Waterbird Populations and Wetland Habitats at Teshekpuk Lake Study Site

1978 Final Report

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INTRODUCTION

In 1976, after management of National Petroleum Reserve-Alaska was delegated to the Bureau of Land Management, Special Studies section of the U.S. Fish and Wildlife Service initiated reconnaissance of the large lake regime near Teshekpuk Lake. In 1977 a camp was established approximately 11 km northeast of the eastern tip of Teshekpuk Lake, to permit assessment of bird populations and habitats used by waterbirds. The results of that field season are reported in Derksen et al. (1977). This report summarizes the results of the 1978 field season at that same site (Figure 1).

Major objectives for 1978 were: 1) record the phenology of bird activities and habitat conditions, 2) conduct weekly bird censuses, 3) record nesting, production and movements of birds, 4) document the use of various wetland classes by waterbirds, and 5) expand the number of wetlands classified and sampling of invertebrates in ice-wedge pools. Field personnel also carried out an investigation of the distribution, feeding ecology and habitat use of molting geese at East Long Lake and other large lakes in the immediate area.

The 1978 field studies were conducted by T.C. Rothe, M.R. Ryan and T.S. Taylor from 2 June through 16 August. Drs. D.V. Derksen and M.W. Weller provided expertise and field assistance on the goose study during July, and W.A. Colgate cooperated on field work in August.

METHODS

Weather and Water Conditions

Minimum and maximum temperatures, wind velocity and direction, sky conditions and precipitation were recorded on a daily basis. Qualitative observations were made on snowmelt, ice conditions and water levels throughout the season.

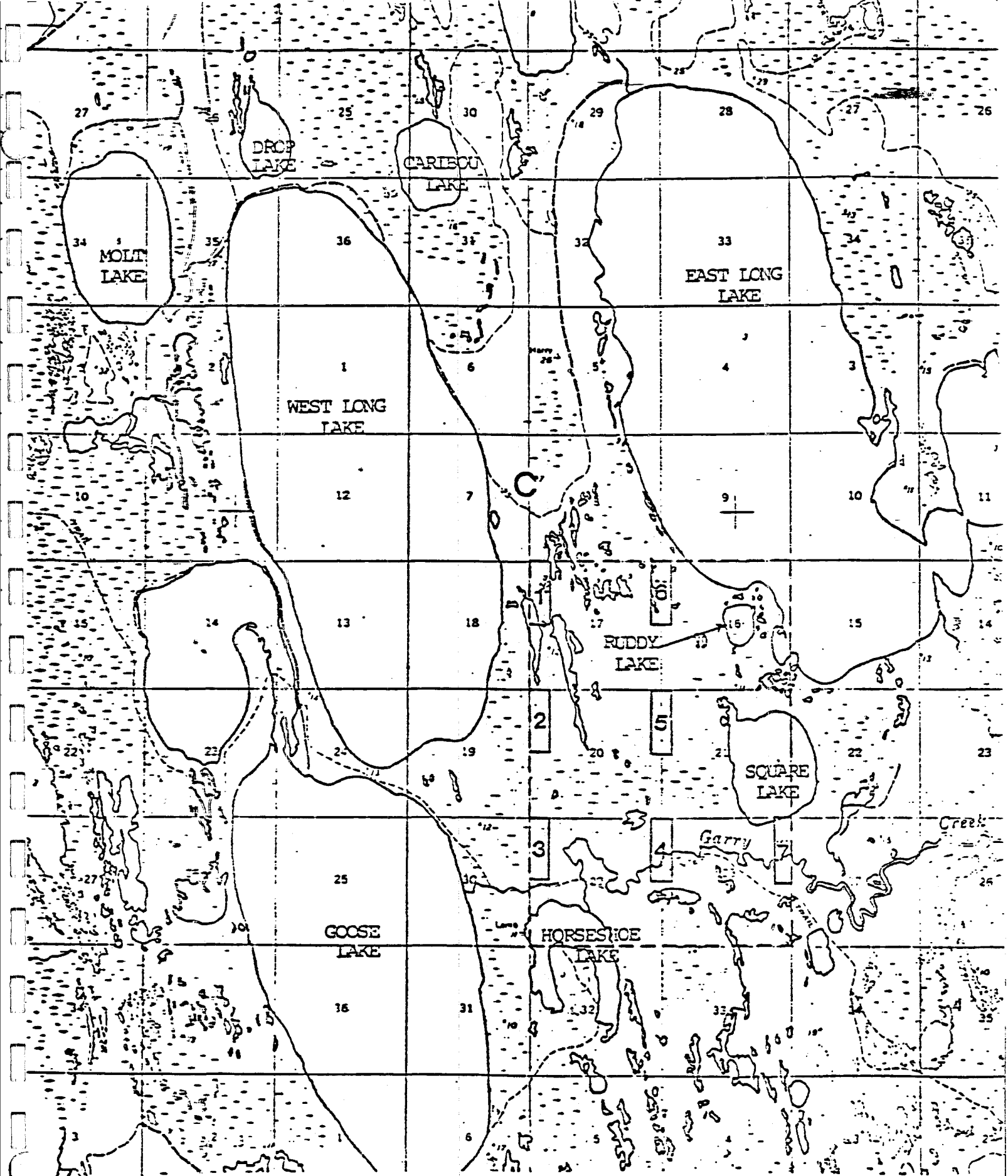

Figure 1. N. E. Teshekpuk Lake 15.6 km^2 Large bird census area (---), seven 0.16 km^2 small bird census areas and lakes censused for geese. Camp location is indicated by "C".

Wetland Classification and Invertebrate Sampling

Classification of wetlands on the study area according to Bergman et al. (1977) was refined and expanded from 1977 data. Additional information was gathered on the formation, types and hydrology of ice wedge pools, and their importance to waterbirds. Each of 10 ice wedge pools was sampled for invertebrates by taking a 3-meter sweep net sample in both the open central zone and the vegetated edges, and one Ekman dredge sample in the central zone. Water depth, sediment thaw depth, water temperature, specific conductance and pH were recorded at each sampling. Invertebrate samples were taxonomically sorted, counted and preserved in 4% formalin solution.

Bird Chronology, Census and Production

The phenology of arrival, presence on the study area and migration of birds were recorded daily on prepared data forms. Weekly large bird censuses on the 13.34-km^2 study area, and small bird censuses on seven 0.16-km^2 plots were accomplished similar to Derksen et al. (1977). Nests were found opportunistically, marked with numbered lath and revisited on estimated hatching dates. By minimizing nest disturbances from visitation we, of necessity, forfeited some data on clutch size and hatching success. Brood sightings were recorded by wetland class.

Wetland Use by Waterbirds

The use of various wetland classes by birds was documented systematically during large and small bird censuses. Most sightings of birds were recorded by group size, activity, and wetland type, by several observers on each census. Thus all wetland types were covered in proportion to their distribution, observer biases in recording various bird species were minimized, and temporal variation in use patterns were more reliably detected.

Mammal Observations

Size, age and sex composition, and directional movements of caribou herds were recorded daily, but observations of other mammals were made incidental to other work.

RESULTS

Snowmelt, Weather and Water Conditions

Spring thaw occurred much later than in 1977. When investigators arrived at Lonely DEW-site on 1 June snow cover was 60-75% in the vicinity of the airfield and camp, but was 95-100% across the region. At Teshekpuk Lake camp snow covered all but a few high-center polygons on the highest lake bluffs. Snow cover of over 95% persisted until 6-13 June when higher temperatures and light winds reduced it to less than 5%. Summaries of seasonal temperatures and sky conditions are presented in Tables 1 and 2.

Solar radiation was intense even on overcast days. Snow-filled ice wedge pools contained water as early as 2 June and warmed to as high as 7.5°C by 5 June. Light rains and rapid melt produced surface water on ice of all wetlands by 7 June. By 10 June some ice-filled ice wedge pools and Class II ponds contained open water with exposed sediments, and Garry Creek was overflowing broadly on bottom ice. Class I flooded sedge meadows were extensive in all the large, ancient lake basins. Open moats 1-5 m wide were observed on Class V Deep Open Lakes as early as 14 June. All small ponds and Ruddy Lake were ice-free by 24 June. Strong winds 11-17 July made Horseshoe and Square Lakes ice-free by 15 July and East and West Long Lakes ice-free by 17 July.

Although the number of days with precipitation was unusually high in 1978 (Table 2), constant winds in this region promoted drying of wetlands. Most Class I Flooded Tundra and temporary ice wedge pools were dry by 25 June.

Table 1. Mean minimum and maximum temperatures (°C) at Teshekpuk Lake study area, 1978.

Date	Mean Min.	Mean Max.	Range
4-10 June	-0.3	8.3	-2 - 13
11-17	0.6	7.4	-1 - 15
18-24	-0.4	6.4	-3 - 14
25-1 July	0.6	13.8	-3 - 22
2-8	2.4	14.2	1 - 18
9-15	1.0	8.7	0 - 10
16-22	1.4	10.0	0 - 15
23-29	3.7	16.0	1 - 22
30-5 August	5.0	12.3	-1 - 22
6-12	-1.0	5.4	-2 - 7
13-15	-2.3	3.6	-3 - 3
Seasonal mean	1.2	10.3	-3 - 22

Table 2. Cloud cover and precipitation at Teshekpuk Lake study area, 1978.

Date	(N)	Clear	Partly Cloudy	Overcast	Precipitation
June	(29)	6	8	15	14
July	(31)	6	13	12	7
August	(15)	0	5	10	11
Seasonal	(75)	12	26	37	32
		(16.0)[a]	(34.7)	(49.3)	(42.7)

[a] percent of total in parentheses

By 9 July Class I zones were rare, 50% of shallow Class IIa wetlands were dry and IIb ponds were starting to dry. Only half of the Class IIb ponds held water by 17 July, decreasing to 25% by 29 July. By this time most semi-permanent ice wedge pools were also dry.

Wetland Classification

Approximately 51% of the study area is covered by wetlands, of which half are Class I Flooded Tundra meadows or depressions, and one quarter are Class V Deep-Open lakes. Composition of wetlands by class is presented in Table 3. Most of the wetlands are found in several large ancient lake basins (Figure 2) and 27.1% of total wetland area is classified Basin Complex (VI). Garry Creek extends 5.99 km within the study area and has an average mid-summer width of 10 m. In the western half of the study area Garry Creek floods broad Arctophila meadows that were used intensively in spring by all waterbirds and throughout the summer by Pintails, Red-throated Loons, a family of Whistling Swans, and phalaropes. These meadows dry and the Arctophila heads open in fall, creating a readily available food source the following spring. The deep beaded portion is of less importance to waterbirds, but east of the study area the floodplain is flat with a distinct moss zone used by geese and their broods all summer.

Ice wedge pools are generally acidic because their incised shapes have more extensive contact with surface and stratified peat deposits. Chemical concentration from seasonal water loss through evaporation usually lowers pH and increases conductance values. However, near West Long Lake many pools are connected in semi-integrated drainages through ice wedge troughs and undergo dilution from meltwater runoff. Older pools that have become shallower and broader develop thick sediments that may also buffer acidity. Thus, varying water chemistry among ice wedge pools is a product of hydrology, age and substrate.

Table 3. Composition of wetlands on Teshekpuk Lake study area, classified after Bergman et al. (1977).

Wetland Class		Surface area (ha)	Percentage of total wetland area
I	Flooded Tundra	379.8	48.1
II	Shallow-Carex	128.4	16.2
III	Shallow-Arctophila	48.2	6.1
IV	Deep-Arctophila	37.4	4.7
V	Deep-Open	190.7	24.1
VII	Beaded Stream	6.0	0.8
	TOTAL	790.5	100.0
VI	Basin Complex[a]	212.5	27.1

[a] composite of several classes

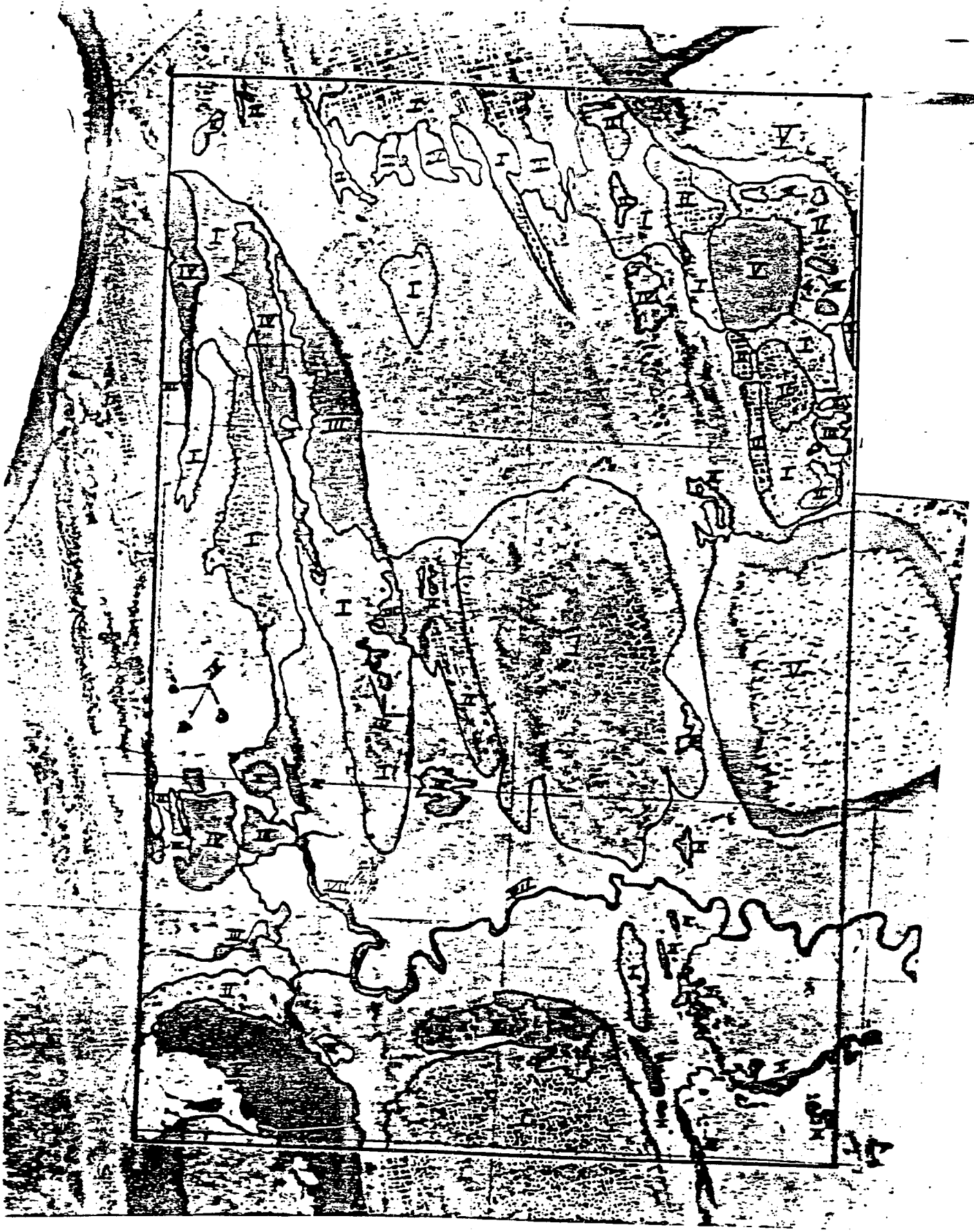

Figure 2. Distribution of wetlands of various classes (Bergman et al. 1977) on Teshekpuk Lake study area.

Sheltered microclimates and small dark basins permit ice wedge pools to thaw, develope active sediments, and produce aquatic invertebrate populations and plant communities earlier than other wetland types. Mean water temperatures at the end of June (Table 4) were higher than those of most coastal wetlands at the seasonal high in late July. Shallow temporary pools rapidly developed higher invertebrate populations than other pool types, representing the first rich food source for waterbirds in spring.

Invertebrate Sampling

The first observation of active invertebrates occurred on 5 June when Oligochaetes were seen in a shallow ice wedge pool. On 10 June Collembola that were active on the snow were seen windrowed in masses on meltwater pools and on flooded ice of lakeshores. Cladocera, Copepoda and a Coleoptera adult were first observed on 12 June. Samples were taken 14-16 June and 28-30 June. Subsequent sampling was suspended because of work schedule conflicts. To study different pool types we selected five pools of average size and depth (Pools 1-5), three shallow, temporary pools with 100% Carex cover (Pools 6-8), and two narrow, deeply incised pools (Pools 9 and 10). A summary of physical and chemical parameters of sampled pools is presented in Table 4, particulars in Appendix 1. No Ekman samples were taken in the deep ponds because of bottom ice, and none were taken in shallow temporary pools because of densely vegetated bottoms. Shallow pools lacked standing water by the time of the second sampling period, thus precluding water chemistry or sweep net sampling. Shallow ponds lost as much as 19 cm of water from evaporation and percolation in two weeks.

Bird Chronology and Census

Resident breeding bird species are listed in Table 5, and non-breeding birds in Table 6. Ten large bird and nine small bird censuses were conducted

Table 4. Summary of mean physical and chemical parameters of ten ice wedge pools sampled for invertebrates, Teshekpuk Camp, 1978.

Parameter	Pool type	14-16 June	28-30 June	Mean change
pH	All	5.9 (10)[a]	6.2 (7)	+ 0.3
	Shallow	5.5 (3)	-[b]	-[b]
	Deep	5.9 (2)	5.9 (2)	± 0.2
Conductivity (μmhos/cm)	All	53.0 (10)	71.1 (7)	+22.9
	Shallow	64.0 (3)	-[b]	-[b]
	Deep	60.5 (2)	84.0 (2)	+23.5
Temperature (°C)	All	5.2 (10)	11.7 (7)	+ 7.8
	Shallow	8.5 (3)	-[b]	-[b]
	Deep	4.1 (2)	10.0 (2)	+ 5.9
Sediment thaw (cm)	All	2.1 (10)	10.3 (9)	+ 8.4
	Shallow	4.0 (3)	13.0 (2)	+ 9.0
	Deep	1.0 (2)	12.5 (2)	+11.5
Sweep samples (organisms/m^3)	All	52.1 (5)	92.2 (5)	
	Shallow	268.4 (3)	-[b]	
	Deep	102.7 (2)	146.1 (2)	
Ekman samples (organisms/m^2)	Common	1203.5 (4)	3714.3 (5)	
	Shallow	-[c]	-[b]	
	Deep	-[c]	1168.8 (1)	

[a] sample size in parentheses

[b] no sample taken, lack of standing water

[c] no sample taken, bottom frozen or heavily vegetated

Table 5. Breeding birds at Teshekpuk study area, 1978

Species	Breeding Evidence	Arrival Date
Arctic Loon (Gavia arctica)	Nest	7 June
Red-throated Loon (Gavia stellata)	Nest	17 June
Whistling Swan (Olor columbianus)	Nest	5 June
Black Brant (Branta bernicula)	Nest	4 June
White-fronted Goose (Anser albifrons)	Nest	3 June
Lesser Snow Goose (Chen caerulescens)	Brood	13 June
Pintail (Anas acuta)	Nest	4 June
Oldsquaw (Clangula hyemalis)	Nest	4 June
Spectacled Eider (Somateria fischeri)	Nest	10 June
Willow Ptarmigan (Lagopus lagopus)	Brood	4 June
American Golden Plover (Pluvialis dominica)	Nest	3 June
Black-bellied Plover (Pluvialis squatarola)	Behavior	3 June
Semipalmated Sandpiper (Calidris pusillus)	Nest	3 June
Pectoral Sandpiper (Calidris melanotos)	Nest	4 June
Dunlin (Calidris alpina)	Nest	3 June
Buff-breasted Sandpiper (Tryngites subruficollis)	Nest	24 June
Long-billed Dowitcher (Limnodromus scolopaceus)	Nest	11 June
Red Phalarope (Phalaropus fulicarius)	Nest	5 June
Northern Phalarope (Lobipes lobatus)	Nest	4 June
Parasitic Jaeger (Stercorarius parasiticus)	Nest	4 June
Glaucous Gull (Larus hyperboreus)	Brood	2 June
Sabine's Gull (Xema Sabini)	Nest	3 June
Arctic Tern (Sterna paradisea)	Nest	7 June
Lapland Longspur (Calcarius lapponicus)	Nest	2 June

Table 6. Non-breeding birds observed at Teshekpuk study area, 1978.

Species	Arrival Date	Last Observation
Yellow-billed Loon (*Gavia adamsii*)	13 July	21 July
Canada Goose (*Branta canadensis*)	23 June	13 August
Northern Shoveler (*Anas clypeata*)	17 June	20 June
Greater Scaup (*Aythya marila*)	1 July	15 July
Common Eider (*Somateria mollissima*)	7 July	3 August
King Eider (*Somateria spectabilis*)	4 June	29 July
Surf Scoter (*Melanitta perspicillata*)	11 June	-[a]
Rough-legged Hawk (*Buteo lagopus*)	4 June	11 June
Peregrine Falcon (*Falco peregrinus*)	27 July	1 August
Ruddy Turnstone (*Arenaria interpres*)	3 June	14 August
Baird's Sandpiper (*Calidris bairdii*)	6 August	-[a]
Stilt Sandpiper (*Micropalama himantopus*)	5 August	12 August
Bar-tailed Godwit (*Limosa lapponica*)	27 July	30 July
Pomarine Jaeger (*Stercorarius pomarinus*)	3 June	29 June
Long-tailed Jaeger (*Stercorarius longicaudus*)	7 June	7 August
Snowy Owl (*Nyctea scandiaca*)	5 June	13 August
Short-eared Owl (*Asio flammeus*)	4 June	5 June
Savannah Sparrow (*Passerculus sandwichensis*)	5 June	-[a]
Snow Bunting (*Plectrophenax nivalis*)	2 June	8 July

[a] single observation only

weekly beginning 10 June. The small bird census for 23 July was not done because of conflicting work schedules. Weekly densities and seasonal mean densities are given in Tables 7 and 8.

Brant were the most abundant large bird on the census area with a mean density of 9.11 birds per km^2. Pintails (6.50/km^2) and Oldsquaws (3.28/km^2) were next in abundance. Lapland Longspurs were the most abundant small birds (47.63/km^2) followed by Red Phalaropes (25.71/km^2), Pectoral Sandpipers (18.48/km^2) and Dunlins (16.02/km^2).

The following species accounts discuss census data and chronology. The term "study area" refers to the general region around our camp, including the census plots.

Large Birds

Arctic Loons were first seen on 7 June. Density on 10 June was low (0.13/km^2). The highest density recorded on weekly censuses was 2.64/km^2 on 17 June. Weekly densities decreased until 8 July. After this date densities remained essentially constant throughout the remainder of the summer, representing resident breeders. Social groups of 3-4 post-breeding birds were seen after 27 July.

Red-throated Loons were first seen on the second census (17 June) and densities changed little over the remaining eight censuses. Red-throated Loons were consistently less abundant than Arctic Loons.

Yellow-billed Loons were observed only between 13 and 21 July and were considered transients. Groups of 1-3 birds were seen feeding and loafing on West Long Lake.

Whistling Swans were first seen on 5 June. A pair of swans seen on the 10 June census nested successfully and were last seen on the study area on 5 August. Transient Whistling Swans were recorded on the 8 and 22 July censuses.

Table 7. Densities (per km^2) of large birds on weekly censues on Teshekpuk study area (15.54 km^2), 1978.

Species	10 June	17 June	24 June	1 July	8 July	15 July	22 July	29 July	5 August	12 August	Mean
Arctic Loon	0.13	2.64	2.19	1.42	0.90	0.84	0.90	0.90	1.09	0.77	1.18
Red-throated Loon	0	0.45	0.84	0.58	0.26	0.64	0.64	0.51	0.84	0.58	0.53
Whistling Swan	0.13	0.13	0.13	0.13	0.32	0.13	0.26	0.13	0.13	0	0.15
Black Brant	1.87	2.06	3.09	1.74	8.11	18.34	30.24	22.20	3.15	0.32	9.11
Canada Goose	1.42	4.63	2.83	2.51	0.58	0.13	0.13	0	0	1.29	1.35
White-fronted Goose	0.26	1.09	2.70	1.80	0.51	0.06	0	0	0	3.35	0.98
Pintail	1.54	10.49	11.13	7.27	2.25	2.96	0.06	1.42	12.93	14.99	6.50
Northern Shoveler	0	0.13	0	0	0	0	0	0	0	0	0.01
Greater Scaup	0	0	0	0.26	0	0	0	0	0	0	0.03
King Eider	0.13	0.58	0.19	0.37	0.58	0	0.13	0.51	0	0	0.25
Spectacled Eider	1.03	0.84	0.06	0.32	0.71	0.32	0.32	0.26	0.58	0.06	0.45
Oldsquaw	2.12	1.99	3.54	3.35	1.54	5.28	4.89	4.18	2.96	2.90	3.28
Pomarine Jaeger	0.19	0.06	0	0	0	0	0	0	0	0	0.03
Parasitic Jaeger	0.19	0.32	0.26	0.45	0.39	0.71	0.19	0.39	0.51	0.32	0.37
Long-tailed Jaeger	0	0.06	0.19	0.06	0	0.51	0	0.13	0	0	0.10
Unidentified Jaeger	0	0	0	0	0	0.32	0	0	0	0	0.03
Glaucous Gull	0.71	0.32	0.39	0.51	0.45	0.64	0.45	0.51	0.06	0.13	0.42
Sabine's Gull	0.19	0.45	0.32	0.32	0.32	0	0.19	0.26	0.71	0	0.28
Arctic Tern	0.26	0.77	0.84	0.51	0.71	0.58	0.26	0.58	0.32	0.19	0.50
Ptarmigan	0	0.13	0	0	0	0	0	0	0	0	0.01
Snowy Owl	0	0	0	0	0	0	0	0	0	0.06	0.01

Table 8. Densities (per km^2) of small birds from weekly censuses on seven plots (1.12 km^2) on Teshekpuk study area, 1978.

Species	11 June	18 June	25 June	2 July	9 July	16 July	30 July	6 August	13 August	Mean
American Golden Plover	0	0.88	0	0.88	0	0	10.62	0.88	0.88	1.57
Black bellied Plover	1.77	1.77	0.88	0	0	0	4.42	0	0.88	1.08
Ruddy Turnstone	0	0	0	0.88	0.88	0	0	0	0	0.20
Pectoral Sandpiper	17.70	30.09	38.05	13.27	6.19	6.19	26.55	4.42	23.89	18.48
Dunlin	18.58	22.12	13.27	10.62	13.27	12.39	7.96	6.19	39.82	16.02
Long-billed Dowitcher	0.88	0	3.54	0	0.88	0	6.19	0.88	0.88	1.47
Semipalmated Sandpiper	6.19	7.96	6.19	0.88	5.31	0	0.88	0	0	3.05
Bar-tailed Godwit	0	0	0	0	0	0	0.88	0	0	0.10
Red Phalarope	66.86	53.78	31.16	14.16	6.19	25.66	17.70	6.19	9.73	25.71
Northern Phalarope	13.27	15.04	11.50	5.31	3.54	20.35	15.04	4.42	0	9.83
Lapland Longspur	43.36	62.27	17.70	24.78	16.81	15.04	109.73	79.65	59.29	47.63

Brant were first observed on the study area on 4 June, and the breeding population was established by mid-June. Brant increased sharply between 1 and 8 July as birds moved into the study area to molt (Table 7). The population reached a peak on the census area on 22 July and declined sharply between 29 July and 5 August as birds completed molt and nesting birds moved broods off the census area.

Canada Geese were first observed on 10 June. They moved into the study area in early June and peak density on the census area occurred on 17 June. Most Canadas, however, moved to adjacent large lakes in late June during the flightless period of molt, and none were seen on the 29 July and 5 August censuses. But the regional population continued to increase steadily through the third week in July. Canadas censused on 12 August were probably migrants that had come into our study area from other molting areas.

White-fronted Geese were first observed on the study area on 3 June. A flock of 26 were observed going east on 4 June and a flock of 40 were seen moving south on 5 June. Other small flocks (2-5) were commonly seen during the first week of June, apparently making local movements and at least seven pairs became resident breeders. Numbers on the census area increased gradually until 24 June. Subsequently White-fronts began leaving to molt and were not seen on the 22 and 29 July and 5 August censuses. Migrants seen on the 12 August census yielded a seasonal high density of 3.35 per km^2.

Snow Geese were observed infrequently throughout the summer, but not seen on the weekly censuses. In late July and early August small groups (10-16) of Snow Geese were seen along Garry Creek, one-half mile east of the census area. A brood of one was observed twice in this area.

The first Pintails observed were small migratory flocks (6-9 birds) moving east on - June. Pintails increased from 1.54 per km^2 on the 10 June

census to 11.13 per km^2 on 24 June. Density then decreased at the onset of molt to a summer low of 0.06 birds per km^2 on 22 July. Pintails remained uncommon until early August when the density increased dramatically. The density on the last census, 12 August, was a seasonal high, 14.99 per km^2.

A pair of Northern Shovelers was seen on 17, 18, and 20 June but not resighted later.

Oldsquaws were first seen on the study area on 4 June. Census data were relatively constant over the summer. Peak numbers occurred in July probably as a result of males and unsuccessful nesting females moving into the area to molt. A flock of 45 Oldsquaws was seen flying very high to the west on 25 June.

We first saw Spectacled Eiders on 10 June. Densities from the weekly censuses fluctuated considerably, possibly because of emmigration by males and inconspicuousness of females during incubation. Males were last seen on the census area on 8 July. Groups of 3-10 females were regularly seen loafing and feeding after 13 July, sometimes accompanying hens with broods.

King Eiders were less common than Spectacled Eiders. Mixed-sex flocks (4-12 birds) were seen frequently in early June. Primary directions of migrations were south and east. Males were last observed on 1 July and females on 29 July. No breeding pairs were observed on the study area.

Common Eiders were observed only twice during the summer. Eighteeen males were seen migrating west on 7 July. On 3 August a large flock (170) of mostly males was seen also moving west.

One male Surf Scoter was observed on 11 June on Garry Creek. A male Surf Scoter, probably the same one, was found dead on 17 June on the shore of Horseshoe Lake.

Greater Scaup were observed only twice, a flock of four birds on 1 July and a single bird on 15 July.

A major migratory movement of Pomarine Jaegers was observed in early June. The peak migration occurred from 3 to 6 June, 118 Pomarines being observed on 4 June alone. Flock sizes during these four days averaged 8.3 (N = 18). Fourteen of the 18 flocks observed during this period were moving east or southeast. Pomarines were seen rarely after early June and the last observation was on 29 June.

No early summer migration of Parasitic Jaegers was noted. Two pair of Parasitics were resident breeders on the census area throughout the summer.

Long-tailed Jaegers were seen sporadically throughout the summer but no nests were found. Eastward migrations of mixed flocks of Long-tailed and Parasitic Jaegers were observed from 14-18 July. These flocks (4-73 birds) stopped to feed on the study area. Both species were observed feeding along edges of ice cakes at East Long Lake (V) and Goose Lake (V). They were feeding on adult midges unable to fly because of cold temperatures and strong winds. These midges were very abundant on the ice floes until 19 July when we observed dead midges windrowed in small melt pools on the ice. Jaegers were not seen on the ice after this. It seems possible that the flocks observed were not migratory but rather were making nomadic movements in search of food.

Glaucous Gulls were present when we arrived on 2 June and were resident on the study area for the entire summer. Densities decreased sharply between censuses on 29 July and 5 August.

Sabine's Gulls were less abundant than Glaucous Gulls. They were first observed on 3 June. Densities from weekly censuses were quite constant throughout the season with a slight increase recorded on 5 August. No Sabine's Gulls were seen after that date and apparently had moved out of the study area. Sabine's were observed at Barrow, Alaska along the coast on 16 August.

Arctic Terns were the most common Larid on the census area. Highest density was recorded in late June. Densities then decreased slightly in earlier July and were fairly constant until August when density began declining again.

Raptor sightings were most common in early June. Snowy Owls were seen on five days, Short-eared Owls on two days and Rough-legged Hawks on two days, between 4 and 13 June. Snowy Owls were seen sporadically the remainder of the season, but Short-eared Owls and Rough-legged Hawks were not seen again.

An adult male Peregrine Falcon was seen roosting on the shore of West Long Lake on 27 July. An adult male, possibly the same bird, was seen on 31 July. This bird was observed to make a kill of a small bird on a high center polygon area between East and West Long Lake. We observed this bird at or very close to the kill site for several hours. We did not flush the bird and, when we examined the area on the following morning, were unable to locate any evidence of what bird species was killed.

Male Willow Ptarmigan were seen frequently from mid-June to early July. Females were rarely observed. Most sightings of males were of one bird that frequented the high center polygons immediately adjacent to our camp almost nightly. A flock of males (4 birds) was seen on 14 July. Two adult females with three young were seen on 26 July. This was the last sighting of Ptarmigan.

Small Birds

American Golden Plovers were first seen on the study area on 3 June. During June and early July Golden Plovers were most common on high center polygon areas. Such areas were uncommon on the census area and therefore Golden Plovers were seen only sporadically during censuses. An increase in numbers of Golden Plovers on the study area was noted on 18 July. From 24 to 27 July flocks of 6-100 birds were seen feeding on moss and Carex dominated

areas along Deep-Open (V) lake shorelines. The population was at a high on the study area between 27 and 31 July. Census data from 30 July show 10.62 birds per km^2. Many of the Golden Plovers seen after 18 July were molting.

Black-bellied Plovers were less common on the study area than Golden Plovers. Black-bellied Plovers were first seen on 3 June. A pair of Black-bellies were seen during censuses on 11 and 18 June near a Shallow-Arctophila (III) wetland. These birds had left the census area by 2 July. Black-bellies were observed with flocks of Golden Plovers in late July and the 30 July census showed 4.42 birds per km^2. Molt was not noted as frequently in late July for Black-bellies as it was in Golden Plovers.

Ruddy Turnstones were on the study area on 3 June and were relatively common at this time. After 5 June Ruddy Turnstones became uncommon, and were found only near Ruddy Lake. Post breeding movements were noted from 3 to 5 August when birds were seen along several large lakeshores. One flock of six was seen flying west but other single birds were heading north and south. Ruddy Turnstones were last observed on 14 August.

Pectoral Sandpipers were first seen on 4 June but were uncommon until 9 June. Courtship displays were first noted on that date. Pectorals increased gradually through June and the peak density (38.05 birds/km^2) was recorded on the 25 June census. Territorial-courtship displays were notably decreased by 2 July and small flocks (5-23) were first seen on 5 July. Fledged young became common on the study area in late July and early August and possibly explains the increase in density recorded at that time.

Dunlins were present on 3 June and courtship first observed on 4 June. Display intensity was markedly decreased by 25 June. The Dunlin population remained basically constant from late June to mid-July but decreased in late July and early August. A seasonal high density of 39.82 birds/km^2 was recorded on 13 August during pre-migration buildup.

Long-billed Dowitchers were first seen on 11 June. Dowitchers were resident on the study area throughout the summer, but were recorded sporadically on censuses. A flock of 35 was seen on 27 July and transients were seen regularly for the remainder of the season.

Bar-tailed Godwits were not breeding on the study area. Two Godwits were observed on 27 July, one of which was well along into winter plumage. Three other sightings were made by 30 July, after which Bar-tails were not observed again.

A flock of six Stilt Sandpipers in winter plumage was seen feeding in a Shallow-Carex (II) pond on 5 August and a single bird in winter plumage was seen on 12 August.

Baird's Sandpipers were not seen in the vicinity of camp but one bird was seen at the east shore of Teshepuk Lake, approximately 12 km southwest of our study area on 6 August.

Buff-breasted Sandpipers were first seen on 24 June. A group of five were seen on an upland dry site. Two of the birds were observed displaying. A pair of Buff-breasted Sandpipers was seen infrequently at a nest site until 25 July when hatching occurred.

Semipalmated Sandpipers were first observed on 4 June. Semipalmateds began nesting early in June and territorial-courtship display intensity was much reduced by 25 June. Populations were stable throughout June but decreased rapidly after 9 July. Large flocks of Semipalmateds were observed in late July. Semipalmateds were last seen on 9 August.

Red Phalaropes were first seen on 5 June. Density was at a seasonal high on the first census on 11 June. Copulations were observed on 11 June. Post-breeding flocks were first seen on 29 June and birds had begun to molt by the same date. Large flocks of up to 50 birds, apparently all females

were seen on 1 July. Population density decreased in July and dropped off sharply after the first of August.

Northern Phalaropes were first seen on 4 June. The population was relatively stable throughout June and July. Fewer birds were counted on 2 and 9 July, possibly the result of the birds being less active during incubation. Flocks of 8–30 Northerns were observed on 22 July. Density decreased sharply between 30 July and 6 August. No Northern Phalaropes were seen during the last census on 13 August. Northern Phalaropes were much less common than Reds throughout the season.

Lapland Longspurs were present on the study area when we arrived on 2 June. Definite territories were established by 4 June and nest building had begun by 7 June. Density decreased markedly between 18 June and 25 June then remained relatively constant until late July. Small groups of males were observed feeding together on 26 June.

Lapland Longspurs began to increase on 25 July. Migratory movements became defined by 26 July and occurred in pulses throughout the day and apparently night as well. Flocks usually were of 8–30 birds. Movements were in both northerly and southerly directions. Migration occurred primarily along the shores of large lakes (V). Density on the 30 July census was 109.73 birds/km^2. Major migratory movements occurred through 31 July and less frequently until at least 6 August. The population decreased in early August but was still high. The 13 August census recorded 59.29 birds per km^2.

Snow Buntings were also present when we arrived and were seen daily through 11 June. Birds were always seen near shores of large lakes (V). Snow Buntings were only seen on five other days the remainder of the season, the last observation was on 8 July.

Nesting and Production

No formal nest or brood searches were conducted during this field season; however, 82 nests and 66 separate broods were located incidental to other field projects. Information on nesting and hatching chronology (Figure 3), clutch size and nesting success (Table 9), and brood observations (Table 10) are presented for each bird species detected.

Large Birds

Arctic Loon nests were most often associated with the dense, emergent Arctophila fulva stands of large Shallow (III) and Deep-Arctophila (IV) wetlands. Exact hatching dates are unknown because disturbance from visitation of loon nests was avoided. Because no chicks were seen until the 15 July weekly survey, they must have hatched sometime within the preceding week. Of two 2-chick broods observed, both lost one chick within seven days of initial sighting (by 5 August).

Red-throated Loons began nesting several days later than Arctic Loons and consequently most hatched later. Red-throated Loons preferred to nest on smaller, open-centered Shallow-Carex (IIb) and Shallow-Arctophila (III) wetlands. Three 2-chick broods were observed, two were resighted and only one had lost a chick by 12 August (seven days after first observation). One young loon from an unusually early nest located in dense Arctophila of a small beaded stream (VII), Garry Creek, was first observed on 5 August. Though it was two-thirds grown and capable of extended dives both adults were still bringing it small fish. Other Red-throated broods on the study area were less than a week old at that time.

Whistling Swans were the earliest nesting species on the Teshekpuk Lake area beginning 3 June with 99 percent snow cover present. Five eggs were laid in an 80-cm diameter, 30-cm tall nest mound. The nest appeared to have

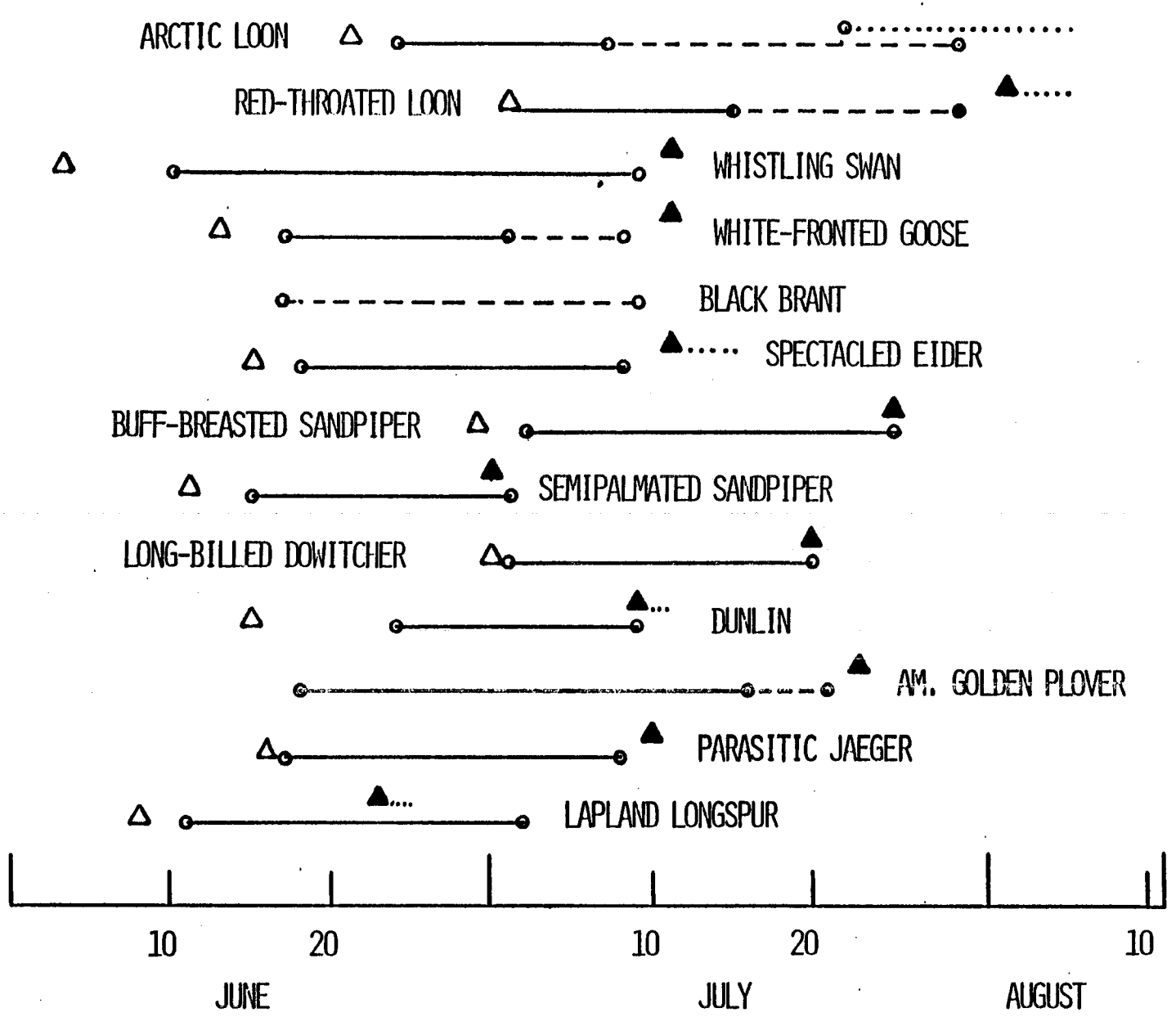

Figure 3. Nesting and hatching chronology of birds at Teshekpuk Lake study site, 1978. (△) = Earliest known nest initiation, (——) = Incubation-initiation known, (---)= Incubation-initiation unknown, (▲) = Earliest known hatching date, (····) = Broods hatched from known nests.

Table 9. Clutch sizes, number of nests and success of nests located at Teshekpuk Lake study site, 1978.

Species	Clutch size mean (range)	Nests found	Nests revisited	Percent successful[a]
Arctic Loon	-	8	6	67%
Red-throated Loon	-	7	4	57%
Whistling Swan	5	1	1	100%
White-fronted Goose	3.1 (2-6)	7	7	100%
Black Brant	3.5 (2-6)[b]	10	5	20%
Pintail	7	1	1	0%
Oldsquaw	6	1	0	Unknown
Spectacled Eider	4.5 (4-5)	2	2	100%
Northern Phalarope	4	1	0	Unknown
Red Phalarope	3 (2-4)	5	2	Unknown
Buff-breasted Sandpiper	4	1	1	100%
Pectoral Sandpiper	4	1	0	Unknown
Semipalmated Sandpiper	4	4	2	100%
Long-billed Dowitcher	2	1	1	100%
Dunlin	4	5	3	67%
American Golden Plover	3.2 (2-4)	5	4	50%
Parasitic Jaeger	1.5 (1-2)	2	2	50%
Sabine's Gull	3	1	0	Unknown
Arctic Tern	2	2	0	Unknown
Lapland Longspur	4.8 (2-6)	17	12	58%

[a] percentage of relocated nests that hatched at least one chick

[b] only four Brant nests with known clutch sizes

Table 10. Percent frequency of occurrence of brood sightings by species and pond class (Bergman et al. 1977) from Teshekpuk Lake study site. Number in parentheses represents number of sightings including resightings.

Species	Date of first observation	Brood size $\bar{x}$ (range)	# of broods N	Wetland class I	IIa	IIb	III	IV	V	VI	VII	Upland
Arctic Loon	22 July	1.4 (1-2)	8			14(2)	28(4)	43(6)	14(2)			
Red-throated Loon	5 August	1.8 (1-2)	5			28(2)	57(4)				14(1)	
Whistling Swan	15 July	3	1								100(4)	
Snow Goose	15 August	1	1								100(3)	
White-fronted Goose	14 July	2.7 (1-4)	6						9(1)		91(10)	
Black Brant	9 July	3.1 (1-15)	10			31(4)			69(9)			
Oldsquaw	22 July	5.6 (3-9)	7			22(2)			78(7)			
Spectacled Eider	13 July	4.7 (4-5)	3			33(2)	17(1)	33(2)	17(1)			
Willow Ptarmigan	26 July	3	1									100(1)
Red Phalarope	14 July	2 (1-3)	2			50(1)		50(1)				
Dunlin	15 July	1.5 (1-2)	4		25(1)	25(1)					25(1)	25(1)
American Golden Plover	29 July	1.3 (1-2)	3			67(2)					33(1)	
Sabine's Gull	25 July	2.2 (2-3)	4			50(2)			50(2)			
Glaucous Gull	4 August	3	2			50(1)			50(1)			
Arctic Tern	25 July	1.5 (1-2)	2			50(1)			50(1)			

been at least partially constructed during one or more previous seasons. It was located inside the bend of a meander of Garry Creek within 20 m of the water and dense Arctophila cover. Three cygnets were hatched 11 July, but the brood was reduced to two by 22 July. The two eggs that failed to hatch contained nearly full-term cygnets with yolk sacs partially reabsorbed. Nearly all brood observations were made on the stream within 200 m of the nest site. On 6 August one lone, unattended cygnet was observed on a large Deep-Open (V) lake (Horseshoe Lake) that was connected with the stream.

Incubating Black Brant were less easily disturbed than White-fronted Geese, but Brant nesting success was unknown. Only one of the relocated nests possessed shell membranes. Most Brant nests were found along the edges of and on small islands (hydrolaccoliths) in large Shallow (III) and Deep-Arctophila (IV) wetlands. The only Brant broods observed were in large wetland complexes composed primarily of smaller Shallow-Carex (IIb) and the moss and moss/carex zones associated with large Deep-Open lake basins (V) outside the study area.

Most of the White-fronted Goose nests found were on polygonal ridges near Shallow-Carex (IIb) wetlands. Nest material was composed primarily of lichens with very little down present. White-fronted Geese were very vocal when flushed from their nests and their white eggs, usually left uncovered, were quite visible. It is thus surprising that all seven nests found were successful. However, no broods known to have come from identified nests were found. The majority of the broods seen were along Garry Creek in a low area of numerous, wide, closely-grouped meanders east of the study area.

No Snow Goose nests were found; however, one gosling was observed attended by two adults along the beaded stream (VII) in the same area as the White-fronted Goose broods.

On 21 June a Pintail nest with seven eggs was found near the campsite on a high-center polygon. The brown/cream colored down blended perfectly with the dark/light mosaic patches of lichen on the polygon rendering the nest inconspicuous. The female had been incubating for at least 10 days when found and was still on the nest as late as 27 June. However, the nest was found empty 29 June and was probably destroyed by Arctic Fox.

Two successful Spectacled Eider nests were found, one on a small hydrolaccolith in Flooded Tundra (I) near large Deep-Arctophila (IV) wetlands and the other on a ridge between Class IIb low-center polygons. The broods were very mobile moving from one wetland to another (Table 10).

The only Oldsquaw nest found was situated on a small polygonal ridge amid a complex of low-center polygons. Broods were observed on both Shallow-Carex (IIb) and Deep-Open (V) wetlands.

One Willow Ptarmigan brood of at least three downy chicks was discovered on upland tundra. The brood was accompanied by two females. Both females performed initial rushes with outspread wings at the observer's feet. Then one female feigned injury and led the observer away (200-250 m) while the remaining female led the chicks off in the opposite direction.

Small Birds

American Golden Plover nests were located on high-center polygons covered with patches of dark and light lichens. The shallow nest bowl and the eggs were inconspicuous even at close range. Incubating adults usually left the nest long before we were within 50-75 m of them, but as we got close they returned and performed broken-wing acts until we departed. Chicks several days old were seen on 29 July and 6 August.

A single Buff-breasted Sandpiper nest with three eggs was found on 1 July in a uniform patch of dry Carex in a weakly polygonal area of Flooded Tundra

(I). The fourth egg was deposited on 2 July. Both adults attended the nest until 5 July, after which only one bird was seen. Two eggs had hatched and two were pipped on 25 July after 24 days of incubation. This brood was not observed later, but single fledged young each with an adult were seen feeding in high-center polygons on 5 and 12 August along Square Lake, and 7 August near Teshekpuk Lake.

Nests of Pectoral Sandpiper (1), Dunlin (5), and Semipalmated Sandpiper (4) were found on dry sites in upland areas or polygon ridges near Flooded Tundra (I) wetlands. Nest cover was usually even stands of dry Carex. A Long-billed Dowitcher nest was found on the edge of a dry ice wedge pool in upland high-center polygons. This nest was initiated about 30 June and the clutch of two eggs was pipped 20 July. No Dunlin nests were relocated for nesting chronology but single chicks were seen with adults on 15 and 16 July, and two broods of two fledglings were seen on 22 July. One Semipalmated Sandpiper nest was found 15 June, the four eggs were pipped on 25 June, but hatch was delayed until 30 June. No Pectoral or Semipalmated Sandpiper broods were observed.

Red and Northern Phalarope nests were found in moist low-center polygons (I). The first Red Phalarope nest was found 29 June and the first brood was seen 14 July. Only one Northern Phalarope nest was found 9 July, but was not relocated.

Two Parasitic Jaeger nests were found on polygon ridges in Flooded Tundra. One nest was successful, the single egg pipped on 8 July. Adults performed distraction displays on subsequent observations but the chick was not found.

Glaucous and Sabine's Gulls and Arctic Terns nested around large Deep-Open (V) lakes. Glaucous Gull nests were found on islands of large lakes or

adjacent wetland complexes, and large downy young were seen on 4 August. A Sabine's Gull nest was found in the moist Carex zone of East Long Lake and two Arctic Tern nests were found in the Moss Zone. Occasional aggressive interactions were noted between these two species on East Long Lake but an ice-push peat bar on northwest West Long Lake was used as a brood rearing area for both species without marked hostility. Downy broods of both species seemed of similar ages on 25 July, and fledged young were seen foraging with adults on 5 August.

Lapland Longspurs nested mostly on dry sites in upland tundra on the sides of high-center polygons but also on low-center polygon ridges. Most nests were initiated the second week of June, and 8 of 17 nests hatched 23-25 June. Fledglings were first observed the first week of July.

Wetland Use by Waterbirds

Bird use of various wetland classes was assessed on the 15.54 km^2 study area twice a week during bird censuses from 10 June through 13 August.

Loons

Arctic Loons preferred Deep-Arctophila (IV) wetlands for nest sites (50%) and during all periods of the summer (Table 11). Deep-Open (V) wetlands and Beaded Streams (VII) were used more intensively in June than later in the summer.

Over fifty percent of all Red-throated Loons and 57% of their nests were found on Shallow-Arctophila (III) wetlands (Table 12). In contrast to the data for Arctic Loons, Red-throated Loon use of Beaded Streams increased throughout the summer, possibly a result of the greater use of fish by Red-throated Loons particularly for feeding young. We believe that Red-throated Loons were flying off the study area to adjacent large lakes to feed and obtain food for young.

Table 11. Wetland use by Arctic Loons, Teshekpuk Lake study area, 1978.

	Wetland Class						
	I	II	III	IV	V	VII	TOTAL
June							
Number of observations	0	12	8	19	8	2	49
Percent of total	0	24.5	16.3	38.8	16.3	4.1	
July							
Number of observations	0	3	14	22	2	0	41
Percent of total	0	7.3	34.1	53.7	4.9	0	
August							
Number of observations	0	4	2	14	1	0	21
Percent of total	0	19.0	9.5	66.7	4.8	0	
Seasonal	0	19	24	55	11	2	111
Total	0	17.1	21.6	49.5	9.9	1.8	

Table 12. Wetland use by Red-throated Loons, Teshekpuk Lake study area, 1978.

	Wetland Class						
	I	II	III	IV	V	VII	TOTAL
June							
Number of observations	0	5	9	0	0	1	15
Percent of total	0	33.3	60.0	0	0	6.7	
July							
Number of observations	0	3	13	2	1	4	23
Percent of total	0	13.0	56.5	8.7	4.3	17.4	
August							
Number of observations	0	5	10	1	1	5	22
Percent of total	0	22.7	45.5	4.5	4.5	22.7	
Seasonal	0	13	32	3	2	10	60
Total	0	21.7	53.3	5.0	3.3	16.7	

Greatest potential overlap between these species was on Shallow-Carex (II) wetlands. However, 1978 nesting data, brood sightings and wetland use data support findings of Bergman and Derksen (1977) that Red-throated Loons use Class III wetlands intensively whereas Arctics are found on deeper Class IV ponds.

Waterfowl

Pintails intensively used Shallow-Arctophila (III) wetlands for feeding and loafing (Table 13). Over sixty percent of all sightings were on these ponds. Late in summer these shallow ponds began drying up and Pintails shifted use to Deep-Arctophila (IV) ponds.

During June Oldsquaws used Deep-Open (V) wetlands most frequently, however Shallow-Carex (II) and Deep-Arctophila (IV) ponds also received considerable use (Table 14). During July no Oldsquaws were seen on Deep Open wetlands and use was concentrated on Deep-Arctophila (IV) and Shallow-Carex (II) wetlands. During August Oldsquaws were molting and showed high preference again for Deep Open (V) lakes. It appears that Deep Open lakes are used intensively by pre- and post-breeding Oldsquaws, and that breeding birds selected Deep-Arctophila (IV) and Shallow-Carex (II) ponds.

Spectacled Eiders were observed on Shallow-Carex (II), Shallow-Arctophila (IV), Deep Open (V) wetlands (Table 15). Shallow-Carex (II) and Deep-Arctophila (IV) ponds were used more heavily but the sample size is small. It is our impression that Shallow-Carex ponds were most important for breeding birds, and Class III and IV ponds were used in brood rearing.

Charadriiformes

American Golden Plovers feed extensively on dry upland sites, especially during the nesting season. In late July post-breeding Plovers and adults with broods were observed using the exposed mud and shallow water portions of Shallow-Carex ponds (Table 16).

Table 13. Wetland use by Pintails, Teshekpuk Lake study area, 1978.

	Wetland Class						
	I	II	III	IV	V	VII	TOTAL
June							
Number of observations	48	0	191	15	0	10	264
Percent of total	17.5	0	69.7	5.5	0	3.6	
July							
Number of observations	0	0	145	10	0	6	161
Percent of total	0	0	90.1	6.2	0	3.7	
August							
Number of observations	0	22	89	145	0	0	256
Percent of total	0	8.6	34.8	56.6	0	0	
Seasonal Total	48	22	425	170	0	16	681
	7.0	3.2	62.4	25.0	0	2.3	

Table 14. Wetland use by Oldsquaws, Teshekpuk Lake study area, 1978.

	Wetland Class						
	I	II	III	IV	V	VII	TOTAL
June							
Number of observations	0	13	3	11	23	1	51
Percent of total	0	25.5	5.9	21.6	45.1	2.0	
July							
Number of observations	0	9	1	36	0	4	50
Percent of total	0	18.0	2.0	72.0	0	8.0	
August							
Number of observations	0	3	1	0	270	0	274
Percent of total	0	1.1	tr.	0	98.5	0	
Seasonal	0	25	5	47	293	5	375
Total	0	6.7	1.3	12.5	78.1	1.3	

Table 15. Wetland use by Spectacled Eiders, Teshekpuk Lake study area, 1978.

	Wetland Class						
	I	II	III	IV	V	VII	TOTAL
June							
Number of observations	0	1	4	0	3	0	8
Percent of total	0	12.5	50.0	0	37.5	0	
July							
Number of observations	0	2	0	7	0	0	9
Percent of total	0	22.2	0	77.8	0	0	
August							
Number of observations	0	6	0	1	0	0	7
Percent of total	0	85.7	0	14.3	0	0	
Seasonal	0	9	4	8	3	0	24
Total	0	37.5	16.7	33.3	12.5	0	

Table 16. Wetland use by American Golden Plovers, Teshekpuk Lake study area, 1978.

	Wetland Class						
	I	II	III	IV	V	VII	TOTAL
June							
Number of observations	2	0	0	0	0	1	3
July							
Number of observations	1	25	0	0	0	0	26
August							
Number of observations	0	1	1	0	0	0	2
Seasonal	3	26	1	0	0	1	31
Total	9.7	83.9	3.2	0	0	3.2	

Flooded tundra (I) was used extensively by Long-billed Dowitchers throughout the summer (Table 17). Late in summer when most Flooded tundra (I) was dry, Long-bills were seen regularly in an area that remained wet because of outflow from a large Shallow-Arctophila wetland, and along Beaded Stream meadows.

Pectoral Sandpipers were observed most frequently feeding and loafing on dry upland areas and polygon ridges. During June and July 99 percent of all wetland use observations were on Flooded tundra (I) (Table 18). In August post breeding birds were observed using dry or partially dry Shallow-Carex (II) wetlands.

Dunlins used a broader range of wetland types than did Pectorals though they also were seen feeding frequently on dry upland sites (Table 19). In June Flooded tundra (I) received over 60 percent of all wetland use. During July Flooded tundra (I), Shallow-Carex (II), and Beaded Streams (VII) were used in nearly equal proportions. Use of Beaded Streams (VII) decreased sharply in August. With the drying of Flooded tundra (I) use of Shallow-Carex (II) ponds by Dunlins doubled. As with American Golden Plovers and Pectoral Sandpipers, Dunlins used exposed mud and shallow water portions of the Shallow-Carex wetlands.

Semipalmated Sandpipers began nesting very early in June. Wetland use at this time was concentrated on Flooded tundra (I), Deep Open (V) lakes and Beaded Streams (VII); those areas that thawed first (Table 20). Use of wetlands in July shifted from Flooded tundra (I) and Beaded Streams (VII) to Shallow-Carex (II) wetlands, with Deep Open (V) lakes continuing to receive considerable use. Semipalmated sandpipers using Deep Open (V) lakes and Beaded Streams (VII) foraged at the water-shoreline interface. By August Semipalmated Sandpipers had left the study area.

In early June Red Phalaropes primarily used Flooded tundra (I), the open water moats of Deep Open lakes and Beaded Streams (VII). Beaded streams

Table 17. Wetland use by Long-billed Dowitchers, Teshekpuk Lake study area, 1978.

	Wetland Class I	II	III	IV	V	VII	TOTAL
June							
Number of observations	7	1	0	0	0	0	8
Percent of total	87.5	12.5	0	0	0	0	
July							
Number of observations	20	4	5	0	1	2	32
Percent of total	62.5	12.5	15.6	0	3.1	6.3	
August							
Number of observations	5	1	0	0	0	0	6
Percent of total	83.3	16.7	0	0	0	0	
Seasonal	32	6	5	0	1	2	46
Total	69.6	13.0	10.9	0	2.2	4.3	

Table 18. Wetland use by Pectoral Sandpipers, Teshekpuk Lake study area, 1978.

	Wetland Class						
	I	II	III	IV	V	VII	TOTAL
June							
Number of observations	31	1	0	0	0	0	32
Percent of total	96.9	3.1	0	0	0	0	
July							
Number of observations	47	0	0	0	0	0	47
Percent of total	100	0	0	0	0	0	
August							
Number of observations	18	22	0	0	0	6	46
Percent of total	39.1	47.8	0	0	0	13.0	
Seasonal Total	96	23	0	0	0	6	125
	76.8	18.4	0	0	0	4.8	

Table 19. Wetland use by Dunlins at Teshekpuk Lake study area, 1978.

	Wetland Class						
	I	II	III	IV	V	VII	TOTAL
June							
Number of observations	18	3	5	0	0	3	29
Percent of total	62.1	10.3	17.2	0	0	10.3	
July							
Number of observations	11	8	1	0	2	9	31
Percent of total	35.5	25.8	3.2	0	6.5	29.0	
August							
Number of observations	10	18	2	0	0	3	33
Percent of total	30.3	54.5	6.1	0	0	9.1	
Seasonal	39	29	8	0	2	15	93
Total	41.9	31.2	8.6	0	2.2	16.1	

Table 20. Wetland use by Semipalmated Sandpipers, Teshekpuk Lake study area, 1978.

	Wetland Class						
	I	II	III	IV	V	VII	TOTAL
June							
Number of observations	4	0	1	0	5	5	16
Percent of total	25.0	0	6.3	6.3	31.3	31.3	
July							
Number of observations	8	41	0	0	35	5	89
Percent of total	9.0	46.1	0	0	39.3	5.6	
August							
Number of observations	None observed						
Percent of total	None observed						
Seasonal Total	12	41	1	1	40	10	105
	11.4	39.0	1.0	1.0	38.1	9.5	

appeared to be particularly important as food sources early in the summer (Table 21). Later in June use of Flooded tundra (I) and Shallow-Carex (II) wetlands increased, possibly as a result of breeding birds dispersing over the study area to wetlands with developing invertebrate populations.

Large flocks of apparently non-nesting Red Phalaropes remained on the study area in early July. The heavy use of Deep Open (V) wetland was confined to one location at the outlet of Garry Creek from Horseshoe Lake. We observed large numbers of Chironomid larvae being drawn from the lake into the creek by the flow. Use of Shallow-Arctophila (III) and Deep-Arctophila (IV) wetlands increased sharply at this time. In late July wetland use by Red Phalaropes was concentrated on Shallow-Carex wetlands and this pattern continued until the end of the study period.

Beaded streams were also important as food sources for Northern Phalaropes early in the summer (Table 22). As birds dispersed after snow-ice melt Flooded tundra (I) and Shallow-Arctophila (III) were used intensively.

In early July 56 percent of all Northern Phalaropes observed were using Shallow-Carex (II) ponds. Later in July and in August Northern Phalaropes were never observed on the Shallow-Carex wetlands that were rapidly drying up. Shallow (III) and Deep-Arctophila wetlands were heavily used in late July and August. Beaded Streams were used intensively in August after being virtually unused in July.

Northern Phalaropes used Shallow (III) and Deep-Arctophila (IV) ponds and Beaded Streams (VII) more heavily than Red Phalaropes. Red Phalaropes used Deep Open (V) lakes much more than did Northern Phalaropes. Flooded tundra (I) and Shallow-Carex (II) were important to both species, but were used slightly more by Red Phalaropes.

Several species were observed too infrequently to show their preferences for certain wetland classes. Black-bellied Plovers used Class I, II, and III

Table 21. Wetland use by Red Phalaropes, Teshekpuk Lake study area, 1978.

	Wetland Class I	II	III	IV	V	VII	TOTAL
10-20 June							
Number of observations	57	14	0	0	57	81	209
Percent of total	27.3	6.7	0	0	27.3	38.8	
21-30 June							
Number of observations	78	20	4	6	17	30	155
Percent of total	50.3	12.9	0.3	0.4	11.0	19.4	
TOTAL JUNE							
Number of observations	135	34	4	6	74	111	364
Percent of total	37.1	9.3	0.1	0.2	20.3	30.5	
1-16 July							
Number of observations	97	54	50	101	250[a]	12	564
Percent of total	17.2	9.6	8.9	17.9	44.3	2.1	
17-31 July							
Number of observations	0	167	7	0	0	0	174
Percent of total	0	96.0	4.0	0	0	0	
TOTAL JULY							
Number of observations	97	221	57	101	250	12	738
Percent of total	13.1	29.9	7.7	13.7	33.9	1.6	
1-13 August							
Number of observations	1	29	4	1	5	5	45
Percent of total	2.2	64.4	8.9	2.2	11.1	11.1	
Seasonal Total	233	284	65	108	329	128	1147
	20.3	24.8	5.7	9.4	28.7	11.2	

[a] 200 birds at creek outlet from lake

Table 22. Wetland Use by Northern Phalaropes, Teshekpuk Lake study area, 1978.

	Wetland Class I	II	III	IV	7	VII	TOTAL
10-20 June							
Number of observations	16	3	0	5	0	29	53
Percent of total	30.2	5.6	0	9.4	0	54.7	
21-30 June							
Number of observations	17	4	21	4	7	33	86
Percent of total	19.8	4.7	24.4	4.7	8.1	38.4	
TOTAL JUNE							
Number of observations	33	7	21	9	7	62	139
Percent of total	23.7	5.0	15.1	6.5	5.0	44.6	
1-16 July							
Number of observations	11	51	10	11	0	8	91
Percent of total	12.1	56.0	11.0	12.1	0	8.8	
17-31 July							
Number of observations	1	0	7	18	0	0	26
Percent of total	3.8	0	26.9	69.2	0	0	
TOTAL JULY							
Number of observations	12	51	17	29	0	8	117
Percent of total	10.3	43.6	14.5	24.8	0	6.8	
1-13 August							
Number of observations	1	0	3	4	0	6	14
Percent of total	7.1	0	21.4	28.6	0	42.9	
Seasonal Total	46	58	41	42	7	76	270
	17.0	21.5	15.2	15.6	2.6	28.1	

ponds, probably similar to patterns of American Golden Plover. Bar-tailed Godwits were seen on Class II and III wetlands in late July, and six Stilt Sandpipers used a Class II polygonal pond on 5 August. Ruddy Turnstones were only seen along Deep Open (V) lakes, Ruddy Lake, Square Lake and occasionally at East Long Lake where there were exposed peat and mud shorelines. Buff-breasted Sandpipers were observed feeding only on dry sites in uplands or high-center polygons along lakeshores.

Table 23 is a summary of wetland use by all waterbirds over the entire season. Significant ($P<0.001$) differential use was made of various wetland classes. Flooded tundra (I) was used proportionately less than expected because of its extensiveness and temporary nature in relation to the supportable populations of birds. Class III, IV and VII were used more than expected perhaps because loons and waterfowl preferred the feeding, nesting and brood cover of Arctophila beds. Arctophila also provided rich feeding sites for shorebirds when water levels dropped after mid-season. Garry Creek (VII) was important as the first available wetland with Arctophila cover, and later provided exposed shoreline feeding sites for shorebirds and brood mobility for geese.

Bird species diversity was greatest (17/19) on Class II Shallow-Carex ponds perhaps because of their usefulness to deep- and shallow-water feeding birds, and the wide range of depths of ponds in this class. Many species also used Shallow-Arctophila zones of Classes III and VII wetlands, because of good cover and seasonally diverse feeding sites. Flooded tundra (I) is generally the first wetland type available to birds arriving in spring, and over half of all species used it at least temporarily. Class IV and V wetlands are relatively deep, providing only marginal shoreline habitat for numerous shorebird species (Tables 16-22).

Table 23. Relative use of wetland classes by waterbirds over the entire season on the Teshekpuk study area, 1978.

	Wetland Class						
	I	II	III	IV	V	VII	TOTAL
Total birds[a] observed	509	555	611	434	688	266	3063
Percent of birds	16.6	18.1	19.9	14.2	22.5	8.7	100.0
Number of species	11	17	13	9	8	13	19
Percent of wetland area	48.1	16.2	6.1	4.7	24.1	0.8	100.0
Expected number[a] of birds	1473	496	187	144	738	25	3063

[a] $\chi^2 = 4509.9$, df = 5, $P < 0.001$

Mammal Observations

Caribou (Rangifer arcticus)

Small cow-calf herds were present on the study area when we arrived on 2 June. These herds of 2-40 animals exhibited local movements lacking a definite direction of travel. This pattern continued until 17 June when the first migratory herds were seen. Three cow-calf herds (21-42 animals per herd) moved northward through the study area on that day. From 18 June until 27 June only local movements were observed. Daily counts from this period were higher than from the earlier period of local movements (35.1 vs. 14.2). From 30 June to 8 July 10 herds (4-222 animals per herd) were seen moving north. Bulls were first observed on 1 July. The cow-calf ratio in the migratory herds seen for the period ending 8 July was 2.0:1. Herd size and composition data for this period of northerly migration is summarized in Table 24.

The first southward migrations were seen on 9 July and for the remainder of the field season (ending 13 August) both northerly and southerly migrations were observed. Thirteen herds seen during this period contained bulls. Eleven of these herds were traveling south (84.6 percent of all herds) and these 11 herds contained 92.8 percent of all bulls seen during this period. Cows were observed with all 22 herds seen after 8 July. Fifty-seven percent of all cows were moving south but only 38.9 percent of cows in herds with calves were moving south. The cow-calf ratio for the period 9 July-13 August was 4.1:1.

Local movements by small herds were observed throughout the field season but such observations were much less frequent after mid-July. Data from 9 July-13 August are summarized in Table 25.

Table 24. Caribou herd size and composition during period of northerly migration (17 June - 8 July) at Teshekpuk Lake study area, 1978.

Herd type	Number of herds	Mean herd size	Mean number of bulls/herd	Mean number of cows/herd	Mean number of calves/herd	Direction of travel	
All bull	3 (23.1)[a]	4.7 (4-5)[b]	4.7	-	-	North South	100% 0%
All cow-calf	10 (77.0)	83.3 (16-222)	-	55.2	28.1	North South	100% 0%
Total-all herds	13	65.2 (4-222)	1.1	42.5	21.6	North South	100% 0%

[a] percent of total in parentheses

[b] range in parentheses

Table 25. Caribou herd size and composition after beginning of southerly migration (9 July - 13 August) at Teshekpuk Lake study area, 1978.

Herd type	Number of herds	Mean herd size	Mean number of bulls/herd	Mean number of cows/herd	Mean number of calves/herd	Direction of travel (by herd)		Direction of travel (by individuals)	
Bull-cow	4 (181)[a]	178.0 (16-447)[b]	113.5	64.5	-	North South	0% 100%	North South	0% 100%
Cow-calf	9 (40.9)	24.4 (6-63)	-	18.2	6.2	North South	77.7% 22.2%	North South	87.7% 12.3%
Bull-cow-calf	9 (40.9)	95.1 (5-250)	28.3	47.8	17.2	North South	22.2% 77.7%	North South	39.1% 60.9%
Total - all herds	22	81.3 (5-447)	32.2	39.5	9.6	North South	40.9% 59.1%	North South	29.5% 70.5%

Arctic Fox (Alopex lagopus)

Two active Arctic Fox dens were located in the vicinity of the Teshekpuk study area (Figure 4). One site consisted of two separate dens on the old shoreline of a Class III wetland. Den 1A was a well developed natal den with six pups attended by two adults. Food items at this den included parts of Oldsquaw, Pintail, an eider hen, sheathed goose (probably Canada) primaries, a large shorebird and lemmings. Den 1B was an old unmaintained den, probably a day-use site. Food items found included parts of an Oldsquaw hen and eight uneaten Collared Lemming (Dicrostonyx groenlandicus) carcasses. Den 2 was located on a dry ancient shore of East Long Lake. Two adults and five pups used this den. Only old bones from waterfowl and caribou were found. We recorded 51 Arctic Fox sightings from 2 June through 15 August.

Lemmings

Ten Collared Lemmings and two Brown Lemmings (Lemmus trimucronatus) were observed near or on the study site.

Other Mammals

A domestic dog was seen on 4 June traveling north between East and West Long Lake. The same dog was seen again on 18 June near a Whistling Swan nest on the study area. The dog appeared to be a pregnant female.

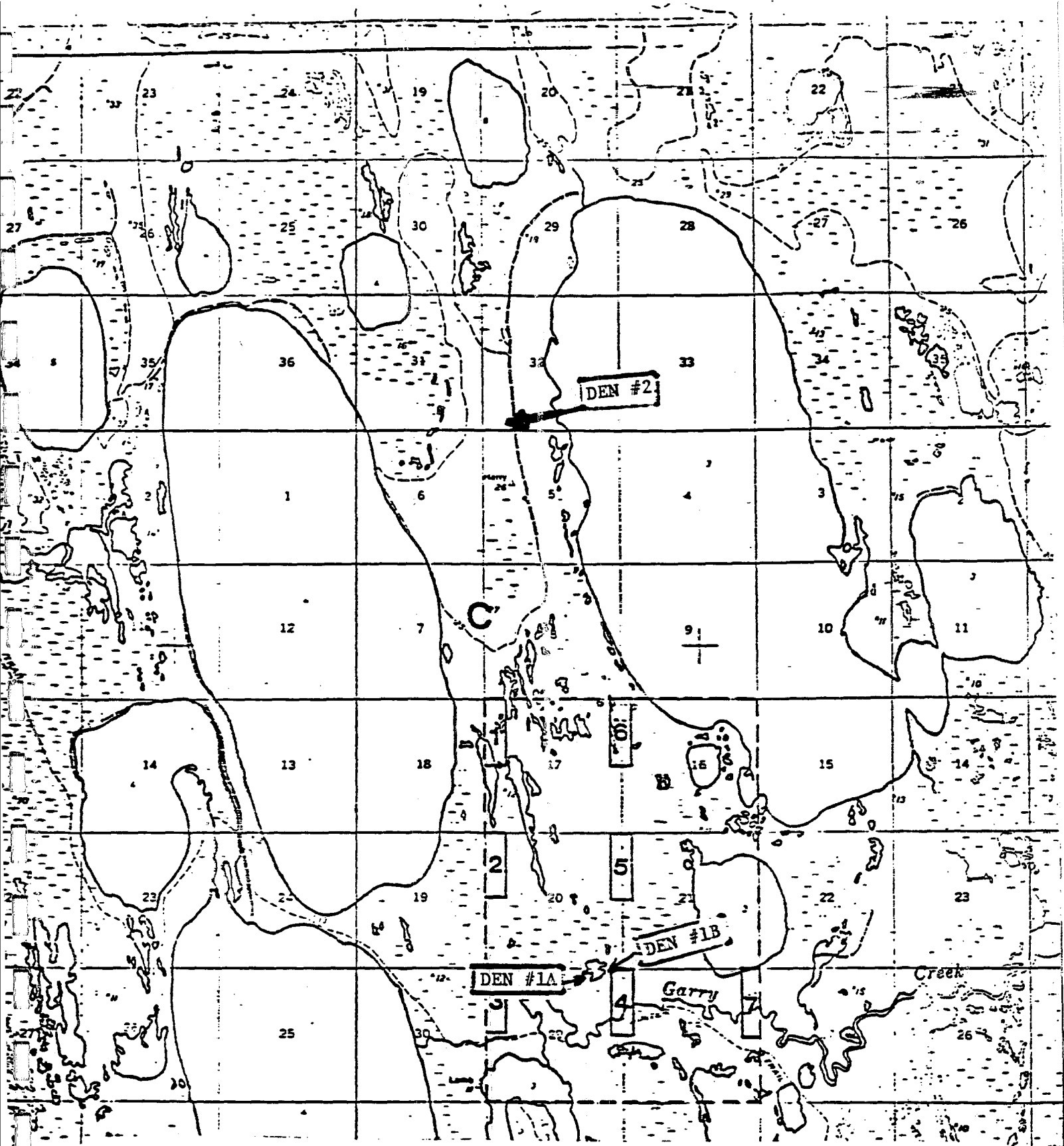

Figure 4. Locations of Arctic Fox dens at Teshekpuk Lake study area, 1978.

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Appendix 1. Physical, chemical and invertebrate samples from ten ice wedge pools, Teshekpuk Camp, 1978.

	Parameter	14-16 June	28-30 June
Pool # 1	Conductivity (umhos/cm)	45	68
	Temperature (°C)	4.8	13
	pH	6.0	6.0
	Water depth (cm)	68	49
	Sediment depth (cm)	2	6
	Sweep	10 (4)[a]	26 (6)
	Ekman	14 (6)	52 (4)
Pool # 2	Conductivity (umhos/cm)	37	64
	Temperature (°C)	3.2	12.5
	pH	6.0	6.5
	Water depth (cm)	64 + ice	79
	Sediment depth (cm)	1	12
	Sweep	34 (4)	116 (8)
	Ekman	32 (3)	17 (3)
Pool # 3	Conductivity (umhos/cm)	40	65
	Temperature (°C)	2	12.5
	pH	6.2	6.5
	Water depth (cm)	42 + ice	74
	Sediment depth (cm)	1	10
	Sweep	31 (5)	45 (8)
	Ekman	- ice	46 (3)
Pool # 4	Conductivity (umhos/cm)	42	58
	Temperature (°C)	2.3	11.5
	pH	6.0	6.3
	Water depth (cm)	64 + ice	52
	Sediment depth (cm)	0	5
	Sweep	26 (5)	26 (7)
	Ekman	1 (1)	36 (5)
Pool # 5	Conductivity (umhos/cm)	53	75
	Temperature (°C)	6.5	12.5
	pH	6.0	6.3
	Water depth (cm)	64	52
	Sediment depth (cm)	3	9
	Sweep	55 (7)	63 (11)
	Ekman	64 (5)	278 (3)
Pool # 6 (Shallow)	Conductivity (umhos/cm)	63	-
	Temperature (°C)	8.0	-
	pH	5.3	-
	Water depth (cm)	15	-
	Sediment depth (cm)	3	11
	Sweep	91 (5)	-
	Ekman	-	-

Appendix 1 (con't.) Physical, chemical and invertebrate samples from ten ice wedge pools, Teshekpuk Camp, 1978

	Parameter	14-16 June	28-30 June
Pool # 7 (Shallow)	Conductivity (umhos/cm)	60	-
	Temperature (°C)	8.3	-
	pH	5.5	-
	Water depth (cm)	17	4
	Sediment depth (cm)	5	15
	Sweep	318 (8)	-
	Ekman	-	-
Pool # 8 (Shallow)	Conductivity (umhos/cm)	69	-
	Temperature (°C)	9.1	-
	pH	5.8	-
	Water depth (cm)	21	7
	Sediment depth (cm)	4	-
	Sweep	73 (5)	-
	Ekman	-	-
Pool # 9 (Deep)	Conductivity (umhos/cm)	64	85
	Temperature	5.1	11
	pH	6.0	5.8
	Water depth (cm)	52	46
	Sediment depth (cm)	2	15
	Sweep	90 (5)	52 (8)
	Ekman	- ice	27 (3)
Pool # 10 (Deep)	Conductivity (umhos/cm)	57	83
	Temperature (°C)	3.1	9.0
	pH	5.8	6.0
	Water depth (cm)	73 + ice	84 + ice
	Sediment depth (cm)	0	10
	Sweep	33 (5)	123 (5)
	Ekman	- ice	- ice

[a] number of taxa in parentheses