10	6	1	17
Northern pintail	14	1	-	21
Northern shoveler	5	1	-	7
American wigeon	3	-	-	8
Green-winged teal	-	-	-	1
Total Dabblers	47	9	1	102
Canvasback	2	1		3
Lesser scaup				
Redhead				1
Ruddy duck				
Total Divers	2	1	-	4
Total Broods	49	10	1	106

Appendix G. Waterfowl pairs censused on Cut Bank Creek, Little Deep Creek, Spring Coulee, and South Egg Creek 24-28 May 1976.[a]

Species	Cut Bank Creek 66.9 km	Little Deep Creek 64.0 km	Spring Coulee 21.8 km	South Egg Creek 8.6 km
Blue-winged teal	656	573	153	65
Gadwall	133	60	20	7
Mallard	124	86	26	10
Northern pintail	102	59	21	10
Northern shoveler	102	75	26	18
American wigeon	35	21	8	2
Green-winged teal	44	19	7	4
Total Dabblers	1,196	893	261	116
Canvasback	15	2	2	3
Lesser scaup	62	12	0	1
Redhead	127	2	2	2
Ruddy duck	10	0	0	3
Total, Divers	214	16	4	9
Total Pairs	1,410	909	265	125

[a] Source: U.S. Fish and Wildlife Service. 1976. Unpublished data, Bismarck Area Office. Bismarck, North Dakota.