WETLAND BIRD POPULATIONS IN THE UPPER TANANA RIVER VALLEY, ALASKA, 1977

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Prepared for

Northwest Alaskan Pipeline Company

December 1977

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For a distance of 75 miles in the upper Tanana River Valley, the proposed Northwest Alaskan Gas Pipeline route adjoins one of Alaska's major waterfowl breeding and molting areas, here referred to as the Tetlin-Northway Wetlands. Waterfowl utilization of portions of these wetlands make them equal in productivity to the best wetland areas of Alaska, including Minto lakes and the most productive strata of the Yukon Flats (J. G. King, Supervisor of Waterfowl Investigations, Alaska, U.S. Fish and Wildlife Service, pers. comm.). The U.S. Fish and Wildlife Service sponsored ground and aerial waterfowl studies in the region during the late 1950's and early 1960's, primarily in the Tetlin lakes area (McKnight 1962, Hansen 1960, Hansen and McKnight 1964, Schneider 1965). James G. King, U.S. Fish and Wildlife Service, has continued to fly annual transects between Tetlin Lake and Northway, and, until 1977, he made annual ground brood counts in the Tetlin lakes area (annual November issue of Pacific Waterfowl Flyway Report). Little, however, has been known about the bird utilization of the Tetlin-Northway Wetlands outside of these areas.

In 1977, a survey of wetland[1] birds was undertaken along the proposed gas pipeline route[2] between Tetlin Junction and Little Scottie

[1]The term "wetland bird" is used in this report to refer to water-affiliated non-passerine birds: loons, grebes, waterfowl, cranes, shorebirds, and raptors which use the wetlands.

[2]For the purposes of this survey, the route was assumed to be the present Haines Petroleum Pipeline right-of-way.

Creek 1) to document habitat utilization, 2) to estimate the size and composition of the wetland bird population, and 3) to determine the wetland bird productivity of the wetland habitats near the proposed route. Such knowledge is important to proper management of pipeline construction--including specific alignments, the types and timing of certain construction activities, and the extent and types of ground and aerial activities over and in these wetlands--if disturbance of nesting, molting, and migratory activities of wetland birds and destruction of wetland habitat is to be avoided.

STUDY AREA

The Tetlin-Northway Wetland study area included portions of the upper Tanana River, and the lower Nabesna River, Chisana River, and Scottie Creek drainages (see Fig. 1). It is a 730 square mile lowland extending for 72 miles in a southeasterly direction from the Tanana River bridge on the Alaska Highway at Milepost 1303 to Little Scottie Creek on the Alaska Highway at Milepost 1223. Maximum width of the wetland area is 18 miles, along a line from Tetlin Lake to Riverside Lodge. Emphasis of fieldwork was to sample the communities of birds most likely to experience impact from pipeline construction and operation; hence, the sampling effort was concentrated along the Alaska Highway (between Tetlin Junction and the U.S.-Canada Border) and along the Northway Road (between the Alaska Highway and the Northway Airport).

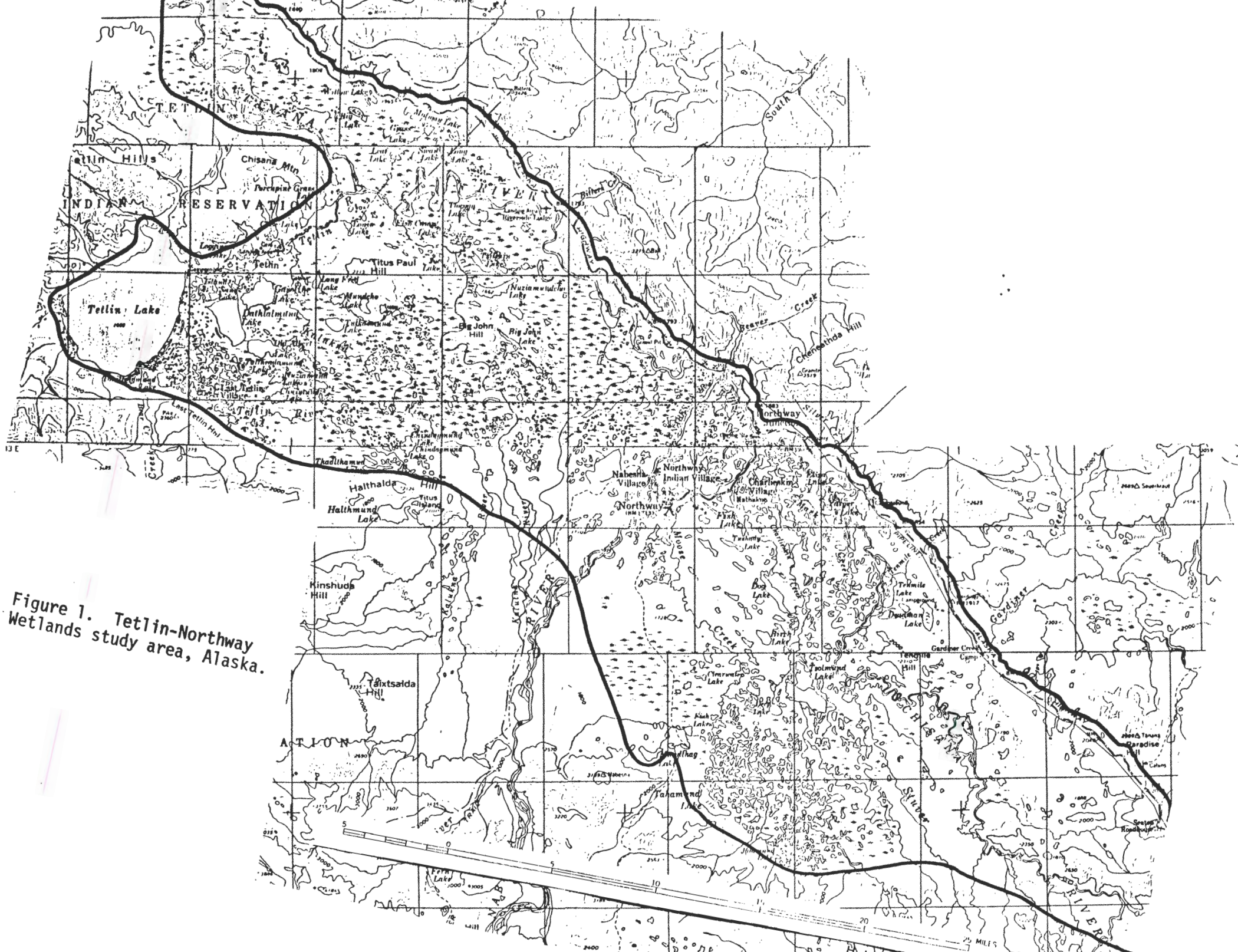


Figure 1. Tetlin-Northway Wetlands study area, Alaska.

The vegetation on the study area is a complex mosaic of forested and treeless habitats typical of the northern taiga. The wetlands within the area are distributed in a spatially-diverse arrangement; e.g., within a square mile of lowland habitat, one may encounter several large and small lakes with shorelines in various stages of plant succession. The major wetland habitat types, which occur mainly in the lowland river valleys, but to a lesser extent in the uplands, may be catagorized as follows:

1. Large lakes (>0.500 mi^2), often with diverse shoreline marshes and floating mats.
2. Small lakes and ponds (<0.500 mi^2), often with, or adjacent to, other wetland types.
3. Floating mats in lakes and ponds--mostly Nymphaea sp., Hippuris sp., Calla palustris, Caltha sp., Myriophyllum sp., and important submerged species such as Potamogeton sp., Zanichellia sp., and Polygonum amphibium.
4. Marsh--emergent grasses, sedges, rushes, and horsetails--mostly Equisetum fluviatile, Scirpus validus, Carex aquatilis, Carex rostrata, Juncus sp., Arctophila fulva. Shoreline marshes are most frequent, but larger lakes have marshy islands of Scirpus validus and Typha latifolia growing in several feet of water.
5. Wet sedge meadow--mostly Eleocharis sp., Eriophorum angustifolium, Eriophorum callitrix, Eriophorum gracile, Eriophorum scheuchzeri, Trichophorum sp., Beckmannia erucaeformis.

6. Tussock bogs--mostly Eriophorum vaginatum.
7. Mudflats and river sandbars--ranging from frequently-flooded and barren flats, to dense grass meadows (Calamagrostis canadensis, Poa spp., Equisetum palustre, Equisetum arvense), to dense herbaceous growth (Senecio congestus).
8. Creeks and rivers.
9. Old river oxbow lakes and marshes.

The vegetative diversity in most taiga mosaic habitats arises from eight interrelated forces: forest fire, permafrost, alluviation, water table, soil type, slope, aspect, and spatial distribution of wetlands (Lutz 1956, Viereck 1970). A more thorough discussion of how these vegetation factors are associated with waterfowl habitats is given by McKnight (1962).

METHODS

A cabin at Riverside Lodge (Alaska Highway Milepost 1281) served as base camp from 28 May to 13 November 1977. Wetland sites along the Northway Road were selected for sampling on 13 June. Sites along the Alaska Highway from Tetlin Junction to Little Scottie Creek were selected between 14 and 17 June. Preliminary surveys to test methods and gain seasonal chronological data began on 17 June.

Forty-five wetland sites were censused, of which 34 were within 1 mile of the proposed Northwest Alaskan Gas Pipeline route. The 34 wetlands, collectively, were a nearly complete sample of the types of

habitats and populations of birds present near the pipeline route in 1977; they included 95% of the wetlands appearing on the 1:63,360 USGS Quadrangle Maps. The remaining 10 sites were located 1-5 miles from the route, along Scottie Creek and the Chisana River. These additional 10 sites were chosen to obtain a representative sample of lowland habitats in the center of the valley, away from possible disturbances associated with a nearby highway. They were selected according to ease of access by canoe. The total area of all 45 wetlands censused was 11.642 mi^2.

A "census" consisted of two persons walking in opposite directions around the shores of a marsh, pond, or small lake. All birds seen when the sample crew first arrived were recorded in order to prevent double-counting later, and all birds seen or flushed during the walk around the shoreline were counted. Large lakes were censused in a similar manner, except a canoe and 30-power spotting scope were used. When the crew first arrived at a large lake, a count of all birds visible through scope and binoculars was made. The crew then paddled along the shoreline and recorded all birds seen. The largest lakes were subdivided into sections, which were then censused sequentially.

Each of the 45 wetland sites was censused once. Censuses were conducted between 0600 and 2200, Alaska Standard Time. Censusing began 6 July 1977 and progressed southeastward towards Canada. Censusing was completed 25 July. Choice of the census period was intended to follow the hatching of most eggs so that broods of young birds could be counted. In this manner, an estimate of production as well as adult population could be made.

In addition to the one-time censuses on the 45 sites, repeated counts were made along the Northway Road. Thirteen lakes, ponds, and marshes were counted on 23 occasions from 13 June to 16 September. This effort was primarily designed to obtain breeding, molting, and chronological data. Counts from the 13 ponds were summed for each month to get a monthly estimate of the species composition and total numbers of birds in the Northway area.

The census data were treated as a stratified random sample (Cochran 1963). The 45 wetland sites were catagorized into five strata, based on habitat types and on geographic location:

Stratum	Name
I	Large Lakes (>0.500 mi^2; all are located in Tanana-Chisana Valley area).
II	Tanana-Chisana Valley Small Lakes, Ponds, and Marshes (<0.500 mi^2).
III	Upland Small Lakes, Ponds, and Marshes (0.001-0.400 mi^2).
IV	Scottie Creek Valley, Small Lakes, Ponds, and Marshes (0.012-0.600 mi^2).
V	Chisana River with adjacent sand and gravel bars and mudflats.

The name, location, and size of census sites assigned to the five strata are presented in Table 1. Exact map locations of these census

Table 1. Name, location, and size of wetland areas censused for birds in the upper Tanana River Valley, Alaska. The census areas were stratified into five groups, based on habitat types and on geographic location. The three statistics which best indicate a wetland area's value to birds--Density of birds, Species Richness, and Species Diversity (H')--are also presented.

Name/Location	Size (mi^2)	Bird Density (birds/mi^2 wetlands)	Species Richness	Species Diversity (H')
STRATUM I. Large Lakes (>0.5 mi^2)				
Deadman Lake S. of Alaska Highway Milepost 1249	0.550	627.3	16	1.952
Midway Lake S. of Alaska Highway Mileposts 1287-1291	2.300	561.7	24	2.101
Yarger Lake S. of Alaska Highway Milepost 1257	0.550	396.4	15	1.710
Eliza Lake S. of Alaska Highway Mileposts 1257-1258	0.665	141.4	13	2.057
STRATUM II. Tanana-Chisana Valley Small Lakes, Ponds, and Marshes ($\leq$0.5 mi^2)				
Chisana Lake #17A N. of Chisana R., Nabesna C-1 Quad., Sec. 24, T11N, R21E, Sec. 19, T11N, R22E	0.130	2746.2	10	1.394
Pond 1261.5 S. of Alaska Highway Milepost 1261.5, Nabesna D-2 Quad., Sec. 13, 14, T14N, R19E	0.007	2428.6	5	1.365
Pond 1271 S. of Alaska Highway Milepost 1271.0, Tanacross A-2 Quad., Sec. 24, T15N, R18E	0.087	1264.3	14	2.369
Willow Lake S. of Alaska Highway Milepost 1292.5, Tanacross A-3 Quad., Sec. 20, T17N, R16E	0.136	654.4	12	2.117
Chisana Pond #21 S. of Chisana R., Nabesna D-2 Quad., Sec. 30, T14N, R20E	0.050	640.0	5	1.546
Pond 1263.5 S. of Chisana R., Nabesna D-2 Quad., Sec. 14, 15, T14N, R19E	0.010	500.0	3	1.055
Pond 1266 S. of Alaska Highway Milepost 1266.0, Tanacross A-2 Quad., Sec. 33, T15N, R19E	0.062	467.7	7	1.597
Pond 1300 S. of Alaska Highway Milepost 1300.0, Tanacross B-4 Quad, Sec. 30, 31, T18N, R15E	0.065	446.2	7	1.688
Marsh 1267 S. of Alaska Highway Milepost 1267.0, Tanacross A-2 Quad., Sec. 28, 29, 32, 33, T15N, R19E	0.109	403.7	7	1.679
Ponds 1293.5-4.0 S. of Alaska Highway Mileposts 1293.5-1294.0, Tanacross A-3 Quad., Sec. 19, 20, T17N, R16E	0.069	289.9	6	1.670
Ten Mile Lake E. of Chisana R., Nabesna D-2 Quad., Sec. 15, 22, 27, 28, T13N, R20E	0.400	287.5	11	1.882
Chisana Pond #17B S. of Chisana R., Nabesna D-2 Quad., Sec. 13, 18, T12N, R20E	0.100	280.0	4	0.907
Steve Lake S. of Alaska Highway Milepost 1262, Tanacross A-2 Quad., Sec. 11, T14N, R19E	0.163	184.0	6	1.421
Chisana Pond #18 SE. of Chisana R., Nabesna D-2 Quad., Sec. 28, 29, 32, 33, T13N, R20E	0.180	88.9	5	1.461
Chisana Pond #20 NE. of Chisana R., Nabesna D-2 Quad., Sec. 29, 30, T14N, R20E	0.150	33.3	3	0.950
Chisana Pond #19 N. of Chisana R., Nabesna D-2 Quad., Sec. 15, 16, 22, T14N, R19E	0.100	20.0	2	0.643
Pond 1263 S. of Alaska Highway Milepost 1263, Tanacross A-2 Quad., Sec. 11, T14N, R19E	0.025	0	0	0

Table 1. continued

Name/Location	Size (mi^2)	Bird Density (birds/mi^2 wetlands)	Species Richness	Species Diversity (H')
STRATUM III. Upland Small Lakes, Ponds, and Marshes (0.001-0.400 mi^2)				
Pond 1246.5 N. and S. of Alaska Highway Milepost 1246.5, Nabesna D-1 Quad., Sec. 3, T12N, R21E	0.008	875.0	1	0.100
Pond 1242.8 N. of Alaska Highway Milepost 1242.8, Nabesna D-1 Quad., Sec. 18, T12N, R22E	0.018	444.4	4	1.213
Pond 1238.5 N. of Alaska Highway Milepost 1238.5, Nabesna D-1 Quad., Sec. 27, T12N, R22E	0.009	444.4	2	0.693
Pond 1245.5 S. of Alaska Highway Milepost 1245.5, Nabesna D-1 Quad., Sec. 11, T12N, R21E	0.010	400.0	2	0.693
Pond 1242.0 N. of Alaska Highway Milepost 1242.0, Nabesna D-1 Quad., Sec. 18, T12N, R22E	0.018	333.3	3	1.011
Gardiner Creek wetlands N. of Alaska Highway Milepost 1246.6, Nabesna D-1 Quad., Sec. 3, T12N, R21E	0.022	227.3	2	0.500
Pond 1241 N. of Alaska Highway Milepost 1241.0, Nabesna D-1 Quad., Sec. 20, T12N, R22E	0.013	153.8	1	0.100
Pond 1239.5 N. of Alaska Highway Milepost 1239.5, Nabesna D-1 Quad., Sec. 21, 28, T12N, R22E	0.056	125.0	2	0.598
Island Lake N. of Alaska Highway Milepost 1231, Nabesna C-1 Quad., Sec. 28, 29, T11N, R23E	0.400	80.0	8	1.900
Lake 1256 S. of Alaska Highway Milepost 1256, Nabesna D-2 Quad., Sec. 33, 34, T14N, R20E	0.109	64.2	3	0.796
Lake 1255 SW. of Alaska Highway Milepost 1255, Nabesna D-2 Quad., Sec. 3, 4, T13N, R20E	0.206	24.3	4	1.332
Marsh 1248 N. of Alaska Highway Milepost 1248, Nabesna D-2 Quad., Sec. 32, T13N, R21E	0.012	0	0	0
Pond 1244.4 N. of Alaska Highway Milepost 1244.4, Nabesna D-2 Quad., Sec. 12, T12N, R21E	0.015	0	0	0
Marsh 1236 NE. of Alaska Highway Milepost 1236.0, Nabesna D-2 Quad., Sec. 2, T11N, R22E	0.007	0	0	0
Pond 1233 (Seaton Roadhouse Pond) W. of Alaska Highway Milepost 1233, Nabesna C-1 Quad., Sec. 13, T11N, R22E	0.010	0	0	0
STRATUM IV. Scottie Creek Valley Lakes, Small Lakes, Ponds, and Marshes				
Little Scottie Creek wetland E. of Alaska Highway Milepost 1222.5, Nabesna C-1 Quad., Sec. 24, 25, T10N, R23E	0.131	2564.8	15	2.092
Scottie Creek Lake #16, S. of Scottie Creek, Nabesna C-1 Quad., Sec. 7, T10N, R23E	0.350	1291.8	15	2.085
Scottie Creek Lake #17, S. of Scottie Creek, Nabesna C-1 Quad., Sec. 13, T10N, R22E; Sec. 18, T10N, R23E	0.600	1146.7	16	1.986
Pond 1225 W. of Alaska Highway Milepost 1225, Nabesna C-1 Quad., Sec. 11, T10N, R23E	0.012	500.0	5	1.561
Scottie Creek wetland, Creek and associated ponds from Little Scottie Creek to Chisana River	0.345	365.2	11	1.761
Scottie Creek Lake #15 S. of Scottie Creek, Nabesna C-1 Quad., Sec. 1, 15, T10N, R22E	0.300	210.0	14	2.288
Grace Lake W. of Alaska Highway Milepost 1224, Nabesna C-1 Quad., Sec. 14, T10N, R23E	0.188	127.7	6	1.577
Desper Creek wetlands, Creek and associated ponds from Alaska Highway Milepost 1224.5 to confluence with Scottie Creek	0.495	70.7	10	1.807
STRATUM V. Chisana River with adjacent sand and gravel bars and mud flats				
Chisana River from confluence with Scottie Creek, downstream to Northway Junction	2.400	77.9	9	0.843

sites are shown in Figure 2. Results of censuses on individual wetland sites are presented in Appendices A and B. Appendix A1-A16 includes census results for the larger sample units (>0.500 mi^2) or for units with high densities close to the proposed pipeline route. Appendix B includes census results of smaller sample units or those with low densities.

Calculation of mean density (birds/mi^2) and its standard deviation for each species and all species in each stratum was based on the "Estimation of a Ratio" method (Cochran 1963, p. 29). Calculation of the 95% confidence interval (95% C.I.) and use of the t-test to make statistical comparisons was according to Steel and Torrie (1960).

RESULTS AND DISCUSSION

Seasonal Chronology

Waterfowl and most migratory raptors generally arrive on the study area during the third week of April (Kessel, unpubl. data). In 1977 the first migrants to arrive at Tok were a group of 10 Whistling Swans on 18 April; they were followed by Marsh Hawks on 19 April and by flocks of Mallards, Pintails, and American Wigeon between 21 and 23 April (R. A. Skarrie, Bureau of Land Management, pers. comm). The first open fields, marshes, and ponds to thaw during this time are important or critical habitats, because the majority of the central Alaska wetlands are still frozen. Usually small streams, ponds, and marshes are the first to thaw, with the larger lakes and rivers not becoming ice-free until early May. The peak of spring migration for waterfowl and raptors is short,

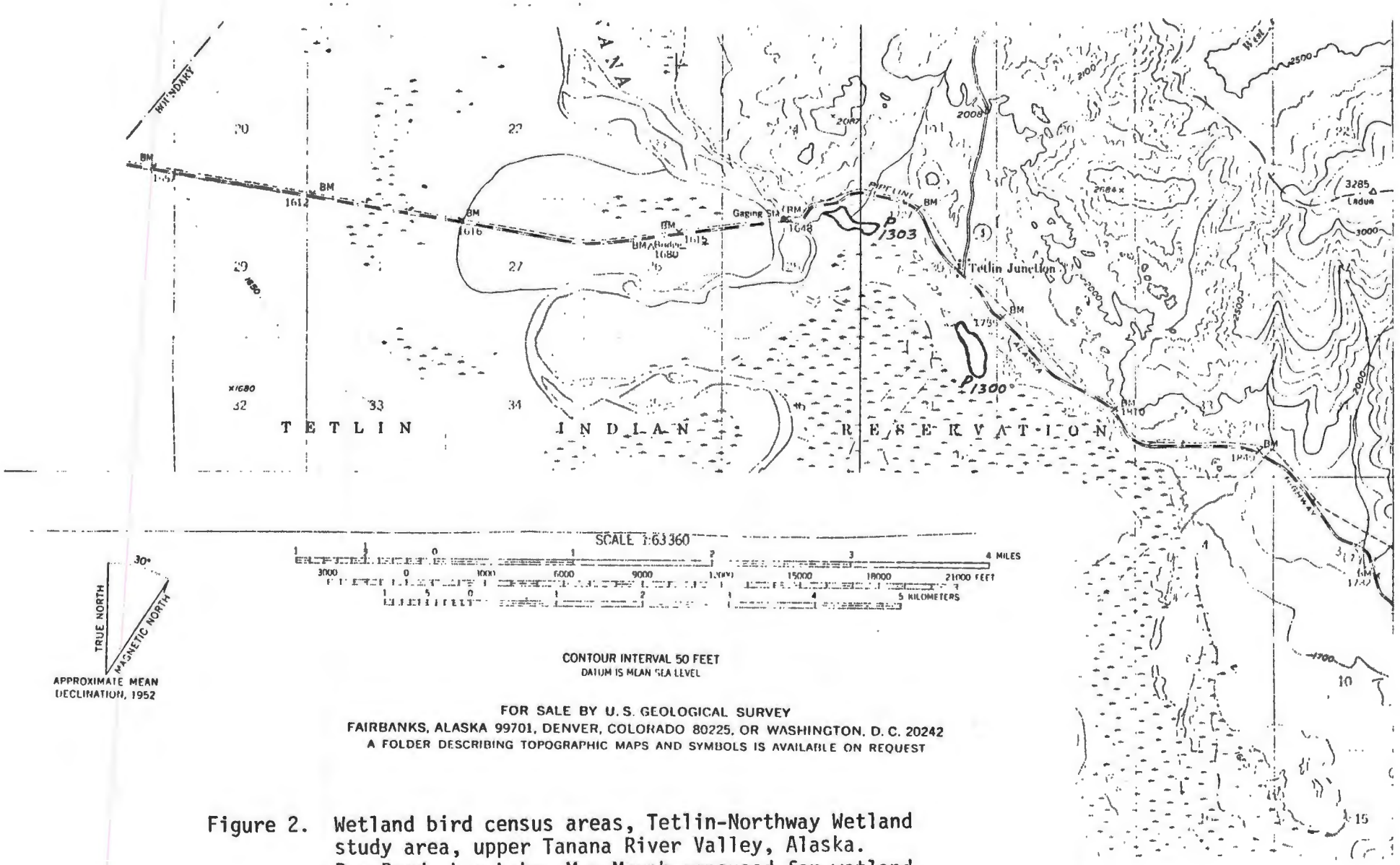
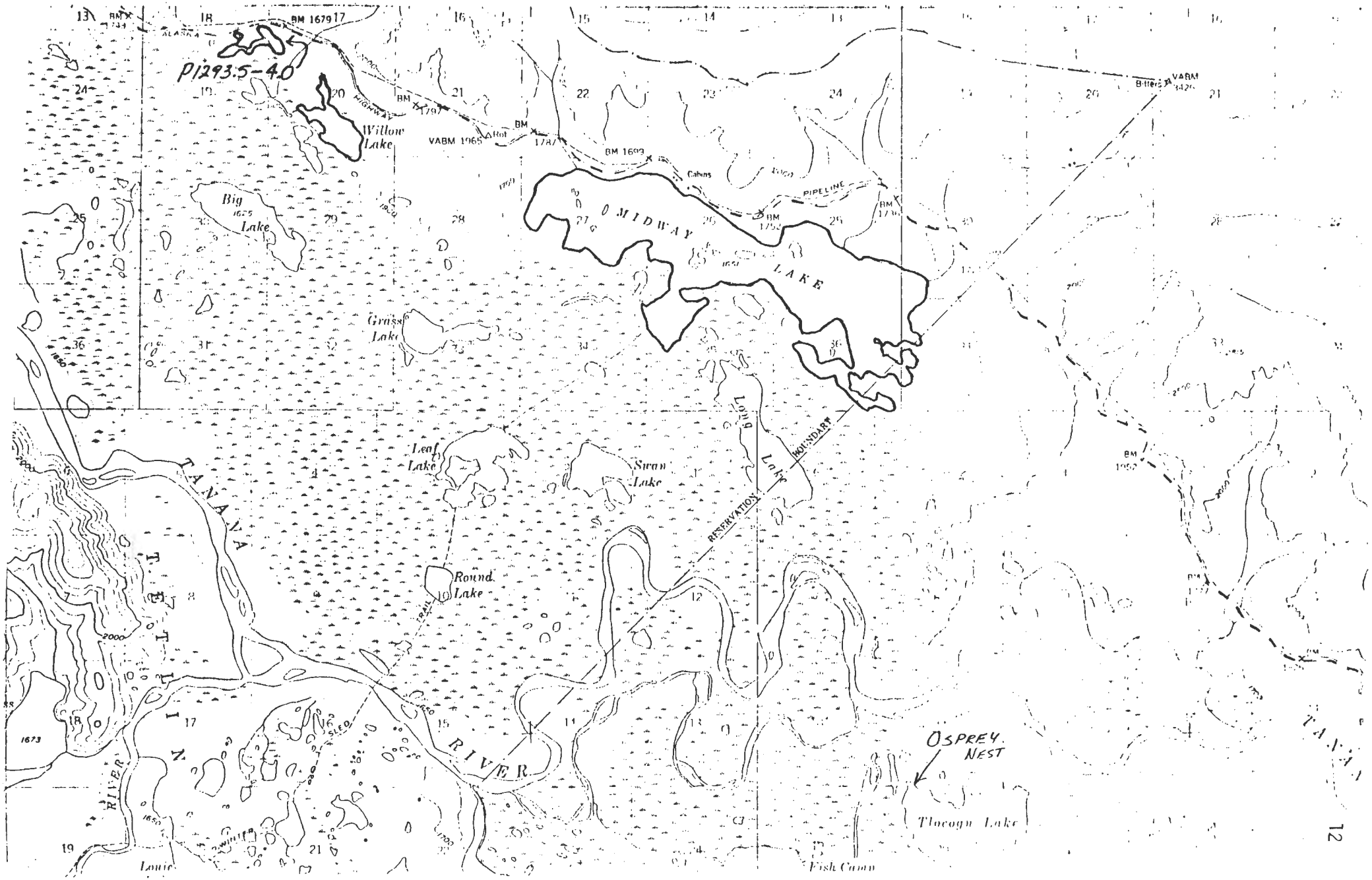


Figure 2. Wetland bird census areas, Tetlin-Northway Wetland study area, upper Tanana River Valley, Alaska. P = Pond, L = Lake, M = Marsh censused for wetland bird population estimates. RS = Roadside survey site.



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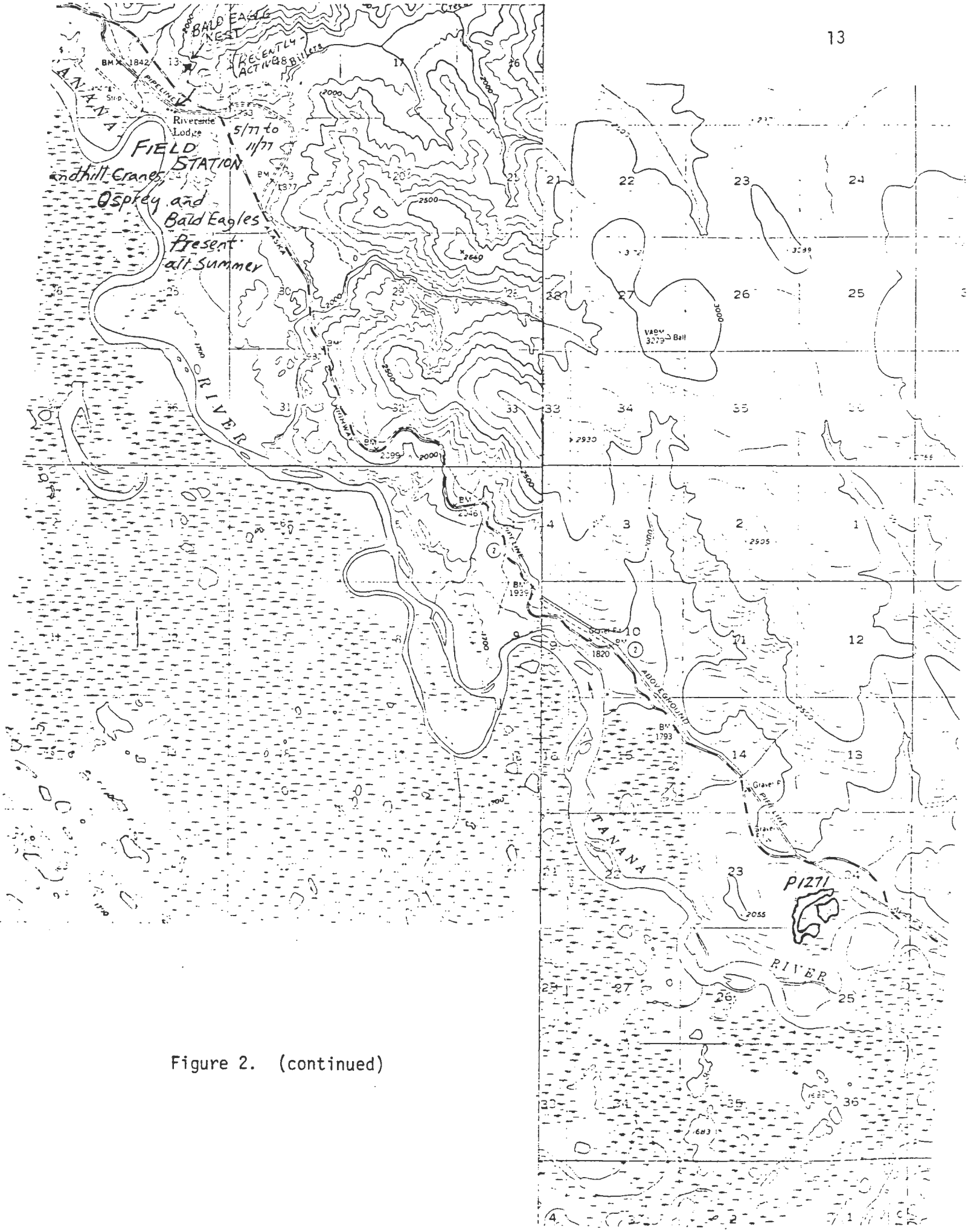

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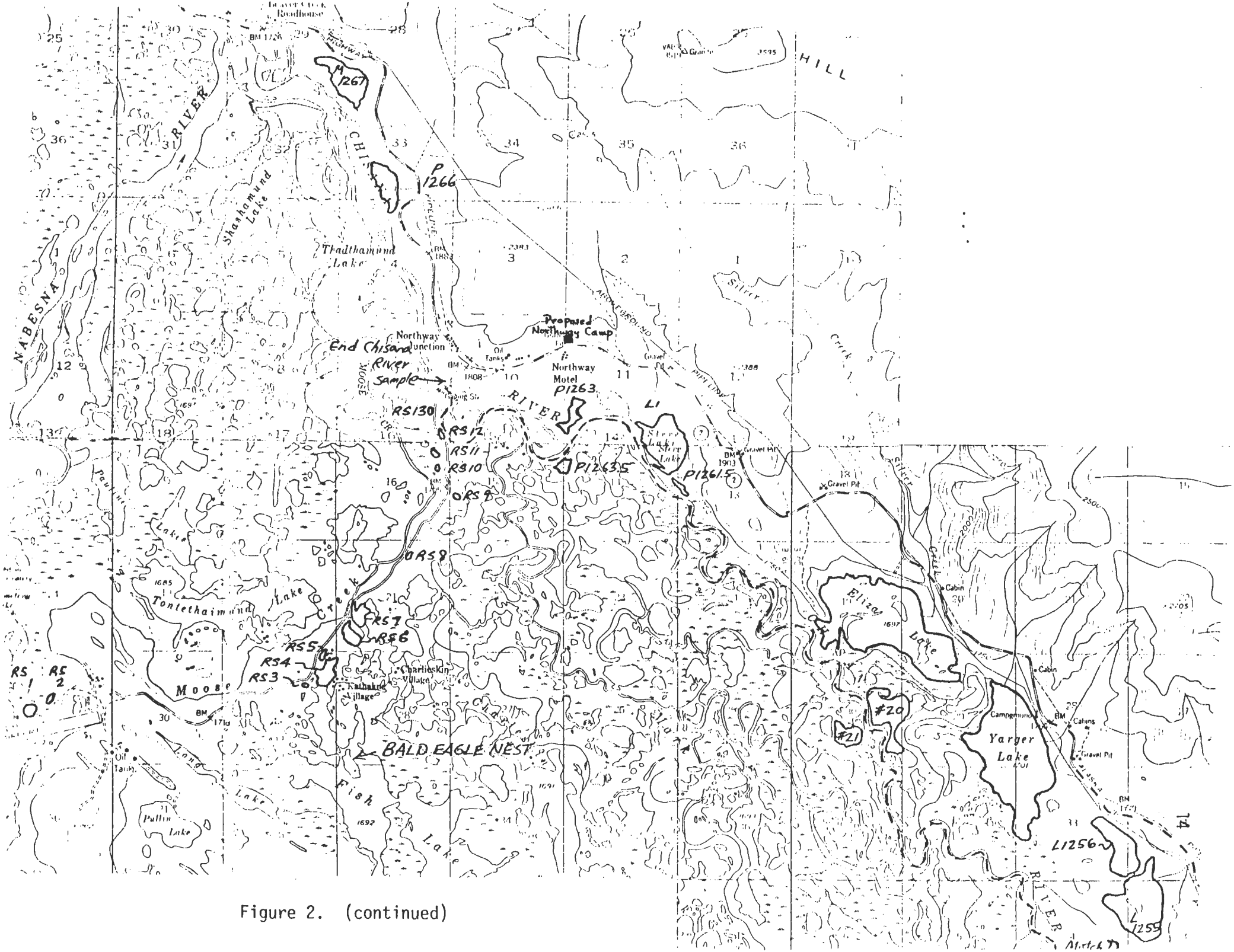

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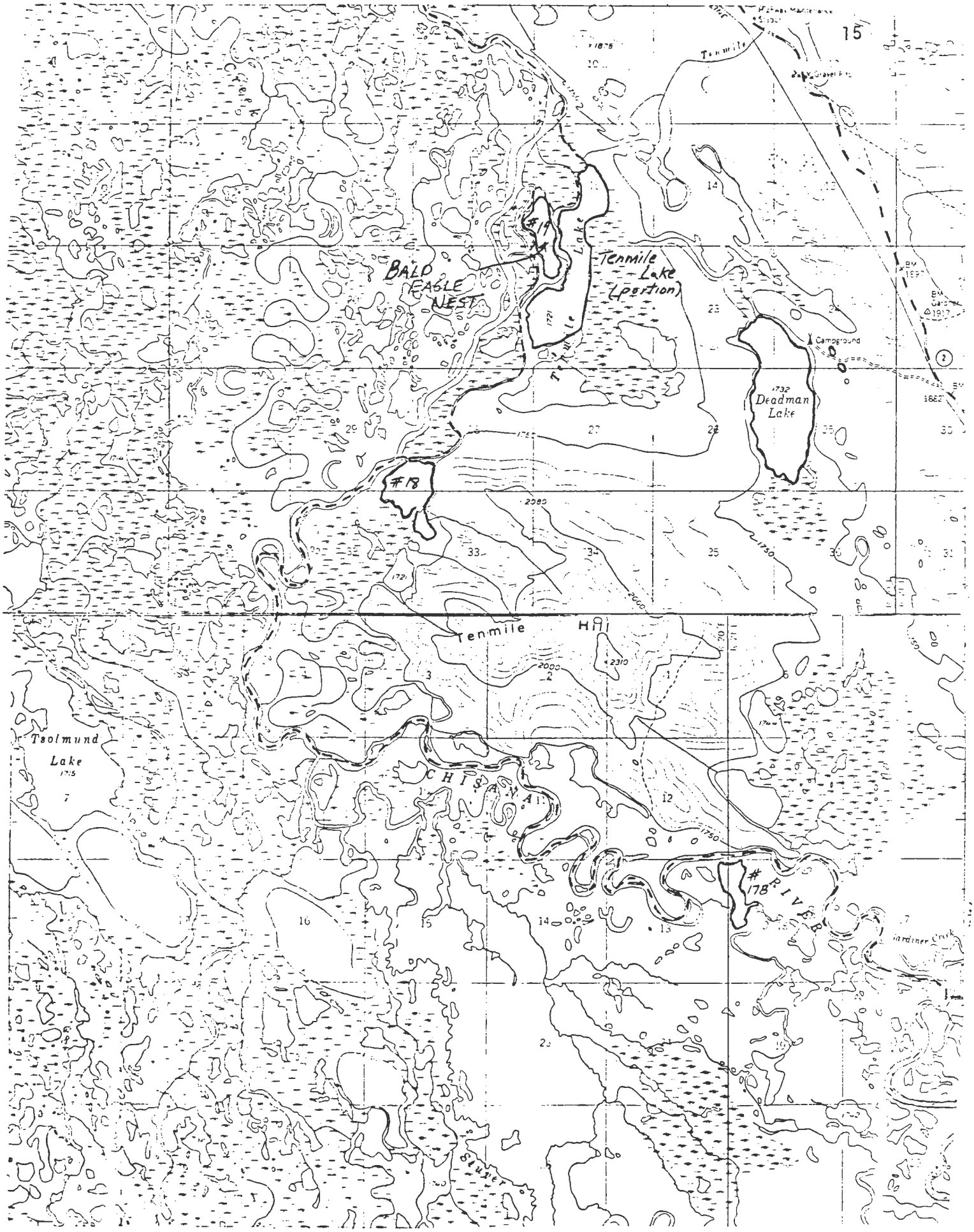

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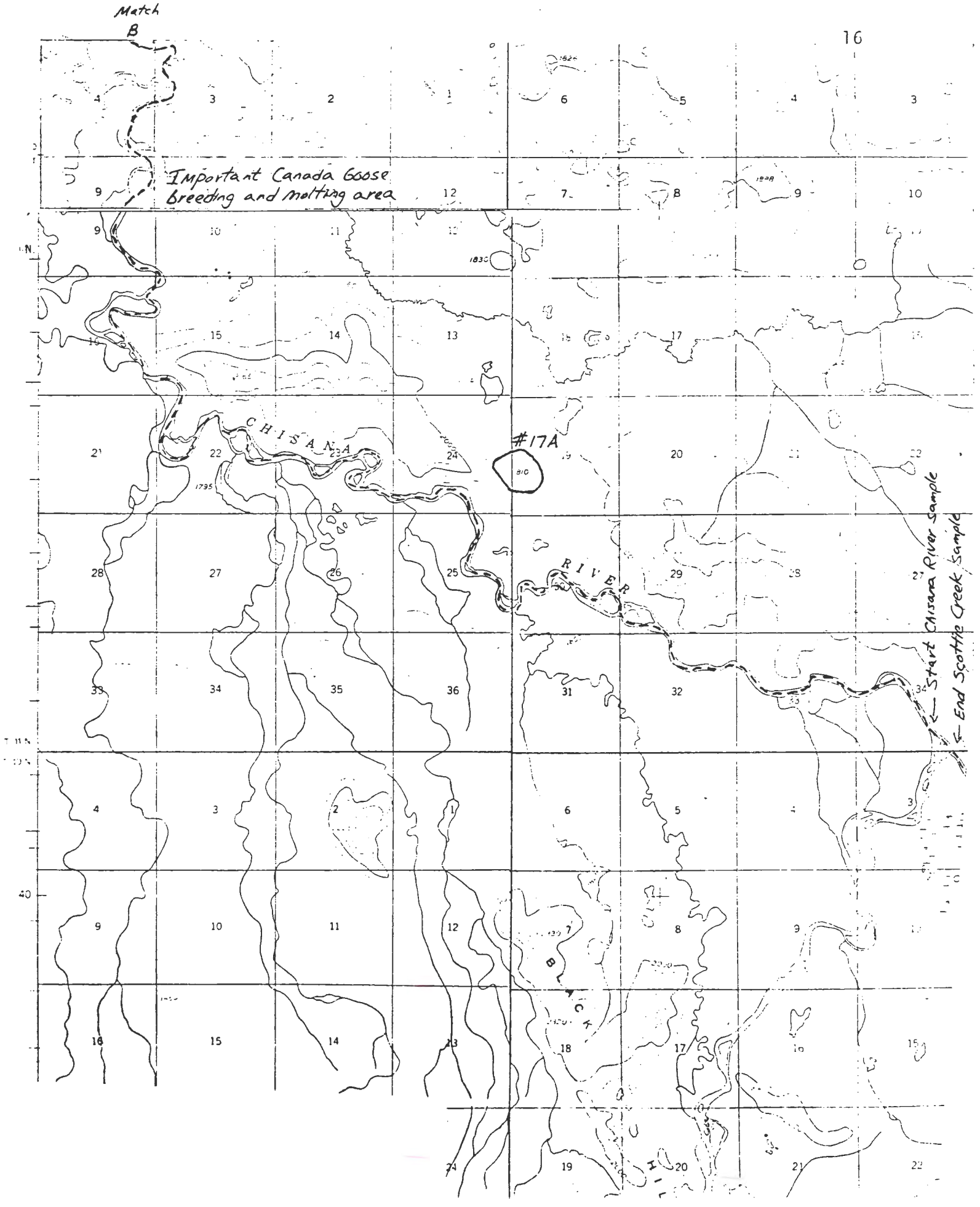

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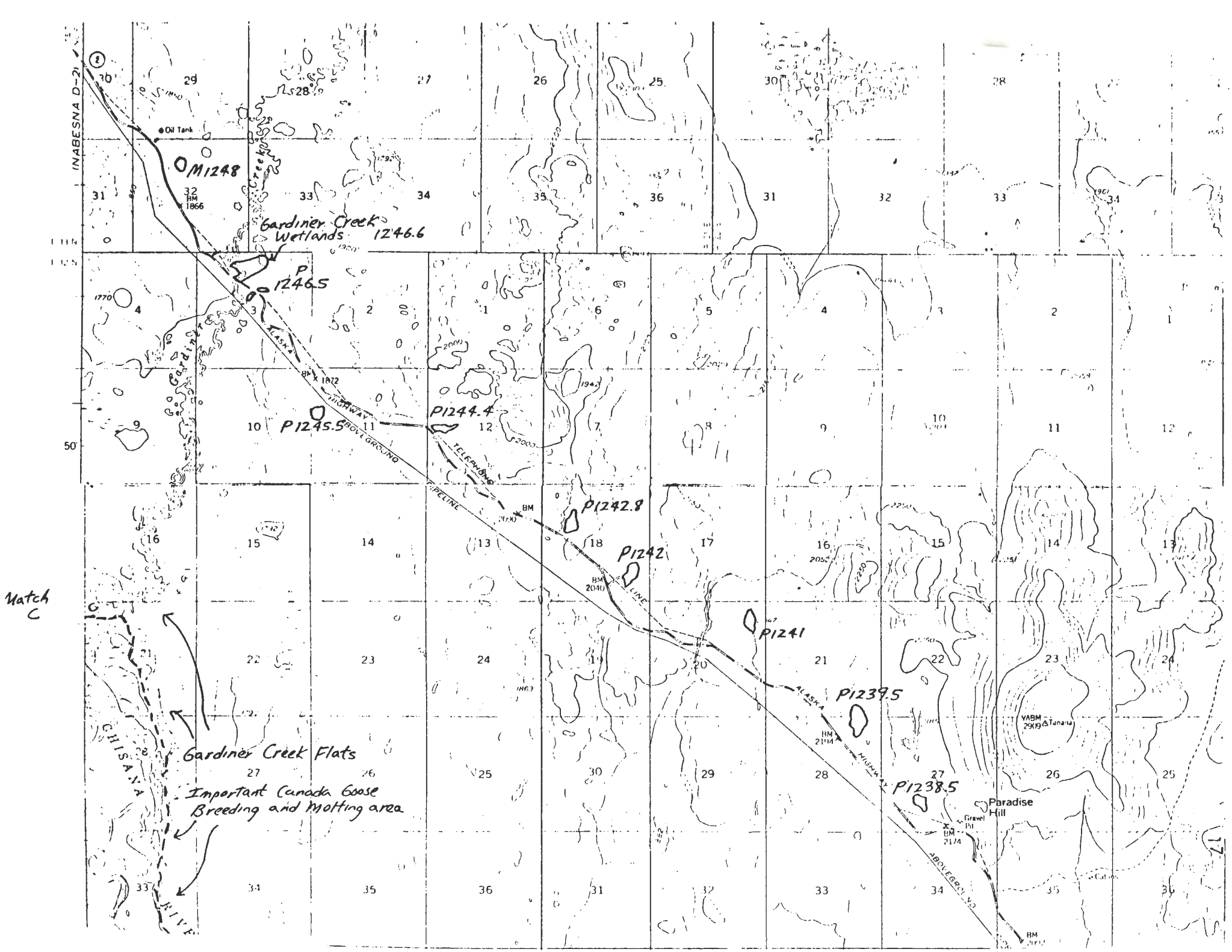

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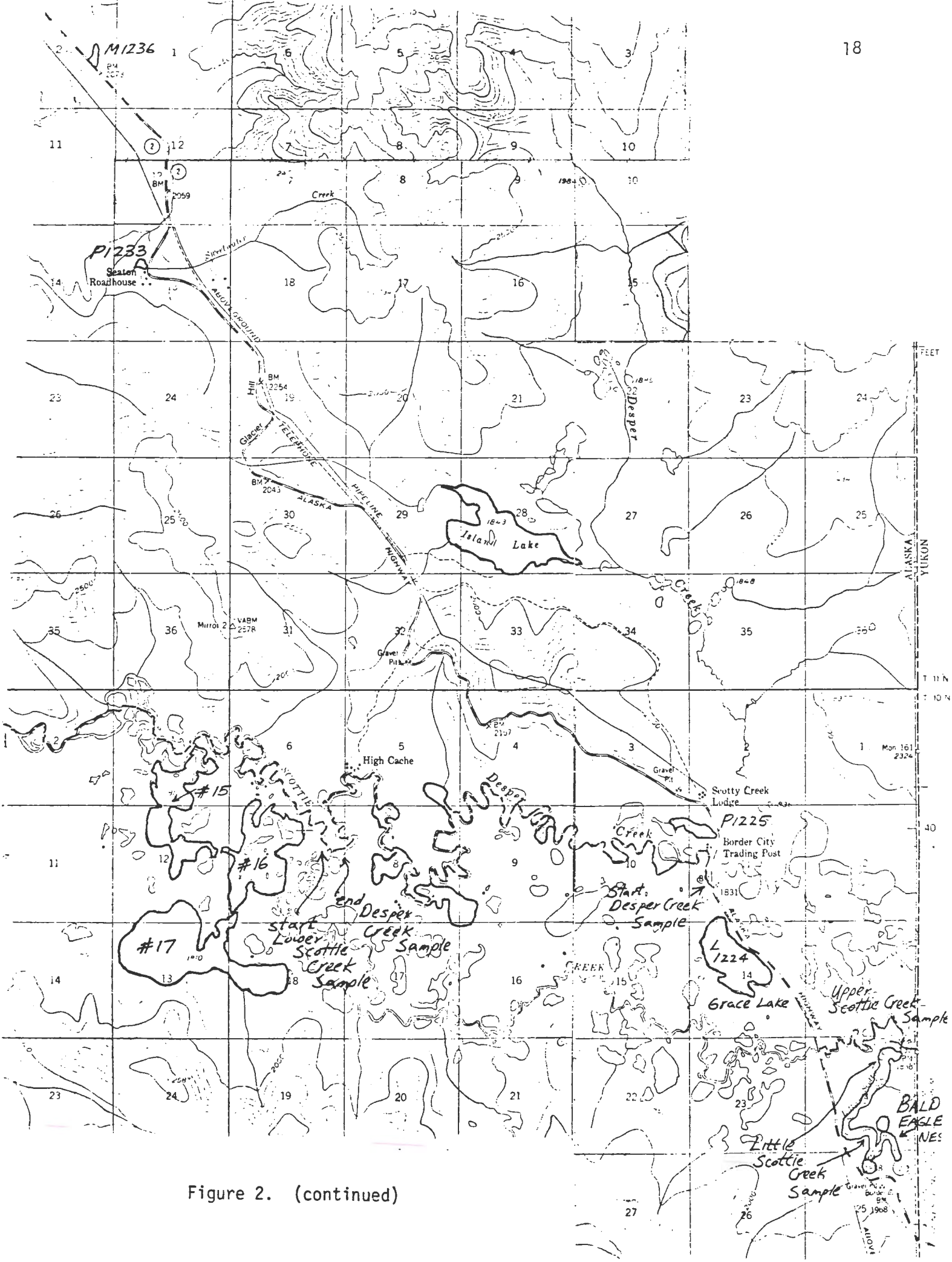

Figure 2. (continued)

and occurs between the last week of April and first week of May. The total span of migration is also short, from mid-April to mid-May for most wetland birds, although until late May for scaup (Kessel, unpubl. data).

Nesting by the early dabblers (Mallards and Pintails) on the study area usually begins in mid-May, although a few may begin egg-laying by the end of the first week of May (McKnight 1962; Kessel, unpubl. data). The peak of nesting activity in wetland birds generally occurs during the first three weeks of June, with the peak of hatching from mid-June to mid-July, with a few scaup not hatching until early August. The total nesting period, therefore, extends from mid-May until early August.

Data gathered throughout the season along the Northway Road showed that the highest numbers of wetland birds occurred in June (Table 2). During July, the numbers of adult birds declined, and young birds comprised a greater percentage of total birds observed. The total bird population along the road continued to decline from July to September.

A significant shift in wetland bird species composition also occurred in July along the Northway Road (Table 2). Shorebirds and diving ducks were most abundant in June, but they declined steadily through the remainder of the summer. Conversely, the numbers of dabbling ducks increased steadily toward September. Loons and Grebes were fairly stable through the summer, with the only fluctuations being the expected increase in numbers due to the appearance of young birds during July and August. The decline of shorebirds may be explained by their dispersal to other habitats in July, and migration in August. Mid-August is when

Table 2. Average number of wetland birds observed in the wetland habitats along the Northway Road (7 miles from Northway to junction with Alaska Highway), 13 June-16 September 1977. Based on 23 roadside counts with binoculars and spotting scope. A 95% confidence interval is given for the total numbers of adult and immature birds seen.

Species	June mean no. of birds	July mean no. of birds	August mean no. of birds	September mean no. of birds
Sample Size (# of counts)	8	8	4	3
Arctic Loon	1.6	0.3		
Red-necked Grebe (ad)	1.4	3.8	5.5	3.7
(imm)		4.6	2.5	2.0
Horned Grebe (ad)	3.6	3.8	2.5	0.7
(imm)		2.6		
Mallard (ad)	5.3	1.9	12.0	17.0
(imm)	0.9	2.3		
Pintail (ad)	0.3	1.1	7.8	9.3
(imm)	1.0	1.6		
American Wigeon (ad)	2.4	1.5	4.8	6.7
(imm)		0.3		
Northern Shoveler (ad)	3.0	0.1	2.8	1.3
(imm)		1.3		
Blue-winged Teal (ad)	1.3	0.8	0.3	3.3
(imm)		0.6		
Green-winged Teal (ad)	2.0	3.8	5.8	7.0
(imm)		1.6		
Canvasback (ad)	0.8	0.3		
(imm)	0.9			
Greater Scaup	0.3			
Lesser Scaup (ad)	18.8	8.6	0.3	1.7
(imm)			1.0	
Scaup spp. (ad)	12.4	13.1	4.5	3.3
(imm)		0.6	4.3	

Table 2. Continued

Species	June mean no. of birds	July mean no. of birds	August mean no. of birds	September mean no. of birds
Goldeneye spp.	0.9	1.8		
Bufflehead	0.6	0.5	1.3	1.3
Scoter spp.		0.1		
Sandhill Crane		0.3	0.3	
Solitary Sandpiper		0.1		
Spotted Sandpiper		0.1	0.5	
Lesser Yellowlegs	2.0	0.6		
Northern Phalarope	18.5	5.8		
Common Snipe	0.1		2.0	2.0
Mew Gull	0.6	0.4		
Bonapartes Gull	11.5	5.3		
Arctic Tern	1.0	0.5		
TOTAL adults	88.4±26.4	54.6±27.1	50.4±24.8	57.3±24.0
TOTAL immatures	2.8±4.4	15.5±5.0	7.8±1.7	2.0±2.3
TOTAL adults and immatures	91.2±30.5	70.1±27.8	58.2±24.4	59.3±25.6
TOTAL loons, grebes	6.6 (7.2%)	15.1 (21.5%)	10.5 (18.0%)	6.4 (10.8%)
TOTAL dabbling ducks	16.2 (17.8%)	16.9 (24.1%)	33.5 (57.7%)	44.6 (75.3%)
TOTAL diving ducks	34.7 (38.0%)	25.0 (35.7%)	11.4 (19.5%)	6.3 (10.5%)
TOTAL shorebirds	33.7 (37.0%)	12.8 (18.3%)	2.5 (4.3%)	2.0 (3.4%)
TOTAL miscellaneous		0.3 (0.4%)	0.3 (0.5%)	

most shorebird species leave central Alaska for their wintering grounds (Kessel, unpubl. data). The declining diving duck numbers beginning in July may be explained by their movement from small breeding ponds to larger lakes for the molting and fall staging periods.

During their flightless period, the diving ducks gathered in large flocks on the larger lakes--Midway, Deadman, Yarger, Eliza, Tlocogn, Scottie Creek Lakes #16 and #17, and Chisana Pond #17A. McKnight (1962) indicated that Tetlin lakes (the complex of large lakes including Tetlin Lake, Gasoline Lake, Fish Lake, Dathlalmund Lake [= Butterfly Lake], and Old Albert Lake) were used extensively by molting diving ducks between mid-July and early September 1955-1961. Dabbling ducks, however, molted in small pond and marsh habitats throughout the area, a situation also noted in 1977. The peak of the flightless period for dabbling ducks is generally 2-3 weeks earlier than for diving ducks (McKnight 1962), with young loons, grebes, and most duck species not capable of flight until mid- to late-August. Hence, flightless waterfowl occur on the Tetlin-Northway Wetlands from mid-June to late August-early September.

Fall migration extends over a much longer period (mid-July to mid-October) than spring migration (Kessel, unpubl. data). By late August 1977 nearly all the shorebirds had departed, and most duck species were staging on the larger lakes. The first flocks of White-fronted Geese passed through the study area on 19 August. A total of 3,000 White-fronted Geese had migrated past Northway by 11 September. Most duck species had left by 18 September, and the peak of Sandhill Crane migration

occurred on 19 September. Peak numbers of migrating raptors occurred between 17 and 23 September; the last Peregrine Falcon was observed 22 September, and the last Bald Eagle on 23 September. Other final observation dates for 1977 were: Marsh Hawk, 8 October; Canada Goose, 14 October; Whistling Swan, 17 October; Red-breasted Merganser, 18 October; and Rough-legged Hawk, 19 October. The last observation of waterfowl was three Mallards on an open portion of the Tanana River near Riverside Lodge on 3 November. Generally, the last observations of waterfowl each year coincide with the last available open water (Kessel, unpubl. data).

Population Density

From the data presented above, it can readily be seen that wetland bird populations are exceedingly variable temporally; population densities may change ten-fold during the natural course of a season. Also, annual variations in total population, breeding population, reproduction, and species composition are frequently caused by climatic and other factors. That prairie-pothole nesting waterfowl often invade subarctic and arctic regions during periods of drought has been well documented (McKnight 1962, Hansen and McKnight 1964, Crissey 1969, and Smith 1970). The year 1977 was such a year. King (1977) reported that May 1977 waterfowl densities in the Tanana and Kuskokwim river valleys were 33% higher than its long-term mean, and suggested that it was a direct result of drought in more southern areas. Another complicating factor was that while total population in 1977 was higher, production suffered, at least in

part, from abnormally high water levels, which flooded many nests (see U.S. NOAA 1977 for high May and June precipitation records).

The 1977 censuses provided data covering a wide range of wetland habitats and hence a wide range of population densities. In the following presentations, we have estimated population in terms of birds per square mile (birds/mi^2) of actual wetland habitat. (Since wetland bird populations may also be expressed as birds per square mile of surface area, irrespective of the amount of wetland habitat comprising that surface area, an estimate of the percent of surface area which is composed of perennial wetlands is given for each stratum [Table 3] so that estimates for each sample unit may be converted for comparison with other Northern American studies using this form of measurement; densities in birds/mi^2 surface for each stratum in the Tetlin-Northway Wetlands are given in Table 4).

The highest wetland bird population was observed in the Scottie Creek Valley, Stratum IV (714.4 birds/mi^2 wetlands; Table 4). The Tanana-Chisana Valley, Stratum II (503.9 birds/mi^2) and the Large Lakes, Stratum I, which occurs in the same region (479.4 birds/mi^2) had moderately high populations densities. These three population estimates, taken together, compare favorably with the density of 607.5 birds/mi^2 surface area that King (1977) estimated from an 8 mi^2 aerial transect flown over similar habitat between Northway and Tetlin Lake in May 1977 (Table 5). Strata showing considerably lower population densities were Upland Small Lakes, Ponds, and Marshes, Stratum III (95.5 birds/mi^2 wetlands) and the Chisana River, Stratum V (78.0 birds/mi^2) (Table 4).

Table 3. Per cent of surface area of the Tetlin-Northway Wetlands study area which was composed of perennial wetlands, based on systematic samples of 1-mi^2 blocks on 1:63,360 U.S.G.S. Quadrangle maps.

Habitat Area Stratum	Per cent which is wetland (%)	Minimum sample (mi^2 of wetland)	Maximum sample (mi^2 of wetland)	Number of 1-m^2 samples	Estimated percentage of each stratum on Tetlin-Northway Wetlands
Large Lakes (50% of Stratum I)	100.00	0.550	1.0	4	10
Tetlin-Gasoline Lake[1] (50% of Stratum I)	43.33	0.100	0.9	30	10[1]
Tanana-Chisana Valley (Stratum II)	26.19	0.500	0.7	42	50
Scottie Creek Valley (Stratum IV)	19.80	0.010	0.5	24	5
Uplands Small Lakes, Ponds, and Marshes (Stratum III)	3.37	0.007	0.5	26	20
Chisana River	100.00	(Not sampled--assumed to be 100.00% at mean water level during July, which is about average. Water levels in May and June tend to be lower than July. August water levels tend to be much higher than July).			5

Weighted Average[2] = 34.1%

[1]McKnight's (1962) study area, included here for comparative purposes. In total population estimate for our 1977 study, this area was combined with the Large Lake habitat, as 50% of the Stratum I surface area.

[2]Represents a best estimate for the mean proportion of surface area in the 730-mi^2 Tetlin-Northway Wetlands study area which consists of perennial wetlands.

Table 4. Comparison of wetland bird population estimates for five different strata in the Tetlin-Northway wetland study area. Data are based on 45 separate censuses on 45 different sites, covering a total area of 11.642 mi^2. Statistical estimates are followed by 95% Confidence Limits (C.I.). Censuses were conducted 6-25 July 1977.

Characteristic	Stratum I Large Lakes (>0.5 mi^2)		Stratum II Tanana-Chisana Valley		Stratum III Upland Small Lakes, Ponds, Marshes		Stratum IV Scottie Creek Valley		Stratum V Chisana River, Sand Bars, and Mud Flats	
Sample Size (n)	4		17		15		8		1	
Sample Area (mi^2)	4.065		1.843		0.913		2.421		2.400	
Density (birds/mi^2 wetland)	479.4±120.8		503.9±62.1		95.5±37.6		714.4±299.5		78.0±0	
Density (birds/mi^2 surface area)	479.4±120.8		132.0±17.6		3.2±1.3		141.5±59.3		78.0±0	
Community Diversity (per stratum)										
Species Richness	27		29		18		27		9	
Species Diversity (H')	2.195		2.768		2.509		2.607		0.843	
Dominance (%)	55.0		33.4		29.7		30.0		86.0	
Site Diversity (per site within stratum)										
Mean Species Richness	17.0±2.8		6.3±1.9		2.1±1.2		11.5±3.4		9	
Mean Species Diversity (H')	1.955±1.600		1.400±0.300		0.582±0.300		1.895±0.213		0.843	
Production										
Young birds/mi^2 (wetland)	52.9±14.6		101.5±15.3		24.1±6.6		162.3±65.2		2.5±0	
Broods/mi^2 (wetland)	12.4±4.7		32.6±5.7		11.0±3.3		26.4±9.5		0.4±0	
Diving Duck Sex Ratio (% males)	39.8		23.6		14.5		40.5		no data	
Dabbling Duck Sex Ratio (% males)	62.2		9.7		12.7		16.9		no data	
Species Composition	%	birds/mi^2	%	birds/mi^2	%	birds/mi^2	%	birds/mi^2	%	birds/mi^2
Loons and Grebes	8.5	40.8	9.5	47.7	29.8	28.5	2.0	14.0	0	0
Dabbling Ducks	4.1	19.7	12.5	62.9	15.0	14.3	30.6	218.6	8.6	6.7
Diving Ducks	71.5	343.2	43.8	220.4	40.2	38.4	44.8	320.8	1.0	0.8
Raptors	0.1	0.2	1.5	7.6	2.3	2.2	0.5	3.3	2.2	1.7
Shorebirds	15.8	75.5	32.4	163.3	11.5	11.0	22.0	156.9	8.1	6.3
Other	0	0	0.3	1.6	1.2	1.1	0.1	0.8	80.1	62.5*

*All Canada Geese

Table 5. Aerial waterfowl transect data for Tetlin-Northway Wetlands, 24 May 1977, from King (1977), expressed in birds/mi^2 surface area, using standardized waterfowl aerial census procedures.

	8 mi^2 surface area sample Northway to Tetlin Lake	18 mi^2 surface area sample along Haines Petroleum Pipeline Tetlin Junction to Canada Border
Mallard	39.5	.7
American Wigeon	56.7	
Green-winged Teal	33.3	1.1
Northern Shoveler	14.4	
Pintail	145.3	5.2
Redhead	24.8	
Canvasback	33.4	
Lesser Scaup	168.0	3.0
Goldeneye spp.	26.1	
Bufflehead	14.4	.9
Oldsquaw	26.0	.7
Scoter spp.	23.7	.9
Unidentified	1.9	.2
TOTAL	607.5	12.7

King (1977) estimated 12.7 birds/mi^2 surface area on an 18 mi^2 aerial transect over 72 linear miles of Haines Petroleum Pipeline right of way (Table 5). The above data show that per unit area of wetland and per unit surface area, the lowland habitats were far more productive of birds than were wetlands in the hills north of the Tanana-Chisana Valley (t-test $p<0.01$). One major exception was the turbid, glacial, cold waters of the lowland Chisana River, which had the lowest population density observed. Scottie Creek overwhelmingly had the highest population density (t-test $p<0.001$).

An estimate of total bird population in the Tetlin-Northway Wetland study area in July 1977 can be made by combining stratum means into an estimate weighted according to the differing surface area occupied by each stratum (Stratified Random Sampling with variable sampling fractions). The overall study area wetland bird density and 95% Confidence Interval was 406.6 $\pm$ 140.1 birds/mi^2 of wetland area (Table 6). Using the estimate of 34.1% perennial wetland on the 730 mi^2 study area (Table 3), a surface area density of 138.7 $\pm$ 47.8 birds/mi^2 was calculated, and a total population of 101,251 $\pm$ 34,894 birds was estimated. We are 95% confident that the total wetland bird population in the 730 mi^2 Tetlin-Northway Wetlands in July 1977 was in the range of 66,357 to 136,145 birds, unless a 1 in 20 sampling or estimation error has occurred. McKnight (1962) estimated the June 1961 waterfowl population of his 700 mi^2 study area at 55,077 birds. There are three probable reasons that our estimate is larger than McKnight's: 1) We included all wetland birds in our population censuses, and a sizeable portion of the July population

Table 6. Relative abundance and density of wetland birds in the Tetlin-Northway Wetlands study area. Data is based on censuses at 45 sites, 6-25 July 1977. Total census area was 11.642 mi^2.

Species	Density (birds/mi^2 wetland)	Relative Abundance %
Lesser Scaup	121.2	29.7
Northern Phalarope	38.0	9.5
Bufflehead	37.6	9.2
Horned Grebe	26.5	6.5
Arctic Tern	24.8	6.1
Green-winged Teal	17.3	4.3
American Wigeon	16.8	4.1
Canvasback	16.6	4.1
Lesser Yellowlegs	14.6	3.6
White-winged Scoter	14.0	3.4
Mallard	13.6	3.3
Arctic Loon	11.9	2.9
Bonaparte's Gull	10.4	2.6
Mew Gull	7.0	1.7
Red-necked Grebe	5.6	1.4
Pintail	5.4	1.3
Goldeneye spp.	5.2	1.3
Solitary Sandpiper	3.6	0.9
Canada Goose	3.1	0.8
Common Snipe	2.2	0.5
Spotted Sandpiper	2.1	0.5
Northern Shoveler	2.1	0.5
Greater Scaup	2.1	0.5
Belted Kingfisher	0.8	0.2
Surf Scoter	0.7	0.2
Scoter spp.	0.7	0.2
Blue-winged Teal	0.5	0.1
Baird's Sandpiper	0.4	0.1
Least Sandpiper	0.4	0.1
Marsh Hawk	0.4	0.1
Bald Eagle	0.4	0.1
Harlan's Hawk	0.4	0.1
Semipalmated Plover	0.2	0.1

TOTAL density (birds/mi^2 wetland) 406±140.1 (95% C.I.)
TOTAL density (birds/mi^2 surface area) 138.7±47.8 (95% C.I.)

consisted of shorebirds (see Table 4; also, discussion of species composition). 2) We considered an additional 30 mi^2 of upland habitat adjacent to the proposed gas pipeline route. 3) The 1961 population estimate was from a year when continential waterfowl populations were generally below normal and Alaska populations were generally above normal, but not as high as the peak invasion of prairie ducks in 1959 (Hansen and McKnight 1964). If 1977 was a peak invasion year, our higher estimate seems realistic.

Species Diversity

Each wetland stratum has an assemblage of species of varying abundances. Species diversity increases as two components increase--Species Richness (number of species) and Species Equitability (eveness with which species are distributed). A community is said to be "diverse" when it has a large number of species, each of equal abundance. Conversely, a community is "simple" when it supports few species or a number of species of which only one or two are abundant. An index which incorporates the two components of diversity into one mathematical function, "H'," has been widely applied by ecologists, and is convenient for comparing diversity of communities (Shannon and Weaver 1949, Peilou 1966); the higher the diversity, the higher the H' value or "Diversity Index." Theoretically, the higher the diversity, the more stable the community, and vise versa.

Species diversity of wetlands may be examined in two ways--the diversity of each individual lake, pond, or marsh within a stratum (Site Diversity), or the diversity of a number of such wetland sites grouped

together as a single stratum of similar habitat types (Community Diversity). Large lakes showed the greatest Site Diversity, averaging 17 species on each lake and an H' value of 1.955 (Table 4) (t-test $p<0.01$). A high Species Richness and Site Diversity were also observed in the small lakes, ponds, and marshes of Scottie Creek Valley, within Stratum IV (average of 11.5 species per site and an H' value of 1.895). The small lakes, ponds, and marshes of the Upland areas, within Stratum III, had the lowest Species Richness and Site Diversity (average of 2.1 species per site and an H' value of 0.582).

Community Richness and Community Diversity showed a markedly different pattern. Collectively, Stratum II wetlands (Tanana-Chisana Valley) had the highest Species Richness and Community Diversity (29 species; H'=2.768; Table 4). Both Stratum IV (Scottie Creek Valley) and Stratum I (Large Lakes) had nearly as many species (27 each). Although Stratum III wetlands (Upland Small Lakes, Ponds, and Marshes), collectively, had a low number of species (18), Community Diversity was fairly high (H'=2.509) because of the relative eveness of the distribution of these species. Stratum I (Large Lakes) and Stratum V (Chisana River) had the lowest Community Diversity (with H'=2.195).

In summary, Species Richness per site and Site Diversity were directly correlated with size of site, i.e., the size of the individual lake, pond, or marsh (Species Richness: $y = 11.4x + 4.4$, $r = 0.74$, t-test $p<.001$; Site Diversity: $y = 0.89x + 1.08$, $r = 0.45$, t-test $p<0.01$). Community Diversity was directly related to the number of wetland sites within the stratum (= community) (Community Diversity: $y = 0.09x + 1.38$

$r = 0.79$, t-test $p<0.02$). Noteworthy, also, is the fact that while the individual small lakes, ponds, and marshes of the Tanana-Chisana Valley (Stratum II) and the Uplands (Stratum III) were not diverse nor did these support large numbers of birds, collectively they were the most diverse communities of the entire Tetlin-Northway Wetland study area.

Species Composition

The estimates of density and relative abundance of each wetland bird species for the entire Tetlin-Northway Wetlands study area were derived from the average of species density estimates from each stratum, weighted according to the proportion of total area occupied by the stratum. Density estimates for wetland species in each of the five strata are presented in Tables 7-11.

The Lesser Scaup was the most abundant species over the entire study area (Table 6). Eight other species exhibited high densities on the area (in order of abundance): Northern Phalarope, Bufflehead, Horned Grebe, Arctic Tern, Green-winged Teal, American Wigeon, Canvasback, and Lesser Yellowlegs. Diving ducks were most abundant in the Large Lakes, Stratum I (71.5% of all birds or 343.2 birds/mi^2; Table 4). A majority of the divers were Lesser Scaup, Buffleheads, White-winged Scoters, and Canvasbacks. Horned Grebes also reached their greatest non-breeding abundance in the Large Lakes (Table 7). Several flocks of molting, non-breeding Horned Grebes appeared on the Large Lakes in mid- and late-July.

Table 7. Summary of wetland bird census results for Stratum I, Large Lakes (>0.5 mi^2), Tetlin-Northway Wetland study area. Censuses were conducted 7-17 July 1977. Census area was 4.065 mi^2 and consisted of the four largest lakes on the study area: Midway Lake, Eliza Lake, Yarger Lake, and Deadman Lake.

Species	Density ($birds/mi^2$) wetlands	95% Confidence Interval	Standard Deviation	Frequency of Occurrence (%)
Scaup spp.	218.9	55.8	216.8	100
Bufflehead	44.8	12.5	43.8	100
N. Phalarope	27.8	7.3	23.0	25
Horned Grebe	26.6	5.9	17.4	75
Lesser Scaup	17.7	6.0	17.6	100
White-winged Scoter	17.0	5.8	16.7	75
Arctic Tern	16.2	5.3	14.9	75
Canvasback	15.3	5.2	14.3	50
Bonaparte's Gull	13.8	4.9	13.2	100
Surf Scoter	13.3	4.7	12.3	50
Lesser Yellowlegs	10.1	3.9	9.1	75
Red-necked Grebe	9.3	3.9	9.4	100
Greater Scaup	9.3	3.7	8.6	50
Mallard	7.9	3.5	7.5	75
American Wigeon	5.9	2.9	5.3	25
Mew Gull	5.2	2.9	5.2	100
Arctic Loon	4.9	2.8	4.8	100
Scoter spp.	3.7	2.3	2.9	50
Goldeneye spp.	3.2	2.3	2.9	50
Green-winged Teal	3.0	1.8	0.9	50
Blue-winged Teal	2.0	2.0	1.6	25
Spotted Sandpiper	1.7	2.0	1.7	75
Pintail	0.7	1.7	0.6	25
Solitary Sandpiper	0.5	1.7	0.3	25
Common Snipe	0.2	1.6	0.2	25
Bald Eagle	0.2	1.6	0.2	25
Northern Shoveler	0.2	1.6	0.2	25
Total	479.4	120.8	476.9	

Diversity

Species Richness for stratum = 27
Species Diversity (H') for stratum = 2.195
Mean Species Richness for units samples = 17.0 ± 7.6 (4.8 std. dev.)
Maximum Richness = 24 Minimum Richness = 13
Mean Species Diversity (H') for units sampled = 1.955 ± 0.300 (0.175 std. dev.)
Maximum Diversity = 2.101 Minimum Diversity = 1.710
Dominance = 55.0%

Production

Broods/mi^2 = 12.4 ± 19.7 95% C.I. (± 12.4 std. dev.)
Young birds/mi^2 = 52.9 ± 82.7 95% C.I. (±52.0 std. dev.)
Mean brood size = 4.2

Diving Duck Sex Ratio (M:F) = 14.8:22.4/mi^2 = 39.8% males
Dabbling Duck Sex Ratio (M:F) = 20.2:12.3/mi^2 = 62.2% males.

Table 8. Summary of wetland bird census results for Stratum II, Tanana-Chisana Valley Small Lakes, Ponds, and Marshes (<0.5 mi^2), Tetlin-Northway Wetland study area. Censuses were conducted 6-24 July 1977. Census area was 1.843 mi^2, and consisted of 17 small lakes, ponds and adjacent marshes.

Species	Density ($birds/mi^2$) wetlands	95% Confidence Interval	Standard Deviation	Frequency of Occurrence (%)
Scaup spp.	101.5	37.3	72.5	35.3
Northern Phalarope	66.7	26.6	51.9	17.6
Bufflehead	44.0	1.9	3.6	52.9
Arctic Tern	36.4	5.3	10.4	17.6
Lesser Scaup	29.8	4.2	8.1	29.4
Horned Grebe	26.0	2.8	5.5	52.9
White-winged Scoter	24.4	11.0	21.4	5.9
American Wigeon	23.3	5.6	10.9	41.2
Lesser Yellowlegs	21.2	4.3	8.3	35.3
Mallard	15.7	2.3	4.5	52.9
Green-winged Teal	14.7	2.0	3.9	29.4
Arctic Loon	14.7	2.7	5.2	47.1
Canvasback	14.1	1.5	3.0	29.4
Bonaparte's Gull	11.9	3.7	7.2	11.8
Least Sandpiper	11.9	4.3	8.4	5.9
Mew Gull	8.7	0.9	1.7	17.6
Red-necked Grebe	7.0	0.5	1.0	29.4
Pintail	7.0	0.8	1.5	29.4
Goldeneye spp.	6.0	2.6	5.0	11.8
Common Snipe	3.8	1.2	2.4	11.8
Semipalmated Plover	3.8	1.3	2.6	5.9
Solitary Sandpiper	3.3	0.9	1.8	17.6
Baird's Sandpiper	2.7	1.0	1.9	5.9
Northern Shoveler	2.2	0.7	1.3	11.8
Belted Kingfisher	1.1	0.5	1.0	5.9
Marsh Hawk	0.5	0.2	0.4	5.9
Surf Scoter	0.5	0.3	0.5	5.9
Bald Eagle	0.5	0.3	0.5	5.9

Diversity

Species Richness for stratum = 29
Species Diversity (H') for stratum = 2.768
Mean Species Richness for units sampled = 6.3 ± 1.9 (3.7 std. dev.)
Maximum Richness = 14 Minimum Richness = 0
Mean Species Diversity (H') for units sampled = 1.400 ± 0.300 (0.560 std. dev.)
Maximum Diversity = 2.369 Minimum Diversity = 0.000
Dominance = 33.4%

Production

Broods/mi^2 = 32.6 ± 5.7 95% C.I. (± 11.0 std. dev.)
Young birds/mi^2 = 101.5 ± 15.3 95% C.I. (± 29.7 std. dev.)
Mean Brood Size = 3.1

Diving Duck Sex Ratio (M:F) = 18.7:60.7/mi^2 = 23.6% males
Dabbling Duck Sex Ratio (M:F) = 6.4:59.7/mi^2 = 9.7% males

Table 9. Summary of wetland bird census results for Stratum III, Upland Small Lakes, Ponds, and Marshes (0.001-0.400 mi^2), Tetlin-Northway Wetland study area. Census area was 0.913 mi^2, and consisted of 15 small lakes, ponds, and marshes. Censuses were conducted 17-19 July 1977.

Species	Density ($birds/mi^2$) wetlands	95% Confidence Interval	Standard Deviation	Frequency of Occurrence (%)
Arctic Loon	16.4	6.1	11.0	33.3
Bufflehead	12.0	2.8	5.1	26.6
Horned Grebe	11.0	0.8	1.4	26.2
Mallard	11.0	3.7	6.7	20.0
Scaup spp.	8.8	2.1	3.8	13.3
Lesser Scaup	7.7	1.7	3.0	6.7
Goldeneye spp.	6.6	1.4	2.5	6.7
Mew Gull	6.6	1.4	2.5	6.7
Surf Scoter	2.2	0.4	0.8	13.3
Lesser Yellowlegs	2.2	0.6	1.1	13.3
American Wigeon	2.2	1.1	1.9	6.7
Harlan's Hawk	2.2	1.1	1.9	6.7
Belted Kingfisher	1.1	0.2	0.4	6.7
Spotted Sandpiper	1.1	0.3	0.6	6.7
White-winged Scoter	1.1	0.3	0.6	6.7
Red-necked Grebe	1.1	0.4	0.8	6.7
Arctic Tern	1.1	0.4	0.8	6.7
Green-winged Teal	1.1	0.5	0.9	6.7
Total	95.5	37.6	67.9	

Diversity

Species Richness for stratum = 18
Species Diversity (H') for stratum = 2.509
Mean Species Richness for units sampled = 2.1 $\pm$ 1.2 95% C.I. (2.1 std. dev.)
Maximum Richness = 8 Minimum Richness = 0
Mean species diversity (H') for units sampled = 0.582 $\pm$ 0.300 95% C.I. (0.597 std. dev.)
Maximum Diversity = 1.900 Minimum Diversity = 0.000
Dominance = 29.7%

Production

Broods/mi^2 = 11.0 $\pm$ 3.3 95% C.I. (5.9 std. dev.)
Young birds/mi^2 = 24.1 $\pm$ 6.6 95% C.I. (11.9 std. dev.)
Mean Brood Size = 2.2

Diving Duck Sex Ratio (M:F) = 9.6:23.4 = 14.5% males
Dabbling Duck Sex Ratio (M:F) = 1.4:9.6 = 12.7% males

Table 10. Summary of wetland bird census results for Stratum IV, Scottie Creek Valley Small Lakes, Ponds, and Marshes, Tetlin-Northway Wetland study area. Censuses were conducted 19-25 July 1977. Census area was 2.421 mi^2, which consisted of 20.0 linear miles of Scottie, Little Scottie, and Desper creeks with associated ponds and marshes' and five small lakes (0.180-0.600 mi^2).

Species	Density ($birds/mi^2$) wetlands	95% Confidence Interval	Standard Deviation	Frequency of Occurrence (%)
Canvasback	129.7	20.3	24.9	25.0
Scaup spp.	86.3	13.9	17.0	50.0
Bufflehead	83.8	24.6	30.2	62.5
American Wigeon	66.1	27.3	33.5	75.0
Green-winged Teal	62.8	13.2	16.2	87.5
Arctic Tern	62.4	22.1	27.1	87.5
Mallard	35.9	12.7	15.6	87.5
Pintail	35.2	18.4	22.6	62.5
Bonaparte's Gull	33.0	13.6	16.7	25.0
Lesser Yellowlegs	30.2	11.8	14.5	50.0
Northern Shoveler	18.6	3.3	4.1	50.0
Lesser Scaup	12.4	3.3	4.1	25.0
Solitary Sandpiper	7.8	1.8	2.2	37.5
Horned Grebe	7.4	1.1	1.3	25.0
Spotted Sandpiper	6.2	2.1	2.6	50.0
Least Sandpiper	6.2	4.1	5.0	25.0
Arctic Loon	5.8	4.9	6.0	62.5
Mew Gull	5.4	2.5	3.1	62.5
Common Snipe	4.5	3.3	4.1	25.0
Goldeneye spp.	4.1	2.1	2.6	25.0
Greater Scaup	4.1	2.7	3.3	25.0
Bald Eagle	2.1	0.9	1.1	62.5
Marsh Hawk	1.2	0.2	0.3	37.5
Northern Phalarope	1.2	0.8	1.0	12.5
Red-necked Grebe	0.8	0.1	0.1	25.0
Belted Kingfisher	0.8	0.6	0.7	12.5
Surf Scoter	0.4	0.2	0.3	12.5
Total	714.4	299.5	367.4	

Diversity

Species Richness for stratum = 27
Species diversity (H') for stratum = 2.607
Mean Species Richness for units sampled = 11.5 ± 3.4 95% C.I. (4.2 std. dev.)
Maximum Richness = 16 Minimum Richness = 5
Mean Species Diversity (H') for units sampled = 1.895 ± 0.213 95% C.I. (0.261 std. dev.)
Maximum Diversity = 2.288 Minimum Diversity = 1.561
Dominance = 30.0%

Production

Broods/mi^2 = 26.4 ± 9.5 95% C.I. (11.6 std. dev.)
Young birds/mi^2 = 162.3 ± 65.2 95% C.I. (80.0 std. dev.)
Mean Brood Size = 6.1

Diving Duck Sex Ratio = 56.2:82.6 = 40.5% males
Dabbling Duck Sex Ratio = 12.0:59.1 = 16.9% males

Table 11. Summary of wetland bird census results for Stratum V, Chisana River with adjacent sand and gravel bars and mudflats, Tetlin-Northway Wetlands study area. Census area was 2.400 mi^2, and included 50.5 linear miles of the Chisana River, from its confluence with Scottie Creek, downstream to Northway Junction, Alaska. Census was conducted 22-24 July, 1977. Since the stratum was comprised of only one sample, no variance, standard deviation, confidence interval, or frequency of occurrence data are presented.

Species	Density (birds/mi^2 wetlands)
Canada Goose	62.5
Spotted Sandpiper	4.6
American Wigeon	4.2
Mallard	2.5
Semipalmated Plover	1.7
Bald Eagle	1.3
Goldeneye spp.	0.4
Bufflehead	0.4
Marsh Hawk	0.4
Total	78.0

Diversity

Species Richness for stratum = 9
Species Diversity (H') for stratum = 0.843
Dominance = 86.0%

Production

Broods/mi^2 = 0.4
Young birds/mi^2 = 2.5
Mean Brood Size = 6.3

No Sex Ratio Data

Diving ducks and shorebirds were the most abundant wetland bird groups in the Tanana-Chisana Valley Small Lakes, Ponds, and Marshes (43.8% and 32.4%, respectively; Table 4). Shorebirds showed their greatest abundance in these smaller lowland ponds, with 163.3 birds/mi^2. Northern Phalaropes, Arctic Terns, Lesser Yellowlegs, and Bonaparte's Gulls were the most abundant shorebirds (Table 8). The Northern Phalarope, Arctic Tern, and Lesser Yellowlegs achieved their greatest density in the Tanana-Chisana Valley Stratum, while dabbling ducks showed intermediate density. Horned Grebes showed the highest breeding density in this stratum (Table 8), which explains the high density of Loons and Grebes indicated in Table 4.

Diving ducks (mostly Buffleheads, Lesser Scaup, and Goldeneye spp.) were the most common birds in the Upland Small Lakes, Ponds, and Marshes (Table 9), although no single group of species achieved great density in the upland ponds when compared to the more productive lowland habitats. Arctic Loons reached their highest density in this stratum; a pair of Arctic Loons occurred on nearly every upland pond.

Dabbling ducks reached their greatest abundance in the Scottie Creek Valley (30.6% of the population, or 218.6 birds/mi^2; Table 4). All of the common dabbling duck species (American Wigeon, Green-winged Teal, Mallard, Pintail, and Northern Shoveler) were most abundant in the Scottie Creek habitats. Despite the concentrations of dabbling ducks, the bulk of total population density in the stratum was comprised of diving ducks (44.8%, or 320.8 birds/mi^2; Table 4). This dominance of divers was probably caused by the tremendous July aggregations of molting

Canvasbacks and Scaup spp. on Lakes #16 and #17. Canvasback, Scaup, and Bufflehead were the most abundant species (Table 10). Shorebirds in Scottie Creek Valley reached the second-highest abundance observed on the study area (156.9 birds/mi^2), mainly a result of nesting colonies of Arctic Tern and Bonaparte's Gull at Lake #17.

Bird populations using the Chisana River with adjacent sand and gravel bars and mudflats were minimal (Table 11). A sizeable population of nesting Canada Geese was found both at Tenmile Lake and at Gardiner Creek Flats (see below, under Habitat Productivity). The Canada Goose was the most abundant species using the Chisana River and surrounding seral mudflats and grassflats. Spotted Sandpipers were the only other species observed breeding in abundance along the river. An occasional Bufflehead, Barrow's Goldeneye, Common Goldeneye, American Wigeon, Mallard, and Red-breasted Merganser were also seen actually using the cold, turbid, glacial waters of the Chisana River. A Peregrine Falcon nest was reported in 1977 near the confluence of Sheep Creek and the Chisana River (T5N, R19E, Nabesna 1:250,000) (F. Miller, Northway, pers. comm.). Bald Eagles, Osprey, Marsh Hawks, and Harlan's/Red-tailed Hawks were seen foraging along the Chisana and Tanana rivers within this stratum.

Habitat Productivity

Total numbers of young birds/mi^2 paralleled the total population density in the various wetland strata (Table 4), with the lowland habitats producing the greatest number of young per square mile of wetlands (t-test,

$p<0.01$). Scottie Creek Valley supported the greatest density of young birds (162.3 birds/mi^2; Table 4), where they constituted 22.7% of the total population. The Upland Small Lakes, Ponds, and Marshes, despite the low density of young birds (24.1 birds/mi^2), had a higher percentage (25.2%) of young birds in the total population, indicating that waterfowl in upland areas apparently escaped the high water levels of May and June which flooded many nests in the lowlands.

The greatest numbers of broods per square mile were observed in the Tanana-Chisana Valley Small Lakes, Ponds, and Marshes (32.6 broods/ mi^2) and in Scottie Creek Valley Small Lakes, Ponds, and Marshes (26.4 broods/mi^2) (t-test, $p<0.01$ and $p<0.10$, respectively). The Large Lakes and the Upland Small Lakes, Ponds, and Marshes supported much lower brood densities (12.4 broods/mi^2 and 11.0 broods/mi^2, respectively).

The Scottie Creek Valley showed the greatest density of dabbling duck broods (15.2 broods/mi^2), whereas Large Lakes supported the greatest density of diving duck broods (7.1 broods/mi^2). The greatest numbers of shorebird broods were observed in the Tanana-Chisana Small Lakes, Ponds, and Marshes (8.7 broods/mi^2), which also had intermediate numbers of loons, grebes, and ducks (Table 12).

Extremely high brood densities may occur locally on the Tetlin-Northway Wetlands; McKnight (1962) counted 125 broods on 1.5 mi^2 Gasoline Lake (= 83 broods/mi^2) on 20 July 1959, and indicated that this lake was "undoubtedly one of the most productive lakes in Alaska."

Two major Canada Goose breeding and molting areas were found in the Chisana River Valley (Fig. 2). The largest area was approximately 5 mi^2

Table 12. Numbers of broods and average brood sizes (in parenthesis) of wetland birds observed during censuses in Tetlin-Northway Wetlands study area. Censuses were conducted between 5 July and 25 July 1977.

Species	Stratum I Large Lakes	Stratum II Tanana-Chisana Valley	Stratum III Upland Small Lakes, Ponds and Marshes	Stratum IV Scottie Creek Valley	Stratum V Chisana River	Total Number of Broods	Overall Mean ± Std. Dev. of Brood Sizes
Arctic Loon	3 (1.0)	1 (1.0)	1 (2.0)	2 (1.0)		7	1.1 ± 0.38
Red-necked Grebe	3 (3.0)	2 (1.0)				5	2.2 ± 1.30
Horned Grebe	2 (1.5)	11 (1.5)	2 (2.0)			13	1.6 ± 0.98
Mallard	1 (7.0)	2 (2.0)	2 (2.0)	4 (5.8)		9	4.2 ± 2.58
Pintail		2 (2.5)		5 (6.8)		7	5.5 ± 2.29
Wigeon		3 (4.3)	1 (1.0)	14 (4.5)	1 (6.0)	19	4.4 ± 1.89
Shoveler				4 (6.5)		4	6.5 ± 3.00
Green-winged Teal	1 (4.0)	3 (2.7)		20 (4.1)		24	3.9 ± 1.72
Canvasback	7 (4.9)	5 (3.0)		3 (2.3)		15	3.7 ± 2.05
Greater Scaup	3 (9.0)					3	9.0 ± 1.00
Lesser Scaup	4 (7.8)	11 (8.0)				5	7.8 ± 1.48
Scaup spp.	1 (1.0)	3 (3.7)	2 (3.0)	7 (5.1)		13	4.2 ± 1.91
Goldeneye spp.	2 (3.0)					2	3.0 ± 2.83
Bufflehead	11 (4.9)	6 (5.5)	2 (2.5)	3 (5.3)		22	4.9 ± 2.35
White-winged Scoter	1 (7.0)	3 (8.0)				4	7.8 ± 0.50
Lesser Yellowlegs	4 (2.8)	5 (2.6)				9	2.7 ± 1.22
Mew Gull		2 (4.0)		1 (1.0)		3	3.0 ± 2.00
Bonaparte's Gull	5 (2.2)	5 (2.6)		2 (2.5)		12	2.4 ± 1.51
Arctic Tern	2 (3.0)	4 (1.8)				6	2.1 ± 0.75
Total Number of Broods	50	56	10	65	1	182	

in size and extended from the confluence of Gardiner Creek and the Chisana River, upstream for 5 miles to an isolated set of hills near Sec 16, T11N, R21E, Nabesna C-1 and D-1 Quad. The other area was about 2 mi^2 in size and was on the north end of Tenmile Lake. Both areas consisted of open mudflat, grassland, wet sedge meadows, marsh, and low shrub habitats. We observed a group of 150 flightless geese (molting) on 23 July in Sec. 16, cited above. Droppings and tracks were observed over extensive areas in the two sites, indicating where large groups of molting geese had grazed and rested. Another similar breeding area probably existed 1-2 miles due south of Alaska Highway Milepost 1274. Geese were often observed and heard at this location, but we were unable to visit the exact site.

Three other species breeding on the study area, which were not studied quantitatively, were Bald Eagle, Osprey, and Sandhill Crane. We determined the location of three Bald Eagle nests (Fig. 2): at Little Scottie Creek; at Chisana Pond #19, a small pond 0.25 mi W of Tenmile Lake; and at Fish Lake, near the Northway Road. A fourth nest, reported active in 1976 (J. Harbison, local resident, pers. comm), was not active in 1977, although we observed adults nearby along the Tanana River at Riverside Lodge. Two active Osprey nests were present in 1977 at Tlocogn Lake, 4 miles west of Riverside Lodge (D. Grangaard, local trapper, pers. comm.). Osprey have also continued over the years to nest at several of the Tetlin lakes (Dathlalmund, Fish, Island, and Sand lakes; Kessel, unpubl. data). Sandhill cranes were observed in the Tanana-Chisana Valley throughout the breeding season. They bred in low densities;

several birds of the year were seen flying at Northway (5 July) and Riverside Lodge (8 July).

Lakes of all three productivity classes (Eutrophic, Oligotrophic, and Dystrophic) occur in close proximity on the Tetlin-Northway Wetlands study area. The tremendous differences observed in the numbers of birds supported by these various lakes and ponds are doubtedly caused by a number of interrelated factors. Water chemistry, temperature, depth, degree of inflow/outflow (water turnover), turbidity, extent of submergent and emergent plant growth (shoreline development) are all related to an aquatic system's productivity (Wetzel 1975). In the subarctic, permafrost relations further influence limnological characteristics (Kane and Slaughter 1973). McKnight (1962) noted that shallow ponds, with gradually sloping shorelines having extensive emergent plant growth were most productive. Conversely, deep ponds with steep banks and relatively limited emergent growth were virtually sterile. Shallow, warm lakes and ponds are generally more productive, because of their warm temperature and increased nutrient availability. Higher water temperatures increase algal productivity, and abundant emergent and submergent plants contribute to productivity by increasing nutrient levels (in the form of detritus). In most lake types (except Dystrophic), abundant detritus allows invertebrate populations to flourish (Wetzel 1975). Invertebrates are the main food source for sandpipers, plovers, and phalaropes (Stout 1967, Brooks 1967, Holmes and Pitelka 1968, Baker 1977, Senner 1977). Also, invertebrates (especially aquatic insect larvae) comprise an important source of protein for laying ducks and newly-hatched ducklings (Chura 1961,

Perret 1962, Krapu 1974, Swanson et al. 1974, Serie and Swanson (1976), and Landers et al. (1977).

In 1977 we censused many lowland ponds which received turbid, glacial water during flood-stages of the Tanana and Chisana rivers. Such ponds had murky water and were nearly devoid of wetland birds, even though they had extensive areas of emergent plant growth. Turbidity and low water temperatures probably hindered the development of an algal/detritus/invertebrate food chain. Adjacent lowland ponds which did not receive turbid floodwaters often had moderately clear water in which we could see enormous numbers of invertebrates (mostly grass-shrimp, leeches, and dragonfly nymphs); such ponds generally had higher wetland bird populations. Most of the upland lakes and ponds had cold tannic-acid-brown water, and we saw relatively few invertebrates in these waters. Any definitive explanation of the great differences in productivity among the wetland habitats in the Tetlin-Northway area will require a study of the limnological characteristics of the various wetlands and the abundance of aquatic invertebrates in addition to the bird populations.

SUMMARY

Spring migrants usually begin to arrive in central Alaska during the third week of April, usually with the first openings in the snow cover. These first open fields, marshes, and ponds are very important habitats during migration, as they provide areas for resting and feeding. The nesting season is from mid-May to early August. Disturbance of

nests during this time is harmful to most wetland bird species because, in Alaska, most do not attempt to renest. The flightless period for molting waterfowl extends from mid-June to late July for dabbling ducks and mid-July to early September for diving ducks. Important molting areas near the pipeline route are Midway, Deadman, Eliza, Yarger, Tlocogn, and Fish (near Northway) lakes, Scottie Creek Lakes #16 and #17, and Chisana Pond #17A (see Fig. 2). Molting areas away from the immediate pipeline route are Tetlin, Gasoline, Fish, Dathlalmund, and Old Albert lakes. Fall migration extends over a longer period than spring migration. Peak movements in 1977 were as follows: White-fronted Geese, 25 August-1 September; Sandhill crane, 15-22 September; raptors, 17-23 September; ducks, 12-22 September; Whisting Swans, 15-20 October.

The lowland small lake, pond, and marsh habitats of Scottie Creek Valley and Tanana-Chisana Valley were the most productive habitats. The uplands immediatly adjacent to the proposed pipeline route were one of the least productive habitats for wetland birds. Population densities of the most productive strata were as follows: Scottie Creek Valley Small Lakes, Ponds, and Marshes, 714.4 birds/mi^2; Tanana-Chisana Valley Small Lakes, Ponds, and Marshes, 503.9 birds/mi^2; and Large Lakes, 479.4 birds/mi^2. The least productive habitats were in Stratum V, the Chisana River with adjacent sand and gravel bars with 78.0 birds/mi^2, and Stratum III, Small Upland Lakes, Ponds, and Marshes with 95.5 birds/mi^2. The greatest production was observed at Scottie Creek Valley with 162.3 young birds/mi^2, and in the Tanana-Chisana Valley with 101.5 young

birds/mi^2. The total population in July 1977 for the 730 mi^2 Tetlin-Northway Wetland study area was estimated at 101,251 birds with a 95% confidence limit of 66,357-136,145 birds. This figure supports previous evidence that the Tetlin-Northway Wetlands are among the most productive wetland areas in Alaska.

Number of species (Species Richness) and Species Diversity were directly correlated with size of the wetland. Large Lakes and the small lakes, ponds, and marshes of Scottie Creek Valley had the highest site diversity. Community Diversity was directly related to the number of wetland sites in the community. Tanana-Chisana Valley had the highest Community Diversity followed by Scottie Creek Valley, and Upland Small Lakes, Ponds, and Marshes. Taken individually, wetland sites in the Upland Small Lakes, Ponds, and Marshes and the Tanana-Chisana Valley Small Lakes, Ponds, and Marshes were not diverse, but collectively, they were the most diverse communities in the study area.

Diving ducks were the most numerous group of birds, with the Lesser Scaup being the most abundant species on the study area. Other abundant species were Northern Phalarope, Bufflehead, Horned Grebe, Arctic Tern, Green-winged Teal, American Wigeon, Canvasback, Lesser Yellowlegs, and White-winged Scoter. Diving ducks were the most abundant group using the Large Lakes. Shorebirds and diving ducks were the most abundant groups in Tanana-Chisana Valley Small Lakes, Ponds, and Marshes. Diving ducks were also the most important group in the Upland Small Lakes, Ponds, and Marshes. Dabbling ducks reached their greatest abundance in Scottie Creek Valley. Canada Geese and Spotted Sandpipers were the most abundant species along the Chisana River.

Four Bald Eagle nest sites and two Osprey nest sites were identified. Sandhill Cranes bred in low densities in lowland habitats.

Extremely variable productivity in wetlands is the result of many interrelated factors. Limnological characteristics and abundance of aquatic invertebrates have been given as the major factors governing wetland productivity in other areas. Any activity which would be adverse to the maintenance of aquatic invertebrate populations and growth of submergent and emergent aquatic plants could lower wetland productivity.

ACKNOWLEDGMENTS

We would like to thank local residents James and Debbie Harbison, Daniel Grangaard, and Terry Brigner of Alaska Highway Milepost 1281; Dave Stout of Milepost 1264; Floyd Miller, Herb Stevens, and Vivian Leblanc of Northway; Matt Grayheck and Charlie Evans of Border City. Their assistance and information was of great help during our summer's fieldwork. Special thanks go to Michele Mouton for her untiring assistance during the field work, data analysis, and writing of this report.

Financial support of this project was provided by Northwest Alaskan Pipeline Co. through a contract with the University of Alaska Museum.

Appendix A-1. Species and number of wetland birds observed at Deadman Lake (Alaska Highway Milepost 1249) during a census count, 17 July 1977. Census area was 0.550 mi^2.

Species	No. Adults	No. Young	No. broods	No. in brood	Total birds	Density (birds/mi^2)
Arctic Loon	6				6	10.9
Red-necked Grebe	5				5	9.1
Horned Grebe	27	3	2	1,2	30	54.5
Mallard	5	7	1	7	12	21.8
Greater Scaup	5				5	9.1
Lesser Scaup	7				7	12.7
Scaup spp.	166				166	301.8
Goldeneye spp.	6				6	10.9
Bufflehead	11	20	3	7,6,7	31	56.4
White-winged Scoter	12	7	1	7	19	34.5
Surf Scoter	22				22	40.0
Scoter spp.	9				9	16.4
Lesser Yellowlegs	10	6	2	3,3	16	29.1
Mew Gull	4				4	7.3
Bonaparte's Gull		1	1	1	1	1.8
Arctic Tern	3	3	1	3	6	10.9
Totals	298	47	11		345	627.3

Species Richness = 16
Species Diversity (H') = 1.952
Diving Duck Sex Ratio (M:F) = 34:58 = 37.0% males
Dabbling Duck Sex Ratio (M:F) = 4:1 = 80.0% males

Remarks: Clear brown water, surrounded by a strip of marsh, and white spruce-birch forest behind the marsh.

Appendix A-2. Species and numbers of wetland birds observed at Midway Lake (Alaska Highway Milepost 1287-1291) during census counts 7-8 July 1977. Census area was 2.300 mi^2.

Species	No. Adults	No. Young	No. broods	No. in brood	Total birds	Density (birds/mi^2)
Arctic Loon	9	3	3	1,1,1	12	5.2
Red-necked Grebe	15	9	3	4,3,2	24	10.4
Horned Grebe	14				14	6.1
Mallard	18				18	7.8
Pintail	3				3	1.3
American Wigeon	22				22	9.6
Northern Shoveler	1				1	0.4
Blue-winged Teal	8				8	3.5
Green-winged Teal	1				1	0.4
Canvasback	13	26	5	5,8,6,5,2	39	17.0
Greater Scaup	6	27	3	8,10,9	33	14.3
Lesser Scaup	20	31	4	8,7,6,10	51	22.2
Scaup spp.	600	1	1	1	601	261.3
Goldeneye spp.	1	6	2	5,1	7	3.0
Bufflehead	104	29	6	7,6,4,3,2,7	133	57.8
White-winged Scoter	43				43	18.7
Surf Scoter	32				32	13.9
Scoter spp.	6				6	2.6
Spotted Sandpiper	4				4	1.7
Lesser Yellowlegs	14				14	6.1
Northern Phalarope	113				113	49.1
Mew Gull	10				10	4.3
Bonaparte's Gull	35	10	4	3,2,2,3	45	19.6
Arctic Tern	55	3	1	3	58	24.8
Totals	1147	145	32		1292	561.7

Species Richness = 24
Species Diversity (H') = 2.101
Diving Duck Sex Ratio (M:F) = 15:9 = 62.5% males
Dabbling Duck Sex Ratio (M:F) = 49:73 = 40.2% males

Remarks: Very large lake; shallow, freezes to bottom. Clear water except during algal bloom. Abundant invertebrate life. Has marsh islands in center. Surrounded by marsh, muskeg, and upland forests.

Appendix A-3. Species and numbers of wetland birds observed at Yarger Lake (Alaska Highway Milepost 1257) during a census count, 12 July 1977. Census area was 0.550 mi^2.

Species	No. Adults	No. Young	No. broods	No. in brood	Total birds	Density (birds/mi^2)
Arctic Loon	1				1	1.8
Red-necked Grebe	5				5	9.1
Horned Grebe	64				64	116.4
Mallard	2				2	3.6
Green-winged Teal	1				1	1.8
Canvasback	15	8	2	3,5	23	41.8
Lesser Scaup	6				6	10.9
Scaup spp.	88				88	160.0
Bufflehead	3	5	2	2,3	8	14.5
Bald Eagle	1				1	1.8
Solitary Sandpiper	2				2	3.6
Spotted Sandpiper	2				2	3.6
Lesser Yellowlegs	6	5	2	1,4	11	20.0
Mew Gull	2				2	3.6
Bonaparte's Gull	2				2	3.6
Totals	200	18	6		218	396.4

Species Richness = 15
Species Diversity (H') = 1.710
Diving Duck Sex Ratio (M:F) = 3:8 = 27.3% males
Dabbling Duck Sex Ratio (M:F) = 2:0 = 100.0% males

Remarks: Clear, brown water. Surrounded by much marsh and some forest and muskeg. Shallow, extensive submergent growth.

Appendix A-4. Species and number of wetland birds observed at Eliza Lake (Alaska Highway Mileposts 1257-1258) during census count, 12 July 1977. Census area was 0.665 mi^2.

Species	No. Adults	No. Young	No. broods	No. in brood	Total birds	Density (birds/mi^2)
Arctic Loon	1				1	1.5
Red-necked Grebe	3	1	1	1	4	6.0
American Wigeon	2				2	3.0
Green-winged Teal	6	4	1	4	10	15.0
Lesser Scaup	8				8	12.0
Scaup spp.	35				35	52.6
Bufflehead	10				10	15.0
White-winged Scoter	7				7	10.5
Spotted Sandpiper	1				1	1.5
Common Snipe	1				1	1.5
Mew Gull	5				5	7.5
Bonaparte's Gull	8				8	12.0
Arctic Tern	2				2	3.0
Totals	89	5	2		94	141.4

Species Richness = 13
Species Diversity (H') = 2.057
Diving Duck Sex Ratio (M:F) = 8:16 = 33.3% males
Dabbling Duck Sex Ratio (M:F) = 0:8 = 0.0% males

Remarks: Muddy, brown water; receives frequent flooding from Chisana River. Surrounded by extensive marshes; contains some marsh and wooded islands. Also some White Spruce forest occurs along shores.

Appendix A-5. Species and numbers of wetland birds observed on census lake #17A (unnamed lake N. of Chisana River, Sec. 24, T11N, R21E, Sec. 19, T11N, R22E, Nabesna C-1, Quad.) during census count 22 July 1977. Census area was 0.130 mi^2.

Species	No. Adults	No. Young	No. broods	No. in brood	Total birds	Density (birds/mi^2)
Arctic Loon	1				1	7.7
Red-necked Grebe	3	1	1	1	4	30.8
Horned Grebe	6				6	46.2
American Wigeon	3				3	23.1
Scaup spp.	148	10	2	7,3	158	1215.4
Goldeneye spp.	1				1	7.7
Bufflehead	19	10	1	10	29	223.1
White-winged Scoter	20	24	3	8,8,8	44	338.5
Lesser Yellowlegs	1				1	7.7
Northern Phalarope	110				110	846.2
Totals	312	45	7		357	2746.2

Species Richness = 10
Species Diversity (H') = 1.394
(No Sex Ratio Data)

Remarks: Clear black water, surrounded by extensive marsh on all shores, with white spruce woods behind marsh.

Appendix A-6. Species and numbers of wetland birds observed on unnamed pond, Alaska Highway Milepost 1271 (Sec. 24, T15N, R18E, Tanacross A-2 Quad.), during a census count, 11 July 1977. Census area was 0.087 mi^2.

Species	No. Adults	No. Young	No. broods	No. in brood	Total birds	Density (birds/mi^2)
Horned Grebe	4	5	2	4,1	9	103.4
Mallard	6				6	69.0
American Wigeon	20	6	1	6	26	298.8
Northern Shoveler	1				1	11.5
Green-winged Teal	6				6	69.0
Canvasback	2	1	1	1	3	34.5
Lesser Scaup	17				17	195.4
Scaup spp.	7	1	1	1	8	92.0
Goldeneye spp.	10				10	114.9
Bufflehead	8				8	92.0
Solitary Sandpiper	3				3	34.5
Lesser Yellowlegs	5				5	57.5
Northern Phalarope	3				3	34.5
Common Snipe	5				5	57.5
Totals	97	13	5		110	1264.3

Species Richness = 14
Species Diversity (H') = 2.369
Diving Duck Sex Ratio (M:F) = 13:31 = 29.5% males
Dabbling Duck Sex Ratio (M:F) = 2:30 = 6.3% males

Remarks: Clear brown water, receives occasional flooding from Tanana River. Surrounded by extensive marsh and tall shrubs, some upland forest.

Appendix A-7. Species and number of wetland birds observed at Willow Lake (Alaska Highway Milepost 1292.5), during census count, 10 July 1977. Census area was 0.136 mi^2.

Species	No. Adults	No. Young	No. broods	No. in brood	Total birds	Density (birds/mi^2)
Arctic Loon	2				2	14.7
Horned Grebe	1	1	1	1	2	14.7
Mallard	1				1	7.4
American Wigeon	2	6	1	6	8	58.8
Lesser Scaup	1	8	1	8	9	66.2
Bufflehead	1				1	7.4
Lesser Yellowlegs	10	13	5	4,1,2,4,2	23	169.1
Northern Phalarope	10				10	73.5
Common Snipe	2				2	14.7
Mew Gull	4	3	1	3	7	51.5
Bonaparte's Gull	5	12	4	6,4,1,1	17	125.0
Arctic Tern	5	2	1	2	7	51.5
Totals	44	45	14		89	654.4

Species Richness = 12
Species Diversity (H') = 2.117
Diving Duck Sex Ratio (M:F) = 0:2 = 0.0% males
Dabbling Duck Sex Ratio (M:F) = 0:3 = 0.0% males

Remarks: Clear, brown water, surrounded by marsh, with patches of white spruce-aspen forest.

Appendix A-8. Species and numbers of wetland birds observed at Ten-mile Lake (Sec. 15, 22, 27, 28, T13N, R20E, Nabesna D-2 Quad.), during census counts, 23-24 July 1977. Census area was 0.400 mi^2.

Species	No. Adults	No. Young	No. broods	No. in brood	Total birds	Density (birds/mi^2)
Arctic Loon	11				11	27.5
Mallard	3				3	7.5
Scaup spp.	6				6	15.0
Marsh Hawk	1				1	2.5
Semipalmated Plover	7	*			7	17.5
Lesser Yellowlegs	2	*			2	5.0
Baird's Sandpiper	5	*			5	12.5
Least Sandpiper	22	*			22	55.0
Mew Gull	2	5	1	5	7	17.5
Bonaparte's Gull	4	1	1	1	5	12.5
Arctic Tern	46	*			46	115.0
Totals	109	6	2		115	287.5

Species Richness = 11
Species Diversity (H') = 1.882
No Sex Ratio Data

Remarks: Muddy, brown water, receives continual flow from Chisana River. Extensive mud flats and marsh. Surrounded by tall shrub, muskeg and forest.

*Age classes not readily distinguishable for these species at a distance in late July.

Appendix A-9. Species and numbers of wetland birds observed on Island Lake (Alaska Highway Milepost 1231), during census count, 19 July 1977. Census area was 0.400 mi^2.

Species	No. Adults	No. Young	No. broods	No. in brood	Total birds	Density (birds/mi^2)
Arctic Loon	4				4	10.0
Mallard	4	1	1	1	5	12.5
Lesser Scaup	7				7	17.5
Goldeneye spp.	6				6	15.0
Surf Scoter	2				2	5.0
Lesser Yellowleg	1				1	2.5
Mew Gull	6				6	15.0
Belted Kingfisher	1				1	2.5
Totals	31	1	1		32	80.0

Species Richness = 8
Species Diversity (H') = 1.900
Diving Duck Sex Ratio (M:F) = 6:9 = 40.0% males
Dabbling Duck Sex Ratio (M:F) = 1:3 = 25.0% males

Remarks: Cold, clear, black water. Surrounded by narrow marsh and extensive open muskeg and white spruce forest.

Appendix A-10. Species and numbers of wetland birds observed in Little Scottie Creek Wetland Complex (Alaska Highway Milepost 1222.5) during census count, 25 July 1977. Census area was 0.131 mi^2.

Species	No. Adults	No. Young	No. broods	No. in brood	Total birds	Density (birds/mi^2)
Mallard	26				26	198.5
Pintail	42	27	4	7,7,7,6	69	526.7
American Wigeon	29	27	5	4,7,4,7,5	56	427.5
Northern Shoveler	18				18	137.4
Green-winged Teal	39	31	9	3,4,1,3,5,5,4,5,1	70	534.3
Scaup spp.	1				1	7.6
Bufflehead	1	4	1	4	5	38.2
Marsh Hawk	1				1	7.6
Bald Eagle	1				1	7.6
Solitary Sandpiper	8	*			8	61.1
Spotted Sandpiper	1	*			1	7.6
Lesser Yellowlegs	32	21			53	404.6
Least Sandpiper	14	*			14	106.9
Common Snipe	11	*			11	84.0
Mew Gull	2				2	15.3
Totals	226	110	19		336	2564.8

Species Richness = 15
Species Diversity (H') = 2.092
Diving Duck Sex Ratio (M:F) = 0:2 = 0.0% males
Dabbing Duck Sex Ratio (M:F) = 1:31 = 3.1% males

Remarks: Cold clear water, numerous small ponds surrounded by tall shrub and marsh.

*Age classes not readily distinguishable for these species at a distance during late July.

Appendix A-11. Species and numbers of non-passerine birds observed on census lake #16 (unnamed lake near Scottie Creek, Sec. 7, T10N, R23E, Nabesna C-1 Quad.) during census counts 20-21 July 1977. Census area was 0.350 mi^2.

Species	No. Adults	No. Young	No. broods	No. in brood	Total birds	Density (birds/mi^2)
Arctic Loon	1				1	2.9
Red-necked Grebe	1				1	2.9
Horned Grebe	12				12	34.3
Mallard	19	11	2	4,7	30	85.7
Pintail	3	7	1	7	10	28.6
American Wigeon	7	8	2	4,4	15	42.9
Northern Shoveler	11	12	2	4,8	23	65.7
Green-winged Teal	14	36	7	4,5,4,7,5 8,3	50	142.9
Canvasback	66	5	2	1,4	71	202.9
Lesser Scaup	22				22	62.9
Scaup spp.	105	36	7	5,6,5,5,5 4,6	141	402.9
Bufflehead	63	3	1	3	66	188.6
Lesser Yellowlegs	5				5	14.3
Arctic Tern	3				3	8.6
Belted Kingfisher	2				2	5.7
Totals	334	118	24		452	1291.8

Species Richness = 15
Species Diversity = 2.085
Diving Duck Sex Ratio (M:F) = 21:91 = 18.8% males
Dabbling Duck Sex Ratio (M:F) = 3:50 = 5.7% males

Remarks: Warm, turbid water, algal bloom made water opaque. Surrounded by marsh or tall shrubs.

Appendix A-12. Species and numbers of wetland birds observed on census lake #17 (unnamed lake near Scottie Creek, Sec. 13, T10N, R22E, Sec. 18, T10N, R23E, Nabesna C-1 Quad.) during a census count, 21 July 1977. Census area was 0.600 mi^2.

Species	No. Adults	No. Young	No. broods	No. in brood	Total birds	Density (birds/mi^2)
Horned Grebe	6				6	10.0
Mallard	3	4	1	4	7	11.7
American Wigeon	13	19	5	3,3,3,3,7	32	53.3
Green-winged Teal	11	6	2	3,3	17	28.3
Canvasback	241	2	1	2	243	405.0
Lesser Scaup	8				8	13.3
Scaup spp.	66				66	110.0
Goldeneye spp.	10				10	16.7
Bufflehead	121				121	201.7
Bald Eagle	1				1	1.7
Solitary Sandpiper	1				1	1.7
Spotted Sandpiper	5				5	8.3
Lesser Yellowleg	14				14	23.3
Mew Gull	1	3			4	6.7
Bonaparte's Gull	24	50			74	123.3
Arctic Tern	54	25			79	131.7
Totals	579	109	9		688	1146.7

Species Richness = 16
Species Diversity (H') = 1.986
Diving Duck Sex Ratio (M:F) = 114:96 = 54.3% males
Dabbling Duck Sex Ratio (M:F) = 6:21 = 22.2% males

Remarks: Warm, turbid water, algal bloom made water opaque. Surrounded by marsh, muskeg, tall shrubs, and forest.

Appendix A-13. Species and numbers of wetland birds observed in Scottie Creek wetland complex (including 7 linear-miles of stream and associated small ponds and oxbow lakes from confluence of Little Scottie Creek to Alaska Highway, and from confluence of Desper Creek to the Chisana River) during census counts 20, 21, and 25 July 1977. Census area was 0.345 mi^2.

Species	No. Adults	No. Young	No. broods	No. in brood	Total birds	Density (birds/mi^2)
Mallard	7	8	1	8	15	43.5
Pintail	1				1	2.9
American Wigeon	14	14	2	4,10	28	81.2
Northern Shoveler	3				3	8.7
Green-winged Teal	3	5	1	5	8	23.2
Solitary Sandpiper	10				10	29.0
Spotted Sandpiper	7				7	20.3
Lesser Yellowlegs	1				1	2.9
Least Sandpiper	1				1	2.9
Mew Gull	1	1	1	1	2	2.9
Arctic Tern	50	*			50	144.9
Totals	98	28	5		126	365.2

Species Richness = 11
Species Diversity (H') = 1.761
Diving Duck Sex Ratio = no data
Dabbling Duck Sex Ratio (M:F) = 7:17 = 29.2% males

Remarks: Cold, clear, brown water, upper reaches of creek lined with white spruce and birch forest; lower reaches surrounded by marsh, tall shrub, and muskeg.

Appendix A-14. Species and numbers of wetland birds observed on census lake #15 (unnamed lake near Scottie Creek, Sec. 1, 15, T10N, R22E, Nabesna C-1, Quad.) during census count, 20 July 1977. Census area was 0.300 mi^2.

Species	No. Adults	No. Young	No. broods	No. in brood	Total birds	Density (birds/mi^2)
Arctic Loon	2				2	6.7
Mallard	7				7	23.3
Pintail	2				2	6.7
American Wigeon	10	3	1	3	13	43.3
Northern Shoveler	1				1	3.3
Green-winged Teal	1	4	1	4	5	16.7
Greater Scaup	1	9	1	9	10	33.3
Bufflehead	8				8	26.7
Surf Scoter	1				1	3.3
Marsh Hawk	1				1	3.3
Bald Eagle	1				1	3.3
Spotted Sandpiper	2				2	6.7
Mew Gull	2				2	6.7
Arctic Tern	8				8	26.7
Totals	47	16	3		63	210.0

Species Richness = 14
Species Diversity (H') = 2.288
Diving Duck Sex Ratio (M:F) = 1:9 = 10.0% males
Dabbling Duck Sex Ratio (M:F) = 5:16 = 23.8% males

Remarks: Cold, clear brown water. Much marsh, surrounded by white spruce and birch forest. Receives cold water inflow from Scottie Creek.

Appendix A-15. Species and number of wetland birds observed in Desper Creek wetland complex (including 12.4 linear miles of stream and associated small ponds and oxbow lakes from the Alaska Highway downstream to the confluence with Scottie Creek) during census counts 19-20 July 1977. Census area was 0.495 mi^2.

Species	No. Adults	No. Young	No. broods	No. in brood	Total birds	Density (birds/mi^2)
Arctic Loon	4				4	8.1
Red-necked Grebe	1				1	2.0
Mallard	1				1	2.0
Pintail	3				3	6.1
American Wigeon	10	6	1	6	16	32.3
Green-winged Teal	1				1	2.0
Bufflehead	3				3	6.1
Bald Eagle	1				1	2.0
Mew Gull	3				3	6.1
Arctic Tern	2				2	4.0
Totals	29	6	1		35	70.7

Species Richness = 10
Species Diversity (H') = 1.087
Diving Duck Sex Ratio (M:F) = 0:1 = 0.0% males
Dabbling Duck Sex Ratio (M:F) = 6:7 = 46.2% males

Remarks: Cold, clear brown water. Upper reaches are lined with white spruce forest and open muskeg; lower reaches with extensive marsh and tall shrub or muskeg.

Appendix A-16. Species and numbers of wetland birds observed along the Chisana River from its confluence with Scottie Creek, downstream to Northway Junction, during census counts, 22-24 July 1977. Census area included 50.5 linear miles of river, or an approximate area of 2.400 mi^2.

Species	No. Adults	No. Young	No. broods	No. in brood	Total birds	Density (birds/mi^2)
Canada Goose	*	*	*	*	150	62.5
Mallard	6				6	2.5
American Wigeon	4	6	1	6	10	4.2
Goldeneye spp.	1				1	0.4
Bufflehead	1				1	0.4
Marsh Hawk	1				1	0.4
Bald Eagle	3				3	1.3
Semipalmated Plover	*	*	*	*	4	1.7
Spotted Sandpiper	*	*	*	*	11	4.6
Totals		6	1		187	77.9

Species Richness = 9
Species Diversity (H') = 0.843

Remarks: A muddy, glacial river, extensive floodplain, sand bars, gravel bars. Banks are high. Surrounding vegetation ranges from natural meadow, to tall shrub, muskeg and coniferous and deciduous forest.

*Age classes not readily distinguishable for these species at a distance during late July.

Appendix B. Wetland bird census results. Species and numbers of wetland birds observed in small (<0.2 mi^2) census lakes, ponds and wetland, or of larger (>0.2 mi^2) census areas exhibiting low bird populations. Unnamed lakes are referenced by the nearest Alaska Highway Milepost or by an arbitrary number if they are not within 1.0 mi of the Alaska Highway or Haines petroleum pipeline right-of-way. Exact locations are given in Figure 2 and Table 1. Population data is presented as: T = total birds observed; A = total adults observed; Y = total young observed; B = brood size. Census areas appear in order of decreasing population density from left to right. All census counts were taken between 6 July and 24 July 1977.

	Pond 1261.5				Pond 1246.5				Chisana Pond #21				Pond 1225.0	Pond 1263.5			
Species	T	A	Y	B	T	A	Y	B	T	A	Y	B	T (no young)	T	A	Y	B
Arctic Loon													1				
Red-necked Grebe	2	1	1	1													
Horned Grebe	2	2							6	4	2	1,1		2	0	2	2
Whistling Swan																	
Mallard																	
Pintail	1	1															
Northern Shoveler																	
Green-winged Teal													1	1	1		
American Wigeon																	
Canvasback	8	2	6	3,3					3	3							
Lesser Scaup									6	6							
Scaup spp.	4	4							10	10			1				
Bufflehead					7	4	3	3	7	1	6	6		2	2		
White-winged Scoter																	
Surf Scoter																	
Marsh Hawk													1				
Harlan's Hawk																	
Bald Eagle																	
Solitary Sandpiper																	
Spotted Sandpiper																	
Lesser Yellowlegs																	
Northern Phalarope																	
Mew Gull																	
Bonaparte's Gull																	
Arctic Tern													2				
Belted Kingfisher																	
TOTALS (birds)	17	10	7	-	7	4	3	-	32	24	8	-	6	5	3	2	-
Census Area (mi^2)	0.007				0.008				0.050				0.012	0.010			
Density (birds/mi^2)	2428.6	1428.6	1000.0		875.0	500.0	375.0		640.0	480.0	160.0		500.0	500.0	300.0	200.0	
Species Richness	5				1				5				5	3			
Species Diversity (H')	1.365				0.000				1.546				1.561	1.055			
Diving Duck Sex Ratio (M:F)	1:5				0:4				6:4				0:1	0:2			
Dabbling Duck Sex Ratio (M:F)	0:1				0:0				0:0				0:1	0:1			
Number of Females with Broods	3				1				3				0	1			
Remarks	Sometimes flooded by river. Thick emergent plants.				Clear brown water surrounded by forest/muskeg.				Flooded by river. Thick emergent plants.				Clear brown water surrounded by marsh/muskeg.	Clear black water surrounded by forest.			

Appendix B. continued

Species	Pond 1266				Pond 1300				Pond 1242.8				Pond 1238.5				Marsh 1267			
	T	A	Y	B	T	A	Y	B	T	A	Y	B	T	A	Y	B	T	A	Y	B
Arctic Loon																				
Red-necked Grebe	1	1																		
Horned Grebe	7	3	4	1,3					4	1	3	3	2	1	1	1	11	9	2	1,1
Whistling Swan																				
Mallard	3	2	1	1	6	3	3	3									4	4		
Pintail	5	1	4	4													2	1	1	1
Northern Shoveler																				
Green-winged Teal					10	3	7	5,2												
American Wigeon	1	1			1	1			2	1	1	1					2	2		
Canvasback																	5	3	2	2
Lesser Scaup																				
Scaup spp.																				
Bufflehead	11	3	8	6,2	6	6			1	1			2	0	2	2	16	7	9	5,4
White-winged Scoter																				
Surf Scoter																				
Marsh Hawk																				
Harlan's Hawk																				
Bald Eagle																				
Solitary Sandpiper	1	1			2	2														
Spotted Sandpiper																				
Lesser Yellowlegs									1	1							4	4		
Northern Phalarope																				
Mew Gull					2	2														
Bonaparte's Gull																				
Arctic Tern																				
Belted Kingfisher					2	2														
TOTALS (birds)	29	12	17	-	29	19	10	-	8	4	4	-	4	1	3	-	44	30	14	-
Census Area (mi^2)	0.062				0.065				0.018				0.009				0.109			
Density (birds/mi^2)	467.7	193.5	274.2		446.2	292.3	153.9		444.4	222.2	222.2		444.4	111.1	333.3		403.7	275.2	128.4	
Species Richness	7				7				4				2				7			
Species Diversity (H')	1.597				1.688				1.213				0.693				1.679			
Diving Duck Sex Ratio (M:F)	0:3				0:6				0:1				0:0				1:9			
Dabbling Duck Sex Ratio (M:F)	0:4				0:7				0:1				0:0				2:5			
Number of Females with Broods	6				3				2				2				6			
Remarks	Flooded by river. Clear brown water surrounded by marsh, forest.				Flooded by river slough. Surrounded by marsh, forest.				Clear brown water surrounded by tall shrubs abundant emergent growth.				Clear black water surrounded by forest.				Occasionally flooded by river. Clear brown water. Ponds becomming filled by emergent growth.			

Appendix B. continued

Species	Pond 1245.5	Pond 1242				Pond 1303				Ponds 1293.5-1294.0				Chisana Pond #17B			
	T (no young)	T	A	Y	B	T	A	Y	B	T	A	Y	B	T	A	Y	B
Arctic Loon						3	3			2	2						
Red-necked Grebe														3	2	1	1
Horned Grebe	2	2	2											3	3		
Whistling Swan						1	1										
Mallard										4	4						
Pintail																	
Northern Shoveler																	
Green-winged Teal						11	1	10	10	6	2	4	4				
American Wigeon						2	2							2	2		
Canvasback																	
Lesser Scaup														20	20		
Scaup spp.		3	1	2	2					3	3						
Bufflehead		1	1							1	1						
White-winged Scoter																	
Surf Scoter																	
Marsh Hawk																	
Harlan's Hawk	2																
Bald Eagle																	
Solitary Sandpiper																	
Spotted Sandpiper																	
Lesser Yellowlegs						1	1			4	4						
Northern Phalarope																	
Mew Gull																	
Bonaparte's Gull																	
Arctic Tern																	
Belted Kingfisher																	
TOTALS (birds)	4	6	4	2	-	18	8	10	-	20	16	4	-	28	27	1	-
Census Area (mi^2)	0.010	0.018				0.058				0.069				0.100			
Density ($birds/mi^2$)	400.0	333.3	222.2	111.1		310.3	120.7	172.4		289.9	231.9	58.0		280.0	270.0	10.0	
Species Richness	2	3				5				6				4			
Species Diversity (H')	0.693	1.011				1.165				1.670				0.907			
Diving Duck Sex Ratio (M:F)	0:0	0:2				0:0				0:2				0:0			
Dabbling Duck Sex Ratio (M:F)	0:0	0:0				1:3				1:3				0:0			
Number of Females with Broods	0	1				1				1				1			
Remarks	Clear brown water surrounded by forest. Few emergents.	Clear, black water very deep. Surrounded by tall shrubs.				Clear brown water surrounded by marsh on all sides. Forest nearby.				Clear, brown water. Small ponds surrounded by marsh and muskeg.				Clear water surrounded by marsh and coniferous forest.			

Appendix B. continued

Species	Gardiner Creek Wetlands (Mile 1246.6)				Steve Lake, Mile 1262				Pond 1241	Lake 1224.0 (Grace Lake)				Pond 1239.5			
	T	A	Y	B	T	A	Y	B	T (no young)	T	A	Y	B	T	A	Y	B
Arctic Loon					4	3	1	1	2	6	5	1	1	2	2		
Red-necked Grebe					3	2	1	1									
Horned Grebe																	
Whistling Swan																	
Mallard	4	1	3	3	1	1				1	1						
Pintail																	
Northern Shoveler																	
Green-winged Teal	1	1															
American Wigeon																	
Canvasback					7	1	6	6									
Lesser Scaup																	
Scaup spp.														5	1	4	4
Bufflehead																	
White-winged Scoter																	
Surf Scoter					1	1											
Marsh Hawk																	
Harlan's Hawk																	
Bald Eagle										1	1						
Solitary Sandpiper																	
Spotted Sandpiper																	
Lesser Yellowlegs																	
Northern Phalarope										3	3						
Mew Gull																	
Bonaparte's Gull										6	1	5	2,3				
Arctic Tern					14	9	5	1,2,2		7	7						
Belted Kingfisher																	
TOTALS (birds)	5	2	3	-	30	17	13	-	2	24	18	6	-	7	3	4	-
Census Area (mi^2)	0.022				0.163				0.013	0.188				0.056			
Density (birds/mi^2)	227.3	90.9	136.4		184.0	104.3	79.8		153.8	127.7	95.7	31.9		125.0	53.6	71.4	
Species Richness	2				6				1	6				2			
Species Diversity (H')	0.500				1.421				0.000	1.577				0.598			
Diving Duck Sex Ratio (M:F)	0:0				1:1				0:0	0:0				0:1			
Dabbling Duck Sex Ratio (M:F)	0:2				0:2				0:0	1:0				0:0			
Number of Females with Broods	1				6				0	3				1			
Remarks	Cold, clear brown water, old river oxbows, steep banks, surrounded by willow and white spruce.				Clear brown water, no flooding from river, surrounded by muskeg and marsh.				Clear black water sur- surrounded by forest and muskeg, no marsh.	Clear brown water, surrounded by marsh, used as floatplane base.				Clear, brown water, surrounded by marsh, tall shrub, and forest.			

Appendix B. continued

Species	Chisana Pond #18				Lake 1256				Chisana Lake #20	Lake 1255	Chisana Lake #19	Pond 1263	Marsh 1248
	T	A	Y	B	T	A	Y	B	T (no young)	T (no young)	T (no young)	no birds	no birds
Arctic Loon	6	5	1	1	5	3	2	2		2	1		
Red-necked Grebe					1	1							
Horned Grebe													
Whistling Swan									1				
Mallard									1	1			
Pintail	2	2							3				
Northern Shoveler	3	3											
Green-winged Teal	4	3	1	1									
American Wigeon													
Canvasback													
Lesser Scaup													
Scaup spp.	1	1											
Bufflehead													
White-winged Scoter										1			
Surf Scoter													
Marsh Hawk													
Harlan's Hawk													
Bald Eagle											1		
Solitary Sandpiper													
Spotted Sandpiper										1			
Lesser Yellowlegs													
Northern Phalarope													
Mew Gull													
Bonaparte's Gull													
Arctic Tern					1	1							
Belted Kingfisher													
TOTALS (birds)	16	14	2	-	7	5	2	-	5	5	2	0	0
Census Area (mi^2)	0.180				0.109				0.150	0.206	0.100	0.025	0.012
Density (birds/mi^2)	88.9	77.8	11.1		64.2	45.9	18.3		33.3	24.3	20.0	0	0
Species Richness	5				3				3	4	2	0	0
Species Diversity (H')	1.461				0.796				0.950	1.332	0.693	0	0
Diving Duck Sex Ratio (M:F)	0:1				0:0				0:0	1:0	0:0	0	0
Dabbling Duck Sex Ratio (M:F)	1:6				0:0				1:3	0:1	0:0	0	0
Number of Females with Broods	2				1				0	0	0	0	0
Remarks	Muddy brown water, flooded by river often. Surrounded by marsh.				Muddy brown water flooded by river often. Surrounded by marsh.				Clear black water surrounded by forest and muskeg, some marsh.	Muddy, brown water flooded by river, surrounded by tall shrubs.	Clear black water surrounded by forest and muskeg, some marsh.	Muddy, brown water flooded by river, surrounded by marsh.	Clear bro water sed filled pc surrounde by muske tussock meadows.

Appendix B. continued

Species	Pond 1244.4	Marsh 1236	Pond 1233 (Seaton's Pond)
	no birds	no birds	no birds
Arctic Loon			
Red-necked Grebe			
Horned Grebe			
Whistling Swan			
Mallard			
Pintail			
Northern Shoveler			
Green-winged Teal			
American Wigeon			
Canvasback			
Lesser Scaup			
Scaup spp.			
Bufflehead			
White-winged Scoter			
Surf Scoter			
Marsh Hawk			
Harlan's Hawk			
Bald Eagle			
Solitary Sandpiper			
Spotted Sandpiper			
Lesser Yellowlegs			
Northern Phalarope			
Mew Gull			
Bonaparte's Gull			
Arctic Tern			
Belted Kingfisher			
TOTALS (birds)	0	0	0
Census Area (mi^2)	0.015	0.007	0.010
Density (birds/mi^2)	0	0	0
Species Richness	0	0	0
Species Diversity (H')	0	0	0
Diving Duck Sex Ratio (M:F)	0	0	0
Dabbling Duck Sex Ratio (M:F)	0	0	0
Number of Females with Broods	0	0	0
Remarks	Clear brown water, sedge filled pond surrounded by tall shrubs.	Cold, clear brown water. Valley bottom marsh surrounded by forest.	Clear brown water surrounded by marsh and muskeg.

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