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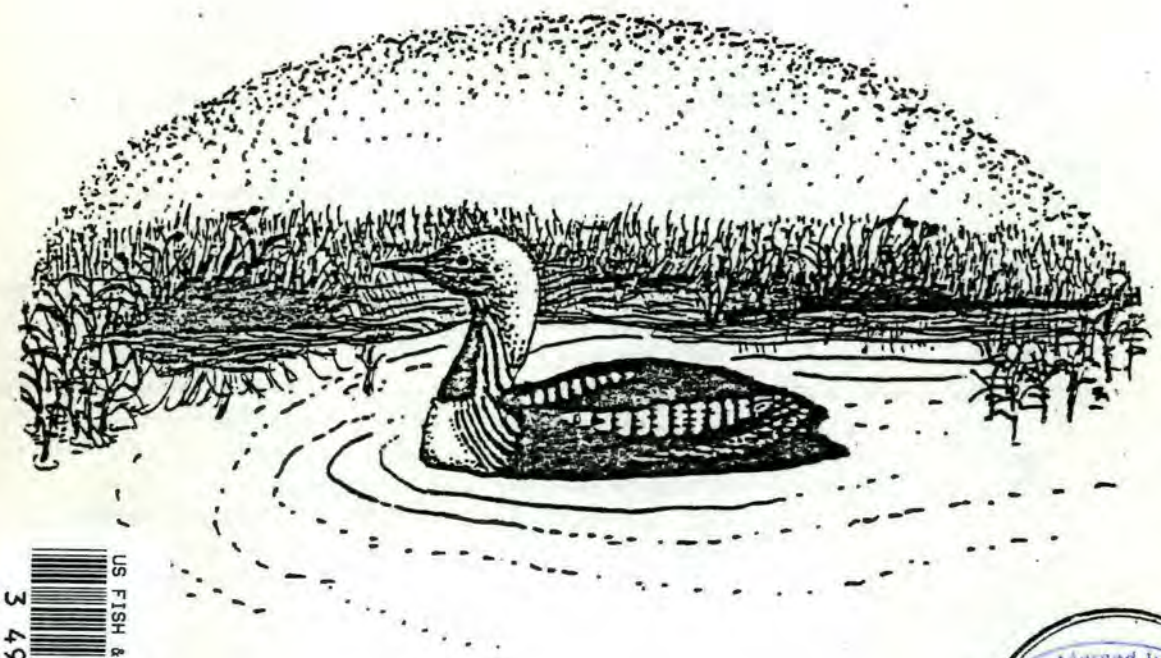
BIRD POPULATIONS AND HABITAT USE, CANNING RIVER DELTA, ALASKA.



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September, 1981

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SUMMARY

Bird populations and use of habitat at the Canning River Delta, Arctic National Wildlife Refuge, was the subject of a study during the summer of 1979 and 1980. Results are presented in four sections.

Bird Use of Tundra Habitats

Two intensive study plots were established in 1979 in a lowland (wet polygonal) tundra area and an upland (well-drained, indistinctly polygonized) tundra area. A third intensived study plot was added in 1980, in a mosaic (intermixed wet and dry microhabitats) tundra area. Populations of "small birds" (i.e. shorebirds, passerines) were moitored through periodic censuses and nest search on the intensive study plots. A smaller auxiliary plot on West Branch Flats (a saline meadow) was also established in 1980 and censused for total bird use.

The mosaic had the greatest breeding population and high diversity of breeding species. Principle breeding species there were Pectoral Sandpiper, Semipalmated Sandpiper, and Lapland Longspur. Breeding densities were lowest on the upland in both 1979 and 1980; the principle breeding species were Lapland Longspur and Semipalmated Sandpiper. On the lowland, densities were higher than the upland, but diversity lower. Red Phalaropes dominated on the lowland, with Pectoral Sandpiper and Lapland Longspur both important species breeding in fair numbers.

Total bird use (including migrants) was high in the mosaic plot in early summer, but much higher still in late summer in the lowland plot, when several species became common as migrants (e.g. Golden Plover, Long-billed Dowitcher, Pectoral Sandpiper). Relative use of the upland was high only in early June, before other areas were snow-free. The West Branch Flats had very high use by all birds for the entire season.

Populations of "large birds" (i.e. loons, watefowl, larids, etc.) were censused on a portion of the study area in 1979 and nesting density estimates were made in both 1979 and 1980 on the basis of nest and brood observations. Principle breeding species recorded were Arctic and Red-throated Loons, Whistling Swan,. Canada Goose, and Oldsquaw, and King Eider. Other species numerous as migrants include Brant and White-fronted Goose.

Different habitats were important to birds of different species and at different times of the year. The upland and mosaic had high populations of Longspurs and shorebirds early in the season, probably as a result of relatively early melt-off at these sites. The mosaic had the highest nesting density of longspurs and shorebirds, while the lowland was most used by late summer migrants. The saline meadow was used extensively by shorebirds including staging phalaropes, but also by breeding and migrant waterfowl, loons, and larids; this habitat attracted the highest concentrations of birds and a diversity of species. Complex wetlands of the deep -Arctophila type had high concentrations of breeding loons and waterfowl.

Bird Use of Shoreline Habitats of the Beaufort Sea

An intensive study of bird use of coastal shoreline habitats was conducted at Canning River Delta in 1980. Bird censuses were conducted on ten transects totalling 27.5 km at four-day intervals throughout the summer, June to September. In addition, three censuses were made of the entire length of Brownlow Lagoon.

It was found that:

1. River mouth habitat was important during spring migration as it provided the first open water for migrating waterbirds, and early snow-melt on the dunes provided first open tundra habitat for migrating shorebirds.
2. Barrier islands provided nesting habitat for Common Eiders, Glaucous Gulls, and Arctic Terns. Certain mainland shorelines were nesting areas for Ruddy Turnstones, Baird's Sandpipers, and Snow Buntings. Other species found nesting on shorelines were Whistling Swan, Canada Goose, Pintail, Oldsquaw, and Black Guillemot.
3. Shoreline use by waterfowl was dominated by Oldsquaw, except during periods of migration.
4. Shoreline use by Oldsquaw showed a dramatic increase in midsummer, (late July) corresponding to the onset of their molt.
5. Shoreline use by shorebirds and passerines also showed a dramatic increase in midsummer, corresponding to termination of nesting and movement to shorelines for feeding and staging before migration.
6. Saline meadow habitat was the most used of any mainland shoreline habitat; especially by shorebirds and Brant resting and feeding during fall migration.
7. Phalaropes and Sanderlings were the main species to use Barrier Island habitats for feeding during fall migration, in mid-August and early September, respectively.
8. Oldsquaws and other waterfowl were generally found in larger numbers outside the barrier islands rather than inside the lagoons, except during their molt period.
9. Gaps in barrier islands were found to be areas of significant concentrations for both feeding and nesting birds, espcially Oldsquaw, eiders, Arctic Terns, Glaucous Gulls, loons.

Migration

Migration watches were conducted in 1980 on the Canning River Delta for ten days in spring from base camp site and for 20 days in fall from Brownlow Point. During the intervening summer period, migration data were obtained by observers on shoreline transects.

Major eastward movement of Brant was observed on 30 May (309/hr.) and

5 June (850/hr.). These were the only days of the spring migration watch period when prevailing winds did not oppose the birds' direction of movement. Oldsquaw were observed migrating east at a rate of 29/hr. on 5 June, and jaegers (mostly Pomarine Jaegers) at a rate of 23/hr. on 30 May and 16/hr. on 5 and 6 June. Major spring migration movements of other species were not observed, probably due to movement along offshore leads.

A gradual westward molt migration of Oldsquaw was observed from mid-June to late July; Oldsquaw appeared to be at the peak of their molt during the first two weeks of August. A westward movement of Scoters (mostly Surf Scoters) was observed mid-June to mid-July. A major westward movement of male Common Eiders peaked on 28 July at 522/hr. Eastward movement of Pintails was recorded mid-July to mid-August.

Westward fall migration of Brant, Oldsquaw, and loons built up gradually from mid-August to a peak on 31 August and 1 September (Brant: 386/hr.; Oldsquaw: 538/hr.; Loons: 147/hr.). Another peak occurred 10 September after our observations were terminated. Large numbers of jaegers (18/hr.), Arctic Terns (39/hr.) and Black-legged Kittiwakes (63/hr.) were also seen moving westward on 1 September; their movements may have been affected by a severe storm with strong west winds on 29 August.

During spring migration the open water of the West Branch of the Canning River was heavily used as a resting place for migrating waterfowl. During fall migration the saline meadow areas of the Lagoon and Bay transects were important resting areas for migrating Brant and shorebirds, while Barrier Islands were heavily used by migrating phalaropes and Sanderlings, and Oldsquaw stopped to rest in the lagoons.

Species Accounts

Species accounts for all 84 bird species recorded at Canning River Delta are presented. A review of status and distribution in the region is included for each species, as well as details of chronology of migration and breeding activities.

INTRODUCTION

Study Objectives

The Canning River Delta region, on the western boundary of the Arctic National Wildlife Refuge (hereafter ANWR) has been identified as an area of relatively high bird use (Spindler 1978c). Within recent years, increasing interest has been focused on this region by the petroleum industry. Exploratory drilling has been conducted onshore just west of ANWR and further leasing of neighboring state lands and nearshore waters for mineral development is expected. In addition, the Alaska Interest Lands Conservation Act of 1980 mandated seismic exploration on the most of the Arctic Coastal Plain within ANWR. In response to the likely acceleration of petroleum industry activity in the region, the U.S. Fish and Wildlife Service initiated a field study of bird populations in 1979 with the following objectives:

1. Estimate avian populations in the major coastal tundra habitat types, according to the species and according to the entire community, during two successive breeding seasons, including the periods of spring and fall migration.
2. Determine the extent of bird utilization of the coastal lagoons and estuaries of the Canning River Delta.
3. Determine the preferred breeding habitats of birds nesting in arctic coastal tundra of the Canning River Delta.
4. Evaluate the relationship of productivity of the major avian habitats to their use by breeding birds on the arctic coastal plain.
5. Identify habitats that are critical to the success of birds using the Canning River Delta.

Itinerary

In 1979, field work was begun 19 May and ended on 3 September. Three workers were present for most of this period, although the number of persons at camp varied from two to four. In 1980, field work was conducted from 24 May to 9 September. Four researchers were present during this entire period.

Study Area

The study area was located in the vicinity of Brownlow Point (70° 10′N, 145° 50′W), approximately 85 km west of the village of Kaktovik (on Barter Island) and 95 km east of Prudhoe Bay (Figures 1 and 2). In this sector the

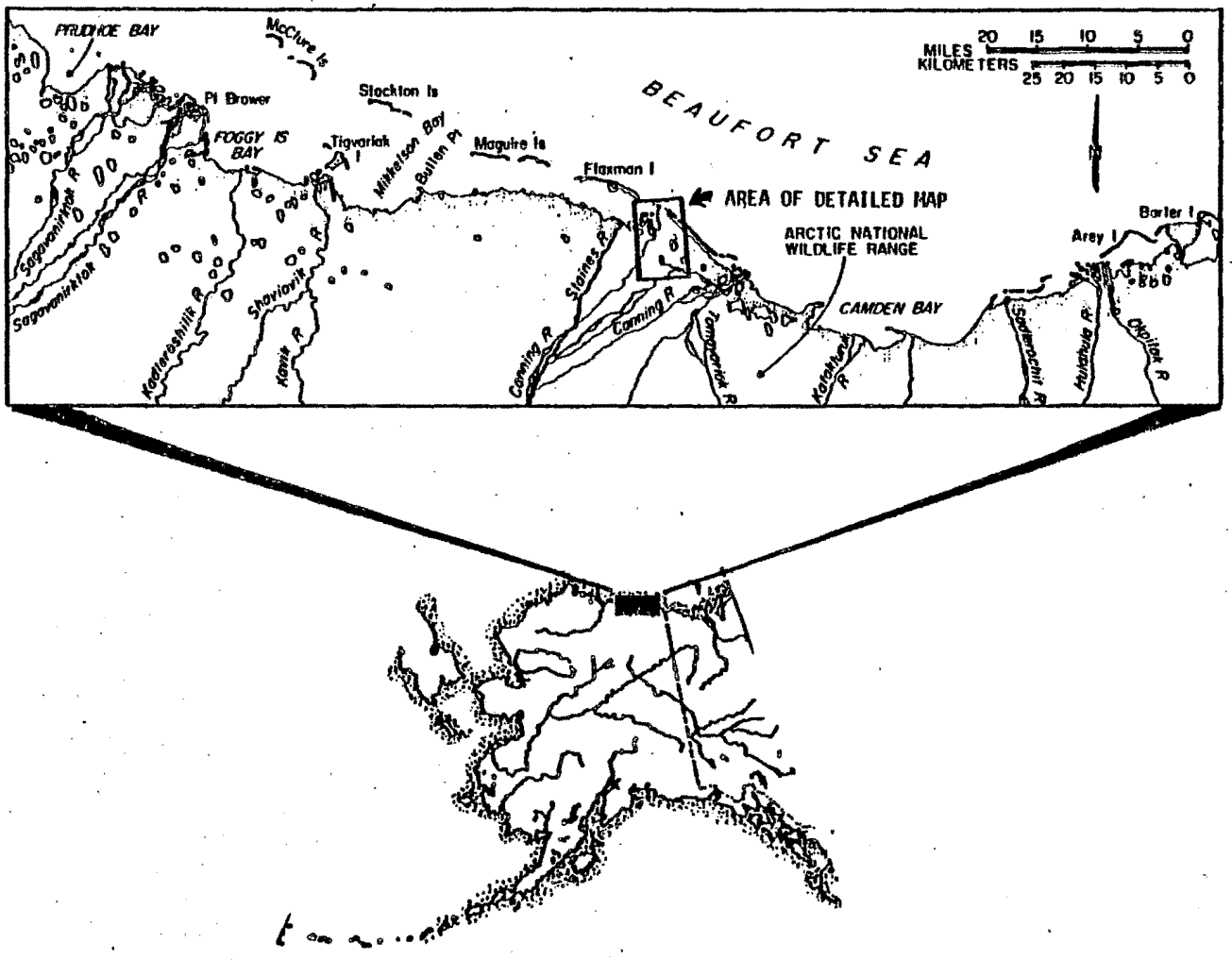

Figure I-1. Location map showing study area in relation to a portion of the Beaufort Sea coast and the state of Alaska.

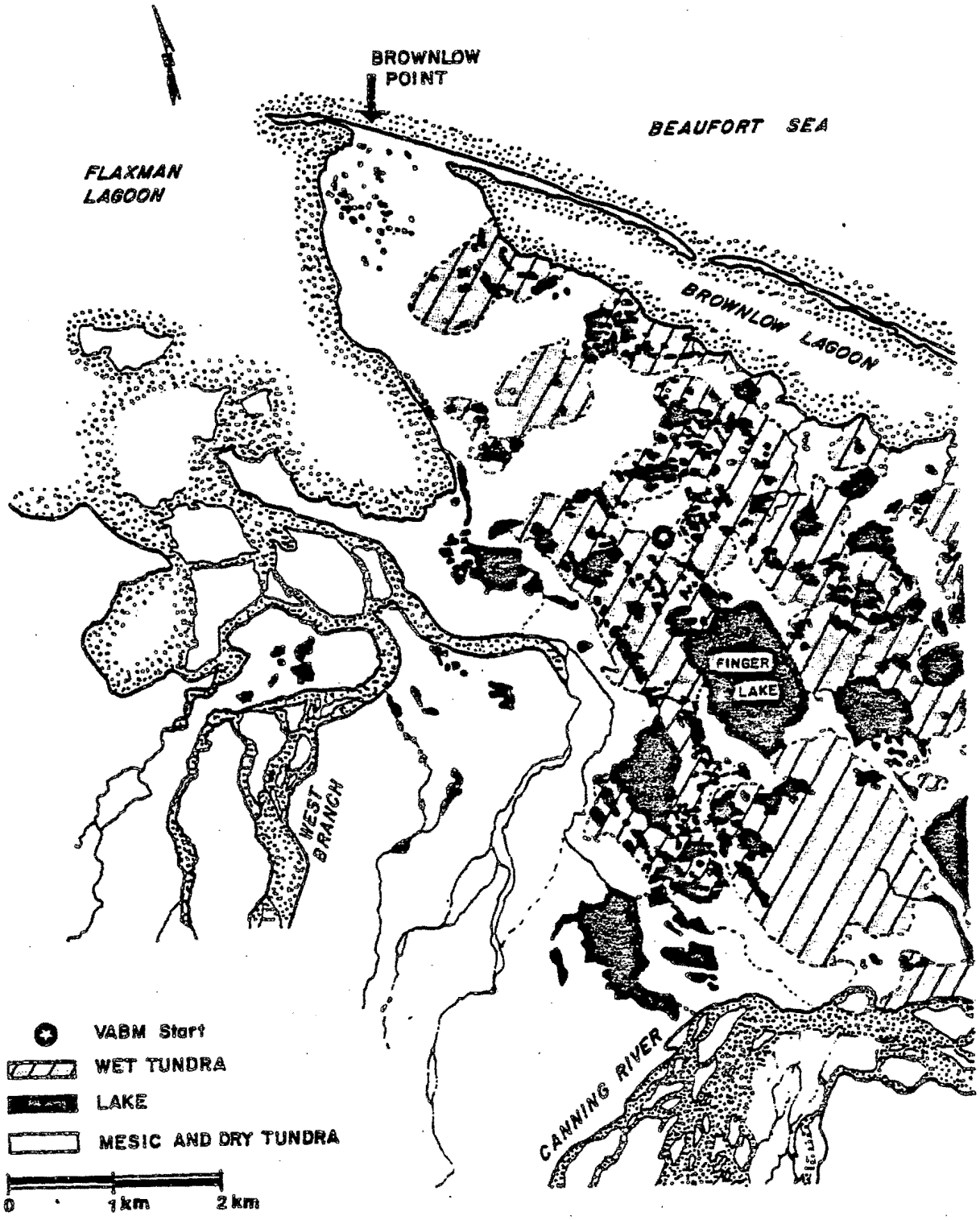

Figure I-2. Detail map of study area, vicinity of Brownlow Point.

Brooks Range mountains approach the coast closely; the Arctic Coastal Plain is only about 45 km across from the Canning River Delta south to the Sadlerochit Mountains. The Canning River emerges from the mountains onto the Arctic Coastal Plain approximately 50 km upriver. The main channel of the river swings abruptly eastward just before reaching the delta, while the Staines River and a second distributary (hereafter named the West Branch) continue northward and enter the Beaufort Sea just south of Flaxman Island. The general study region encompassed the area between the West Branch Delta and the Canning-Tamayariak River Delta. Most of our work was concentrated in the vicinity of Brownlow Point, in a 20 square kilometer area named the Primary Study Area (PSA). The PSA, camp locations, tundra study plots, and other localities referred to in this report are delineated in Figure I-3.

Geology and Geomorphology

The entire study area is underlain by a geological unit described and named the "Flaxman Formation" by Leffingwell (1919). Hopkins (1978) contrasted the Flaxman Formation outcrops with the predominant arctic coastal plain surface geology.

> ...east of Oliktok Point, the Arctic Coastal Plain is underlain by a series of coalescing alluvial and glacial outwash fans extending northward from the Brooks Range...They consist mostly of sandy gravel. The alluvial fans generally extend to the coast, but in some places, the immediate coastal area is occupied by the Flaxman Formation, a marine sandy mud of Pleistocene age which contains abundant glaciated pebbles, cobbles, and boulders foreign to Alaska and quite different in lithology from the gravel of the Brooks Range origin in alluvial fans...
>
> Gravel derived from alluvium and outwash of streams draining the Brooks Range consists largely of chert, graywacke, and grit, and includes notable quantities of vein quartzite, while gravel derived from the Flaxman Formation consists largely of dolomite and also includes notable quantities of red quartz, red granite, pyroxenite and diabase.

The origin of the Flaxman Formation is a matter of dispute, but it is possible that these materials were ice-rafted from arctic Canada or Greenland during a period of transgression (i.e. at a time when sea levels were higher than at present) (S. Rawlinson, U. of Alaska, pers. comm.).

Typical of Arctic Coastal Plain localities, the Canning River Delta study area is flat and topography is dominated by erosional features associated with the river system and the Beaufort Sea coast, and by patterned ground associated with the permafrost which is continuous in this region. The highest point in the study area (about 14.5 m) is along a sand dune system on the west bank of the Canning River mouth.

Coastal "bluffs", many of them exceeding three or four meters in height, occur on the lagoon shoreline; they are particularly pronounced on the east shore of Flaxman Lagoon, in a stretch 2.5 km long, south of Brownlow Point and also near the mouth of the Canning River. Cut banks of considerable height (in excess of three meters) also occur along the Canning River. Sand dunes formed by wind deposition of fluvial sediments (see Walker et. al 1980) occur at the mouth of the Canning River along the West Branch, and to a lesser extent along the Canning River channels away from the coast. Lakeshore bluffs three to five meters in height are also common. These constitute the only abrupt landscape features; elevations over the study area are in the range of 1.5 m to 3.5 m above sea level in lowland areas, to seven or eight meters above sea level on ridges associated with lakeshore bluffs, and a gentle ridge reaches about ten meters in height (it runs east-west approximately 3.5 km sout of Brownlow Point and was the location for the upland study plot).

This uniformity of terrain is not indicative of biological uniformity, however. The microrelief features associated with permafrost, as well as the erosional features described, provide distinct drainage and soil characteristics producing an array of vegetation types.

Viewed from the air, the study area has the appearance of a lattice-work due to the presence of patterned ground associated with ice-wedge polygons. The growth of subterranean ice-wedges is manifested at the surface by a pattern of polygonally shaped basins enclosed by rims and troughs. Each of these units has distinct vegetation types, modified by the extent of polygonization. Polygon troughs are often enlarged and deepened by the process of thermokarst subsidence, forming ice-wedge pools. Polygon rims may develop into so-called "bird mounds" which are apparently a product of relatively rapid build-up of peat on polygon rims through fertilization by birds and mammals which use these high and dry sites for perches, nests, or burrows. Other permafrost landforms, such as frost-boils and string-bogs, also modify the local vegetation.

Overlain upon the process of polygonization is the formation and eventual drainage of ponds and lakes in the "thaw lake cycle" (Walker et. al. 1980). Over a timespan of thousands of years small impoundments of water in polygon basins coalesce to form larger ponds and lakes. Wind driven wave action and thermal erosion continue to enlarge these lakes until a divide is breached and the lake drains, leaving a marsh or a complex of ponds and marsh. The remaining lakeshore bluffs provide a special habitat type; erosion of polygons near lake shores results in formation of high-centered polygons and this well-drained terrain may remain long after lake waters have drained (Walker et. al. 1980).

Thus, in spite of its apparent monotony, the arctic landscape is a dynamic landscape which contains a great variety of microrelief features associated with geomorphic processes of permafrost areas. The interplay of these geomorphic processes determine the landform and the vegetation patterns referred to as "habitat" by the zoologist.

There are several special geographical features of the Canning River Delta area that undoubtedly influence bird use of the area. First, there is an unusual concentration of large lakes from the West Branch to Konganevik Point, in striking contrast to most of ANWR. Second, the delta system of the Canning River provides considerable expanses of tidal mud flat habitat and the spring flood from the rivers provides early open water. Finally, the barrier island-lagoon system of the Beaufort Sea coast provides a habitat of particular importance to sea ducks, phalaropes, loons and other species. Characteristics and biological importance of this system have been described by Johnson and Richardson (1981) who summarize as follows.

> In general, the nearshore environment of the Beaufort Sea appears to be highly productive (in terms of the biota of interest to man) relative to the adjacent ocean. Productivity is enhanced by (1) circulation that causes nutrients and biological products to accumulate in the nearshore, (2) shallow depths that promote rapid utilization of nutrients and biota, (3) short food webs that promote efficiency in net production, and (4) migrant populations of birds that populate the shallows during growth and feeding stages of their lives

Climate and Weather Data

Canning River Delta has an arctic coastal climate, similar to that of the U.S. Weather Service station at Barter Island. The Beaufort Sea is frozen most of the year, but from break-up (in mid-June to mid-July) to freeze-up (sometime during the period from September to November) the Beaufort Sea exerts a moderating influence over the weather of the coastal areas. Compared with inland areas, the immediate coast experiences warmer autumns and cooler spring and summer temperatures. In spring and summer there is a very steep temperature gradient on the Arctic Coastal Plain along the pipeline corridor, with temperatures falling off rapidly as one approaches the coast (Walker et.al. 1980) and this climatic feature is undoubtedly present at the Canning River Delta as well.

Summer temperatures at Barter Island are cool, with mean daily maxima of about 3.4° C., 7.5° C., and 6.4°C. for June, July, and August, respectively. Heavy fog is characteristic of the coastal area in summer and is recorded on

about half the days during the months of June through August at Barter Island (U.S. Department of Commerce 1979) and fog cover is a factor in keeping temperatures cool. Wind is a constant element of Arctic Coastal Plain weather, although average wind velocities are least during the summer months. At Barter Island, summer winds are predominantly east to east-northeast and mean wind speeds are 17-18.5 km/hr during the summer months (U.S. Department of Commerce 1979). Strong winds also occur from a westerly direction; very little north or south wind is recorded. Annual precipitation is difficult to measure on the Arctic Slope because much of it falls as wind-driven snow in winter or mist in summer, and is underestimated by conventional rain gauges. Annual precipitation at Barter Island is about 165 mm (1948-1978 30-year average) with about 70 mm (40% of total) falling in the months of June through August (U.S. Department of Commerce 1978).

At Canning River Delta, daily minimum and maximum temperatures were recorded June through August 1979 and 1980 (Figure I-4) and temperatures were also recorded on a continuous basis using a recording thermograph. Wind direction and velocity was recorded twice daily using a Sims hand-held anemometer. Sky condition and occurrence of precipitation was also recorded twice daily (Table I-1) although quantitative records of precipitation were not kept.

Temperatures in the two years were very different. One way of illustrating this is the graph of cumulative deviation from average mean temperature (Figure I-5). To develop this graph, daily mean temperature for each day during the months of May through August was first computed by summing the daily maximum and minimum, and dividing by two. Then, for each date, the mean of daily means over 30 years of records (1949 - 1979) was computed, and this value subtracted from daily mean temperature, yielding a value for deviation from average mean temperature for each day. When these deviations are graphed cumulatively over the season, comparisons between years are made easily. A horizontal line segment would indicate temperatures at or near normal for that time period; slope is proportional to the magnitude of deviation of observed mean temperature from the 30 year average.

Figure I-5 shows that the month of May was very different in the two years. May temperatures were well above average in 1979, resulting in an early melt-off. At Canning River Delta snow cover was diminished by 27 May, ice was "candled" on small ponds by 28 May, and by 1 June snow was essentially gone and standing water was abundant. Small ponds and lakes were quite open by 6 June. May of 1980 was colder than average and snow melt did not even begin until 1 June; one to two thirds of the ground's surface (depending on slope, aspect and elevation) was still snow covered on 8 June (see Figure II-2). Significant amounts of open water were not present on the tundra until 5 June 1980 and small ponds and lakes were not open until 10 June. Although other factors such as the accumulated snow pack doubtless influence chronology of snow melt, the two years of study provide a good example of how spring temperatures can have an impact on timing of snow melt, and thereby affect the favorability of the environment which greets spring migrant birds.

The two years were also widely divergent in their mid-summer tempera-

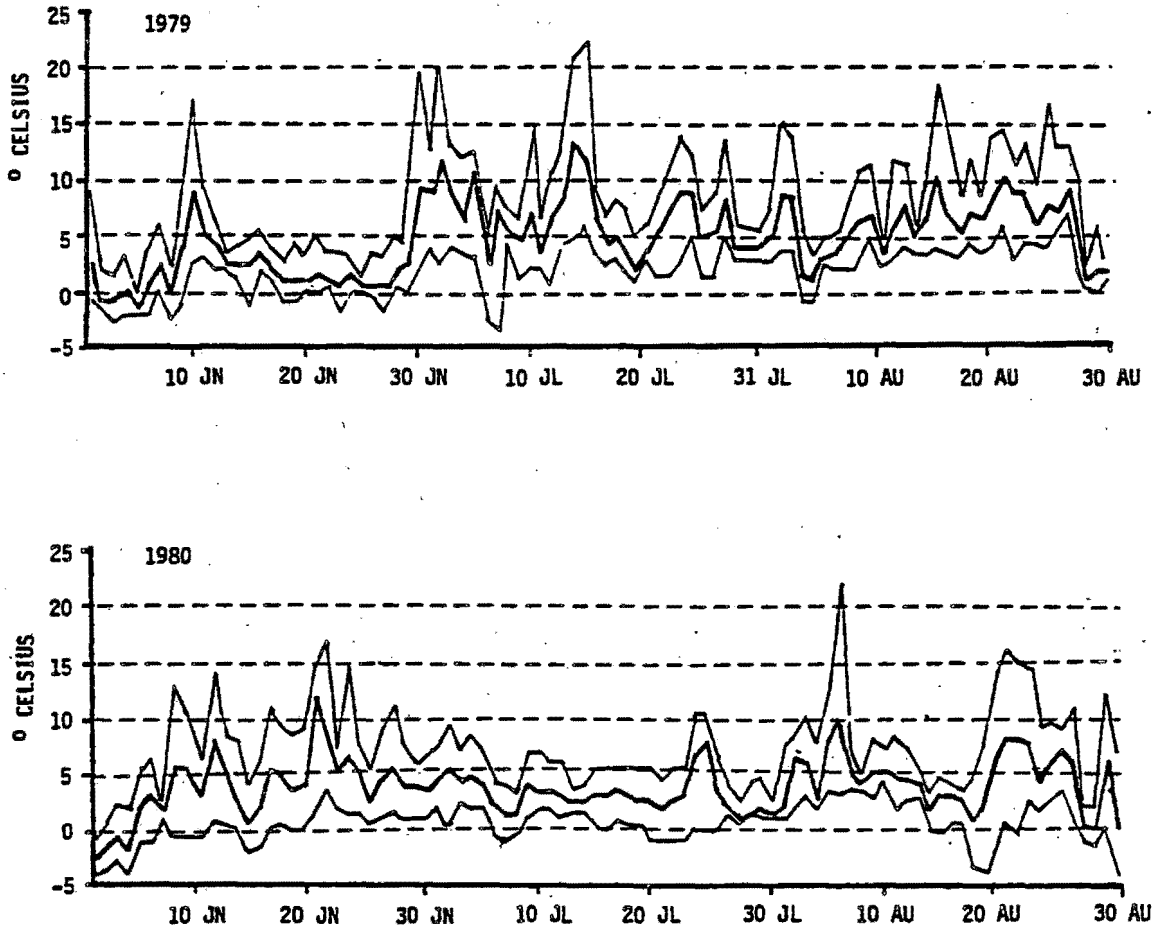

Figure I-4. Daily mean (heavy line), maximum (upper line) and minimum (lower line) temperatures at Canning River Delta, summers of 1979 and 1980.

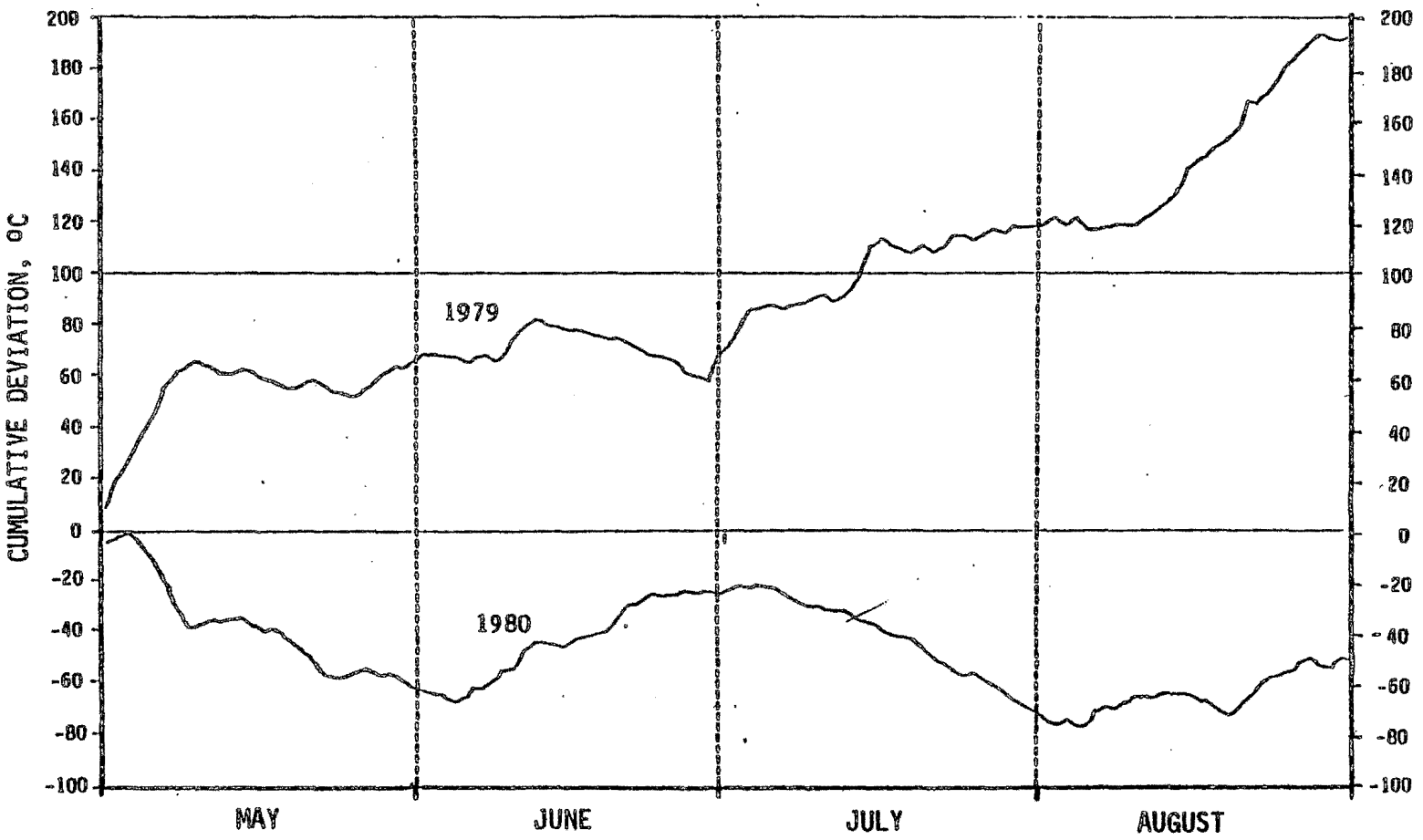

Figure I-5. Cumulative deviation from average mean temperature, Barter Island, May to August 1979 and 1980 (data from National Weather Service). See text for explanation.

Table I-1. Sky conditions, wind direction and precipitation types recorded from Canning River Delta, 1979-1980. Sky and wind observations made twice daily and results expressed in per cent frequency of observations.

	1979			1980		
	June	July	August	June	July	August
Sky Cover (% of observations)						
overcast	57	39	68	41	59	67
broken	12	7	15	12	18	14
scattered	17	47	15	34	18	14
clear	14	7	2	13	5	5
Wind Direction (% of observations)						
calm	0	8	8	7	2	5
north	2	7	3	2	0	11
northeast-east	78	70	60	71	85	35
south	0	0	0	0	0	0
southeast	0	0	3	7	3	4
southwest	1	2	0	2	0	4
west	17	10	21	9	7	34
northwest	2	3	0	2	3	7
Precipitation Types (# of days occurred)						
snow	5	0	2	3	0	2
rain	4	10	21	6	10	15
fog/mist	15	15	13	8	19	10

tures. At Barter Island, July 1979 was the fourth warmest in 30 years of records. July 1980, however, was colder than any other July on record except in 1965. At Canning River Delta, recording thermograph records show that in the first three weeks (a total of 504 hours) of July 1980, temperatures exceeded 5 C. for only 40 hours in 1980, while falling below 5 C. for only 100 hours during this period in 1979. In 1980, temperatures fell below freezing on 6-8 July and 19-21 July; no freezing temperatures were experienced in 1979. This period of the summer is critical in that it coincides with hatch, growth, and development of longspur and shorebird chicks. Cold weather at this time can have a profound depressive effect on insect abundance and activity, and this decrease in prey availability may reduce survivorship among juvenile birds.

Wind direction may affect bird migration on the Beaufort Sea coast, as has been noted for Brant and Oldsquaws (Richardson 1978). Unusual wind conditions existed in late August of 1980, in that west winds prevailed from 21 August on. Normally, east winds are predominant at this time. This probably delayed Brant movement westward until the second week of September in 1980.

Catastrophic weather events sometimes occur which may have long term as well as short term effects on bird poipulations. One such event was the westerly storm of 29-30 August, 1980, which brought winds peaking at 56 miles per hour to Barter Island. At Canning Delta the resulting storm tides altered the coastline considerably. The barrier spits washed out in several places forming new gaps in the beach. The resulting new "barrier islands" may temporarily make nesting areas for eiders, gulls, terns, and guillemots less accessible to ground predators. Short term effects of the storm included the occurrence of unusual numbers of terns, kittiwakes, and a few alcids at Brownlow Point.

Human History of the Study Area

The Flaxman Island-Brownlow Point area has been an important traditonal trading and meeting site for Beaufort Sea coast Eskimo groups. The arctic explorer Stefansson (1913) noted numerous families waiting to trade at Flaxman Island in 1908, and whalers had noted tents and men at Flaxman Island in the mid-19th century. A "large camp" was noted at the Canning River by an expedition in 1837 (Neilson 1977). The North Slope Borough Commission on History and Culture (Traditional Land Use Inventory for the mid-Beaufort Sea 1980; Neilson 1977) has documented that several Eskimo families lived in the area from the end of the 19th century to the 1940's.

The Anglo-American Polar expedition of 1906-1907 was the first major scientific effort in the area. Ernest de K. Leffingwell was a member of that expediton and he spent the years of 1909-1911 and 1913-1914 in the Canning River Delta region, having built a house of ship's timbers on Flaxman Island. A U.S. Geological Survey scientist, Leffingwell made the first accurate maps of the area and described the geology of the coastal plain.

During the 1920's and 1930's many trading posts were established along the Beaufort Sea coast as a result of the highly profitable fur trade. Eskimo

families gravitated towards these trading posts, and in the case of Kaktovik, the ten or twelve families which moved there at this time formed the nucleus of the modern village. Numerous other small communities lasted only as long as the trading posts, among them the village at Brownlow Point known as Agliguagruk. A white trader named Henry Chamberlin maintained a trading post here for 20 years 1923-1943. He built his trading post using the materials from Leffingwell's house on Flaxman Island, which he transported to Brownlow Point. He also built a dwelling and both structures are still standing, as well as a smaller sod and wood hut. The Reverend Klerekopfer reported several families here in 1927 and a U.S. Census listed 27 people at this site during this period (North Slope Borough Commission on History and Culture 1980).

The Panningona family moved to Flaxman Island in 1921 and members remained in the area until about 1947-1949. These were probably the last year-round residents of the Canning River Delta. Living members of this family have described their subsistence lifestyle in several interviews (North Slope Borough Commission on History and Culture 1980; Sverre Pederson, Alaska Department of Fish and Game pers. comm.). Winters were spent on Flaxman Island, where they trapped (mostly arctic foxes) and hunted seals and ptarmigans. In summer, the family moved to Agliguagruk (Brownlow Point) for fishing. The whole Canning River Delta area was used for caribou hunting in summer, and the Staines River area was used for caribou hunting all year round. Waterfowl were also hunted in the area: eiders at the eastern end of Flaxman Island in spring, and Brant from Brownlow Point in fall. The Brownlow Point area was good for seal hunting and polar bears were hunted in fall from the Point.

The Panningonas remained in the area until the 1940's — since then use of the area has probably been sporadic. Brownlow Point has recently been cited (Wentworth 1978) as a summer fish camp for several Kaktovik families. We noticed only one visit by people from Kaktovik, an overnight stay in late August, 1979.

After the era of fur trade, the next profound change in cultural patterns of the Arctic Slope people came with the arrival of the U.S. military. Particularly important was the establishment of the DEW-line stations along the northern coast of Alaska. The rationale behind the DEW-line was to have a chain of radar and communications stations across the entire northern tier of North America in order to intercept long range bombers (presumably from the U.S.S.R.) on their way south towards continental U.S.A. The original "experimental" section of the line across northern Alaska was built in the spring of 1953 and was operational by 1954. Several different types of station were built; main stations (such as the one at Kaktovik), auxiliary stations, and intermediate stations. The facility built at Brownlow Point was an intermediate station, the smallest type. These were manned by two to four persons and were equipped with radars to intercept any low-altitude flights between the main and auxiliary stations. The threat of long-range bombers was replaced by inter-continental missiles and the DEW-line intermediate sites were decommissioned in 1963. The shell of the building remains along with

large quantities of 55 gallon fuel barrels, lumber, hardware, and other refuse. Vehicle tracks leading to the site along the Flaxman Lagoon shore are also an enduring legacy from the DEW-line era at Brownlow Point.

A completely new phase of development in the Canning River Delta area was ushered in by the oil industry in the last decade. The first oil well in the area was Exxon Corporation's on Flaxman Island, in operation in 1975. Although Exxon intended to keep their success a secret to prevent competitive bidding on nearby leases, a minor public furor developed there as a result of illegal dumping of a slurry of drilling mud, water and small quantities of oil into the sea (Fairbanks Daily News Miner, July 26, 1975). Exxon was eventually fined $100,000 as a result of the incident.

Six years after their initial successful well, oil industry activity in the area has expanded greatly. Exxon Corporation and Mobil Corporation now have seven wells onshore in the Point Thomson area south and west of Flaxman Island and all within 23 km of ANWR, the nearest being about five kilometers west of the Staines River and about eleven kilometers from our 1980 base camp. In addition to these state owned tracts, the offshore areas leased under the Joint Federal-State sale of 1979 include the barrier islands and Beaufort Sea tracts east to the western end of Flaxman Island. Farther west, near the Shaviovik River delta, another group of wells has been erected by several of the major corporations. No current plans have been announced for actual production, but if production occurs it will necessitate development of transportation facilities, probably a pipeline tie-in to the Trans-Alaska Pipeline System. Oil-related development activities are likely to increase in the near future. The State of Alaska plans to hold two lease sales in May of 1982. One of these covers a 1.5 million acre area between the Canning River and the pipeline corridor inland from the coast. The other is a smaller area around the east end of Flaxman Island and in the Staines River estuary and along the Staines River; these tracts were included in the aborted Point Thomson sale which was canceled in 1978 by Alaska Governor Jay Hammond, largely in response to opposition from Alaska Natives. Both of these lease sale areas adjoin the Arctic National Wildlife Refuge. Also, federal leasing of offshore tracts in the Beaufort Sea off ANWR is in the planning stages and seismic exploration on refuge lands was mandated by the Alaska National Interest Lands Act. Petroleum extraction and accompanying development are likely to play a major part in the future of the Canning River Delta in the near future.

Introduction to the Avifauna of the Canning River Delta

A total of 84 species was recorded at Canning River Delta in the two years of study (Table I-2). This represents about 45% of the total number of species listed for the North Slope of arctic Alaska (Pitelka 1974). For purposes of comparison, Pitelka (1974) listed 151 species for the Barrow region and Bergman et. al. (1977) listed 72 species from their five year study at Storkersen Point, in the Prudhoe Bay area.

At Canning River Delta 29 breeding species were confirmed, with six ad-

Table I-2. Species List, Canning River Delta, 1979-1980

Yellow-billed Loon	*Gavia adamsii*	V
Arctic Loon	*Gavia arctica*	B
Red-throated Loon	*Gavia stellata*	B
Whistling Swan	*Olor columbianus*	B
Canada Goose	*Branta canadensis*	B
Brant	*Branta bernicla*	B
White-fronted Goose	*Anser albifrons*	V
Snow Goose	*Chen hyperborea*	V
Ross' Goose	*Chen rossii*	V
Mallard	*Anas platyrhynchos*	V
Gadwall	*Anas strepera*	V
Pintail	*Anas acuta*	B
Green-winged Teal	*Anas carolinensis*	V
Northern Shoveler	*Anas clypeata*	V
American Wigeon	*Anas americana*	V
Greater Scaup	*Aythya marila*	V
Oldsquaw	*Clangula hyemalis*	B
Common Eider	*Somateria mollissima*	B (mar)
King Eider	*Somateria spectabilis*	B
Spectacled Eider	*Lampronetta fischeri*	B
White-winged Scoter	*Melanitta deglandi*	V
Surf Scoter	*Melanitta perspicillata*	V
Black Scoter	*Melanitta nigra*	V (mar)
Red-breasted Merganser	*Mergus serrator*	B?
Rough-legged Hawk	*Buteo Lagopus*	V (in)
Marsh Hawk	*Circus cyaneus*	V
Gyrfalcon	*Falco rusticolus*	V (in)
Peregrine Falcon	*Falco peregrinus*	V
American Kestrel	*Falco sparverius*	V
Willow Ptarmigan	*Lagopus lagopus*	B?
Rock Ptarmigan	*Lagopus mutus*	B
Sandhill Crane	*Grus canadensis*	V

cont. on following page

Table I-2, cont.

American Golden Plover	*Pluvialis dominica*	B
Black-bellied Plover	*Pluvialis squatarola*	B
Hudsonian Godwit	*Limosa haemastica*	V
Bar-tailed Godwit	*Limosa lapponicus*	V
Whimbrel	*Numenius phaeopus*	V
Ruddy Turnstone	*Arenaria interpres*	B
Northern Phalarope	*Lobipes lobatus*	B
Red Phalarope	*Phalaropus fulicarius*	B
Common Snipe	*Capella gallinago*	V (in)
Long-billed Dowitcher	*Limnodromus scolopaceus*	B
Red Knot	*Calidris canutus*	V
Sanderling	*Calidris alba*	V
Semipalmated Sandpiper	*Calidris pusilla*	B
Western Sandpiper	*Calidris mauri*	V
White-rumped Sandpiper	*Calidris fuscicollis*	B?
Baird's Sandpiper	*Calidris bairdii*	B
Pectoral Sandpiper	*Calidris melanotos*	B
Dunlin	*Calidris alpina*	B
Stilt Sandpiper	*Micropalama himantopus*	B
Buff-breasted Sandpiper	*Tryngites subruficollis*	B
Pomarine Jaeger	*Stercorarius pomarinus*	B?
Parasitic Jaeger	*Stercorarius parasiticus*	B
Long-tailed Jaeger	*Stercorarius longicaudus*	V (in)
Glaucous Gull	*Larus hyperboreus*	V
Herring/Thayer's Gull	*Larus argentatus/thayerii*	V
Black-legged Kittiwake	*Rissa tridactyla*	V (mar)
Sabine's Gull	*Xema sabini*	B
Arctic Tern	*Sterna paradisea*	B
(Thick-billed?) Murre	*Uria sp.*	V (mar)
Black Guillemot	*Cepphus grylle*	B
Horned Puffin	*Fraterculus corniculata*	V (mar)

cont. on following page

Table I-2, cont.

Snowy Owl	*Nyctea scandiaca*	B?
Short-eared Owl	*Asio flammeus*	B?
Empidonax sp.	*Empidonax sp.*	V
Horned Lark	*Eremophila alpestris*	V (in)
Cliff Swallow	*Petrochelidon pyrrhonota*	V (in)
Common Raven	*Corvus corax*	V (in)
Varied Thrush	*Ixoreus naevius*	V (in)
Gray-cheek-d Thrush	*Catharus minimus*	V (in)
Yellow Wagtail	*Motacilla flava*	V (in)
Water Pipit	*Anthus spinoletta*	V (in)
Orange-crowned Warbler	*Vermivora celata*	V (in)
Yellow Warbler	*Dendroica petechia*	V (in)
Rusty Blackbird	*Euphagus carolinus*	V (in)
Redpoll	*Carduelis flammea/hornemanni*	B
Savannah Sparrow	*Passerculus sandwichensis*	V (in)
Dark-eyed Junco	*Junco hyemalis*	V (in)
Tree Sparrow	*Spizella arborea*	V (in)
White-crowned Sparrow	*Zonotrichia leucophrys*	V (in)
White-throated Sparrow	*Zonotrichia albicollis*	V
Lapland Longspur	*Calcarius lapponicus*	B
Snow Bunting	*Plectrophenax nivalius*	B

V = visitor, not a breeding species
B = confirmed breeder
B?= possibly breeding in some years
(mar) = presence probably due to proximity of marine environment
(in) = breeds inland in foothills and Brooks Range

ditional species considered likely breeders in some years (based on published information on range or our own observations). The Barrow list of breeding birds includes only 22 regular breeders and 13 occasional breeders. Thus, although the total species richness for Barrow is greater, there are as many breeders at Canning River Delta. Only 25 breeders were recorded at Storkersen Point (Bergman et. al. 1977). Compared with Barrow, Canning River Delta has fewer species (primarily due to the greater number of stragglers recorded at Barrow) but a higher proportion of breeders. Compared with Storkersen Point and probably most other Arctic Coastal Plain sites, Canning River Delta is species rich.

Causal factors contributing to the species richness include the proximity of the mountains and location on the Beaufort Sea coast. A total of 17 species that are visitors at Canning River Delta are breeders in the foothills and the Brooks Range. Most of these are passerines and most occur at Canning River Delta as stragglers either in spring (late May or first week of June) or in late summer. Birds wandering off course are stopped and concentrated on the coastline where they are often seen around man-made structures and debris or along sheltering coastal bluffs.

Another factor contributing to species richness is the area's proximity to the Beaufort Sea. Not only is the sea coast an important migration route for many tundra nesters, but some birds (i.e. kittiwakes, puffins, murres) are more or less pelagic in the non-breeding season and are not generally seen on land away from breeding areas.

The ecological diversity of Canning River Delta may also play a part in the relative species richness (including high number of breeding species). The delta, with its river channels, bluffs, salt marshes, lakes and ponds provides a variety of habitat not found in many other areas of comparable size in the Arctic Coastal Plain of the Arctic National Wildlife Refuge.

PART II. BIRD USE OF TUNDRA HABITATS

INTRODUCTION

The primary objective of the Canning River Delta bird population project of 1979 and 1980 was to estimate bird populations according to habitat type. Although LANDSAT satellite imagery keyed to vegetation type is available for most of the Arctic National Wildlife Refuge, accurate imagery is unavailable for the Canning River Delta. In the absence of more precise habitat information, we decided to locate census plots in contrasting habitat types discernible in high altitude aerial photographs. We picked two contrasting sites representing "upland" (well drained) and "lowland" (poorly drained) tundra.

Since waterfowl and other large birds occur in low densities on the Arctic Coastal Plain compared with shorebirds and the principle passerine species, Lapland Longspur, a separate sampling scheme was used for these birds. We chose a modified version of the methods used by U.S. Fish and Wildlife Service teams in the National Petroleum Reserve- Alaska (Derksen et al. 1979), which consists of walking a standard route through a 15.6 square kilometer area, censusing all large birds. We used a smaller area of only 2.45 square kilometers, however we attempted to estimate large bird breeding densities within a 20 square kilometer area which we traversed regularly, termed the "Primary Study Area".

In 1980, large bird survey was eliminated in favor of increasing our coverage of different habitat types used by shorebirds and passerines and increasing our work in marine littoral habitats. We added a third intensive study site to the upland and lowland plots already established in 1979. The upland and lowland sites were homogenous habitats with very different characteristics (especially with respect to amount of wetland) and differences in patterns of bird use. Although the contrast between the two homogenous and vastly different habitat types was instructive, it provided no insight into what to expect from a more heterogenous environment. Would bird use of a heterogenous habitat which was a mixture of upland and lowland be some sort of "average" of bird use on these two plots, or did the heterogeneity itself confer some special quality on the environment resulting in a unique pattern of bird use? Were some species more abundant in areas of mixed wet and dry habitat? We established the "mosaic plot" (in mixed wet and dry tundra) to address this question. Comparative descriptions of the habitat in these plots appear in the results.

We also had noticed that areas of coastal wetland (sensu Bergman et al. 1977) attracted large numbers of shorebirds and waterfowl, particularly in migration. In 1980 we established a small (20 ha) plot on the West Branch Flats in order to quantify bird use of this habitat. The West Branch Flats area is bounded by the West Branch River on one side, an embayment of Flaxman Lagoon (hereafter "the bay") on another, and the bluff which extends south from Brownlow Point along the old river bank on the third side. The entire area is within the zone of salt water influence; the high water mark indicated by a band of driftwood completely encloses the area. The presence

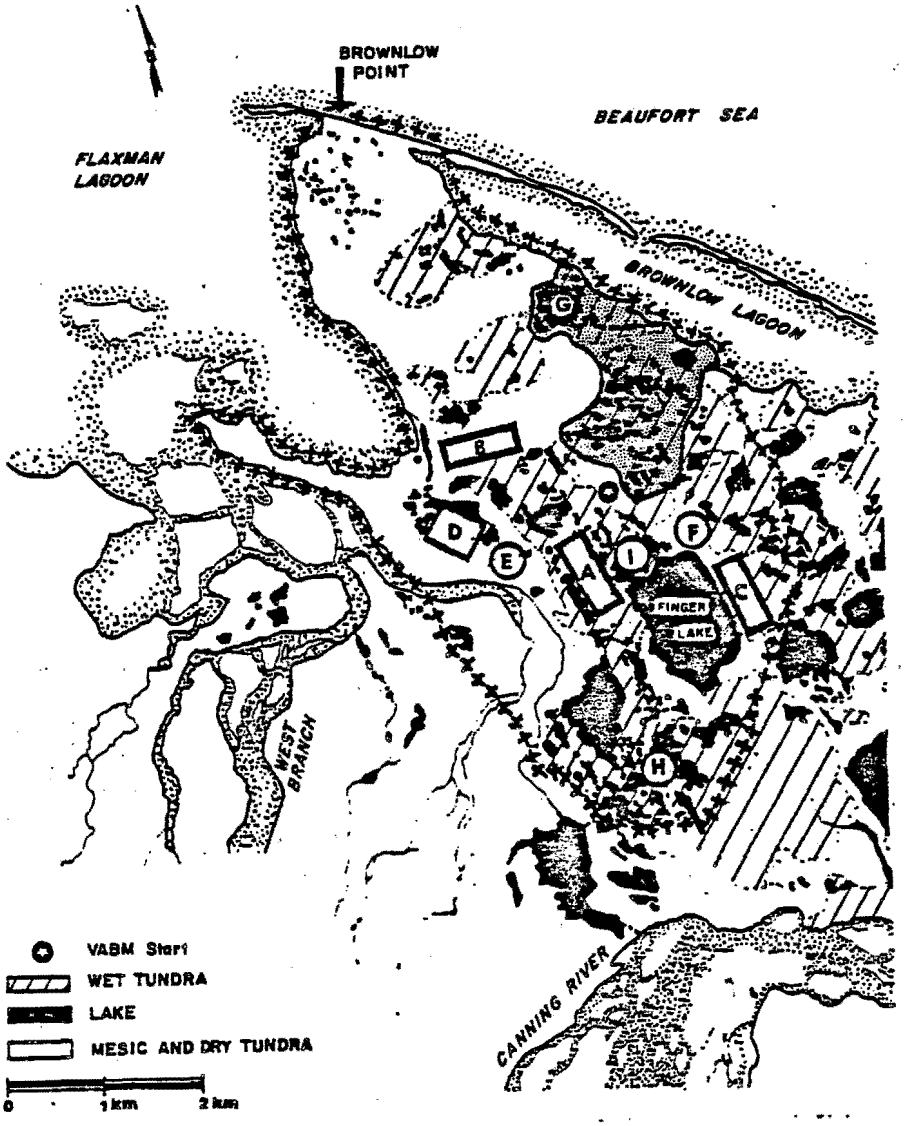

Figure II-1. Location map Canning River Delta study sites and place names used in text. Primary study area enclosed in line of crosses. The 1979 large-bird survey area is shown in dark stippling (area adjacent to Brownlow Lagoon).

A. Lowland study plot
B. Upland study plot
C. Mosaic study plot
D. West Branch Flats study plot
E. 1980 camp location
F. 1979 camp location
G. Lagoon Marsh
H. Chain Lakes
I. Corner Marsh

of plastics and other modern refuse in this storm wrack indicates that the area has been completely inundated in the recent past. The zone adjacent to the bay shore is vegetated chiefly by Carex subspathacea but farther back from the salt water there is graminoid vegetation dominated by Carex aquatilis and Dupontia fisheri. The area is dominated by ponds of varying sizes and depths. During spring flood the Flats were entirely flooded by overflow water from the West Branch, run-off from the tundra, and intrusion of brackish water from the bay. As the summer progressed, much of the area dried out, leaving expanses of non-vegetated sediments, but some of the deeper ponds retained water through the entire season. The area is highly polygonized, and the polygon rims provide the only dry ground convenient for a person on foot. In general, it is sparsely vegetated, perhaps due to the severe flooding or the influence of salt water.

Summarizing briefly, the following areas were used as study sites for estimating bird populations: 1) intensive study plots in an upland, lowland, and mosaic tundra habitat, used in estimating densities and comparing habitat use of small birds; 2) the West Branch Flats census plot used to monitor the use by all birds of coastal wetland; 3) a large bird survey area southeast of Brownlow Point censused in 1979 to yield information on abundance of loons, waterfowl, jaegers, gulls, terns and raptors, and 4) the Primary Study Area which was used as a unit for estimating nesting densities of some large bird species. All of these areas are shown in Figure II-1.

METHODS

Intensive Study Plots--Bird Census

The locations of the upland and lowland plots were chosen with the aid of an aerial photograph (scale of approximately 1:33,300). Criteria for selecting these sites included sufficient size of a homogenous habitat of contrasting types and accessibility. The mosaic plot was established during the summer of 1979 and was chosen as a result of ground reconaissance.

The mosaic and the upland measured 300 m x 850 m (25.5 ha) and the lowland measured 300 m x 900 m (27 ha). Size and shape of the plots were determined by the configuration of habitat units in the area, i.e. we attempted to maximize area without overlapping habitat discontinuities. All plots were surveyed using a compass and 50 m surveyor's tape and marked with surveyor's stakes in a 50 m grid pattern.

These plots were used to determine densities of shorebirds, passerines, and ptarmigan only. Other bird species seen within the plots were recorded but not included in this analysis. Censuses were conducted on each plot at five to seven day intervals from 23 June to 30 August, 1979 and 6 June to 26

August, 1980. Censuses were conducted by two to four people walking abreast down each 50 m wide "corridor" along the long axis of the plot, recording all birds seen on the ground within the plot; birds that flew over the plot were not counted in the census total. None of the species censused are generally aerial foragers. Unfledged young of the year were not included in census totals.

All birds were mapped on a scale map of the study plot and direction of flight was noted if flushed to another portion of the plot. It was impossible to eliminate duplicate sightings of birds moving around on the plot; however, a concerted effort was made to keep track of individual birds and flocks.

Censuses took up to six hours to perform during the nesting season when we were locating nests and broods, but as little as two and a half hours during late summer when only migrants were present. Intensive nest searches were conducted whenever observers were on the plot. Rope dragging to flush incubating birds from their nests was combined with census at least once per year on each plot. Estimated nest densities are based on nests found and are independent of the census results. The census data are used to indicate numbers of birds using each plot throughout the season.

Flats Census

The census of the 20 ha West Branch Flats plot was accomplished by a single observer traveling a regular route through the area. Because of the configuration of lakes and ponds, it was impossible to walk sraight line routes through the area. Instead, the censuser traversed the narrow polygon rims that wound through the area, covering essentially all the dry land areas of the plot. The census took about two hours to perform and was conducted on 12 dates on a time available basis from 25 June to 22 August, 1980. No special effort was made to find nests on this study plot. All birds using the area were included in the survey. Use was determined subjectively; birds that flew over the plot without deviating from their course were not counted in the total but birds (such as jaegers and terns) that appeared to be hunting from the air were included. In contrast to the situation in the other intensive study plots, some large birds ocurred in relatively high densities on the West Branch Flats, and so were included in this survey.

Large Bird Survey

The 2.45 square km large-bird survey area was chosen during break-up in 1979 for its diversity of wetland habitat and accessibility to camp. It was censused by a single observer traversing a regular route through the area that allowed full coverage of all the major ponds and lakes. The census was conducted at five-day intervals, 5 June to 29 August, 1979.

Intensive Study Plots—Habitat Description

Habitat characteristics of the intensive study plots were examined to complement description of bird use. Habitat variables chosen for study included microrelief, wetness, vegetation, and insect abundance. Results of insect sampling are not available for this report.

Vegetation on each plot was characterized using a systematic sampling scheme. Seven of the 300 m short axis grid lines on each plot were chosen randomly to serve as vegetation transects. Circular quadrats 0.25 square meters in area were placed at 10 m intervals along these transects yielding a total of 217 samples per plot. The small size of the quadrats avoided overlap of microtopographic units. All identifiable plant taxa contained within each quadrat were recorded.

The vegetation data for all plots combined were analyzed using the TWINSPAN program of the Cornell Ecology Program Series (Hill 1979). This program performs an ordination of taxa and samples simultaneously, using the multivariate technique of reciprocal averaging (Hill 1973). This results in a mutually dependent ordination of samples based on their floristics, and an ordination of plant taxa based on their distribution within samples. The ordination is refined and divided into two segments on the basis of differential occurrence of certain species on one side of the division or the other. This dichotomization of the ordination is repeated successively—each time the group of samples along a segment of the ordination is divided into two groups based on indicator species with strong affinities for one group or the other. Any number of levels may be requested, with 2 groups resulting from n levels of division.

This procedure was intended to define vegetation types present on the plots in an objective manner for descriptive purposes. It was also intended to test the nature of inter-plot habitat differences — did the plots support completely different vegetation associations, or were they composed of similar units of vegetation present in varying proportion? For this analysis, the third level of division was used primarily, although fourth level divisions were used in a few cases and two small third level groups were lumped together into their parent group from the second level of division. Only taxa that were consistently identifiable (in all phenological stages present) in the field were included in this analysis, and samples in ponds lacking vegetation were dropped from the analysis as well.

Snow cover and wetness in the plots were examined using systematic transects. Five of the 300 m short axis grid lines in each plot were chosen randomly to serve as line transects. Lengths of ground along this line were classified into one of the following categories:

1. Snow or ice covered ground.
2. Dry — ground does not feel wet to touch.
3. Wet — no standing water, but ground feels wet to touch.

4. Saturated — no standing water, area continuously vegetated, water covers boot when stepping down.
5. Flooded — standing water, area continuously vegetated.
6. Saturated pond sediments — no standing water, but water/mud covers boot when stepping down; little or no vegetation.
7. Shallow water — pond water less than three cm in depth.
8. Medium depth water — pond water three to ten cm deep.
9. Deep water — pond water over ten cm deep.

Classes six and seven were combined in analysis. Lengths of transect were assigned to one of these categories and the total for each category for each line was computed. Minimum length of a recorded segment was one meter, and segments were measured to the nearest 0.5 m. Mean and variance for each class was derived using the five transects in each plot as replicates. These transects were sampled five times during the summer. In 1979, snow cover was measured with two systematic transects radiating out from VABM Start. For analysis, the two were pooled, yielding essentially a single transect with 143 sample points spaced at 10 m intervals.

Average microtopographic relief for each plot was determined by measuring vertical differences in relief to the nearest 0.1 m within a five meter radius of each surveyor's stake on four of the long axis grid lines. These were treated as replicate systematic samples. Sites that were in ponds were eliminated from the analysis because they distorted the measure of relief for landforms within the plot, which was the variable of interest.

RESULTS

Snow Melt and Surface Water Area

Figure II-2 shows results of the 1979 snow transect and mean snow cover on intensive study plots derived from sampling in 1980. In 1980, snow cover on 8 June differed significantly between the three plots (Kruskal-Wallis $T=8.78$, $n1=n2=n3=5$, $p < 0.009$). The upland melted off faster than the lowland (Figure II-2). The mosaic plot began melting off earlier than the lowland, but retained snow patches later in the season. Although there is no statistically significant difference in snow cover between the mosaic and the lowland on any one sampling date, the apparent trend is probably accurate; the more pronounced microrelief in the mosaic resulted in rapid early melt-off from polygon rims and tops with southern exposures while deep drifts persisted

in the troughs long after other areas were snow free. Melt-off on the lowland was more abrupt since the poor drainage and flat ground collected large quantities of water which hastened general snow melt. The upland plot appeared to be about three days ahead of the other two plots in phenology of snow melt. Extent of flooding also affected availability of habitat for birds arriving in spring. Figure II-3 shows the relative composition of the plots with respect to ground moisture and surface water, over the summer season. The lowland was markedly wetter in mid-June at the end of snow melt, with about 70% of the area classified as deep water or flooded tundra, compared with 20% for the upland and 28% for the mosaic. By mid-July the distribution of samples shifted, with the drier classes predominating even in the lowland. At this time, the lowland plot had extensive areas of shallow water and exposed pond sediments while the other two plots had very little standing water whatsoever.

In August, cool and rainy weather altered the distribution of samples, with a second flooding of low areas. This was most pronounced on the lowland where the proportion of wet area (moderate to deep water and flooded tundra) increased from 11% in July to 57% in August, a five-fold increase. The increase in wet area on the upland was by a factor of 4.4 and on the mosaic it was only by a factor of 1.3. The difference between the lowland and the others is heightened by the relatively large amounts of deep water on the lowland. The drier classes still predominated in the upland and mosaic plots in August.

A three-way contingency test for mutual independence between wetness, location (plot), and season (month) shows a highly significant interdependence between these factors (chi-square=1724, d.f.=52, $p < 0.001$). The cells contributing most to the test statistic are the ones representing the large amounts of deep water and flooded area on the lowland in June, saturated sediments and shallow water on the lowland in July, and flooded tundra in the lowland during August.

Microrelief

Mean microrelief calculated for each of four replicate systematic samples within each plot is presented in Table II-1. Mean microrelief differs significantly between plots (Kruskal-Wallis T=9.85, n1=n2=n3=4, $p < 0.01$). Mean microrelief was greatest on the mosaic but sample variance was greatest on the upland, reflecting the presence of isolated mounds up to one meter in height in an otherwise flat terrain. On the mosaic plot, microrelief in the polygonal terrain was consistently geater than in the other two plots. The lowland was most homogenous in terms of mean microrelief and variance of microrelief.

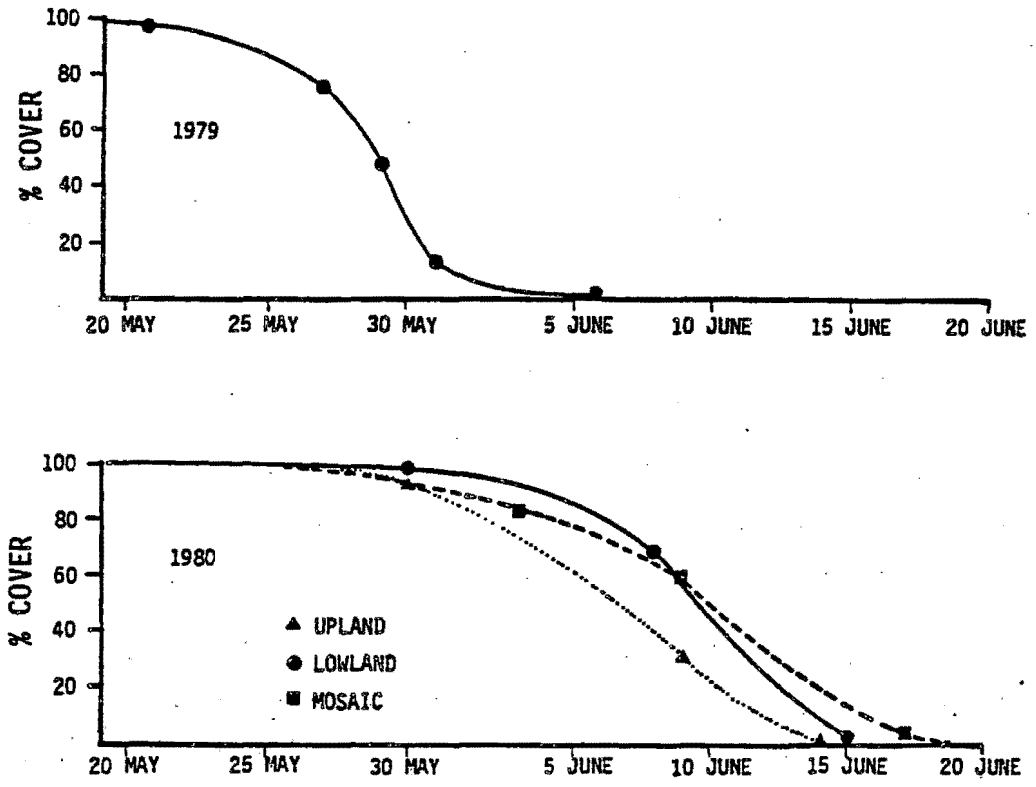

Figure II-2. Snow cover at Canning River Delta, spring 1979 (above) and spring 1980 (below). The 1980 values are means derived from systematic sampling of the upland (▲), lowland (●), and mosaic (■) study plots. Data from 1979 from a single transect through lowland and mosaic tundra.

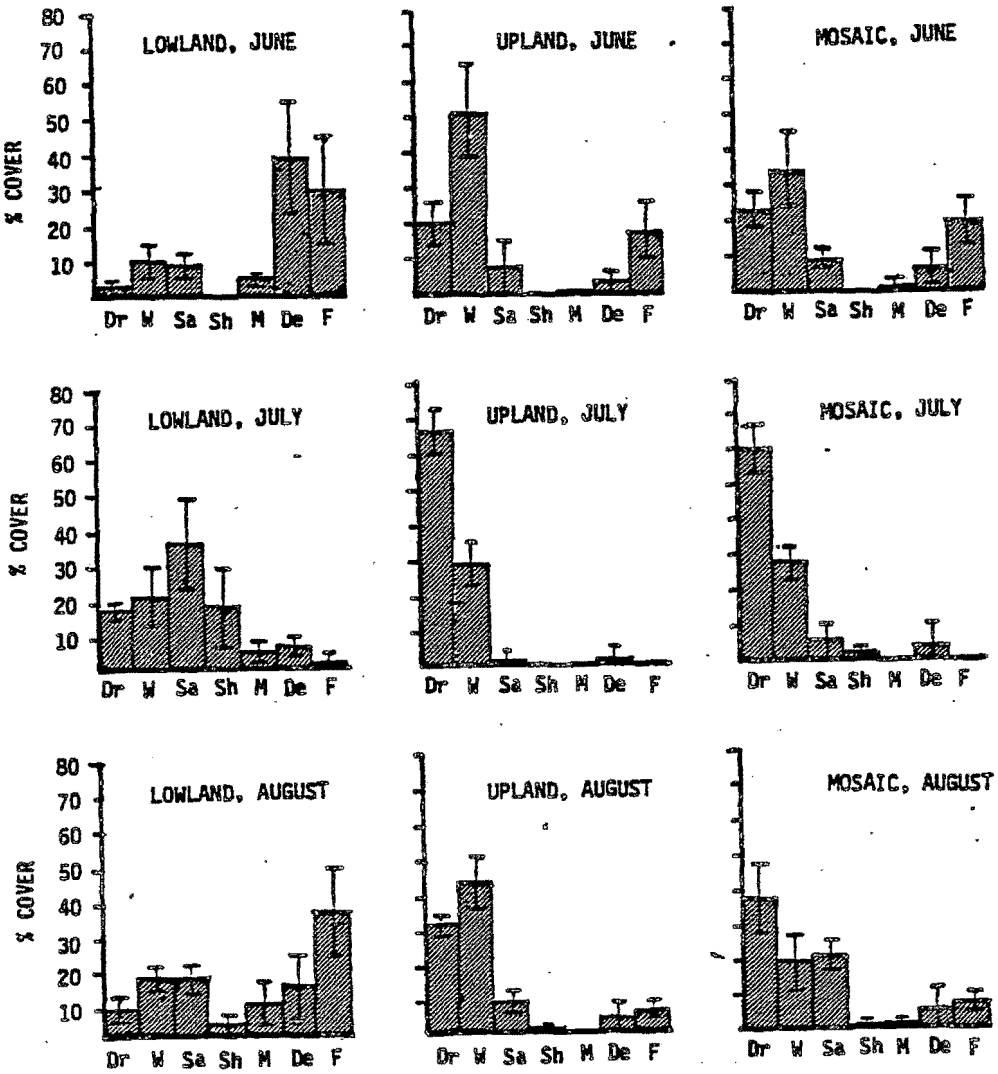

Figure II-3. Distribution of samples classified by wetness on the three intensive study plots, Canning River Delta, 1980. Data derived from systematic samples taken on three occasions; mean and standard deviation indicated.

Dr = dry ground
W = wet ground
Sa = saturated ground
Sh = shallow water
M = moderate depth water
De = deep water
F = flooded tundra

See text for further explanation.

Table II-1. Results of microrelief sampling in the intensive study plots, Canning River Delta, 1980. Means expressed in centimeters of greatest relief within a five meter radius.

	Upland	Lowland	Mosaic
Transect 1, $\bar{x}$ =	28.9 ± 5.9	17.1 ± 4.6	34.7 ± 12.8
Transect 2, $\bar{x}$ =	24.4 ± 7.8	16.8 ± 5.8	30.6 ± 7.7
Transect 3, $\bar{x}$ =	28.3 ± 21.5	17.8 ± 5.5	33.9 ± 10.4
Transect 4, $\bar{x}$ =	27.2 ± 16.4	18.9 ± 5.7	33.3 ± 12.4
$\bar{x}$ =	27.2	17.7	33.1

Vegetation

Based on the results of the TWINSPAN analysis of vegetation data, ten classes of vegetation were identified on the intensive study plots.

1a. Dry sedge/forb.
1b. Mesic frost boil sedge.
2a. Mesic sedge.
2b. Mesic sedge (mosaic plot).
3a. Moist sedge.
3b. Moist sedge (mosaic plot).
4. Wet sedge.
5. Flooded sedge.
6. Pond-edge emergent sedge.
7. Trough-edge emergent sedge.

These classes (primarily based on third level of division from the TWINSPAN analysis) are described in Appendix II-1, including a list of characteristic and/or common taxa within each class as well as a brief description of landforms associated with each class. A schematic illustration of landforms present on the study plots and associated vegetation is presented in Figure II-4. Table II-2 shows frequency of occurrence of each of the taxa used in the analysis in each of the vegetation classes. The taxa are arranged in the order assigned by the reciprocal averaging ordination used in TWINSPAN. This first axis of ordination is readily interpretable as a moisture gradient. The columns of vegetation types are also arranged in order from dry to wet. Therefore, maximum values for frequencies for each taxon generally occur along the diagonal from upper left to lower right. However, plant species diversity is much higher in relatively dry sites; only a few hydrophiles actually exhibit maxima on the lower right.

The frequency distribution of each vegetation class in the three plots showed that the upland plot was the most homogenous, with 66% of all samples falling into a single class (Table II-3). The lowland contained a significant number of samples in both Class 2a and Class 2b, and the mosaic contained samples in both Class 3a and Class 3b, but in general the subdivision of Classes 2 and 3 represents a contrast between the mosaic and the other two plots. This dichotomy arose in the fourth level of division of the TWINSPAN analysis.

In order to simplify analysis of vegetation type and moisture gradient the vegetation classes were divided into three categories: wet (Classes 5,6,7), mesic (Classes 3,4), and dry (classes 1,2), and the number of samples of each type entered separately for each plot (Table II-4). A contingency test for mutual independence between moisture and location (by plot) reveals a significant relation between the two variables (chi-square=179, d.f.=4, $p < 0.001$). Cells representing the mosaic plot's distribution of

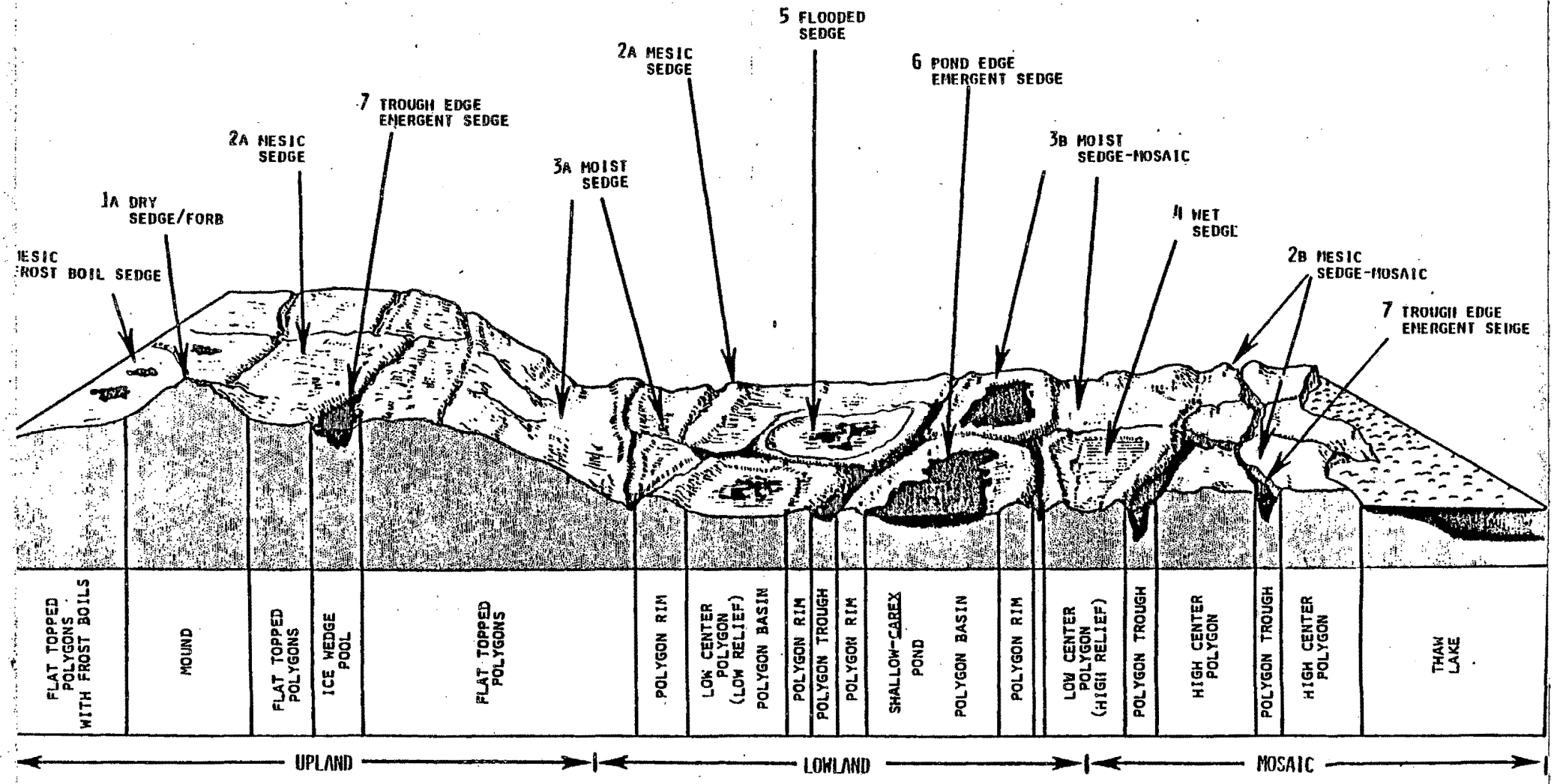

Figure II-4. Schematic illustration of landforms present on intensive study plots, and associated vegetation classes as resulted from TWINSPAN analysis (vertical relief exaggerated).

Table II-3. Vegetation Data. Frequency of samples within each vegetation class (and ponds) by location, Canning River Delta, 1980.

	1a/b	2a	2b	3a	3b	4	5	6	7	Pond	Total
Upland	144	37	0	26	0	0	1	3	6	0	217
Lowland	7	24	13	46	2	20	25	48	11	21	217
Mosaic	2	12	90	20	48	6	7	10	15	7	217
Total	153	73	103	82	50	26	33	61	32	28	651

Table II-4. Vegetation Data. Frequency of samples by moisture class (see text for derivation) and by location, Canning River Delta, 1980

Plot	Wet	Mesic	Dry
Upland	10	26	181
Lowland	84	68	44
Mosaic	32	74	104

samples contribute less than 1% of the value of the test statistic. Wet vegetation types predominate in the lowland, dry types in the upland, with the mosaic a more even mix of vegetation/moisture classes than either of the other two.

In conclusion, the three plots support vegetation which indicates that they are indeed areas of contrasting habitat. The upland is composed primarily of a vegetation type hardly present at all in the other two plots. Mesic vegetation types are present in both upland and lowland, but the wet vegetation types that predominate in the lowland are hardly present at all in the upland. The mosaic is an "average" of the other two in the sense that the distribution of samples by moisture class is close to the expected value (based on the composition of the three plots) but it is a unique area floristically as demonstrated by the strong dichotomies in the mesic classes (2a and 3a vs. 2b and 3b) representing contrasts between the mosaic and the other two plots.

Bird Populations -- Nesting Density

Breeding densities for all birds found nesting on the three tundra census plots are presented in Table II-5. In a study of this sort there is inevitable uncertainty about the number of nests "missed" that were actually present in the study area. In recognition of this problem we have included a notation to designate species for which nests are likely to have been left unlocated (for 1980 only). These judgments have been made on the basis of continued presence of "suspicious" birds in a portion of the plot.

The data presented in Table II-5 show differences between the plots in species composition and density of breeding birds. In the lowland plot, species richness was lowest and Red Phalaropes were the most numerous breeder. Lapland Longspurs, Pectoral Sandpipers, and Northern Phalaropes also nested in the lowland. Dunlins may have nested there, although a nest was never found, and certainly used the area when they were attending broods. Red Phalaropes nearly doubled their breeding density in 1980 from the 1979 level; in both years this species in the lowland achieved the highest breeding density of any shorebird.

The upland had a greater species richness but lower overall nest density. Lapland Longspurs were the most numerous species and Semipalmated Sandpipers (which did not breed at all in the lowland) were the most numerous breeding shorebird. The presence of scattered ice-wedge pools in the upland provided some wet habitat; probably for this reason both Phalaropes and Pectoral Sandpiper were found nesting there. There was considerable change in species composition from one year to the next; Golden Plovers, Buff-breasted Sandpipers and Northern Phalaropes bred on the upland plot in 1979 but not in 1980. Pectoral Sandpiper bred there in 1980 but not in 1979.

The mosaic plot was censused only in 1980. It had the greatest species richness and the highest overall nest density. All of the shorebirds nesting in the other two plots also nested in the mosaic, with the possible exception

Table II-5. Number of nests found in census plots, Canning River Delta, 1979-1980. Densities expressed in nests per km^2. For 1980, a single asterisk (*) indicates that an additional nest was probably present in the plot but not located; a double asterisk (**) indicates two additional nests were likely. These additional nests not included in density calculations.

	1979		1980		
	Upland # nests (density)	Lowland # nests (density)	Upland # nests (density)	Lowland # nests (density)	Mosaic # nests (density)
Oldsquaw	0	0	0	0	1 (3.9)
King Eider	0	0	0	1 (3.7)	0
Rock Ptarmigan	0	0	1 (3.9)	0	1* (3.9)
American Golden Plover	1 (3.9)	0	0	0	1 (3.9)
Northern Phalarope	1 (3.9)	3 (11.1)	0	1 (3.7)	2 (7.8)
Red Phalarope	2 (7.8)	7 (25.9)	2 (7.8)	13 (48.1)	0*
Semipalmated Sandpiper	2 (7.8)	0	6 (23.5)	0	5* (19.5)
Pectoral Sandpiper	0	3 (11.1)	1 (3.7)	4** (14.8)	8 (31.2)
Dunlin	1 (3.9)	0	1 (3.7)	0*	2* (7.8)
Buff-breasted Sandpiper	1 (3.9)	0	0	0	2 (7.8)
Lapland Longspur	5 (19.6)	3 (11.1)	9** (35.1)	6* (22.2)	13** (50.7)
Total	13 (51.0)	16 (59.2)	20 (78.1)	25 (92.5)	35 (136.5)

Table II-6. Minimum breeding densities (nests per square kilometer) for some large bird species, Canning River Delta 1979-1980.

SPECIES	1979	1980
Arctic Loon	0.55	0.75
Red-throated Loon	0.45	0.60
Whistling Swan	0.25	0.15
Canada Goose	0.25	0.30
Pintail	0.0	0.10
Oldsquaw	0.40	0.45
King Eider	0.45	0.30
Spectacled Eider	0.10	0.05
Parasitic Jaeger	0.0	0.10
Glaucous Gull	0.25	0.20
Sabine's Gull	0.10	0.20
Arctic Tern	0.10	0.10

of Red Phalarope which was not a confirmed breeder in the mosaic. Species more or less characteristic of the upland (Lapland Longspur, Golden Plover, Buff-breasted Sandpiper, Dunlin) were found in the mosaic nesting in equal or greater numbers. Species characteristic of the lowland (Pectoral Sandpiper, Northern Phalarope) were also found nesting in the mosaic in equal or greater numbers.

Minimum estimates for nesting density of large birds (i.e. loons, waterfowl, larids, jaegers) on tundra areas exclusive of the barrier islands and spits and off-shore islands are based on nests located and brood observations in the Primary Study Area (Table II-6). We observed considerable interspecific variation in conspicuousness of nests and broods, therefore some of these estimates are better than others. Loons, Whistling Swans, Canada Geese, and larids are fairly conspicuous, and nest estimates for these are reliable although still probably an underestimate. Ducks, on the other hand, were extremely hard to locate on the nest and reasonably secretive with broods as well. We have much less confidence in these estimates, especially since predation rates on waterfowl seemed to be high and brood observations gave no indication of the number of failed nests. The actual nest density of these birds was probably much higher than our figures indicate.

Use of Tundra Habitat by Breeding Resident and Transient Birds

Large Birds

Data pertaining to densities of large birds are contained in Tables II-7, II-8, and II-9 (in part). The 1979 large-bird surveys were stratified by month in order to convey some sense of the seasonal fluctuation, and a seasonal mean (all censuses combined) is also presented. There was great variability in the abundance of these species as determined by the surveys (Table II-7). Densities of large birds seen on the 1979 West Branch counts are presented in Table II-8 and densities of all birds seen on the 1980 West Branch censuses are presented in Table II-9. The sampling method for the West Branch in 1979 was dissimilar to that employed in 1980. In 1979, counts were made from a fixed point overlooking the area (see Part III), so shorebirds were difficult to see and were not included in this summary (with the exception of phalaropes which were sometimes present in large, conspicuous flocks). The most common species in the 1979 large-bird survey were Canada Goose, Pintail, and Oldsquaw in that order. Densities were highest in June and August, lower in July. This result is probably due to a number of factors: males of several species of ducks leave after nest initiation, non-breeding ducks and geese were present during the spring migration and fall migration periods but not in July, and many species are much less conspicuous in mid-summer while nesting. In August, young of the year also augmented numbers. The West Branch was used by King Eiders and Oldsquaws in both springs. Pintails used the Flats in spring and again in late July and early August, reaching very high densities in 1980. Canada Geese made heavy use of the area in 1979, when

Table II-7. Large-bird survey data, Canning River Delta, 6 June - 29 August 1979, based on census of a 2.45 square kilometer area. Mean, minimum, and maximum densities (in birds per square kilometer) are given for each month, as well as seasonal mean. Frequency is expressed as the number of censuses in which the species was recorded (total number of censuses for month given in parentheses following heading).

Species	June (6)			July (5)			August (6)			Seasonal Mean (±S.D)
	Mean (±S.D.)	Min-Max	Freq.	Mean (±S.D.)	Min-Max	Freq.	Mean (±S.D)	Min-Max	Freq.	
Yellow-billed Loon	0.1 (±0.2)	0- 0.4	1	0.1 (±0.2)	0- 0.4	1	0		0	0.1 (±0.1)
Arctic Loon	2.9 (±1.8)	1.2- 6.1	6	1.7 (±1.4)	0- 3.3	4	2.4 (±0.6)	1.6- 3.3	6	1.3 (±2.4)
Red-throated Loon	0.7 (±1.2)	0- 2.4	2	1.3 (±0.5)	0.8- 2.0	5	2.5 (±1.6)	0.8- 4.9	6	1.6 (±1.4)
Whistling Swan	1.2 (±0.8)	0.8- 2.9	6	2.0 (±0.6)	0-10.2	5	2.0 (±0.0)	2.0- 2.0	6	1.7 (±3.7)
Canada Goose	5.4 (±5.0)	0.8-13.0	6	2.3 (±4.4)		2	3.7 (±9.0)	0-22.2	1	3.9 (±6.3)
Brant	1.4 (±2.8)	0- 7.0	2	0		0	6.5 (±13.9)	0-34.7	2	2.8 (±8.4)
White-fronted Goose	0		0	0		0	2.6 (±6.3)	0-15.5	1	0.9 (±3.8)
Snow Goose	0.3 (±0.8)	0- 2.0	1	0		0	0		0	0.1 (±0.5)
American Wigeon	1.4 (±1.1)	0- 2.0	4	0		0	0		0	0.5 (±0.9)
Pintail	4.5 (±2.7)	0- 7.4	5	1.0 (±1.8)	0- 4.1	2	4.9 (±2.8)	1.2- 8.2	6	3.6 (±2.9)
Oldsquaw	4.9 (±1.0)	4.1- 5.7	6	4.0 (±4.4)	1.6-11.9	5	1.1 (±1.6)	0- 3.1	3	3.3 (±3.0)
Common Eider	0.3 (±0.7)	0- 1.6	1	0		0	0	2.0- 4.0	0	0.1 (±0.4)
King Eider	3.3 (±2.0)	1.2- 7.0	6	1.1 (±0.9)	0- 2.0	4	3.3 (±0.9)			2.6 (±1.7)

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Table II-7, cont.

Species	June (6) Mean (±S.D.)	June (6) Min-Max	June (6) Freq.	July (5) Mean (±S.D.)	July (5) Min-Max	July (5) Freq.	August (6) Mean (±S.D.)	August (6) Min-Max	August (6) Freq.	Seasonal Mean (±S.D.)
Spectacled Eider	0.7 (±0.6)	0- 1.2	4	1.5 (±1.5)	0-3.7	4	0.7 (±1.0)	0- 2.0	2	0.9 (±1.1)
Pomarine Jaeger	0.3 (±0.4)	0- 0.8	3	0		0	0		0	0.1 (±0.3)
Parasitic Jaeger	0.7 (±0.6)	0- 1.2	4	0.7 (±0.5)	0- 1.2	4	0.4 (±0.5)	0- 1.2	3	0.6 (±0.5)
Long-tailed Jaeger	0.1 (±0.2)	0- 0.4	2	0.1 (±0.2)	0- 0.4	1	0.1 (±0.2)	0- 0.4	1	0.1 (±0.2)
Glaucous Gull	1.6 (±1.8)	0- 5.0	5	0.3 (±0.4)	0- 0.8	2	0.5 (±0.6)	0- 0.4	4	0.9 (±1.3)
Sabine's Gull	0		0	0.1 (±0.2)	0- 0.4	1	0		0	0.0
Arctic Tern	0.6 (±0.6)	0- 1.2	4	0.6 (±0.2)	0- 2.4	1	0		0	0.4 (±0.7)
Common Raven	0.1 (±0.2)	0- 0.4	1	0		0	0		0	0.0
Short-eared Owl	0.1 (±0.2)	0- 0.4	1	0		0	0		0	0.0
Total	30.8 (±6.1)			17.5 (±10.1)			30.7 (±13.6)			26.9 (±11.5)

Table II-8. Density of large birds (in birds per square kilometer) seen on West Branch Flats coastal survey, Canning River Delta, 1979.

Species	5/31	6/2	6/3	6/5	6/10	6/15	6/20	6/25	6/29	7/5	7/10	7/15	7/21	7/25	7/28	8/2	8/5	8/8	8/9	8/11	8/14	8/16	8/20	8/25	8/29	Seasonal Mean
Arctic Loon	0	0	0	17	0	2	1	1	4	1	0	3	0	2	3	0	0	1	2	1	3	4	0	0	2	1.9
Red-throated Loon	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	7	0	4	0	1	0.6
Whistling Swan	2	1	0	0	0	0	0	0	0	3	0	2	6	5	0	0	0	0	0	0	0	0	0	0	0	0.8
Canada Goose	0	0	0	0	1	2	0	2	4	15	21	5	2	65	106	0	30	0	0	32	0	0	0	0	0	11.2
Brant	48	3	0	0	0	0	0	34	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	4.3
White fronted Goose	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	101	0	0	4.0
Pintail	47	1	2	1	5	19	6	0	0	0	0	3	0	12	0	17	3	8	2	11	8	7	32	3	0	7.5
American Wigeon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0.1
Oldsquaw	0	4	13	16	10	4	13	8	6	14	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	3.6
unid. female eider	0	0	0	0	0	0	0	0	0	7	5	12	18	0	0	0	0	0	0	0	0	0	0	0	0	1.7
King Eider	0	4	0	4	3	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0.6
Spectacled Eider	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1
Phalarope sp.	0	0	0	0	3	0	1	0	0	0	0	0	4	0	1	0	10	0	6	0	1	0	0	150	0	7.0
Pomarine Jaeger	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.05
Parasitic Jaeger	0	0	0	1	0	0	0	1	0	0	0	0	0	0	5	0	0	0	0	0	2	0	0	0	0	0.4
Long-tailed Jaeger	0	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0.1
Glaucous Gull	1	0	0	0	2	10	0	2	0	1	0	3	1	2	1	0	1	2	0	0	0	0	5	2	1	1.4
Sabine's Gull	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1
Arctic Tern	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0.2
Total	98	15	15	40	25	37	23	49	26	43	26	30	33	86	122	17	44	11	10	45	21	9	142	169	4	45.6

Table II-9. Densities (birds per square kilometer) of all birds, West Branch Flats study plot, Canning River Delta, 1980.

Species	25 JN	27 JN	5 JL	8 JL	12 JL	19 JL	23 JL	27 JL	3 AU	7 AU	13 AU	22 AU	Seasonal Mean (± S.D.)
Arctic Loon	5	10	0	0	0	0	0	0	0	0	15	0	1.7 ± 1.3
Red-throated Loon	0	0	0	0	0	0	5	0	0	5	0	0	0.8 ± 1.9
Canada Goose	10	0	0	0	0	0	0	0	0	0	0	0	0.8 ± 2.9
Pintail	15	10	0	0	0	0	0	40	105	820	70	0	88.3 ± 233.0
Northern Shoveler	0	0	15	0	0	0	0	0	0	0	0	0	1.3 ± 4.3
Oldsquaw	150	55	30	95	60	15	35	20	10	0	0	0	39.2 ± 45.3
King Eider	25	25	5	0	70	0	0	0	0	0	0	0	10.4 ± 3.2
American Golden Plover	15	45	10	50	55	10	65	5	5	5	0	10	22.9 ± 23.4
Black-bellied Plover	0	0	10	0	0	5	0	0	20	15	0	50	8.3 ± 14.8
Ruddy Turnstone	45	30	0	0	5	0	0	15	10	0	0	0	8.8 ± 14.6
Northern Phalarope	35	390	500	160	215	5	165	10	5	5	10	0	125.0 ± 169.3
Red Phalarope	75	190	0	40	10	20	30	0	0	0	5	5	31.3 ± 54.8
Long-billed Dowitcher	0	0	0	0	0	0	0	0	0	0	0	40	3.2 ± 11.5
Red Knot	0	5	0	0	0	0	0	0	0	0	0	0	0.4 ± 1.4
Semipalmated Sandpiper	75	275??	50	45	150	75	135	235	255	180	5	10	125.0 ± 94.7
Western Sandpiper	0	0	0	0	0	0	0	0	0	0	0	70	5.8 ± 20.2
White-rumped Sandpiper	0	0	0	0	10	0	0	0	0	0	60	0	1.2 ± 3.5
Baird's Sandpiper	20	40	0	0	0	0	0	10	0	0	0	0	5.8 ± 12.4
Pectoral Sandpiper	65	145	10	10	15	10	15	20	10	35	30	10	31.3 ± 39.3
Dunlin	20	35	10	20	40	20	40	25	50	65	0	50	31.3 ± 18.7
Stilt Sandpiper	0	0	0	20	0	15	35	0	0	35	0	45	12.5 ± 17.1
Buff-breasted Sandpiper	0	0	0	0	0	0	0	0	0	0	0	5	0.4 ± 1.4
Parasitic Jaeger	0	0	0	0	0	0	0	0	0	10	0	0	0.8 ± 2.9
Sabine's Gull	15	0	10	20	0	5	5	5	30	0	0	0	7.5 ± 9.7
Arctic Tern	10	45	5	0	5	15	20	5	20	5	0	0	12.5 ± 13.4
Rock Ptarmigan	0	0	0	0	0	0	0	0	0	20	0	0	1.7 ± 33.4
Lapland Longspur	0	10	10	5	5	35	40	80	125	30	20	15	31.3 ± 36.8
unidentified shorebird	5	15	25	85	0	10	0	10	20	0	0	0	15.0 ± 23.5
Total	585	1325??	690	550	640	240	590	480	665	1230	215	310	626.7 ± 344.7

broods and large numbers of flightless birds were seen; they were not seen in 1980.

Small Birds

Data pertaining to small bird densities in tundra habitats are contained in Table II-9 (in part) and Tables II-10 through II-14. The value for Semipalmated Sandpiper for the 27 June West Branch Flats census (Table II-9) is suspect; we believe it to be an overestimate of the actual number present. In subsequent West Branch Flats censuses, a standard route was traveled at a relatively constant rate of speed. These methods combined with a conscious effort to avoid duplicate sightings of mobile birds were employed to reduce the probability of inflated estimates, but the Flats area was used by highly mobile transient birds so this problem could not be completely avoided using the plot census technique. Nevertheless, we are confident that the census results accurately reflect high shorebird use of the area in early summer, and our observations suggest that the area attracts birds which nest on nearby tundra areas but use the Flats for feeding.

Figures II-5 and II-6 show seasonal changes in numbers of Longspurs and shorebirds (all species combined) on the three intensive study plots and the West Branch Flats. Longspurs have been separated from shorebirds because the numerical dominance of the former would obscure population shifts in the latter. Since the Flats plot is only 20 ha in extent, the numbers of birds seen on the Flats census have been adjusted upward by 25% to represent density in terms of birds per 25 ha, an area comparable to that of the other plots.

We will describe major differences in bird use of the plots, ignoring for the time being some inter-annual differences which are also apparent. Censuses were not begun until late June in 1979; in the early melt-off period in 1980 the upland plot had the greatest bird use of the three plots (see census on 6 June). Soon, however, the other two plots became more heavily used than the upland. Shorebirds increased rapidly on the mosaic and the lowland through the month of June, while on the upland they declined. Longspur numbers in early summer were similar in the upland and mosaic plots and lower in the lowland. Around 15 July the upland lost most of the shorebirds and a similar though less drastic decline in shorebird numbers occurred on the mosaic and lowland. From mid-July through the end of August the lowland diverged sharply from the upland and mosaic. Shorebird numbers on the lowland were two to three times higher in late summer than those recorded during June and July. This shorebird peak is exhibited less strongly on the mosaic and even less strongly on the upland. Longspurs, on the other hand, peaked most strongly in migration on the upland and the mosaic, although there was a substantial increase in Longspur use of the lowland in late summer.

The West Branch Flats area was unique in several aspects of bird use. Shorebird numbers in early summer were an order of magnitude above those on the other plots, even allowing for some uncertainty in the counts of Semipal-

Table II-10. Densities (birds per square kilometer) of small birds, upland study plot, Canning River Delta, 1979.

	23 JN	27 JN	2 JL	7 JL	12 JL	17 JL	25 JL	31 JL	9 AU	16 AU	23 AU	30 AU	Seasonal Mean (± S.D.)
Rock Ptarmigan	0	0	7.8	7.8	7.8	0	0	0	0	0	0	27.4	4.2 ± 8.0
American Golden Plover	7.8	3.9	7.8	7.8	3.9	7.8	0	0	0	11.8	23.5	19.6	7.8 ± 7.5
Whimbrel	0	0	3.9	0	0	0	0	0	0	0	0	0	0.3 ± 1.1
Northern Phalarope	11.8	7.8	11.8	0	0	0	0	0	0	0	0	0	2.6 ± 4.8
Red Phalarope	7.8	7.8	0	0	3.9	0	0	0	0	0	0	0	1.6 ± 3.1
Common Snipe	0	0	0	0	0	0	0	0	0	0	3.9	0	0.3 ± 1.1
Semipalmated Sandpiper	11.8	7.8	27.5	15.6	27.5	0	3.9	0	0	0	0	0	7.8 ± 10.6
Baird's Sandpiper	3.9	0	0	0	0	0	0	0	0	0	0	0	0.3 ± 1.1
Pectoral Sandpiper	0	11.8	7.8	0	15.7	0	3.9	35.3	27.5	23.5	7.8	0	11.1 ± 12.0
Dunlin	3.9	7.8	3.9	3.9	23.5	0	0	0	0	0	0	0	3.6 ± 6.7
Buff-breasted Sandpiper	15.6	19.6	39.2	0	23.5	3.9	0	3.9	35.2	3.9	0	0	12.1 ± 14.3
Lapland Longspur	98.0	92.0	74.5	50.9	31.4	23.5	62.7	39.2	109.8	74.5	58.8	23.5	61.6 ± 29.1
Total	160.6	158.5	184.2	86.0	137.2	35.2	70.5	78.4	172.5	113.7	94.0	70.5	113.4 ± 48.1

Table II-11. Densities (birds per square kilometer) of small birds, upland study plot, Canning River Delta, 1980.

	6 JN	13 JN	19 JN	26 JN	3 JL	9 JL	15 JL	21 JL	27 JL	2 AU	8 AU	14 AU	20 AU	26 AU	Seasonal Mean (± S.D.)
American Golden Plover	0	3.9	0	0	0	0	15.7	0	0	31.4	0	27.4	66.6	0	10.4 ± 19.5
Red Phalarope	0	7.8	7.8	7.8	7.8	3.9	3.9	3.9	0	0	0	0	3.9	0	3.3 ± 3.4
Long-billed Dowitcher	0	0	0	0	0	0	0	0	0	0	0	0	0	7.6	0.5 ± 2.0
Semipalmated Sandpiper	35.3	19.6	31.4	11.8	23.5	15.7	0	0	0	0	0	0	0	0	9.8 ± 13.0
Baird's Sandpiper	7.8	3.9	0	0	0	0	0	3.9	0	0	0	0	0	0	1.1 ± 2.4
Pectoral Sandpiper	27.4	0	11.8	11.8	3.9	3.9	7.8	0	0	23.5	3.9	0	19.6	15.7	9.2 ± 9.3
Dunlin	7.8	11.8	3.9	3.9	3.9	0	0	0	0	7.8	0	3.9	0	0	3.1 ± 3.8
Buff-breasted Sandpiper	15.7	7.8	27.4	3.9	0	0	3.9	0	0	0	0	3.9	0	0	4.5 ± 8.0
Rock Ptarmigan	3.9	3.9	3.9	15.7	0	0	0	0	0	0	7.8	54.9	0	0	7.0 ± 14.5
Horned Lark	0	0	3.9	0	0	0	0	0	0	0	0	0	0	0	0.5 ± 1.3
Yellow Wagtail	3.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5 ± 1.3
Lapland Longspur	94.1	78.4	94.1	110.0	137.2	74.5	70.6	39.2	82.3	227.4	62.7	58.8	109.8	15.7	89.6 ± 50.0
Snow Bunting	3.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5 ± 1.3
Total	199.8	137.1	184.2	164.9	176.3	98.0	101.9	47.0	82.3	290.1	74.4	148.9	199.9	39.0	138.8 ± 69.8

Table II-12. Densities (birds per square kilometer) of small birds, lowland study plot, Canning River Delta, 1979.

	26 JN	1 JL	6 JL	11 JL	17 JL	22 JL	27 JL	1 AU	9 AU	16 AU	24 AU	30 AU	Seasonal Mean (± S.D.)
American Golden Plover	0	7.4	0	11.1	7.4	14.8	3.7	0	7.4	114.8	18.5	29.6	17.9 ± 31.7
Black-bellied Plover	0	0	0	0	0	0	0	11.1	14.8	3.7	29.6	55.5	9.6 ± 17.1
Whimbrel	0	0	18.5	0	3.7	0	0	0	0	0	0	0	1.9 ± 5.4
Northern Phalarope	37.0	14.8	18.5	3.7	3.7	0	0	11.1	11.1	3.7	0	0	8.6 ± 11.1
Red Phalarope	96.2	33.3	25.9	7.4	0	0	11.1	11.1	3.7	0	0	0	16.7 ± 27.8
Long-billed Dowitcher	0	0	0	0	0	0	0	0	14.8	107.3	107.3	0	19.1 ± 41.4
Semipalmated Sandpiper	3.7	0	0	0	0	14.8	3.7	25.9	14.8	3.7	0	0	5.6 ± 8.4
Pectoral Sandpiper	22.2	70.3	77.7	11.1	114.7	3.7	55.5	81.4	81.4	33.3	59.2	3.7	51.2 ± 36.0
Dunlin	11.1	3.7	14.8	0	11.1	44.4	3.7	3.7	0	22.2	3.7	3.7	10.2 ± 12.6
Stilt Sandpiper	0	0	0	0	0	0	0	0	11.1	0	0	0	0.9 ± 3.2
unidentified shorebird	0	0	0	0	0	0	7.4	0	0	0	14.8	0	1.9 ± 4.6
Lapland Longspur	25.9	37.0	33.3	37.0	22.2	33.3	18.5	62.9	29.6	85.1	99.9	29.6	41.2 ± 27.4
Total	196.1	166.5	188.7	70.3	162.8	111.0	103.6	207.2	188.7	373.7	333.0	122.1	185.2 ± 89.6

Table II-13. Densities (birds per square kilometer) of small birds, lowland study plot, Canning River Delta, 1980.

	6 JN	12 JN	18 JN	25 JN	1 JL	7 JL	13 JL	19 JL	27 JL	2 AU	8 AU	14 AU	20 AU	26 AU	Seasonal Mean (± S.D.)
Willow Ptarmigan	0	3.7	0	7.4	0	0	0	0	0	0	0	0	0	0	0.8 ± 2.1
Rock Ptarmigan	14.8	3.7	3.7	3.7	0	0	3.7	0	0	0	7.4	0	0	0	2.6 ± 4.2
American Golden Plover	0	0	3.7	0	0	0	0	14.8	51.9	59.3	0	3.7	11.1	0	10.3 ± 19.7
Black-bellied Plover	0	0	0	0	0	0	0	0	7.4	37.0	11.1	14.8	37.0	25.9	9.5 ± 14.0
Ruddy Turnstone	0	0	0	0	0	0	0	0	0	0	7.4	0	0	0	0.5 ± 2.0
Northern Phalarope	0	0	7.4	3.7	3.7	3.7	0	3.7	0	0	0	0	0	0	1.6 ± 2.4
Red Phalarope	0	37.0	66.6	92.5	29.6	62.9	25.9	22.2	14.8	18.5	22.2	7.4	0	0	28.5 ± 27.8
Long-billed Dowitcher	0	0	0	0	0	0	0	0	0	3.7	0	0	62.9	29.6	6.9 ± 17.9
Semipalmated Sandpiper	0	0	0	0	0	0	3.7	3.7	3.7	7.4	7.4	0	0	0	1.9 ± 2.8
White-rumped Sandpiper	0	0	0	0	0	0	0	0	0	0	3.7	3.7	0	0	0.5 ± 1.3
Pectoral Sandpiper	40.7	33.3	33.3	62.9	48.1	51.8	44.4	33.3	66.6	48.1	151.7	66.6	151.7	59.2	63.7 ± 39.1
Dunlin	19.8	3.7	7.4	7.4	11.1	11.1	0	7.4	3.7	7.4	3.7	0	18.5	0	7.2 ± 6.3
Stilt Sandpiper	0	3.7	0	0	0	0	3.7	0	0	0	11.1	0	0	0	1.3 ± 3.1
Buff-breasted Sandpiper	0	0	0	0	0	0	0	0	0	0	0	3.7	0	0	0.3 ± 1.0
Lapland Longspur	55.5	37.0	48.1	59.2	77.7	66.6	74.0	14.8	144.3	22.2	55.5	85.1	59.2	3.7	57.4 ± 34.6
Total	130.8	122.1	170.2	236.8	170.2	196.1	155.4	99.9	292.4	203.6	281.2	185.0	329.3	118.4	193.0 ± 71.8

Table II-14. Densities (birds per square kilometer) of small birds, mosaic study plot, Canning River Delta, 1980.

	8 JN	13 JN	20 JN	27 JN	2 JL	8 JL	14 JL	20 JL	26 JL	31 JL	6 AU	12 AU	18 AU	24 AU	Seasonal Mean (± S.D.)
American Golden Plover	7.8	11.8	0	0	0	0	0	0	7.8	0	0	11.8	15.7	3.9	3.6 ± 5.6
Northern Phalarope	0	15.7	15.7	11.8	7.8	7.8	7.8	11.8	7.8	0	0	0	0	0	6.2 ± 6.1
Red Phalarope	7.8	0	7.8	23.5	3.9	0	0	0	11.8	0	3.9	3.9	7.8	0	5.0 ± 6.5
Long-billed Dowitcher	0	0	0	0	0	0	0	0	3.9	7.8	0	0	0	0	0.8 ± 2.3
Semipalmated Sandpiper	35.3	31.4	47.0	27.0	23.5	23.5	3.9	0	23.5	0	7.8	0	0	0	15.9 ± 16.0
White-rumped Sandpiper	0	0	0	0	0	0	0	0	0	0	3.9	3.9	0	0	0.6 ± 1.4
Pectoral Sandpiper	0	27.5	47.0	47.0	54.9	54.9	19.6	35.3	39.2	47.1	70.6	15.7	27.5	23.5	37.2 ± 19.8
Dunlin	7.8	15.7	15.7	11.8	19.6	7.8	3.9	0	27.5	7.8	31.4	0	0	0	10.6 ± 10.3
Stilt Sandpiper	0	0	0	0	0	0	0	0	0		0	0	0	0	0.3 ± 1.0
Buff-breasted Sandpiper	0	15.7	3.9	7.8	3.9	3.9	0	3.9	0	0	3.9	0	0	0	3.1 ± 4.4
Rock Ptarmigan	15.7	11.8	7.8	3.9	3.9	3.9	3.9	0	0	39.0	0	0	0	0	6.4 ± 10.6
Willow Ptarmigan	0	0	3.9	0	0	0	15.7	15.7	0	0	11.8	0	0	0	3.4 ± 6.1
Lapland Longspur	105.9	105.9	117.6	156.9	129.4	101.9	101.9	78.43	180.4	82.4	266.7	51.0	43.1	11.8	109.5 ± 63.0
Total	180.3	235.5	266.4	289.7	258.3	203.7	156.7	145.1	301.9	188.0	400.0	86.3	94.1	39.2	203.2 ± 97.2

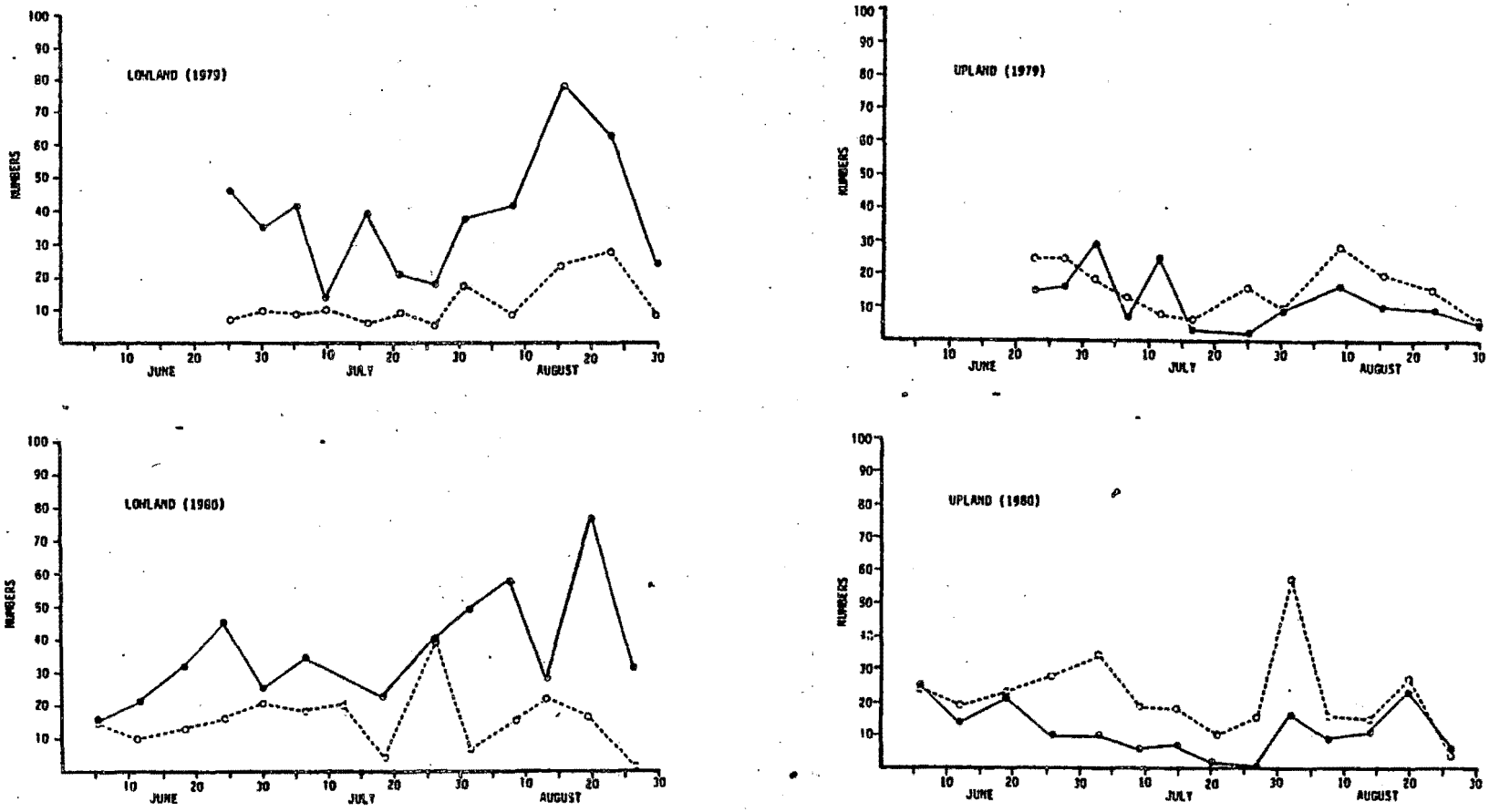


Figure II-5. Numbers of shorebirds (●) and longspurs (○) on upland and lowland study plots, Canning River Delta, 1979 and 1980.

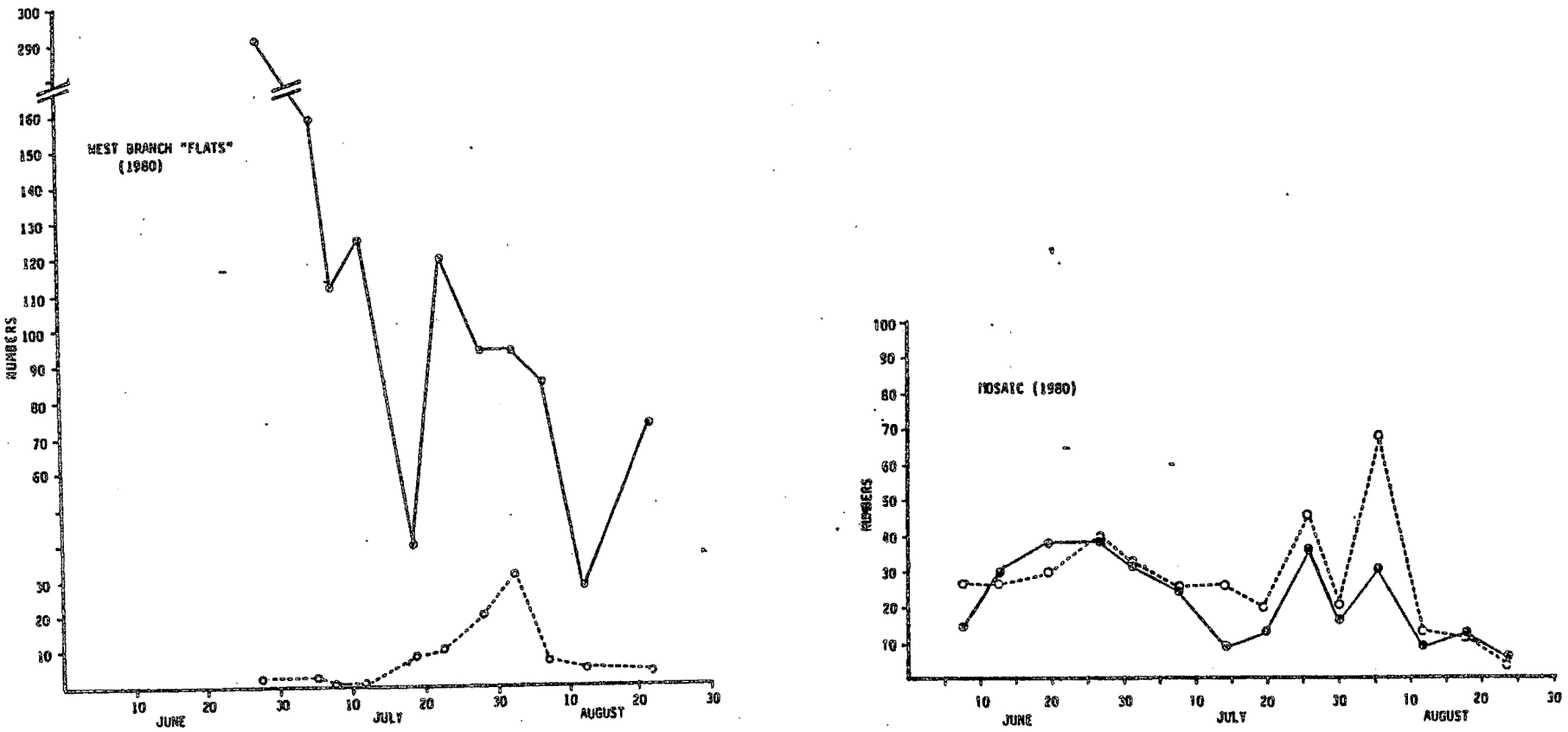


Figure II-6. Numbers of shorebirds (●) and longspurs (○) on West Branch Flats and mosaic study plots, Canning River Delta, 1980.

mated Sandpipers. The main component of the high shorebird density was large phalarope flocks that gathered on the ponds in the area in late June and July. Large numbers of migrating Semipalmated Sandpipers used the area from mid-June to mid-July. Shorebird numbers remained equivalent to or greater than those on the lowland throughout August. Longspur numbers were generally low except for a brief period in late July and early August.

Although this analysis points to some important differences between areas, some of the underlying seasonal population shifts are obscured by combining shorebird species. Figures II-7 through II-10 show seasonal shifts in the two years of study for four major shorebird species. We will discuss these and other species which appear in the results of the censuses (Tables II-9 through II-14).

Golden Plovers (Figure II-7) maintained low densities on all plots during the breeding season, although no nests were actually located on the lowland. Migratory movement began in mid-July when flocks of adults appeared. The juveniles followed later in August. In 1979 there were two peaks on the lowland, one around 20 July representing adults and a much larger peak in August representing the movement of juveniles. In 1980 there were more adults seen (the peaks prior to 10 August represent adults) and fewer juveniles. In 1980 there were more adults seen (the peaks prior to 10 August represent adults) and fewer juveniles. In both years, however, the lowland was heavily used by Golden Plovers in late summer, though not in early summer. Flocks fed actively on the study plots; residence time was difficult to judge but often the visits were very brief, on the order of several minutes to several hours, with a high turnover rate during peak migration periods.

Golden Plovers were one of the few species that continued to occur on the upland plot during the late summer migration period. Buff-breasted Sandpipers, common on the upland in 1979, were also closely tied to upland sites throughout the summer. In 1979 there was a peak in early July on the upland (see Table II-8) probably representing movement of adult male Buff-breasts after the courtship period was over. A second peak in early August probably represented movement of adult females and/or juveniles. Buff-breasted Sandpipers nested on the mosaic plot but were seen only once on the lowland in the two years of study.

Red Phalaropes (Figure II-8) arrived later than other shorebirds and reached peak density on the tundra in late June. They were abundant only on the lowland but present in low numbers on the mosaic. In both years one or two nests were located on the upland but transient phalaropes did not use the area. By early to mid-July the females left the tundra and there was a substantial decline in numbers on the plot. Males remained into August and fledged juveniles were commonly seen on the lowland plot during the first half of August.

Northern Phalaropes were less abundant than Red Phalaropes at Canning River Delta. They were fairly common on the lowland in 1979, and seasonal abundance parallelled that of Red Phalarope. An aborted nesting attempt was made on the upland in 1979, but otherwise this species did not use that area.

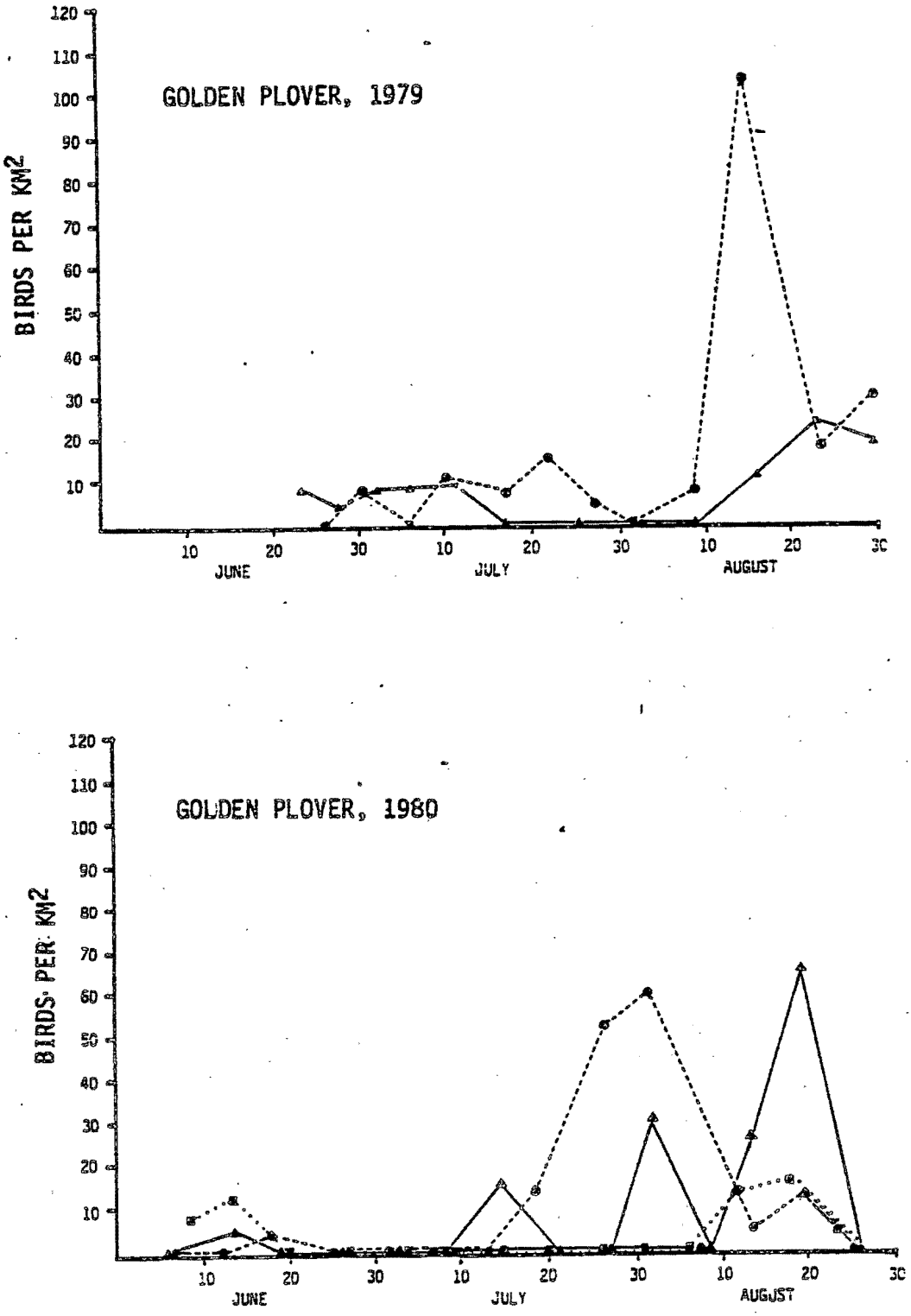


Figure II-7. Densities of Golden Plovers on the upland (▲), lowland (●), and mosaic (■) study plots, Canning River Delta, 1979 and 1980.

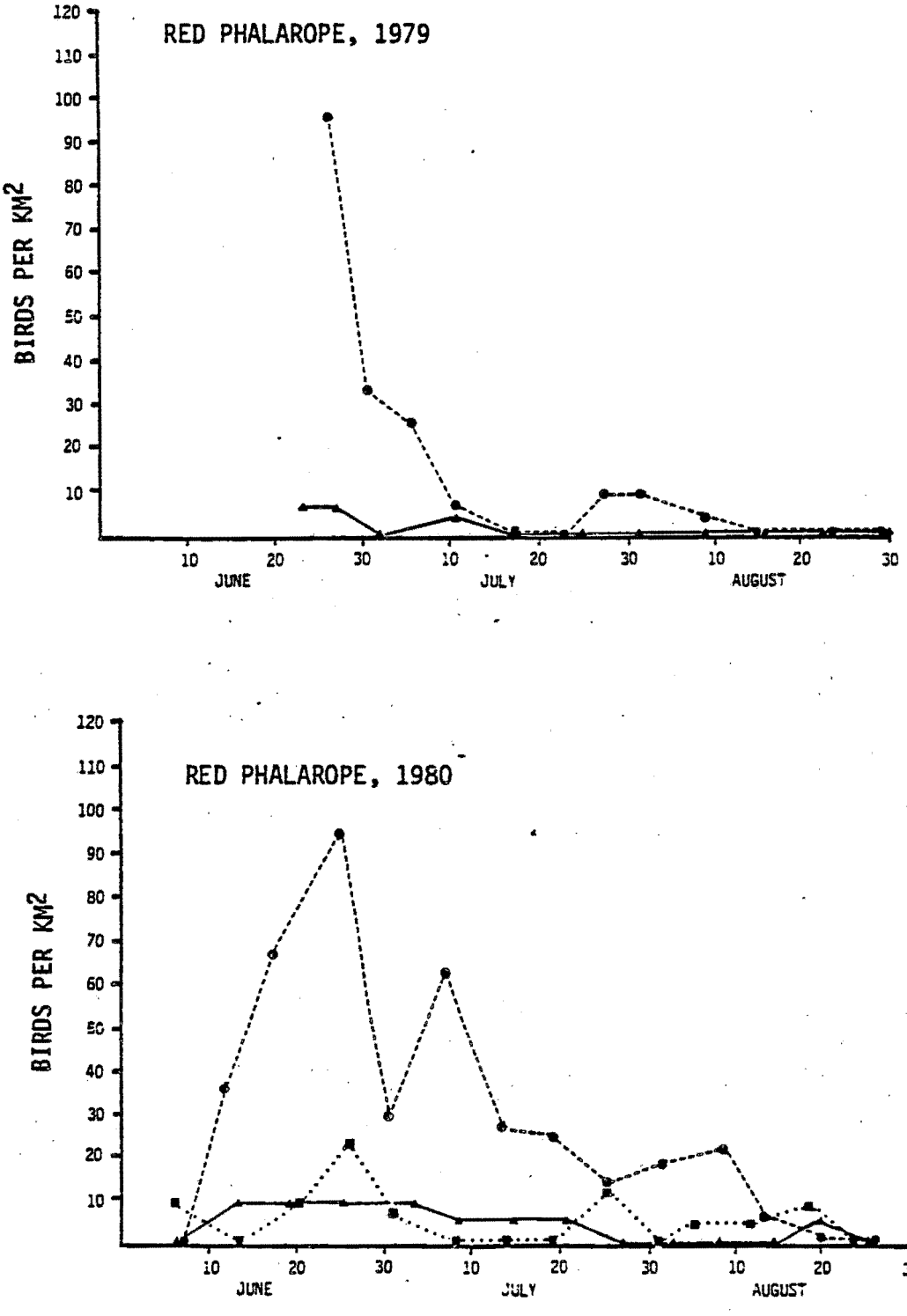
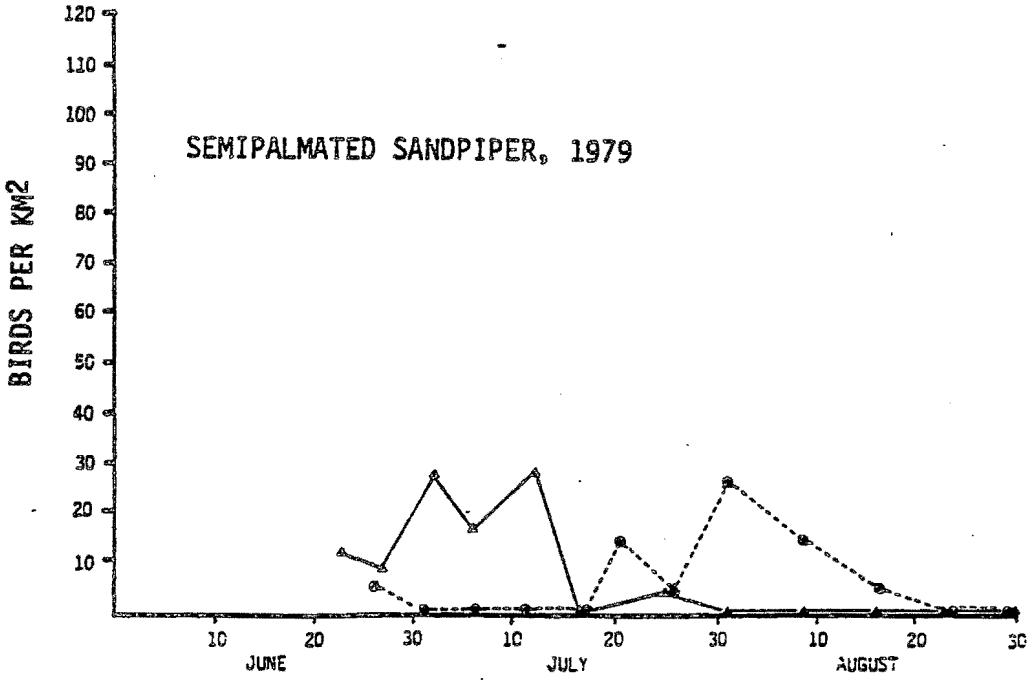


Figure II-8. Densities of Red Phalaropes on the upland (▲), lowland (●), and mosaic (■) study plots, Canning River Delta, 1979 and 1980.



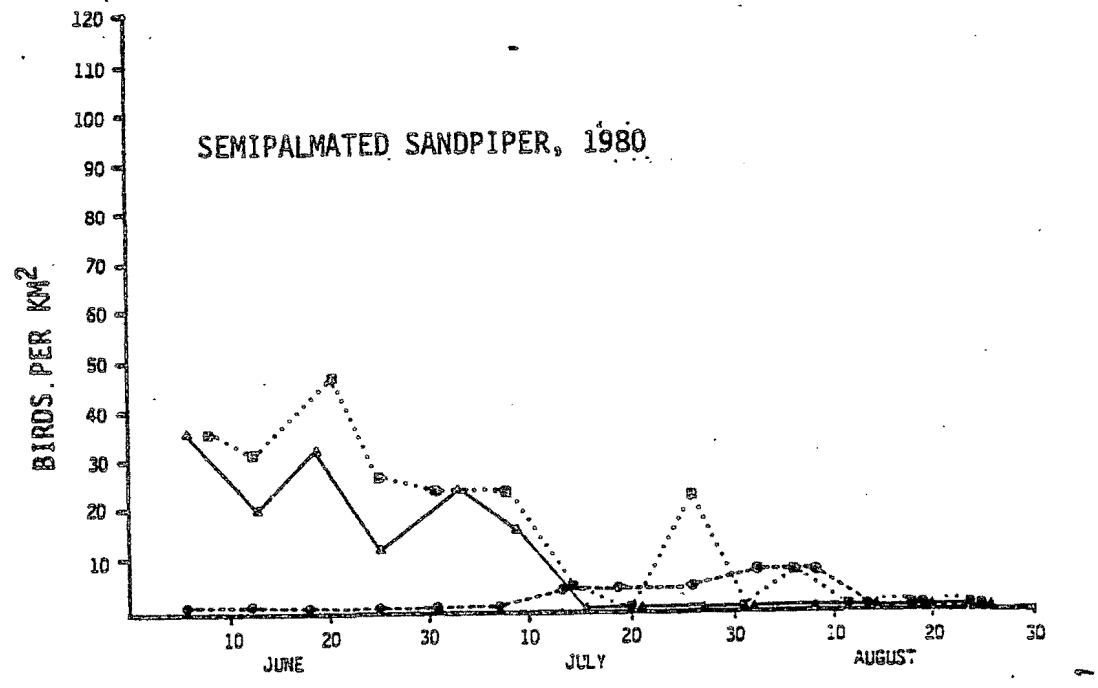
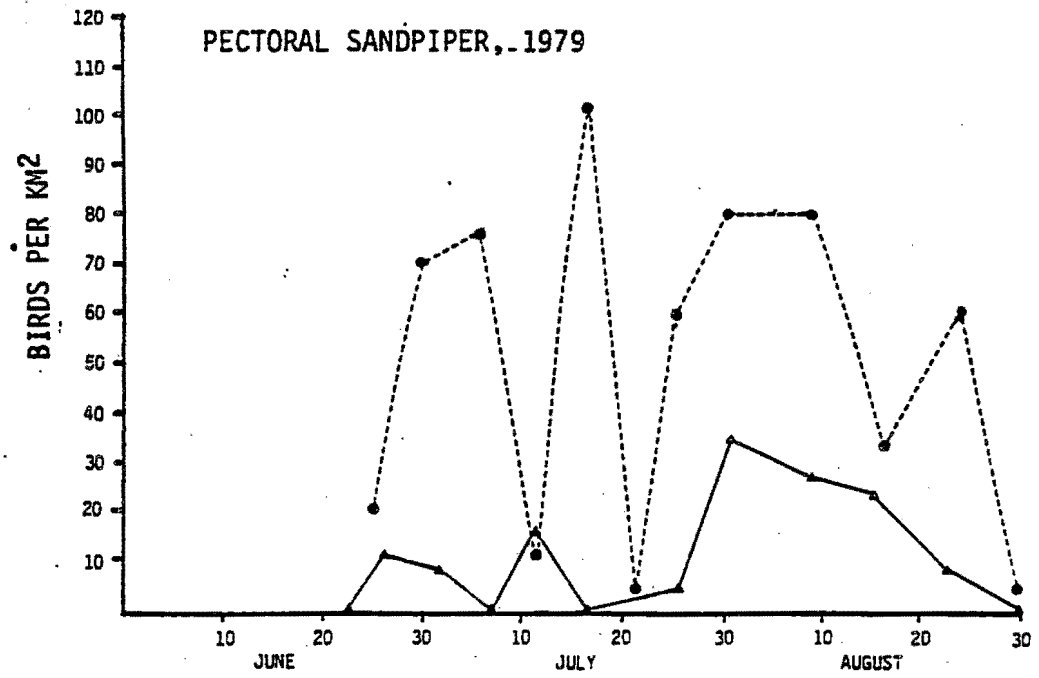


Figure II-9. Densities of Semipalmated Sandpipers on the upland (▲), lowland (●), and mosaic (■) study plots, Canning River Delta, 1979 and 1980.



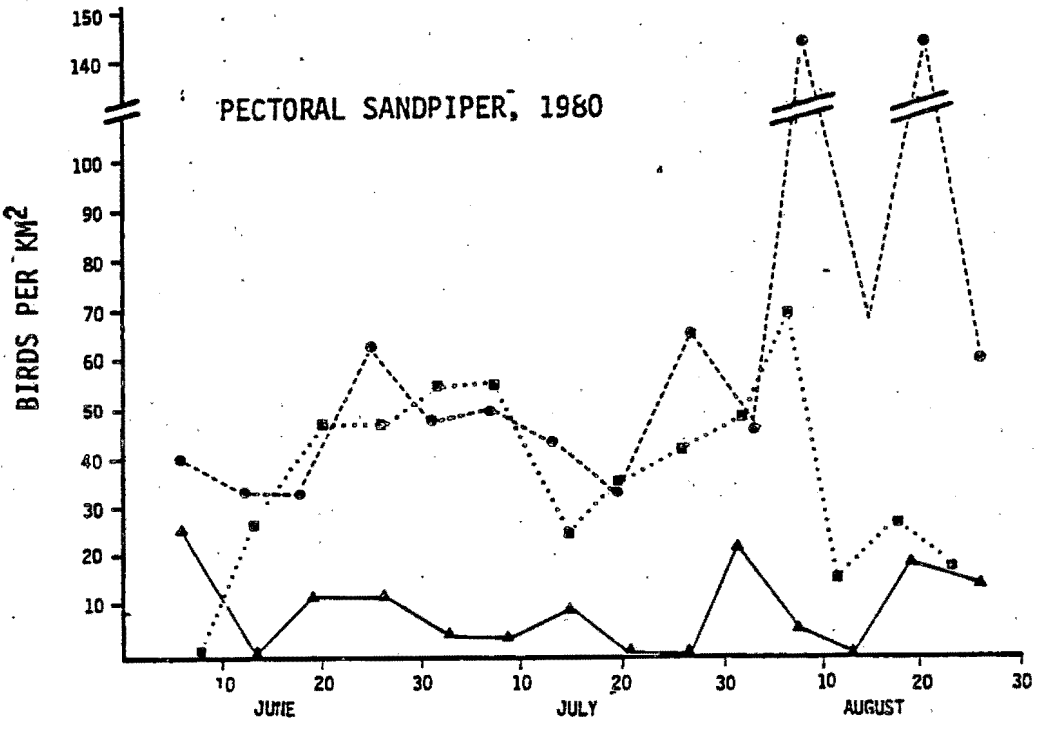


Figure II-10. Densities of Pectoral Sandpipers on the upland (▲), lowland (●), and mosaic (■) study plots, Canning River Delta, 1979 and 1980.

Northern Phalaropes were less common in 1980 than in 1979; in 1980 they used the mosaic plot most heavily.

Semipalmated Sandpipers were present in fairly high numbers on the mosaic and upland from early June to mid-July. After the young hatched in early June they virtually disappeared from the upland. In both years the decline on the upland was coincident with the beginning of use of the lowland by this species, although there were less seen on the lowland in 1980 than in 1979 (Figure II-9). Semipalmated Sandpipers used the mosaic longer than the upland; flocks of adults migrating through the area in mid-July used the mosaic.

Red and Northern Phalaropes and Semipalmated Sandpipers underwent a general decline on tundra areas throughout the summer, although there was some increased use of lowland tundra. However, these species occurred in large numbers in shoreline habitats (see Part III and species accounts, this report) and also on West Branch Flats at times during the summer when they; were virtually absent from the tundra.

Dunlins were similar to Semipalmated Sandpiper in seasonal pattern of abundance except that they seemed to have broader habitat requirements early in summer; they were found quite often in the lowland and may have nested there. They also disappeared from the upland in mid-July. Both adults and juveniles used the mosaic and lowland into mid-August. Both of these species made heavy use of marine littoral habitats in migration. Large numbers of Semipalmated Sandpipers used the Flats area from mid-July to mid-August, in concentrations far greater than those on the intensive study plots. Dunlins were less common at Canning River Delta but fairly high concentrations were present on the Flats in August.

Pectoral Sandpipers (Figure II-10) were most numerous overall on the lowland, although higher nesting density occurred on the mosaic. Transient Pectoral Sandpiper males moved through the area mainly in late June to mid-July after which females, then juveniles, moved through the area in large numbers. In 1979 there was heavy movement of adult females in mid-July with a longer period of movement of juveniles in late July and August. In 1980 there was a less conspicuous movement of females but the peak of juvenile movement in August was very high, with densities exceeding that of any shorebird species on the intensive study plots. Although Pectoral Sandpipers used the upland very little in early summer (except during break-up in 1980) the late summer influx of juveniles seemed to "spill over" into the upland. Pectoral Sandpiper numbers were small in the upland compared with the lowland, but they made up a substantial fraction of total shorebird use of the plot.

Long-billed Dowitchers and Black-bellied Plovers occurred almost exclusively on the lowland during late summer migration eastward. The flight of Black-bellied Plovers consisted mostly of adults, at least until about 20 August. Few juveniles were seen in 1980. The Dowitcher movement consisted almost entirely of juveniles. The flight of Long-billed Dowitchers was earlier and more intense in 1979 than in 1980. These two species, along with the Golden Plover and the Pectoral Sandpiper, represented the bulk of the late

summer peak in shorebird use of the lowland. Since these are among the largest of the shorebirds at Canning River Delta, comparing bird biomass among the plots during late summer would produce an even more striking contrast between the lowland and upland plots, with the mosaic falling somewhere in between.

DISCUSSION

The differences in abundance and behavior of the bird species groups of the Canning River Delta required that information regarding their dispersion and use of tundra habitat be gathered by different means. This discussion therefore will begin with a look at habitat use by large birds and then examine the information on small birds derived from the intensive study plots.

Large Birds

The 1979 large-bird survey results have been compared with results from other Arctic Coastal Plain localities in Table II-15. I have used seasonal mean densities as the basis for comparison, which may be misleading in some cases. The Canning River Delta study period was longer than in most other studies, therefore the sesonal mean for Canning River Delta includes more of a contribution from spring and fall migration periods. Brant and White-fronted Geese, for instance, were rarely seen during mid-summer and their seasonal mean value is derived almost entirely from records of migrants. Obviously, this is not strictly comparable to the East Long Lake and Island Lake sites, both of which attract large numbers of molting geese as well as a breeding population. This problem varies with the species and the reader is referred to Table II-7 to clarify seasonal patterns of abundance of these birds. Another problem is that the Canning River Delta large-bird survey area of 2.45 square kilometers was much smaller than the area used in other studies, which were 15 square kilometers or larger. The larger areas were appropriate in that they integrated density over a wide variety of tundra habitat. Oldsquaw densities reported from Canning River Delta were probably an underestimate because large lakes used by molting Oldsquaws were not included within the large-bird survey.

In spite of these difficulties, seasonal means are the only convenient way to compare densities from one site to another, given the form in which other studies' results have been presented. Some tentative conclusions may be drawn. Arctic Loon densities at Canning River Delta are comparable to other sites. Red-throated Loon densities seem above average. Many authors (Derksen et al. in press) have noted a habitat difference between the two common loon species of the Arctic Coastal Plain, Arctics using larger, deeper lakes for nesting and Red-throats using smaller, shallower lakes with more emergent vegetation. The relative density of these wetland types in a study area un-

Table II-15. Comparison of large bird densities (birds per square kilometer), Canning River Delta and other Arctic Coastal Plain localities.

	ANWR		PRUDHOE BAY	NATIONAL PETROLEUM RESERVE		
	Canning River Delta	Okpilak River [1] Delta	Storkersen [2] Point	Meade River [2] Delta	East Long [2] Lake	Island Lake [2]
Arctic Loon	1.3	1.6	1.6-1.9	2.1	1.2-1.5	0.8
Red-throated Loon	1.6	1.0	0.5-0.6	0.2	0.5-1.3	0.1
Whistling Swan	1.7	0.4	0.1-0.3	0.2	0.2	0
Canada Goose	3.9	0.1	0	0	1.4-3.7	6.6
Brant	2.8	5.5	0.3-0.7	0.3	5.4-9.1	9.6
White-fronted Goose	0.9	NA	1.0-2.2	0.7	1.0-1.1	0.9
Pintail	3.6	NA	6.2-14.1	5.1	6.5-17.1	2.3
King Eider	2.6	0.6	1.9-2.4	0.1	0.0-0.3	0.3
Spectacled Eider	0.9	0	0.2	0.3	0.5-0.6	0.1
Oldsquaw	3.3	10.0	1.8-2.3	1.1	3.2-3.3	2.3
Parasitic Jaeger	0.6	NA	0.5	0.4	0.4	0.4
Glaucous Gull	0.9	2.0	0.1-0.2	1.1	0.4-0.7	1.4
Arctic Tern	0.4	NA	0	0.7	0.5-0.8	0.1

1. Source, Spindler (1978a).

2. Source, Derksen et. al. (in press).

doubtedly affects the relative density of loons. Ac
that the Red-throat's apparent predispositon to small
wetlands results in an underestimate of numbers r
Canada Goose density was high at Canning; higher densiti
East Long Lake and Island Lake, both of which are wit
goose molting area known in Alaska. Pintail numbers ir
lower than at sites farther west, although there
variability in numbers (Derksen and Eldridge 1980) acros
Plain, apparently related to drought conditions in the
continent. King Eiders seem to be much more plentiful i
than in the National Petroleum Reserve sites to the w
were comparable to those reported farther west, but lowe
at the Okpilak River Delta. Whistling Swan density a
may have been distorted due to fortuitous location of t
within the home range of a successfully breeding swa
based on the nest density reported in Table II-6, densit
swans alone would be 0.3 - 0.5 birds per square kilome
include non-breeding adults and young.

The nest densities reported for the Primary Study
for comparative purposes. As noted previously, breeding
are likely to be greatly underestimated. The mean de
scure the fact that there are restricted areas of very g
species where densities may be much higher than the re
and Canada Geese, for instance, have extremely patchy di
Chain Lakes, an area approximately three square kilomet
the 1980 base camp (Figure II-1), six pairs each of Arc
Loons and three pairs of Canada Geese nested. Thus, n
local area was two and a half to three and a half times
tire study area for these species. Another species
distribution was the Sabine's Gull, which nests colonial
Only three nesting areas were discovered for this sp
Delta.

Some wetland types seemed consistently above avera
waterfowl, loons, gulls and terns. Large basin-complexe
by Bergman et al. (1977), which have irregular shore
extensive beds of emergent vegetation (Carex aquatilis a
were often prime areas for nesting activity. In
protected nest sites on islands (Canada Goose nests, for
on islands surrounded by deep water) these areas
Arctophila which provided cover for waterfowl broods.
grass beds during wing molt and migration, as well. The
of birds in these wetland types was markedly higher than
the study area.

Another habitat that appeared especially important
water birds is the coastal tundra, designated Class
1977, of which the West Branch Flats is an example. The

centered at the edge of the Bay and so represents the interface between the marine environment and coastal tundra. The West Branch Flats was used by Brant, White-fronted Geese, and especially by Canada Geese (Table II-8). Canada Geese with broods used the area in late July and flocks of 30 - 100 adults were seen in late July and early August during and shortly after the wing-molt period. Although these birds did not use the same area in 1980, a flock of 18 flightless adults and several family groups were noted in a visit to one of the islands at the mouth of the West Branch on 17 July 1980, indicating that Canada Geese do use the estuary consistently from year to year. Pintails were found commonly on the Flats in 1979 and small flocks of eiders (unidentified females) used the area in July.

The 1980 Flats census was in a different section of the area, away from the bay shore, but included many ponds of various depths and sizes. This area was used heavily by Pintails in late June and again from late July to mid-August. The extraordinary density of Pintails recorded there on 7 August is misleading in that it is based on a census of a small area (20 ha) but it is an accurate reflection of the heavy use migrating Pintails made of this area. These ducks stopped to feed in small flocks scattered over the entire area. Oldsquaws used the area particularly in June. Several Oldsquaw nests were located on the plot, and small flocks of females were present through July. The densities of these duck species calculated for the Flats was far greater than that calculated for the large-bird survey of 1979. Other species that used the area included King Eiders, Sabine's Gulls, and Arctic Terns, and although not recorded on the 1980 census plot, Brant, White-fronted Geese and Canada Geese used various portions of the West Branch Flats during migration in late summer.

Small Birds

In considering habitat use patterns of small birds at the Canning River Delta it must be recognized that this study did not attempt replicate samples of census plots within habitat types. The data are certainly suggestive of major differences in use between habitats but it is dangerous to extrapolate from these results. Only to the extent that these findings are corroborated in the literature can more general conclusions be drawn, and we attempt in this discussion to include supportive data from other studies.

At the Canning River Delta the mosaic plot had the highest nesting density both of Lapland Longspurs and of shorebirds. In analyzing this result it is useful to consider what qualities of the mosaic environment make it different from the other plots. There is greater microtopographic variation in the mosaic. Polygon rims tend to be higher and there are high-center polygons with deeply incised troughs, probably remnants of an old lake shore. These high spots melted free of snow earlier in spring than surrounding areas, providing foraging and nest sites for birds during the first week in June. There was relatively little shallow pond edge habitat; most of the ponds in the mosaic plot retained at least some water through the entire summer.

During mid-summer, when the tundra dried out considerably, there was very little shallow water/exposed pond sediment as was present on the lowland, because of the absence of shallow polygon center ponds.

The mosaic is intermediate in vegetation composition between the upland and the lowland in the sense that it contains a more even mix of vegetation types associated with different moisture regimes. The upland was the most homogenous, with over 66% of the, vegetation samples falling into the single class which encompasses frost-boil/sedge meadow. The lowland, with its many ponds, contained more of the emergent vegetation types than the other plots. The mosaic, although composed mainly of drier vegetation types, contained patches of vegetation from very wet to very dry. In this sense, it was composed of units which occurred in the other plots. However, there was an array of plant species which occurred on the mosaic but were virtually absent in the other two plots, including Salix planifolia ssp. pulchra, Cassiope tetragona, Ledum palustre, Rubus chamaemorus, and Pyrola grandiflora. Several other taxa, such as Saxifraga foliolosa, Saxifraga caespitosa, and the lichen Peltigera apthosa occurred far more frequently on the mosaic than on the other two. The greater microrelief on the mosaic accompanied by later melting snow patches may be correlated with the presence of Cassiope tetragona, as has been noted at Prudhoe Bay (Walker et al. 1980). Soil pH may also play a part in the distribution of some of these species. Walker et al. (1980) noted that while most Arctic Coastal Plain sites are acidic, at Prudhoe Bay most soils are alkaline due to the influence of wind deposited river sediments from the Sagavanirktok River onto adjacent tundra areas. An analagous situation would seem to exist at the Canning River Delta. Both Salix planifolia ssp. pulchra and Saxifraga foliolosa (two of the strongest indicator species for mosaic plot vegetation types) were described as acidophiles in the Prudhoe Bay region. Whether these are the actual ecological factors underlying the observed between plot differences is unknown. Furthermore it is unclear whether these vegetation differences are important to birds, or indicators of environmental conditions that are important to birds.

The Canning plots also differed in their susceptibility to flooding. The lowland was by far the most inundated by spring run-off and melt water, although the other plots were at their wettest at this time also. In late summer, much of the lowland reflooded as a result of increased rainfall. The change in surface area covered by standing water was greatest in the lowland and least in the mosaic. In this sense, the mosaic is the most predictable environment in terms of amount of area available for feeding shorebirds. In a dry or normal year there might be much shallow water/exposed sediment for feeding shorebirds on the lowland but in a wet year this large area would become unavailable to waders.

The most likely factor linking soil conditions, vegetation, and microtopography to bird abundance is food availability. The principle prey items of both Lapland Longspurs and shorebirds studied at Barrow are Dipterans including three tipulids (craneflies) and various members of the family Chironomidae (midges) (Holmes and Pitelka 1968; Custer and Pitelka 1978).

These insects are not found in equal abundance in all microhabitats. The various cranefly species have differing affinities for soil moisture regimes but on average, biomass of cranefly larvae has been found to be greatest in mesic and dry sites (Seastedt and MacLean 1979). Chironomids, on the other hand, are largely aquatic or semi-aquatic. Final instar cranefly larvae and pupae are large and generally near the ground's surface. They are heavily preyed upon by tundra nesting birds from melt-off until the adult insects emerge in early July. As MacLean (1980) pointed out, the large size of these prey items makes it energetically efficient to forage for craneflies rather than the larvae of smaller insects such as Chironomids. Cranefly adults emerge at about the same time young shorebirds hatch; the precocial young shorebirds are totally reliant on surface-active invertebrates for the first two weeks after hatch, and while adult birds prey extensively on adult craneflies at this time the young specialize more on smaller Diperans (Holmes and Pitelka 1968). At summer's end most species have switched to feeding on Chironomid larvae as the principle food of both adults and juveniles.

For a breeding shorebird, then, there are somewhat conflicting habitat requirements to be satisfied. During early summer, access to drier habitats is essential as it is the best source of cranefly larvae and pupae. However, the young shorebirds need an ample supply of small Dipterans which are most abundant around swales and ponds where they emerge in numbers up to 500 to 5000 per square meter over the course of a summer (Butler et al. 1981). Vegetation is more lush in the wet areas as well and may be important as cover from predators. The less shorebird broods need to travel between patches of wet ground, the less are their chances of being found by predators. These factors would provide a theoretical basis for greater nesting densities in areas where both wet and dry habitat is available within a small area, as was found at Canning River Delta.

To this simplified picture of predator-prey interactions must be added several levels of complexity. Weather may have a profound influence on prey availability in terms of absolute abundance of adult insects and in the level of activity of those insects. Thus, a cold year in 1969 in Barrow resulted in cranefly emergence well below average (Seastedt and MacLean 1979). At Canning River Delta, a cold July in 1980 was probably responsible for a low cranefly emergence. During such cold years, emergence of the high density populations of chironomids from tundra pools may be an important food resource to adult shorebirds as well as young. This would be true particularly if the aquatic system buffered the effects of weather and reduction in chironomid emergence was not coincident with years of low cranefly emergence.

Another factor not explicit in the model stated above is the variable food habits of different shorebird species. Phalaropes, for instance, are reliant primarily on semi-aquatic or aquatic insect larvae (D.M. Tracy MS). They feed mostly in deep and shallow water of ponds and so are subject to a different set of constraints in habitat selection. The singular abundance of Red Phalaropes on the lowland plot serves to emphasize this point.

There is some support in the literature for the notion that heterogeneity

of microhabitat is correlated with high nesting densities on Arctic Coastal Plain tundra habitats. Spindler (1978a) found highest nest densities at the Okpilak Delta in a wet/dry sedge mosaic habitat (most similar to the mosaic at Canning River Delta) and second highest densities were in a flooded tundra habitat (most similar to the lowland plot at Canning River Delta). A homogenous wet sedge habitat and tussock-sedge meadow supported fewer birds, although Longspur densities were high in the tussock habitat. Myers and Pitelka (1980) used factor analysis to analyze habitat selection in shorebirds at Barrow and Atkasook on the Arctic Coastal Plain. They found tht the first two axes of ordination explaining most of the variability in shorebird use of habitat were "polygonization" and "pondiness". The first axis represented a gradient from flat and poorly drained areas to areas which exhibit strong polygonization. The second axis represented a gradient from dry area to areas with a high proportion of surface area covered by ponds. At Barrow, they found relatively even distribution of shorebirds over "habitat space" during the nesting seson; however two portions of habitat space exhibited peaks. One was in areas of high polygonization (i.e. similar microrelief features to those on the mosaic plot) and the other peak was in areas of low to moderate relief polygons with many ponds (i.e. similar habitat to that found in the lowland plot). Spindler's (1978a) data correspond well to this result, as do the data from the Canning River Delta study site.

Lapland Longspurs seem to be tolerant of a broad range of tundra habitats. They nest both in tussock tundra (Spindler 1978a; Jones et al. 1980) and wet polygonized tundra. Unlike shorebirds, they do not achieve high nesting densities in very wet areas with well developed ponds (as in the lowland plot of this study and flooded tundra of the Okpilak River study). The intersection of habitat preferences of Longspurs and shorebirds seems to be in the mosaic type tundra; wetter areas lack high numbers of Longspurs and drier areas lack high numbers of shorebirds.

So far, we have examined only between-plot difference in nesting density. Table II-16 summarizes results of breeding bird surveys conducted at various Arctic Coastal Plain sites. Sites from the Arctic National Wildlife Refuge are listed at the top of the page. With a few exceptions, breeding densities reported from ANWR are lower than those from other locations, particularly Barrow. Differences in study methods may be partly responsible for this discrepancy. All the studies in ANWR used the conservative approach of basing nest densities only on actual nests found while other studies used the presence of territorial males as well as actual nests. The former method is almost certain to underestimate nest density to some extent; the latter may result in an overestimate of nest density for some species. Lapland Longspurs, for instance, have been found to have a rather fluid social system in some studies at Barrow (Tryon and MacLean 1980) including polygyny and a nest "helper" male that raised young of a different male, so that number of males may not equal number of nests. At the Canning Delta upland plot, 18 male Lapland Longspurs were banded in June of 1979, of which only three actually nested on the plot, with up to four others seen regularly in the area. That

Table II-16. Breeding bird densities (nests per square kilometer) from various locations on Arctic Coastal Plain. Range of densities is presented for sites which have been censused for more than one year. The category "others" includes ptarmigans, waterfowl, loons, etc.

Location	Years	Breeding Densities			
		Shorebirds	Longspurs	Others	Total
ANWR					
Demarcation Bay[1]	'78-'79	47-90	43-67	3-10	123-143
Okpilak River Delta[2]					
Flooded Tundra	'78	38	10	13	61
Mosaic Wet/Dry Sedge	'78	28	55	4	87
Wet Sedge Meadow	'78	14	29	2	43
Upland Sedge-Tussock	'78	8	40	5	53
Canning River Delta					
Upland	'79-'80	31-39	20-35	0-4	51-78
Lowland	'79-'80	48-67	11-22	0-4	59-93
Mosaic	'80	74	51	12	137
BARROW					
Wet Coastal Plain Tundra I[3]	'75-'79	66-115	30-44	1-21	107-167
Wet Coastal Plain Tundra II[3]	'75-'79	68-115	15-69	4-39	109-171
Wet Coastal Plain Tundra III[3]	'78-'79	40-74	44-45	7	126-162
PRUDHOE BAY					
IBP sites[4]	'71-'72	87-91	7-9	0	93-100
Wet Coastal Plain Tundra[5]	'79-'80	74-101	44-45	7	126-152
INLAND SITES					
Atkasook[3]	'77-'79	92-144	40-96	26-40	155-284
Pipeline Corridor (Franklin Bluffs)[6]	'79-'80	27-37	25-29	14	72-76

1 source, R.M. Burgess pers. comm.
2 source, Spindler 1978a
3 source, Myers and Pitelka 1980
4 source, Norton et. al. 1975
5 sources: Hohenberger et. al. 1980; Hohenberger et. al. 1981
6 sources: Jones et. al. 1980; Jones et. al. 1981

same year, attempts at territory mapping were confounded by the presence of what appeared to be non-nesting males. Given this kind of instability in territoriality, mapping would likely be inaccurate and probably inflate the actual number of nests in the area.

The Okpilak River Delta study, in particular, may have found fewer nests because of less intensive coverage of very large study plots (total of 175 ha censused).

Methods aside, the differences between Barrow nest densities and those reported from ANWR seem significant and further study is needed to clarify the situation.

Many studies of Arctic Coastal Plain bird populations have either concentrated solely on nesting birds or have not sought to separate use by nesting birds and transients. A major finding of this study is that bird use of some tundra areas and shoreline habitat may be highest in the post-breeding season. The late summer shift of shorebirds to littoral habitat has been noted at Barrow (Connors et al. 1979) and the same phenomenon was strikingly obvious at Canning River Delta. However, shorelines are not the only habitats to receive increased avian use in mid- to late summer. Myers and Pitelka (1980) report that shorebirds move coastally from their breeding sites inland during July and August. At the inland site of Atkasook, shorebird use declined steadily after nesting, while at Barrow, peak use occurred from early July, when the transient Pectoral Sandpipers and Red Phalaropes appeared, through the end of August, with successive waves of transients. A similar pattern seems to exist in coastal and inland sites in NPR-A and near Prudhoe Bay (Derksen et. al. in press) and this study confirms that the same phenomenon of sharp increase in shorebird numbers on the Beaufort Sea coast in late summer occurs at least as far east as ANWR. Furthermore, at Canning River Delta, this population shift was expressed differentially in different habitats, with the upland plot exhibiting a pattern more typical of Atkasook (inland) than Barrow (coastal).

This result is important because it indicates that certain habitats on the Beaufort Sea coast are vital to many more birds than just the local breeders. Also, the local impact of birds on the populations of their prey may be much greater than if calculated on the basis of breding densities alone as by MacLean (1980) and this aspect should be explored in order to further understand the role of avian predators in the tundra ecosystem. During the period of flocking at the start of fall migration large portions of the North Slope breeding populations of many bird species appear to concentrate in a limited geographical belt along the Beaufort Sea coast. Favorable habitats within this zone, therefore, assume greater significance in terms of their importance in sustaining North Slope bird populations.

APPENDIX II-1. Vegetation Classes on Canning River Delta Study Plots

This section summarizes and provides a brief characterization of the attributes of the vegetation classes derived from the TWINSPAN analysis. Each class is numbered and given a name reflecting its moisture regime. Vegetation classes tended to be associated with certain microrelief features and these are described under the section "Associated Terrain". The list of "Characteristic Taxa" is derived from three sources: taxa that were identified as indicators by TWINSPAN are listed first and followed by an asterisk(*), common species (with frequency exceeding 30% for that type) too widespread to be indicators for any one type, and species that were either rare or were dropped from the analysis for other reasons, but which we believe are typical of a particular class. Indicator species are not necessarily common, rather they exhibit a strong affinity for a certain vegetation class.

Class 1A. Dry Sedge/Forb

Associated Terrain: Peaty mounds up to one meter in height, either isolated or in association with high relief polygon features, often near ice wedge pools. These mounds often contain numerous lemming burrows and are used by predatory birds for perches, and by Longspurs for singing posts.

Characteristic Taxa: Astragalus umbellatus*, Minuartia arctica*, Papaver macounii*, Cardamine hyperborea, Salix rotundifolia, (Alopecurus alpinus), and a variety of forbs, especially on mounds used by birds.

Class 1B. Mesic Frost Boil Sedge Meadow

Associated Terrain: Better drained areas on upland plot, primarily centers of flat topped polygons with indistinct rims and shallow troughs. This unit actually consists of two vegetation types: one associated with the frost boils themselves and the other present in the meadow surrounding the frost boils. The distinction is probably unimportant in terms of bird habitat except that the proportion of frost boils to meadow may affect the suitability of the habitat.

Characteristic Taxa: Chrysanthemum integrifolium*, Saxifraga oppositifolia*, Senecio atropurpureus*, Carex bigelowii*, Cardamine hyperborea*, Salix rotundifolia, Cetraria sp., Dryas integrifolia, Dactylina sp., Thamnolia vermicularis, Salix arctica, Eriophorum angustifolium, Polygonum viviparum, Saxifraga hirculus, Carex aquatilus, (Draba sp., Arctagrostis latifolia).

Class 2A. Mesic Sedge

Associated Terrain: Flat tops of indistinct polygons and gently sloping non-polygonized ground in upland plot. Rims of low center polygons in the lowland plot.

Characteristic Taxa: Salix arctica*, Senecio atropurpureus*, Cetraria sp., Dactylina sp., Dryas integrifolia, Salix rotundifolia, Thamnolia vermicularis, Eriophorum angustifolium, Equisetum sp., Polygonum viviparum, Carex misandra, Carex aquatilus, (Poa sp.).

Class 2B. Mesic Sedge

Associated Terrain: Moist to dry polygon rims in mosaic plot.

Characteristic Taxa: Salix planifolia ssp. pulchra*, Salix reticulata*, Alectoria sp.*, Peltigera sp.*, Cassiope tetragona*, Cetraria sp., Dactylina sp., Dryas integrifolia, Salix rotundifolia, Thamnolia vermicularis, Eriophorum angustifolium, Polygonum viviparum, Carex aquatilis, (Pyrola grandiflora, Luzula multiflora, Eriophorum vaginatum, Stellaria sp.).

Class 3A. Moist Sedge

Associated Terrain: Moist swales in poorly defined polygonal ground in the upland plot; moist centers of low center polygons (which flood only briefly or not at all during melt-off) in lowland plot.

Characteristic Taxa: Salix arctica*, Saxifraga hirculus*, Saxifraga cernua*, Dryas integrifolia, Eriophorum angustifolium, Polygonum viviparum, Carex rariflora, Salix ovalifolia, Carex aquatilis, (Saxifraga foliolosa, Carex misandra, Melandrium apetalum).

Class 3B. Moist Sedge

Associated terrain: Moist polygon rims and polygon centers in mosaic plot.

Characteristic Taxa: Salix planifolia ssp. pulchra*, Salix reticulata*, Saxifraga foliolosa*, Saxifraga caespitosa, Carex misandra, Polygonum viviparum, Carex aquatilis, (Dactylina sp., Dryas integrifolia, Thamnolia vermicularis, Pedicularis langsdorfii, Luzula multiflora, Saxifraga cernua).

Class 4. Wet Sedge

Associated Terrain: Low centers of low center polygons, subject to flooding during melt-off and during rainy periods throughout the summer.

Characteristic Taxa: Pedicularis sudetica*, Juncus biglumis*, Saxifraga hirculus*, Polygonum viviparum, Salix ovalifolia, Saxifraga foliolosa, Carex aquatilis, (Carex rariflora, Melandrium apetalum, Cardamine pratensis).

Class 5. Flooded Sedge

Associated Terrain: Low centers of low center polygons, low areas adjacent to ponds. These areas contain standing water for the entire summer, or dry occasionally leaving saturated sediments exposed. Vegetation cover is sparse.

Characteristic Taxa: Eriophorum russeolum, Eriophorum angustifolium, Pedicularis sudetica, Carex aquatilis.

Class 6. Pond Edge Emergent Sedge

Associated Terrain: Edges of shallow-Carex ponds, often associated with flooded low center polygons which contain standing water all summer.

Characteristic Taxa: Carex aquatilis*, Eriophorum angustifolium.

Class 7. Trough Edge Emergent Sedge

Associated Terrain: Steep-sided banks of polygon trough pools, often troughs are enlarged into ice wedge pools.

Characteristic Taxa: Eriophorum angustifolium*, Carex aquatilis, (Cardamine pratensis, Dupontia fisheri).

PART III. BIRD USE OF SHORELINE HABITATS OF THE BEAUFORT SEA

METHODS

Coastal Surveys - 1979

In 1979 we designed a sampling protocol to compare bird use of estuarine, Beaufort Sea, and barrier lagoon shoreline sites. We chose four points along the shoreline prior to our arrival, from U.S.G.S. topographic maps. These points are shown on Figure III-1. The census areas were roughly semicircular, including the area within an 800 m radius from the sampling point. Each site was censused for 45 minutes approximately every five days (although inclement weather and the demands of other field research activities caused considerable variation in this schedule). Procedure was to scan the census area contiually from the chosen point, recording all birds that entered the area. Location, time, sex (if distinguishable), numbers, and activity were recorded for each bird or group of birds seen during the watch.

Shoreline Transects - 1980

Bird censuses were conducted at regular 4-day intervals throughout the summer of 1980 on 27.5 km of shoreline at the Canning River Delta. Ten transects were designated, defined on the basis of geography and convenience, covering all tidal influenced shoreline areas within a day's walk of our base camp location. Each transect was measured and marked at 100 m intervals (designated as "subunits" of the transect) with numbered stakes. For convenience, a descriptive name was given to each transect, and these names and lengths of transects are listed in Table III-1.

Table III-1. List of shoreline transects, Canning River Delta, 1980.

River	3.6 km
Bay	4.1 km
Bluff	2.6 km
Inner Lagoon Shore	3.2 km
Inside West Spit	1.8 km
Outside West Spit	2.2 km
Inside East Spit	2.5 km
Outside East Spit	2.5 km
Inside Barrier Island	2.5 km
Outside Barrier Island	2.5 km

For locations of the transects, refer to Figure III-2 (map of the study area). For dates of transects see Table III-2.

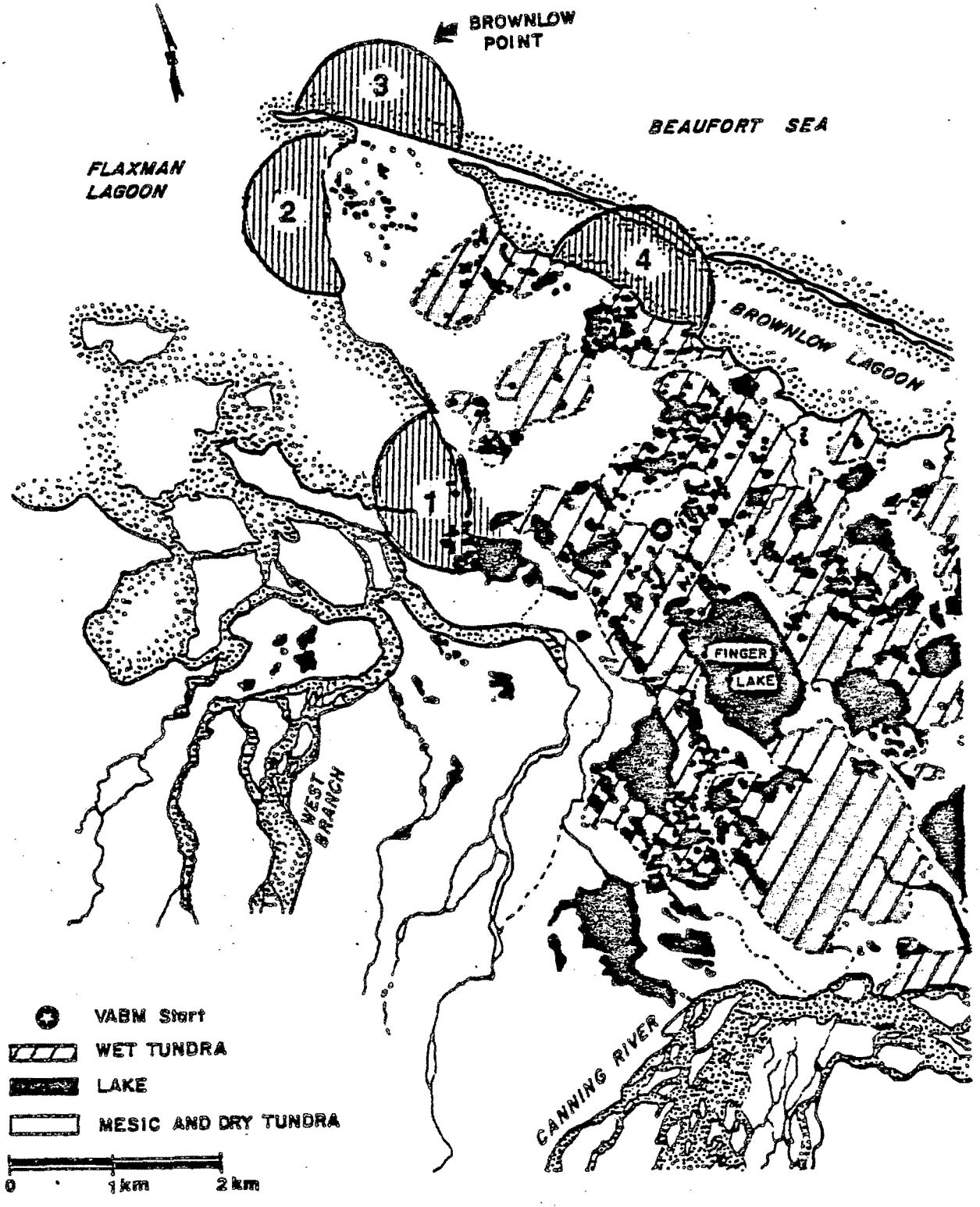


Figure III-1. Location of coastal surveys, Canning River Delta, 1979. Shaded areas were censused from a fixed point on shore.

1. West Branch Flats
2. Flaxman Lagoon
3. Brownlow Point
4. Brownlow Lagoon

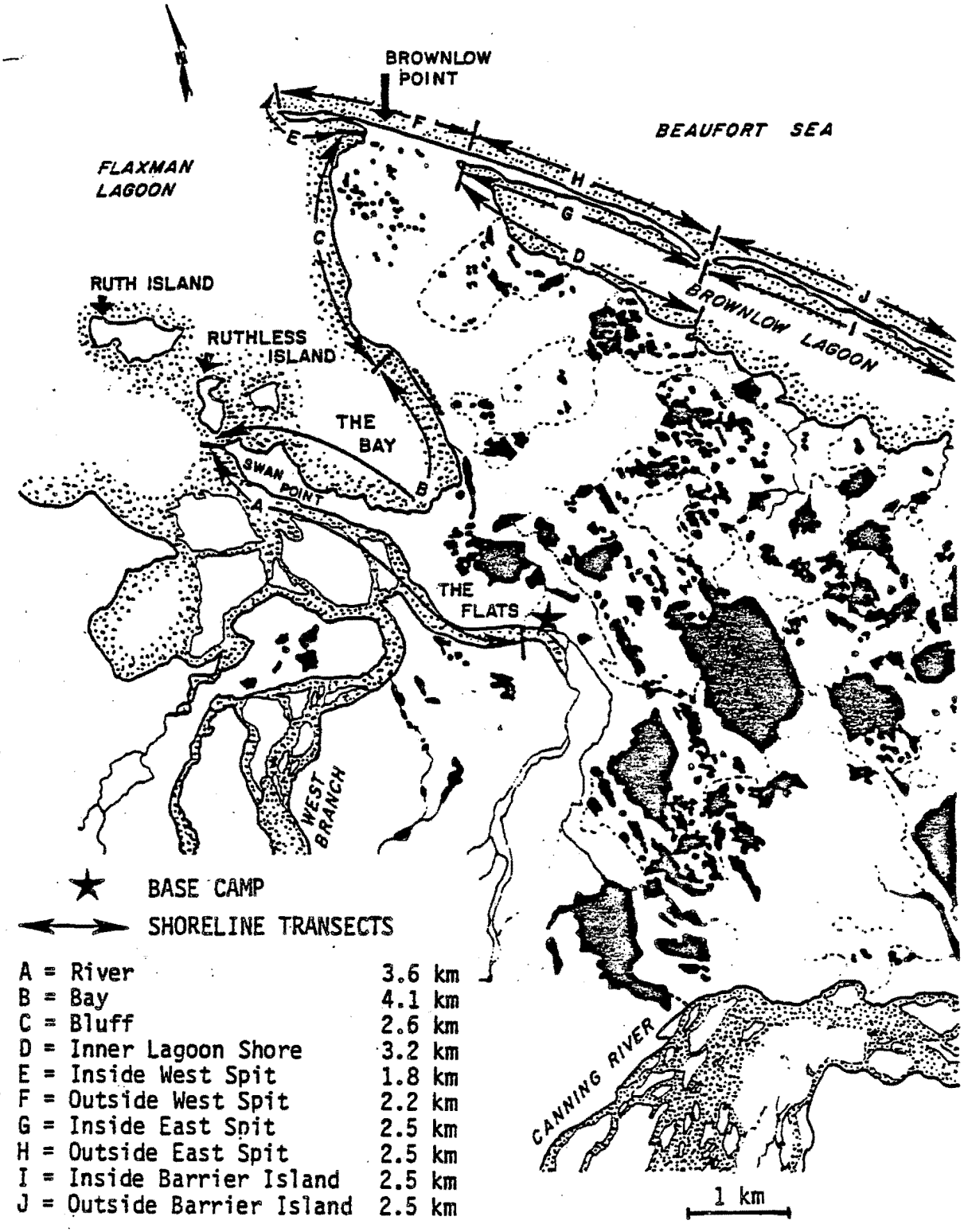


Figure III-2. Map of study area and shoreline transects, Canning River Delta, 1980.

Table III-2. Dates of shoreline transects, Canning River Delta, 1980.

OUTER WEST SPIT	OUTER EAST SPIT	OUTER BAR. ISL.	INNER WEST SPIT	INNER EAST SPIT	INNER BAR. ISL.	LAGOON SHORE	BLUFF	BAY	RIVER	RIVER ISLANDS	MONTH
6/2	5/29		6/2	5/29		6/7			6/4,5,6,7		
	6/10			6/10		6/10	6/10		6/8		J
6/14	6/14		6/14	6/14		6/14	6/14	6/12	6/12		U
6/17	6/17		6/17	6/17		6/17	6/17	6/17	6/17		N
6/21	6/21		6/21	6/21		6/21	6/21	6/21	6/21		E
6/24	6/24		6/24	6/24		6/24	6/24	6/24	6/24	6/23	
6/28	6/28		6/28	6/28		6/28	6/28	6/28	6/28		
7/2	7/2		7/2	7/2		7/3	7/2	7/1	7/1		
7/6	7/6		7/6	7/6		7/6	7/6	7/6	7/6		J
7/11	7/11		7/11	7/11		7/11	7/11	7/10	7/10		U
7/16	7/16	7/18	7/16	7/16	7/18	7/16	7/16	7/16	7/16	7/17	L
7/20	7/20	7/22	7/20	7/20	7/22	7/20	7/20	7/21	7/21		Y
7/24	7/24	7/24	7/24	7/24	7/24	7/24	7/24	7/26	7/26		
7/28	7/28	7/28	7/28	7/28	7/28	7/28	7/28	7/28	7/28		
8/1	8/1	8/1	8/1	8/1	8/1	8/1	8/1	8/2	8/2		A
8/6	8/5	8/5	8/6	8/5	8/5	8/5	8/6	8/6	8/6		U
8/9	8/9	8/9	8/9	8/9	8/9	8/9	8/9	8/11	8/11		G
8/13	8/13	8/13	8/13	8/13	8/13	8/13	8/13	8/14	8/14		U
8/17	8/17	8/17	8/17	8/17	8/17	8/17	8/17	8/18	8/18		S
8/21	8/21	8/21	8/21	8/21	8/21	8/22	8/22	8/22	8/22		T
8/25	8/25	8/25	8/25	8/25	8/25	8/25	8/25	8/27	8/27		
9/1	9/1	8/30	9/1	9/1	8/30	8/30	9/1	8/31	8/31		S
	9/6			9/6		9/4	9/6	9/5	9/5		E
											P
											T

Censuses of the shorelines of two small islands (designated Ruth Island and Ruthless Island on the map, Figure III-2) located at the mouth of the west branch Canning River, were conducted on 23 June and 17 July. Due to logistical problems with boat access, these transects could not be censused further.

A transect census was conducted by a single observer on foot walking the length of the transect and recording all birds seen. When enough observers were available, all transects were walked on the same day, in order to make results comparable between transects (i.e., all transects conducted under similar conditions, on one date). When this was not possible, the river and bay transects were sometimes walked on a subsequent day, as these transects were judged to have a high correlation with each other but not with the other transects. Census of the barrier island transect did not begin until mid-July, due to logistical problems of boat access.

The direction in which transects were walked was alternated with the following exception: beginning in mid-July, high concentrations of Oldsquaw at the gap between the east spit and barrier island transects made it preferable to always start these two transects with two observers arriving by boat and beginning their counts simultaneously from the gap and moving in opposite directions, in order to avoid problems of double-counting (i.e., birds flushed from one transect being counted again on another transect).

The time of day when transects were walked varied, but was generally between the hours of 10:00 a.m. and 5:00 p.m., this generally being the time of optimal visibility. (Morning fog along the shoreline sometimes interfered with visibility.) Before beginning a transect the observer recorded pertinent data on weather, visibility, ice conditions, and tidal stage. The observer recorded time upon entering each subunit of a transect, and then recorded all birds seen in that subunit, by species, sex/age, number, and location. Notes were also made on the behavior of the bird, and its flight direction if flying. Location was defined by the following zones within each subunit.

1) On shore, within 50 m of water's edge
2) On bluff above shore, if also within 50 m of water's edge
3) On water, within 0-50 m of water's edge
4) On water, within 50-200 m of water's edge
5) On water, over 200 m from water's edge
6) Flying (all birds seen flying were recorded, whether or not they passed directly over the subunit being counted).

If the same bird was observed subsequently in more than one zone or more than one subunit, only the first observation was recorded. If flying birds landed on water or shore, they were recorded in the subunit and zone in which they landed. These "zones" were chosen in order to make our data comparable with Connors and Risebrough (1978), and also to make it comparable to the 200 m transect width used in the USFWS aerial lagoon surveys (Spindler, pers. comm.). A sample data sheet for shoreline transects is included in the appendix.

Lagoon Surveys - 1980

A series of aerial lagoon surveys was conducted along the entire shoreline of the Arctic National Wildlife Refuge during the summer of 1980 by USFWS personnel (Spindler 1981). In coordination with these aerial surveys, we conducted three surveys of the entire length of Brownlow Lagoon on the dates of 22 July, 5 August, and 21 August 1980. These surveys were conducted in the following manner:

One observer walked the east spit transect, beginning from the gap and walking west towards Brownlow Point, and recording all birds observed both inside and outside the barrier spit in the same manner as described for shoreline transects. (For the 22 July survey, no observer was available to walk the east spit transect, so numbers are extrapolated for this section of the lagoon from east spit counts made on 20 and 24 July.) A second observer walked the barrier island transect, beginning at the gap, and continuing eastward past the end of the transect all the way to the east end of the barrier island. The second observer's observations were supplemented by a third observer, travelling by inflatable raft with 4.5 h.p. motor, in a zig-zag course up the lagoon. The dates of these lagoon surveys did not correspond precisely with the dates of the aerial surveys, as the hazards of small boat travel made it necessary to conduct lagoon surveys only on rare days of calm winds, calm seas, and clear skies. Dates of corresponding aerial surveys were 1-3 August and 20 August.

Habitat Descriptions

In order to formulate accurate descriptions of the shoreline habitats included in the shoreline transects, a qualitative description was made of each subunit of each transect, including slope, aspect, topography, elevation change, substrate description, and estimates of percent vegetation cover by species. In addition, water depth profiles were recorded on a line perpendicular to the shoreline at the center of each subunit. These water depths were measured by a person in hip-boots with a meter-stick, and were recorded for specific intervals up to 50 m from the shoreline, or until the water was deeper than the top of the hip-boots, whichever came first. A 50-meter tape held between the person in the water and a second person on shore, was used to measure the intervals. Samples were also taken of the substrate at various water depths. Three water depth profiles in cross section of Brownlow Lagoon were also taken, by travelling by boat at a uniform speed in a straight line across the lagoon, and measuring water depth with a stick marked in decimeters, at uniform time intervals. Information on offshore water depths was obtained from depth profiles on USGS topographic maps. The habitat information thus obtained is summarized in the following section.

RESULTS AND DISCUSSION

Habitat Descriptions

Some geographical names are names given to geographic features by our study group, not to be found on topographic maps, but identified in Figure III-2. For simplicity in the following descriptions, most plants are named by genus only. For species names, refer to Table III-3.

1. River Transect

The river transect encompassed 3.6 km of shoreline along the east bank of the west branch distributary of the Canning River, from our base camp location to the river mouth in Flaxman Lagoon. This area was included in our shoreline transects due to evidence of tidewater influence.

The river transect can be broadly divided into two distinct habitat regions: the upper 1.4 km of the transect being a low flat river floodplain, and the lower 2.2 km of the transect being characterized by elevated sandy dunes, contained within the narrow peninsula of land labelled on the map as Swan Point.

The river adjacent to the floodplain area was approximately 70 m wide (measured in late July), with the deepest channel being about 60 cm deep and nearest to the far (western) shore. The river adjacent to the transect was quite shallow with a silty bottom, with some gravel areas near the shore. The slope from the river edge was extremely shallow and almost flat. During spring snowmelt much of this area (which grades to the east into the area described elsewhere in this report as the flats) was flooded with standing water. Later in the summer the area dried out, leaving broad expanses of practically barren dried mud, marked by a fine, reticulate pattern of cracks. The vegetation in this area consisted of 50-90% bare ground, with moss, Cochlearia officinalis, Stellaria humifusa, and clumps of Puccinellia phryganodes being the only prominent vegetation. This area was backed by flat areas of dry tundra vegetation where the graminoid cover became more extensive. Portions of this segment of the river transect exhibited fluctuating water levels over wide moist silty mudflats, interspersed with low wet areas of emergent grasses along the river's edge.

The entering of a side channel expanded the river width to 150-200 m in the lower section of the river transect. The deepest channel was adjacent to the transect shore in this section, with the silty bottom sloping steeply to depths of over 70 cm at 5-20 m from shore. The shoreline topography in this section consisted generally of steep eroding mud banks (up to 2 m high) falling directly into the river, with little if any beach area, except in a few silty bays. These steep banks were sometimes vegetated with clumps of grasses, Artemisia (two spp.), Draba spp., Cochlearia, Salix spp. Stellaria spp., Sedum, and traces of other plants from the bluff above. The bluff edge above the river was generally very dry and sparsely vegetated for 5-30 m, with 50-80% of the area being bare ground or lichen. Other vegetation consisted of scattered clumps of grass, Cochlearia, Draba spp., Androsace,

Table III-3. Species list of vascular plants identified on shoreline transects, Canning River Delta. Letters indicate transects on which species were seen: L = lagoon transect; B = bluff transect; A = bay transect; R = river transect; S = Brownlow shoreline, west spit transect.

Alopecurus alpinus	LBAR-	*Parrya nudicaulis*	-B-R-
Androsace chamaejasme	-BAR-	*Pedicularis Kanei*	L?-?-
Arctophila fulva	L--??	*Pedicularis Langsdorffi*	LBAR-
Artemisia arctica	LBARS	*Pedicularis sudetica*	LBAR-
Artemisia borealis	LBAR-	*Pedicularis sp.*	LBAR-
Astragalus umbellatus	-BAR-	*Polemonium boreale*	-BAR-
Cardamine hyperborea	LBA--	*Polygonum viviparum*	LBAR-
Carex subspathacea	LBAR-	*Potentilla pulchella*	LBAR-
Carex spp.	LBAR-	*Primula borealis*	LBAR-
Cerastium Beeringianum	LBAR-	*Puccinellia phryganodes*	LBAR-
Cerastium sp.	L???-	*Ranunculus petadifidus*	-BAR-
Chrysanthemum integrifolium	LBAR-	*Ranunculus pygmaeus*	-B---
Chrysosplenium sp.	L---	*Rumex arcticus*	L---
Cochlearia officinalis	LBARS	*Salix arctica*	LBAR-
Draba spp.	LBAR-	*Salix ovalifolia*	LBARS
Dryas integrifolia	LBAR-	*Salix rotundifolia/ phlebophylla*	LBAR-
Elymus arenarius	L-AR-	*Salix reticulata*	LBAR-
Equisetum sp.	L-AR-	*Salix sp.*	--A--
Erigeron eriocephalus	-B---	*Saussurea angustifolia*	-B---
Eriophorum spp.	LBAR-	*Saxifraga caespitosa*	LBA--
Eutrema Edwardsii	LB-R-	*Saxifraga cernua*	LBAR-
Honckenya peploides	L---S	*Saxifraga hieracifolia*	L---
Lagotis glauca	--A--	*Saxifraga hirculus*	LBAR-
Lloydia serotina	-BAR-	*Saxifraga oppositifolia*	LBAR-
Melandrium apetalum	LBAR-	*Sedum rosea*	LBAR-
Mertensia maritima	----S	*Senecio atropurpureus*	LBAR-
Minuartia arctica	-BAR-	*Senecio resedifolius*	---R-
Minuartia Rossii	-BA--	*Silene acaulis*	LB-R-
Oxytropis borealis	---R-	*Stellaria Edwardsii*	LBARS
Oxytropis campestris	-B---	*Stellaria humifusa*	LBAR-
Oxytropis nigrescens	-BAR-	*Stellaria sp.*	LBAR-
Papaver Macounii(?)	LBAR-	*Taraxacum sp.*	-BAR-

Primula, Potentilla, moss, Salix spp., Artemisia spp., Cerastium spp., Sedum, Dryas, Chrysanthemum, and others.

Beyond the dry bluff crest, the topography consisted of dry upland sandy areas vegetated with a patchy mosaic of Dryas, Salix spp., moss, Oxytropis nigrescens, graminoids, Artemisia, and Sedum, with a large number of other species present in small amounts. Among these were: Stellaria, Androsace, Potentilla, Chrysanthemum, Saxifraga spp., Primula, Draba spp., Minuartia, Ranunculus, Polemonium, Lloydia, Papaver, Cerastium, Polygonum, Pedicularis, Senecio, Parrya, and Astragalus. These higher dry areas were popular ground squirrel habitat. They were interspersed with lower flat areas of moist low center polygon tundra (vegetation 70-80% Carex spp., 5-10% moss, along with Salix spp., Dryas, Saxifraga hirculus, Pedicularis spp., Cerastium spp., Draba spp., Cochlearia, Melandrium, and traces of other species) and also some low flat expanses of dry, barren habitat similar to that already described for the river floodplain area. Isolated sandy dunes and mounds supported stands of Elymus and a host of herbaceous species. A couple of the subunits in this section of the river transect contained small ponds, but in general this area was quite dry with little standing water after spring snowmelt.

2. Bay Transect

The area described as the bay in our shoreline transects was actually a large, shallow, silty inlet of Flaxman Lagoon (see map, Figure III-2). This bay was not more than 50 cm deep but was underlain by a thick layer of soft silt and organic ooze. The bay transect, which totalled 4.1 km in length, can be broadly divided into three distinct habitat areas. The first 1.7 km of the transect, on the western shore of the bay, consisted of dry sandy dune habitat interspersed with low moist areas essentially similar to that already described for the lower section of the river transect. The major difference was that without the erosive action of the river channel, the shoreline of the bay transect contained more extensive silty mudflat areas, along with some thick deposits of organic debris. The next 1.2 km of the bay transect, on the southern shore of the bay, consisted of a very irregular shoreline of flooded low-center polygon ponds surrounded by very moist saline meadow vegetation composed principally of Carex subspathacea and Stellaria humifusa, along with some moss, other graminoids, and Cochlearia officinalis. Farther inland this short saline meadow vegetation gave way to taller wet graminoid meadows and merged with the flats area described elsewhere in this report.

The final 1.2 km of the bay transect, on the eastern shore of the bay, traversed the edge of a low narrow shelf of land containing a string of small rectangular ponds at the base of a bluff sloping up to dry upland tundra. In general the transect itself did not include these ponds, although occasionally their edges were included. The ponds were somewhat elevated from the shoreline transect area, and surrounded by a fairly lush moist tundra vegetation of Carex spp., Salix spp., moss and small amounts of

Stellaria spp., Cerastium spp., Melandrium, Saxifraga hirculus and S. cernua, Polygonum, Pedicularis, Cardamine, Cochlearia, Draba, Papaver, and Senecio. Most of the shoreline area actually included in the transect showed evidence of periodic innundation by saltwater (this was particularly evident after a storm with strong west winds on 29 August 1980); hence, the vegetation was quite sparse and depauperate. At low tide wide expanses of silty mudflat were exposed, covered in places by thick layers of organic debris (the bay appeared to be a collecting basin for organic debris), especially after the 29 August storm. Above the mudflats was a highly eroded moist clay shelf, generally flat, but dissected at intervals by ditches perpendicular to the shore and 30 cm to 1 m in depth. This area was 50-90% bare of vegetation other than lichen, but contained clumps of grasses, Stellaria humifusa, moss, Cochlearia, Draba spp., Salix ovalifolia, Cerastium, Sedum, Artemisia, Primula, and Eriophorum; with Melandrium, Saxifraga hirculus, Polygonum, Dryas, and other Salix spp. on the drier ridges. Piles of large driftwood and other garbage were evident at the high tide line.

3. The Bluff Transect

The division between the bay and the bluff transects, though not obvious from the map, was marked by a distinctive change in habitat. This was where the low flat shelf along the eastern shore of the bay ended, and the bluff behind it swung out to fall directly into Flaxman Lagoon. Thus the bluff transect was characterized by a high dry bluff, rising steeply to 3-4 m in elevation, and extending all the way around to Brownlow Point, where it merged with the dune area along the outer coast. At the foot of this bluff was a narrow (2-15 m wide) rocky beach, with occasional lumps of peat sloughed off from the bluff above.

There was a subtle change of habitat along the bluff transect from south to north, as the bluff at its northern end became more exposed to wave action at its base and wind scouring at its crest. At its southern, or bay end, the bluff was lower in elevation and more gentle in slope, and was well vegetated with a tussock mat of Dryas, Salix rotundifolia/phlebophylla, Saxifraga oppositifolia, moss, Oxytropis nigrescens, O. campestris, Minuartia, and Carex spp., interspersed with bare frost boils and with lesser amounts of Astragalus, other Salix spp., grasses, Silene, Draba, Lloydia, Chrysanthemum, Papaver, Pedicularis spp., other Saxifraga spp. Androsace, and Senecio. Many other species appeared in localized patches in troughs, gullies, or on the bluff face; these can be found in the full species list (Table III-3).

Further north the bluff became higher with a more abrupt face, more deeply dissected by gullies, and with a much more sparse vegetation cover (at least 50% bare ground). Salix spp., Cochlearia, Cerastium, and Potentilla became more prominent, while Minuartia, Dryas, and Oxytropis were less prominent, in the vegetation cover.

Finally, near Brownlow Point, the top of the bluff became dissected in-

to distinct high center polygon mounds separated by ditches 20 cm to 1 m deep draining into gullies that dissected the bluff. Here a sparse cover of Artemisia arctica became the most prominent vegetation, with Salix spp., Carex spp., Cochlearia, Stellaria, moss and a number of other species in lesser quantities.

A vivid exhibition of the rapid modification of shoreline habitats by the forces of nature was provided during a severe storm on August 29, 1980. Strong west winds drove waves that undercut the permafrost of the bluff to a horizontal depth of up to 10 m and exposed the ice wedges between polygons. Thus, when the cohesive forces of ice and soil gave way, huge sections of the bluff cracked off and settled as isolated mounds, to be further eroded by the action of future storms. This process is described by Hopkins and Hartz (1978).

4. Lagoon Shore Transect

The lagoon transect covered 3.2 km of the inner shoreline of Brownlow Lagoon, from Brownlow Point eastward. Brownlow Lagoon itself is relatively narrow (no greater than 800 m wide) and shallow (averaging 1.5 m in depth) with a silty bottom. The portion of the lagoon shore covered by this transect was all relatively low in elevation, nowhere more than 2 m above water level, and with portions showing evidence of periodic flooding. (Eastward towards the mouth of the main branch of the Canning River, portions of the lagoon shore not included in our transect exhibit much higher bluffs.)

The western end of the lagoon transect (near Brownlow Point) exhibited sandy soils, with a corresponding vegetation pattern. The lagoon here was extremely shallow with large expanses of mud and organic debris exposed at low tide. Behind this beach area of variable width was a low, eroded bank ranging from 10 cm to 1 m in height. In places this shoreline was interrupted by small irregular inlets, with sandy mudflats containing Carex subspathacea. Above the bank, the lagoon shore in this section was mostly flat, with sandy clay soil, dissected by shallow polygonal troughs and with relatively sparse vegetation (35-75% bare). Major plant species were grasses and Carex spp., Artemisia arctica, Cochlearia, Stellaria humifusa, S. Edwardsii, S. sp., Cerastium sp., Salix spp., and moss, with small amounts of Dryas, Saxifraga spp., Cardamine, Senecio, Pedicularis, Polygonum, Melandrium, Potentilla, and Primula.

The next 500 m of this transect contained a slightly different habitat, with a higher (2 m) bank dropping steeply into the lagoon, with a peat mat at the top tending to break away and fall in lumps into the lagoon as the bank was eroded from below. The tundra above this bank was a relatively flat, dry meadow dominated by graminoids, with Salix spp., Stellaria spp., Cerastium spp., Melandrium, moss, Saxifraga (4 spp.), Polygonum, Pedicularis, Senecio, Dryas, Draba spp. and Cochlearia.

The next 500 m of the transect returned to a habitat type similar to that previously described for the western end, with a low bank (30 cm - 1 m) and sparse vegetation influenced by saltwater flooding. The final 200 m

of the transect consisted of a small saline meadow area dominated by Carex subspathacea, and with some bare sand, Stellaria humifusa, moss, and Cochlearia. This portion of the transect was completely flooded by the 29 August storm.

5. Barrier Island Transects

The east and west spit and barrier island transects will be described together, as they were similar in morphology, and differed principally in their location relative to the mainland. These barrier islands were of the type described by Hopkins and Hartz (1978) as "construction islands", that is, recent constructional accumulations of sand and gravel affected by ice push in winter and storm surges in summer.

The west spit extended approximately 1.5 km northwest of Brownlow Point; towards Flaxman Island, which continues the barrier island chain to the west. Beyond the tip of west spit, shoals and isolated small island segments exposed at low tide indicated that this formation may extend nearly to Flaxman Island, which is 2 km distant. In fact, the filling of a gap in the west spit in 1979 joined two island segments and extended the accessible area of the west spit considerably. Likewise, the storm tide of 29 August 1980 breached several new gaps in the west spit (one being immediately adjacent to Brownlow Point and thus cutting short our shoreline transect) indicating the dynamic state of flux in the formation and destruction of these barrier islands. The east spit extended 2.5 km southeast of Brownlow Point, at which point a deep pass (which we called the gap) separated it from the barrier island which extended another 8 km towards the mouth of the main branch of the Canning river, where it became dissected by numerous wide shallow channels. Our barrier island transect included only the western 2.5 km of this island.

Because of its apparent importance to bird use of the area, the gap will here be described in more detail: when measured during a late summer high tide, it was 90 m wide and more than 2.5 m deep at its deepest point. (We had not measured it earlier in the summer, but had the subjective impression that it had become deeper due to tidal scouring over the course of the summer). Strong tidal currents were evident during incoming and outgoing tides. The combination of northeast wind and incoming tide would sometimes bring a parade of large icebergs sailing across the lagoon through the gap opening. The tips of the barrier islands on either side of the gap were deflected landward in the typical "bow" shape described by Hopkins and Hartz (1978). The westernmost tip of the barrier island transect also showed evidence of the westward migration described by Hopkins and Hartz, in the form of several remains of bypassed accretionary spits along the lagoon side of the island. Also, in accordance with Hopkins and Hartz' description, this segment of the barrier island was the highest in elevation, as shown dramatically during the storm of 29 August, when it was the only portion of the barrier island not to be totally wave-washed. This slight difference in elevation was not obvious to the casual observer, but apparently

was evident to the birds, as it was the site chosen by Arctic Terns and Common Eiders for nesting. (Another chosen nesting site was at the westernmost tip of west spit, and this area also appeared to be slightly higher in elevation.) Several new gaps also appeared in the east spit and barrier island transects during the storm surge of 29 August 1980, but these appeared to be shallow and temporary.

As for the morphology of the barrier islands, they were generally low (less than 1 m high) and narrow (30-70 m wide, except in the region of accretionary spits or near the junction with Brownlow Point, where they extended as wide as 150 m). They were composed of fine sand and scattered large cobbles (up to 10 cm diameter), with small gravel (1-5 cm diameter) especially on the seaward shore, and large quantities of driftwood and debris. The profile consisted of a long shallow slope on the lagoon side, which continued under the lagoon (with silty substrate) to a maximum depth of 1.5 m. A steeper slope on the seaward side was often marked by gravel ice-thrust ridges and occasional water-filled troughs. This slope continued off shore to a depth of about 70 cm at 10 m from shore, with a fine gravel substrate. The depth was 2 m at 50-200 m from shore, and 6 m at about 800 m from shore (from USGS topographic maps: Flaxman Island A-4&5, 1955). The barrier islands were unvegetated except for one or two isolated clumps of Honckenya peploides. The offshore current was predominantly westward, as described by Hopkins and Hartz (1978).

6. Brownlow Point

The shoreline at Brownlow Point was included in 800 m of the outer west spit transect. The beach itself was similar in composition to that described for the barrier island spit with which it merged to the east and west, and ranged from 20 to 50 m in width. The beach was backed by an area of sandy dunes of elevation up to 2 m, which were 60-80% barren, with scattered patches of grass, Artemisia arctica, Salix ovalifolia, Stellaria sp., Cochlearia, Honckenya, and Mertensia. The beach and dunes were littered with empty oil drums and other garbage from the abandoned DEW-line building and abandoned native dwellings.

7. Ruth and Ruthless Islands

Two shoreline censuses were taken on each of two small islands off the mouth of the west branch Canning River in June and July. The larger of these was named Ruth Island due to the presence of a USGS survey marker labelled "Ruth"; the smaller was named Ruthless Island due to the lack of such a marker.

Ruthless Island was a low dry barren island located across a 100 m channel from the tip of Swan Point, the end of the river transect. Since 1955 USGS topographic maps show this island as connected to Swan Point, it can be presumed that this was once all part of the same peninsula, and only recently has the river channel breached the gap that now separates Ruthless Island from the mainland. This island was low in elevation, about 0.1 km

in area, 50-60% barren, with a sparse vegetation of Stellaria humifusa, grass, Cochlearia, Sedum, and Artemisia.

Ruth Island was a larger island located about 500 m north of Ruthless Island. It included about 0.3 km of land area, with at least an equal amount of mudflat area (exposed at low tide) adjoining to the northeast, as well as small mudflat areas to the west. The southern shore of the island was marked by high sandy dunes, up to 4 m in height, and the northern shore by a steep sandy bluff of equal height. The central area of the island contained one large pond and seven smaller ponds. The vegetation was not inventoried in detail, but was abundant and diverse, appearing to include all species similar to those found on the river transect.

Chronology of Break-up on Shoreline Habitats - 1980

1. River

There was some open water in the river (West Branch Canning) near our base camp site from the time of our arrival, 25 May. By 4 June the river was open for 2.5 km upstream from its mouth, with 50 m wide ice shelves remaining along the shores. By 8 June the river was entirely open, with some shore ice remaining. By 21 June all ice was gone other than a few bergs near the mouth.

2. Bay

The bay was totally ice covered on our arrival 25 May. On 2 June some overflow appeared on the bay. By 10 June the bay was 50% open. On 12 June the south shore was ice free; the east and west shores had 50 m of ice; and there was much ice remaining in the middle of the bay. By 17 June a 200 m strip was ice free. By 1 July the bay was totally clear of ice.

3. Bluff

Ice lingered longer along the bluff transect than in the bay. On 14 June there were a few open leads and overflow. On 17 June there was 50-100 m of ice on shore with a 50 m open lead. On 21 June there was 25 m of ice on shore with 100-150 m open. Patchy ice in the middle of the bay remained until 1 July, but patches of shore ice along the bluff remained until 11 July.

4. Lagoon

On 7 June the lagoon appeared to have much open water (waves were seen on the surface and Oldsquaw were seen swimming) but it is likely that this was just overflow water from the heavy snow-melt run-off occurring that day. Truett (1981) reports that spring meltwater may reach depths up to a meter over the ice of near shore waters; this intense flooding usually lasts less than 2 weeks. On 10 June only 50-100 m of water appeared open on the inner lagoon shore. Ice remained in the center of the lagoon until 24 June, and was not clear from the shore until 28 June.

5. Inner Spits

There was a small strip of open water inside the east spit on 29 May. This widened to 150 m on 10 June, narrowed to 50 m on 14 June, widened to 200 m on 21 June, and all ice was gone from the lagoon on 28 June.

Seventy-five meters of open water appeared by the inner west spit on 14 June; this widened to 100 m by 17 June; and the area was essentially clear of ice by 24 June.

6. Outer Spits

The sea ice was solid upon our arrival 25 May. Shore leads and overflow began to appear near the end of east and west spits on 10 June. 100 m water was open by the gap on 17 June, widening to 200 m by 24 June and 300 m by 28 June. Ice cover was 75-85% along the rest of the spits on 24 June, with with no large leads; and 50% open on 28 June. By 1 July there was a large shore lead of 400-500 m. Subsequently the icebergs moved closer to or further from the shore, depending on the wind, but were always visible within 1 km from shore until 30 August, when the west winds of the 29 August storm had blown them out of sight.

7. Summary

As early as 25 May the river provided the first open water in the area, and was completely ice free by 21 June. The lagoon was ice free by 28 June, and the bay soon followed by 1 July. A major open lead did not appear offshore until 1 July. Ice was forming on the river and bay edge at the time of our departure from the study site, 6 September.

Coastal Surveys - 1979

One of the sites chosen for survey in 1979 was centered on the edge of the West Branch Flats and the bay shore (see Figure III-1). It was flooded with river overflow and meltwater from adjacent tundra in late May and early June, and formed a continuous body of water with the estuary. As water level receded in mid to late June, it became apparent that the area was composed largely of mud flat with pools and salt marsh vegetation (see description of West Branch Flats, Introduction to Part II). Bird use of this area was not analogous to the other three sites, so it has been covered along with the tundra bird census in Part II.

The Flaxman Lagoon count was made in the area corresponding to the 1980 "bluff" transect. Overflow water from the West Branch created pools of fresh water over half the area by 31 May, and opened a small lead in the first week of June. By 10 June ice cover was only 15% in the census area, with an open lead along the shore; however, most of Flaxman Lagoon towards the west was still ice-bound at this time.

The Brownlow Point count was made from the DEW-line site and was located on the seaward side of the barrier beach, corresponding to the 1980 "west spit" transect. No counts were made at this site until 25 June, when a shore lead developed. After this date the ice broke up rapidly, with a

shore lead 50-100 m in width by 29 June, and only scattered ice (10% cover) by 5 July.

The Brownlow Lagoon site corresponded to the "lagoon" transect of 1980. It was opposite the gap in the barrier beach, and thus contained open water fairly early in the season. By 1 June there was a channel of open water by the gap and barrier beach. By 10 June the moat of open water was present but most of the lagoon was still ice-covered, with surface melt pools over 45% of the ice. Ice cover was 95% on 15 June but reduced to 60% on 20 June and only 5% on 25 June.

Table III-4 shows dates of census for each of these three sites and indicates the seasonal division of counts used in analysis. Seasonal abundance of selected species are presented in Figure III-3. These were the most important species in this habitat; others were recorded infrequently. The sampling method was not adequate to cover small birds along the shoreline, so these have been eliminated from the analysis. All loons have been lumped since species were sometimes indistinguishable. Although all flying birds were recorded, the data presented here include only those flying birds judged subjectively (by behavior) to be "using" the area. Because the data obtained from the 1979 coastal survey was judged inadequate for the information desired, additional personnel in 1980 made possible the replacement of this sampling method by the more intensive shoreline transects and lagoon surveys described elsewhere in this report.

Shoreline Nesting Birds

Certain arctic bird species use shoreline habitats almost exclusively for nesting purposes. The actual numbers of nesting birds found on our transects was small; however, given the fact that some of these birds do not nest elsewhere on the coastal tundra, the critical nature of environmental impacts to shoreline habitats can easily be seen for these species.

1. Whistling Swan

Swans do not nest exclusively in coastal shoreline areas, but two nests were found within the area of our shoreline transects. One nest was located approximately 200 m from the tip of Swan Point on the river transect, on a mound between two small ponds. This nest contained three eggs but was depredated before hatching, presumably by a red fox seen in the area. The second nest was located within 10 m of the bluff edge of the lagoon transect, in that section of the transect characterized by a high (2 m) bluff and mesic graminoid meadow, about 2 km east of Brownlow Point. This nest contained three eggs; initiation date was estimated as 9 June and hatching date as 10 July. Maximum incubation time for this nest would have been 30 days, which is low compared to values reported elsewhere. Two swans with three cygnets were observed on a large lake inland from the nest site on 18 July. Swans are sensitive to human disturbance; they will defend their nests against non-human predators but would flush from their nest when a human observer approached within 200 m, and would not return for a long time

Table III-4. Dates of coastal surveys, Canning River Delta, 1979. Dashed lines indicate grouping of dates into the six periods used to present the data in Figure III-3.

Date	Flaxman Lagoon	Brownlow Point	Brownlow Lagoon
31 May	x	-	-
1 June	-	-	x
5 June	x	-	x
10 June	x	-	x
15 June	x	-	x
20 June	x	-	x
25 June	x	x	x
29 June	x	x	-
30 June	-	-	x
5 July	x	-	x
10 July	x	x	x
15 July	x	x	x
21 July	x	x	-
28 July	x	x	x
2 August	-	x	x
5 August	x	x	x
8 August	x	x	x
9 August	-	x	-
11 August	x	x	x
14 August	x	x	x
16 August	x	x	x
17 August	-	x	-
18 August	-	x	-
19 August	-	x	x
20 August	x	x	-
21 August	-	x	-
24 August	-	x	x
25 August	x	x	x
26 August	-	x	-
27 August	-	x	-
28 August	-	x	-
29 August	x	x	x
30 August	-	x	-
31 August	-	x	-

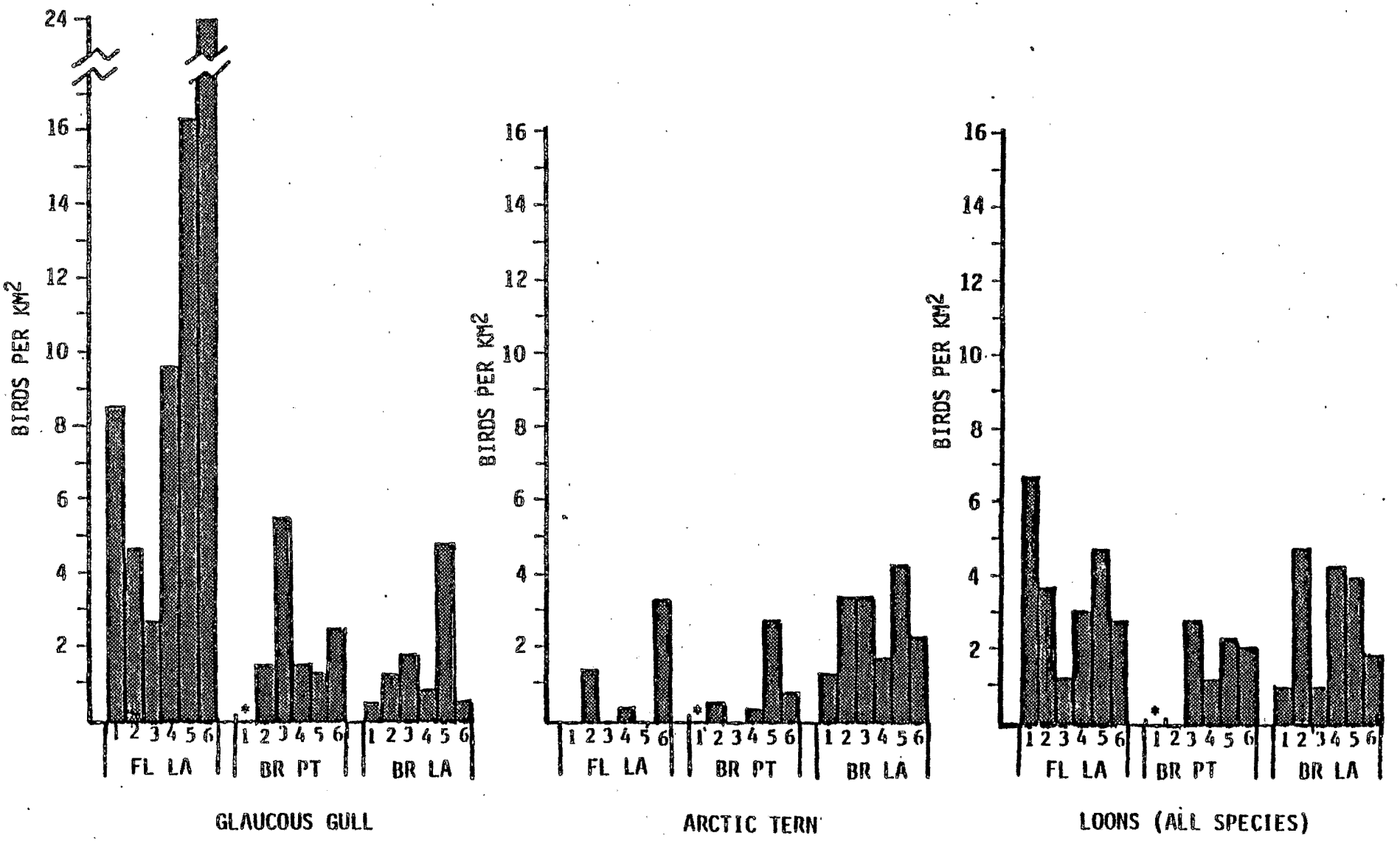


Figure III-3. Densities of some birds seen on coastal surveys, Canning River Delta, 1979. The months June-August have been divided into six periods, roughly two weeks each, and mean densities (birds per square kilometer) for all counts within a period are shown in bar graphs. Numbers under each bar refer to period and Table III-4 gives count dates for each period. The three sites are: Flaxman Lagoon (FL LA), Brownlow Point (BR PT), and Brownlow Lagoon (BR LA). Brownlow Lagoon was not censused in period 1 because it was still completely frozen: the asterisk (*) distinguishes this case from that of zero density. (Continued on next page.)

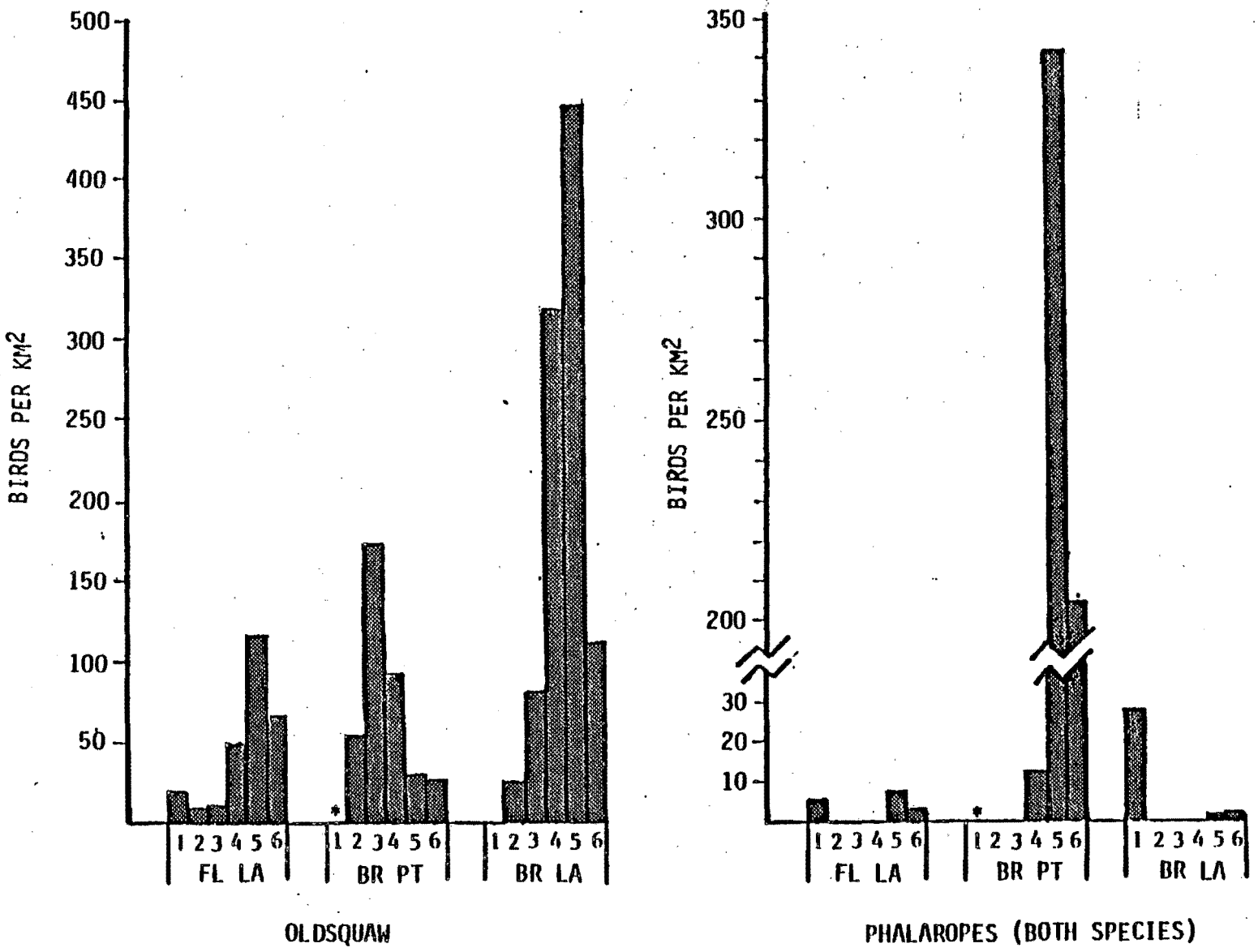


Figure III-3. Densities of some birds seen on coastal surveys, Canning River Delta, 1979. See preceding page for explanation.

afterward, leaving their large visible eggs vulnerable to other predators.

2. Canada Goose

Two pairs of Canada Geese with three and five young respectively were seen swimming near the north shore of Ruth Island on 17 July. The exact locations of their nests were unknown.

3. Pintail

Pintails are secretive nesters, and only two nests were found within our entire 1980 study area, both of which were subsequently depredated. One of these nests was located on a shoreline transect, hidden in a grass clump on a dune just above the beach at Brownlow Point. The grass nest was lined with down and contained eight eggs.

4. Oldsquaw

Oldsquaw nest near inland tundra lakes and ponds, as well as in coastal shoreline areas. Out of eight Oldsquaw nests discovered in our study area in 1980, three were on shoreline transects. The only successful Oldsquaw nest we observed was one of the tundra nests.

One shoreline Oldsquaw nest was located on the river transect in an area of 50% Carex cover on the river floodplain section of the transect. This nest contained two eggs but was depredated at the same time as the swan nest. Two Oldsquaw nests were located on the barrier island, within 500 m of the gap, in the same area as the Arctic Tern colony. These nests contained four and five eggs respectively, but were abandoned in late July, presumably due to the effects of the unseasonable period of cold, wet windy weather in this month.

5. Common Eider

The Common Eider nested only in coastal shoreline areas, generally on barrier islands. The nests were shallow depressions in the sand or driftwood, lined with down.

Eleven active Common Eider nests were discovered in the study area in 1980, all on offshore islands, of which six were within the shoreline transect areas. A number of unused nest scrapes were also observed, and several non-nesting females were often seen resting on shore near the females with nests. Three Common Eider nests were located at the western end of the west spit transect, on a promontory which became a separate island at high tide. (This was also the location of a Glaucous Gull nest and an Arctic Tern nest.) Three Common Eider nests were located at the western tip of the barrier island transect, all within 100 m of the gap, in the same area as the Arctic Tern colony. Four more nests were found at the eastern end of the barrier island during the lagoon surveys. A final nest was found on the southwest side of Ruth Island, in a grassy area on the shore below the dune.

Out of seven nests in which the number of eggs was known, clutch size ranged from 3 to 7 with a mean of 4.4 eggs. Nest initiation times ranged

from around 16 June to 2 July. All nests were either hatched or abandoned by 28 July. Two nests contained evidence of successful hatching with nine out of eleven chicks surviving (two chicks found dead at nests). One successful nest was on Ruth Island and one was by the gap. Of the other nine nests, at least three were abandoned, four were depredated, and the fate of the other two was unknown. One of the apparently successful nests was unusual in that it contained three normal sized eggs and two small eggs, approximately the size of Oldsquaw eggs. One of the smaller eggs did not hatch, but apparently the other one did. The Common Eider brood observed near Ruth Island on 17 July was the only brood observed. Female Common Eiders did not flush easily from their nests, but when they did, they took a long time to return, leaving their eggs vulnerable to predators.

6. Ruddy Turnstone

The river floodplain section of the river transect was the favored nesting habitat for Ruddy Turnstones. Of eight nests observed in our study area in 1980, five were within the river transect itself. Of the other three nests, one was on the dry river bluff south of our base camp, one was on the dry frost-boil bluff east of the flats, and the third was on a dry bank near the lagoon transect.

Seven of the nests contained four eggs, and four of these had estimated initiation times between 11 and 16 June, and known hatching dates between 3 and 8 July. One nest initiated 30 June contained only three eggs, and was probably a renesting attempt. It hatched successfully on 21 July. Two nests were depredated before hatching, and the fate of one nest was unknown.

Subsequent to hatching, adult Ruddy Turnstones were observed on the river and bay transects and in the flats area with fledglings, but no more than one or two fledglings per pair. A low fledgling survival rate was suspected due to the exceptionally cold wet July and lack of emerging insect food. Several downy chicks were found dead in or near nests soon after hatching.

Ruddy Turnstones generally chose dry, flat, open, exposed areas for their nest sites (50-90% unvegetated bare gound or lichen within 1 m diameter of all but one nest we found). Turnstones were correspondingly aggressive in defending their nest sites: they flushed at some distance and relied on their bright colors, loud call, and active display to lure potential predators away. Turnstones were observed to actively chase Jaegers from their nest areas.

7. Baird's Sandpiper

The Baird's Sandpiper was another shorebird nesting on dry river bluff and shoreline areas rather than on the open tundra, but in contrast to the Ruddy Turnstone, Baird's Sandpipers nested on bluff sites that were more thickly vegetated (only 1-30% bare ground or lichen within 1 m diameter of all nests we found), offering more concealment for the nest. This difference in nest site selection corresponded with a difference in nest

defense behavior. The Baird's Sandpiper relied more on camouflage and concealment, not flushing from the nest until almost stepped on, and then often slinking quietly away to wait for the disturber to leave.

All Baird's Sandpiper nests discovered in the study area in 1980 were located on the dry bluff east of the flats area and east of the bay transect, continuing as the bluff transect to Brownlow Point. Four nests were discovered, but others were suspected in this area. Known and estimated initiation dates were between 21 and 27 June. Three nests contained four eggs and one contained three eggs. One nest was known to have hatched successfully on 16 July; the fate of the other three was unclear. Since Baird's Sandpipers nested and hatched later than most other shorebirds, their chicks were not exposed to the worst of the summer's cold weather in July, so fledging success may have been greater.

8. Glaucous Gull

Glaucous Gulls nested on tundra lakeshores and on islands within lakes as well as on coastal shoreline habitats, in our study area. Glaucous Gull nests were large constructions of roots, driftwood, and debris, and were defended vigorously by the parents.

One Glaucous Gull nest was found on the small semi-island at the tip of west spit, near three of the Common Eider nests. Nest initiation was estimated at 13 June; one egg hatched on 11 July but the chick was never seen and the other two eggs did not hatch, although the adult gulls continued to defend the nest site. A Glaucous Gull nest on the shore of the largest pond on Ruth Island contained two eggs, one of which had just hatched on 17 July. Other Glaucous Gull nests were located along the barrier island east of our transects, especially at the easternmost tip. A total of 11 Glaucous Gull chicks were seen during the 22 July lagoon survey.

9. Arctic Tern

Arctic Terns nested in colonies on barrier islands, but also nested singly on barrier islands, at inland lake sites, and on Canning River gravel bars. In our study area we found a small colony of at least eight pairs nesting on a barrier island site, one single pair nesting on the small island at the tip of west spit, and one single pair nesting on an island in the flats area. The flats and west spit pairs both successfully raised a single chick to fledging. These pairs appeared to have nested sooner than the birds in the colony (estimated nest initiation dates between 11 and 20 June), judging by the large size of their chicks observed when some of the colony birds were just hatching their eggs.

The Arctic Tern colony was located on the western end of the barrier island transect, within 500 m of the gap. As mentioned elsewhere, this portion of the barrier island was slightly more elevated, providing some protection from storm surges, and was also the location of three Common Eider, two Oldsquaw, and one Black Guillemot nests. Besides its higher elevation, this location may have been a favored nesting site due to its

proximity to the gap in the barrier islands, which was suspected to be an optimal feeding site because of the flushing action of tidal currents bringing sediments from the lagoon. During shoreline transects, the largest concentrations of Oldsquaw were nearly always observed in and adjacent to the gap area. When the tide was flowing out of the gap, a distinct band of sediment-laden water could sometimes be seen extending westward from the gap adjacent to the outer east spit. It appeared that this area of lagoon "outwash" was a preferred feeding area for Oldsquaw during the outgoing tide. Because of these observations we suggest that tips of barrier islands, especially western tips, should be given particular study in terms of nesting habitat, and that the importance of passes between barrier islands is a subject in need of further study. The Arctic Tern colony was not visited until 17 July due to lack of boat access. At this time it was determined that there were at least eight breeding pairs in the colony (by number of adults and number of nests and chicks observed). At this time four eggs, seven dead chicks, and four live chicks were found. Three of the four eggs subsequently hatched, but a total of only three chicks (out of a potential 15) survived to fledging. Most chicks died soon after hatching, and the cold, wet, windy weather during July was suspected as the cause. Apparently Arctic Terns fared poorly throughout the Beaufort Region during the summer of 1980 (George Divoky, pers. comm.). These Arctic Terns and their fledged young were last seen in the vicinity of the colony on 17 August.

10. Black Guillemot

Black Guillemots are not a traditional nesting species on the Beaufort Sea, but their range has expanded westward from Canada in recent years due to man's influence in providing nest sites in the form of empty oil drums. One Black Guillemot nest was found in an empty oil drum deeply buried in the sand of the barrier island transect, 400 m from the gap, in the same general area as the Arctic Tern colony. Two eggs were discovered on 8 July, which hatched on 28 July. The nest was buried in sand by the storm tide of 29 August but the young were probably adequately fledged to have survived. At least six other adult Black Guillemots were frequently seen in the area with the nesting pair, but apparently they did not find suitable nesting habitat.

11. Snow Bunting

Snow Buntings may nest in a variety of habitats, but in our study area they nested only in coastal shoreline areas. Under natural conditions they will choose nest sites in driftwood piles, but at Brownlow their favored sites were in the buildings and garbage abandoned by former human inhabitants. Because the nests were usually in concealed cracks and crevices, not much data can be given. Three nests were discovered in 1980 in empty oil drums and buildings at Brownlow Point and one was discovered in driftwood debris on the east shore of the bay transect, but many more nests were suspected in these areas. Parents were observed feeding chicks in

nests between 28 June and 21 July; fledged chicks were observed outside nests between 11 and 26 July. Two nests were observed to contain a single dead chick after the other chicks had fledged.

Lagoon Surveys

Three surveys of the entire length of Brownlow Lagoon were made on 22 July, 5 August, and 21 August, 1980. The results of these surveys are presented in Table III-5. Temperature was warm, skies were clear, wind was slight, barometric pressure was high, and visibility was excellent on all of these days.

Several interesting results appeared from these three surveys. Numbers of Loons and Glaucous Gulls did not change significantly over the summer. Numbers of Eiders dropped significantly after the first survey; by 5 August most female Common Eiders had either hatched their eggs or abandoned their nests, and were no longer seen in the area. Numbers of other ducks and shorebirds were larger during the final survey, due mainly to the presence of Red-breasted Mergansers and Sanderlings. The Arctic Terns of the barrier island colony had departed by 21 August, the final survey. The timing of Oldsquaw molt is evident from the number of Oldsquaw seen flying during each of the three surveys: the middle survey (5 August) was during the peak of their molt.

By far the most numerous species observed on these surveys were Oldsquaw and Phalaropes, and some interesting patterns appear in their use of shoreline habitats. The graphs in Figure III-4 illustrate these relationships. Oldsquaw numbers doubled between the first and second survey, but then remained at a similar level in the third survey. On the first survey Oldsquaw were found more or less evenly divided between inside barrier island and outside barrier island habitats, but on the second survey they were predominantly inside the barrier island, while on the third survey they were predominantly outside the barrier island. Perhaps this can be explained by the fact that on the second survey the Oldsquaw were in the middle of their molt, and hence seeking the protection of the lagoon, while by the third survey Oldsquaw had begun their fall westward movement (see migration section), and flying flocks tended to stop outside the barrier island to rest and feed.

However, it is interesting to note that the shoreline use by Phalaropes exhibited the same pattern: predominantly on the inner shore of the barrier island on the second survey, and 100% on the outer shore on the third survey. Connors and Risebrough (1978) reported a correlation between wind direction and Phalarope use of the leeward side of barrier islands at Barrow Spit in some years but not in others. Johnson and Richardson (1981) reported that on calm days or days of less than average wind speeds (from offshore directions), well over half of all feeding Phalaropes were present along the seaward side of barrier island beaches at Simpson Lagoon; but on days of greater than average wind speeds, only 23% of feeding Phalaropes were found on the exposed seaward beaches. Their results for barrier island

Table III-5. Summary of Brownlow Lagoon survey data, 1980.

TOTAL BIRDS ON SHORE AND WATER

	INSIDE EAST SPIT			INSIDE BAR. ISL.			INSIDE TOTAL			OUTSIDE EAST SPIT			OUTSIDE BAR. ISL.			OUTSIDE TOTAL			IN & OUT TOTAL		
	*	+	#	*	+	#	*	+	#	*	+	#	*	+	#	*	+	#	*	+	#
Loons[1]	0/5	4	0	8	7	8	8/13	11	8	2/0	4	2	12	5	12	14/12	9	14	22/25	20	22
Geese[2]	0	0	0	3	0	0	3	0	0	0	0	0	0	1	0	0	1	0	3	1	0
Oldsquaw	38/105	497	51	130	263	189	168/235	760	240	135/57	68	41	196	190	777	331/253	258	818	499/488	1018	1058
Eiders[3]	0	0	0	2	4	0	2	4	0	0/7	0	0	14	1	0	14/21	1	0	16/23	5	0
other ducks[4]	0	2	0	0	0	0	0	2	0	0	0	17	7	0	0	7	0	17	7	2	17
shorebirds[5]	0	1	2	0	3	4	0	4	6	0	0	8	0	3	24	0	3	32	0	7	38
Phalaropes[6]	0	196	0	13	52	0	13	248	0	0	0	23	0	63	94	0	63	127	13	311	127
Glaucous Gull	0	1	0	14	5	10	14	6	10	0	0	0	1	2	2	1	2	2	15	8	12
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	1	3	0	1	3	0
Black Guillemot	0	0	0	1	3	0	1	3	0	0	0	0	5	2	0	5	2	0	6	5	0

TOTAL BIRDS FLYING

	INSIDE EAST SPIT			INSIDE BAR. ISL.			INSIDE TOTAL			OUTSIDE EAST SPIT			OUTSIDE BAR. ISL.			OUTSIDE TOTAL			IN & OUT TOTAL		
	*	+	#	*	+	#	*	+	#	*	+	#	*	+	#	*	+	#	*	+	#
Loons[1]	3/1	0	7	5	11	16	8/5	11	23	2/1	4	0	6	4	9	8/7	8	9	16/12	19	32
Oldsquaw	138/39	0	1	0	1	3	138/39	1	4	42/7	0	2	14	0	16	56/21	0	18	194/60	1	22
Eiders[3]	6/0	0	0	1	0	0	7/1	0	0	7/0	2	4	24	1	0	31/24	3	4	38/25	3	4
other ducks[4]	15/1	0	1	3	0	0	18/4	0	1	0/3	0	1	0	0	0	0/3	0	1	18/7	0	2
shorebirds[5]	0	0	5	0	8	3	0	8	8	0	0	18	15	0	6	15	0	24	15	8	32
Phalaropes[6]	0/8	0	1	0	7	15	0/8	7	16	0	8	18	0	25	45	0	33	63	0/8	40	79
Jaegers[7]	1/0	0	0	2	0	0	3/2	0	0	0	0	0	4	1	1	4	1	1	7/6	1	1
Glaucous Gull	3/9	2	1	12	11	2	15/21	13	3	2/6	0	1	16	8	7	18/22	8	8	33/43	21	11
Sabines Gull	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	2	0	1	0
Arctic Tern	1/0	1	0	0	14	0	1/0	15	0	4/1	2	0	10	7	2	14/11	9	0	15/11	24	2
Black Guillemot	0	0	0	0	0	0	0	0	0	0/1	0	0	0	1	0	0/1	1	0	0/1	1	0

1) Arctic, Red-throated, and Yellow-billed
2) Snow Goose, Canada Goose, and Brant
3) most are Common Eider females
4) American Wigeon, Greater Scaup, Pintail, Red-breasted Merganser, White-winged Scoter, and unidentified
5) Sanderling, Dunlin, Ruddy Turnstone, Red Knot, Pectoral Sandpiper, Semipalmated Sandpiper, Golden Plover, Long-billed Dowitcher, and unidentified
6) most are Northern; some Red
7) Parasitic, Pomarine, and Long-tailed

* Census date 7/22/80: where two figures are given, the first includes East Spit census of 7/20/80 and second includes East Spit census of 7/24/80 (see text)
\+ Census date 8/5/80
\# Census date 8/21/80

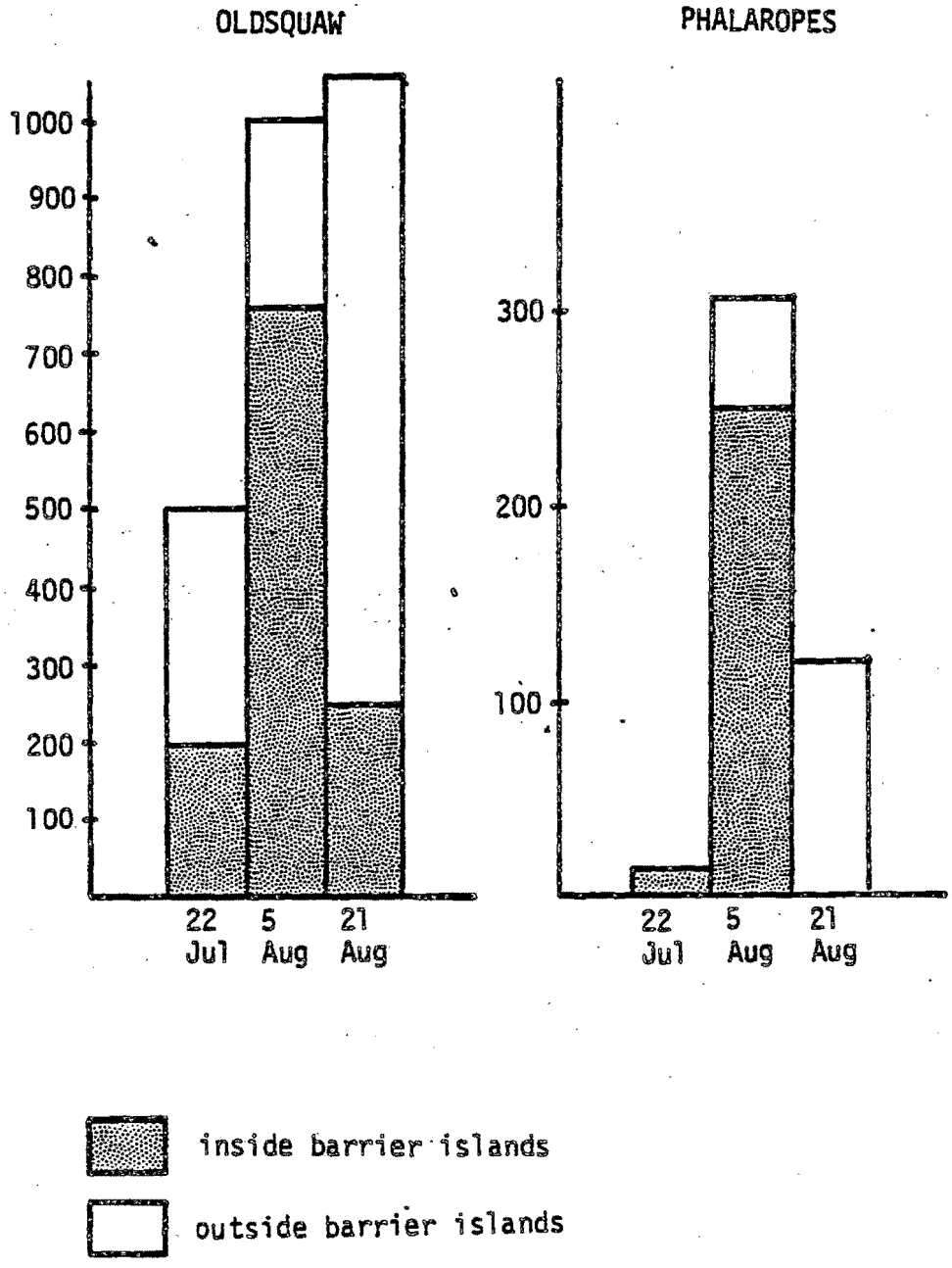


Figure III-4. Oldsquaw and Phalarope numbers from lagoon surveys, Canning River Delta, 1980.

use by all shorebirds also indicate a significant preference for oceanside beaches, regardless of wind speed or direction.

Our data from the 5 August lagoon survey do not fit the Johnson wind hypothesis. Since this was a day of relative calm, the expected pattern of use according to Johnson's prediction would have been a greater percentage of phalaropes feeding on the outer shore of the barrier islands, which is contrary to what we found. Since both wind conditions and tidal stage were virtually identical for our 5 August and 21 August lagoon surveys, some other explanation must be found for the difference in Phalarope distribution. The logical assumption in this case is a difference in food availability, so it would be extremely interesting to study in more detail the seasonal pattern of food availability in the coastal system, and its influence by current, tidal and weather patterns. For example, we noticed that after the strong west winds of 29 August, shorebirds (mostly Sanderling) were feeding primarily on the inner shore of the barrier islands, where previously they had been observed more on the outer shore. It appeared that the west winds had stirred up the lagoon and left large deposits of bottom material (presumably including invertebrate food items) on the inner shore of the barrier islands. However, the lagoon survey of 5 August was not preceded by a strong west wind, so this question remains unanswered. The major problem in interpreting these data is small sample size. It is impossible to say whether the observed variations are the result of daily or seasonal changes, or whether they represent localized or general phenomena. Clearly it would be necessary to conduct daily surveys in order to fully answer these questions, but even if unlimited time and manpower were available, such a study would be unfeasible because of the limitations of weather and visibility on boat travel (not to mention the harassment to the birds afforded by such intensive sampling). With surveys limited to optimal weather conditions, the information gained must necessarily be fragmentary. Our shoreline census with 4-day sampling interval did provide a more detailed picture of temporal changes in shoreline use as discussed in that section of this report; however, in that case the sample size limitation was one of spatial distance covered more than of temporal frequency of sampling. For example, if fewer Oldsquaw were observed on one day than the next, it could not be determined whether they had simply moved to another part of the lagoon, or left the area entirely. It is clear that some thought should be given to designing future studies that can shed more light on these questions.

River Islands (Ruth and Ruthless)

Our surveys of these two islands on 23 June and 17 July, 1980, indicated that an assortment of shorebirds, passerines, and waterfowl comparable to the river and bay transects used the areas. In addition there was evidence of nesting Common Eiders, Glaucous Gulls, and Canada Geese on Ruth Island, which are discussed in the section on nesting birds. On 17 July, eighteen Canada Geese and three Brant were observed resting near

the two pairs of Canada Geese with broods, and fourteen Pintail were observed feeding in shallow water above mudflats near Ruth Island.

The extensive mudflats adjacent to Ruth Island were heavily used by migrating shorebirds later in the summer; however, we did not have boat access at this time to determine numbers and species. Large flocks of Glaucous Gulls also congregated on these mudflats in late summer. Bird use of islands and mudflats at river mouths is an area in need of further study.

Shoreline Transects

Twenty-three series of shoreline censuses were conducted on the ten transects previously described, at 4-day intervals throughout the summer of 1980. Table III-6 presents a list of all bird species ever recorded on these shoreline transects, with a tabulation of presence or absence by census period. (A census period, designated by a vertical row of circles on Table III-6, included one census for each transect on the dates indicated in each horizontal row in Table III-2.) Note that this table does not indicate relative abundance of the various species, but simply whether they were observed or not observed on each date.

Some species, such as Loons, Oldsquaw, Pintail, Glaucous Gull, Arctic Tern, Parasitic Jaeger, Lapland Longspur, and Snow Bunting were seen nearly constantly throughout the summer. Others, such as Eiders, Ruddy Turnstone, Golden Plover, and Baird's and Semipalmated Sandpipers, disappeared only at summer's end. Some birds, such as the Scoters, Geese, Black-bellied Plover, Sanderling, and other shorebird species appeared only during specific migration periods. Others such as Phalaropes, Dunlin, Pectoral Sandpiper, Long-tailed Jaeger, and Sabine's Gull, appeared sporadically throughout the summer, being seen principally during migration but also at other times.

Figure III-5 gives a graphic representation of general trends for all shoreline transects combined throughout the summer. This graph includes only birds seen on the shore or water, not flying birds. A few general statements can be made concerning this graph:

1) The shoreline use by waterfowl at Canning Delta is dominated by Oldsquaw. Other waterfowl are present in large numbers only during spring, fall, and midsummer migrations.
2) Shoreline use by both Oldsquaw and shorebirds shows a sudden dramatic increase in midsummer (late July), with numbers doubling or tripling. This time period corresponds to onset of molt in Oldsquaw, and to termination of nesting and beginning of migration by most shorebirds.
3) Passerine use of shorelines also increases during the same late summer period, after fledging of young.
4) Shorebird use declines steadily during August, with another surge in early September when the Sanderling migration occurs.
5) Oldsquaw use of shoreline habitats remains high through early September.

One facet of this graph cannot be readily explained from the data ob-

Table III-6. Presence/absence of bird species on shoreline transects by date, Canning River Delta, 1980.

	June	July	August	Sept.
Yellow-billed Loon	○	○	○	○
Arctic Loon	●	●	●	●
Red-throated Loon	○	●	●	●
(unidentified loon)	●	○	●	●
Whistling Swan	○	○	○	○
Canada Goose	●	○	○	○
Brant	○	●	○	●
White-fronted Goose	●	○	○	○
Snow Goose	○	○	○	○
(unidentified goose)	○	○	○	○
Mallard	○	○	○	○
Gadwall	○	○	○	○
Pintail	●	●	●	●
Green-winged Teal	○	○	○	○
Shoveler	○	○	○	○
American Wigeon	○	○	○	○
Greater Scaup	○	○	○	○
Oldsquaw	●	●	●	●
Common Eider	○	●	○	○
King Eider	○	●	○	○
(unidentified eider)	○	●	○	○
White-winged Scoter	○	○	○	○
Surf Scoter	○	○	○	○
Black Scoter	○	○	○	○
(unidentified scoter)	○	○	○	○
Red-breasted Merganser	○	●	○	●
(unidentified duck)	●	○	○	○
(unidentified waterfowl)	○	○	○	○
Gyrfalcon	○	○	○	○
Peregrine Falcon	○	○	○	○
Rock Ptarmigan	○	○	○	○
Willow Ptarmigan	○	○	○	○
(unidentified ptarmigan)	○	○	○	○
Golden Plover	○	○	○	○
Black-bellied Plover	○	○	●	●
Ruddy Turnstone	○	●	●	○
Pectoral Sandpiper	○	○	○	●
Red Knot	○	○	○	○
White-rumped Sandpiper	○	○	○	○
Baird's Sandpiper	○	●	●	○
Dunlin	●	○	○	●
Long-billed Dowitcher	○	○	○	○
Stilt Sandpiper	○	○	○	○
Western Sandpiper	○	○	○	○
Semipalmated Sandpiper	●	○	●	○
(Baird's/Semi/W-r Sandpiper)	○	○	○	○
Buff-breasted Sandpiper	○	●	○	○
Bar-tailed Godwit	○	○	○	○
Sanderling	○	○	○	●
Red Phalarope	○	●	●	●
Northern Phalarope	○	●	●	●
(unidentified phalarope)	○	●	○	●
(unid. small shorebird)	●	○	●	○
(unid. medium shorebird)	○	○	○	○
(unid. large shorebird)	○	○	○	○
Pomarine Jaeger	○	○	○	○
Parasitic Jaeger	○	○	○	○
Long-tailed Jaeger	○	○	○	○
(unidentified jaeger)	○	○	○	○
Glaucous Gull	●	●	●	●
Sabine's Gull	○	○	○	○
Black-legged Kittiwake	○	○	○	●
Arctic Tern	●	●	●	○
Black Guillemot	○	○	●	○
Snowy Owl	○	○	○	○
Short-eared Owl	○	○	○	○
Common Raven	○	○	○	●
Empidonax sp.	○	○	○	○
Redpoll	○	○	○	○
White-throated Sparrow	○	○	○	○
Lapland Longspur	●	●	●	●
Snow Bunting	●	●	●	●

○=species not observed ◐=species observed flying only ●=species observed on shore or water only
●=species observed both on shore or water AND flying

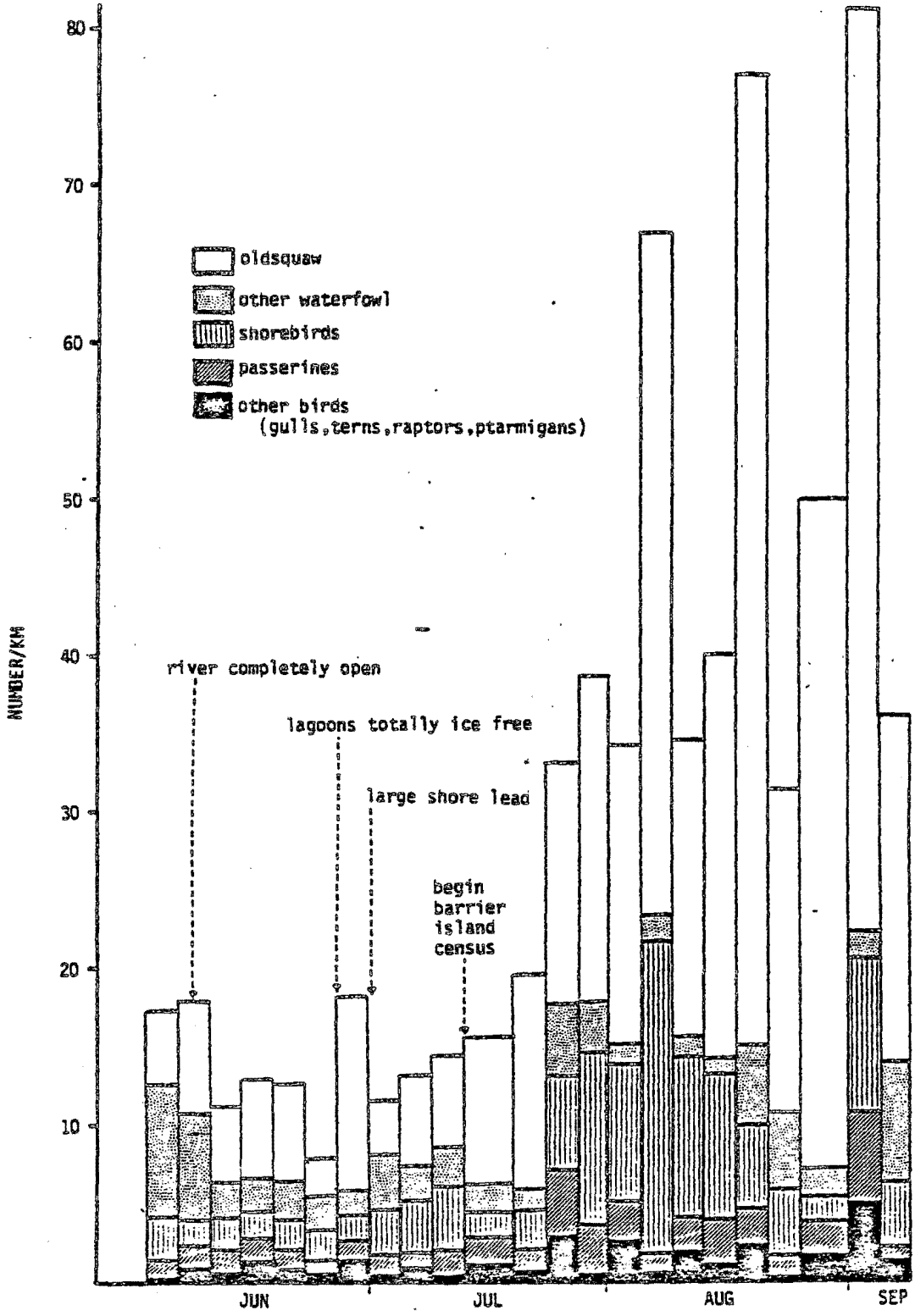


Figure III-5. Total bird use of shorelines, Canning River Delta, 1980.

tained in our study. This is the apparent tri-modal peak of Oldsquaw numbers. The first of these peaks corresponds to the height of the Oldsquaw molt period, which occurred during the first two weeks of August. One might then hypothesize that following their molt, these birds moved westward down the coast and were replaced by two successive waves of Oldsquaw moving in from other areas and building to high numbers before moving on. In fact, the third Oldsquaw peak on the graph corresponds to a peak day of fall migration, and the middle peak might be presumed to be an influx of non-breeding females or failed nesters. However, comparison with the lagoon survey data (Figure III-4) reveals a possibly different story. The 5 August (second) lagoon survey on Figure III-4 corresponds to the second shoreline transect for August (the first Oldsquaw peak) on Figure III-5. The 41 August (third) lagoon survey on Figure III-2 corresponds to the sixth shoreline transect for August on Figure III-5. While the shoreline transect for 21 August showed Oldsquaw numbers to be quite low compared to 5 August, the lagoon surveys for the same dates showed Oldsquaw numbers for all of Brownlow Lagoon to be relatively constant. Thus, it is possible that the valleys in Oldsquaw numbers represented by the August shoreline transects in Figure III-5 simply indicate movement of the Oldsquaw to the eastern end of the lagoon, where they would not be counted on shoreline transects. Three major factors could influence Oldsquaw movements in lagoons: diel movements, seasonal (migration) movements, and weather-related movements.

This difficulty in interpretation clearly illustrates the need for more detailed and extensive study of Oldsquaw use of coastal lagoon systems, their immigration and emigration rates, and timing of movement between lagoons. Such information can only be obtained by an extensive study using marked birds, but the difficulties involved in such a study have already been discovered (Levison, pers. comm.), and it appears that a successful study of this nature would require a team of workers involved primarily with marking birds, as well as a series of observers stationed at various sites in various lagoon systems along the coast. The hazards and difficulties of long-distance boat travel in this area make such a project impossible to accomplish by a single researcher based in one location.

Figure III-6 breaks down the information from Figure III-5 into birds/km for each individual transect. For location of these transects, refer to the map, Figure III-2. Since the ten transects correspond to distinct divisions in geographical location and to more or less distinct differences in habitat type, these graphs help to illustrate the differences in shoreline habitat use by birds throughout the summer. For simplicity the birds have been lumped into two categories on these graphs: "waterfowl" which (as was seen on Figure III-5) are predominated by Oldsquaw, and "other birds" which are primarily shorebirds. The following general trends appear from the graphs in Figure III-6:

1) Except during specific peaks of migration, shorebirds were seen more on the four mainland shore transects (the top four on the page) than on the spit and barrier island transects. With a few

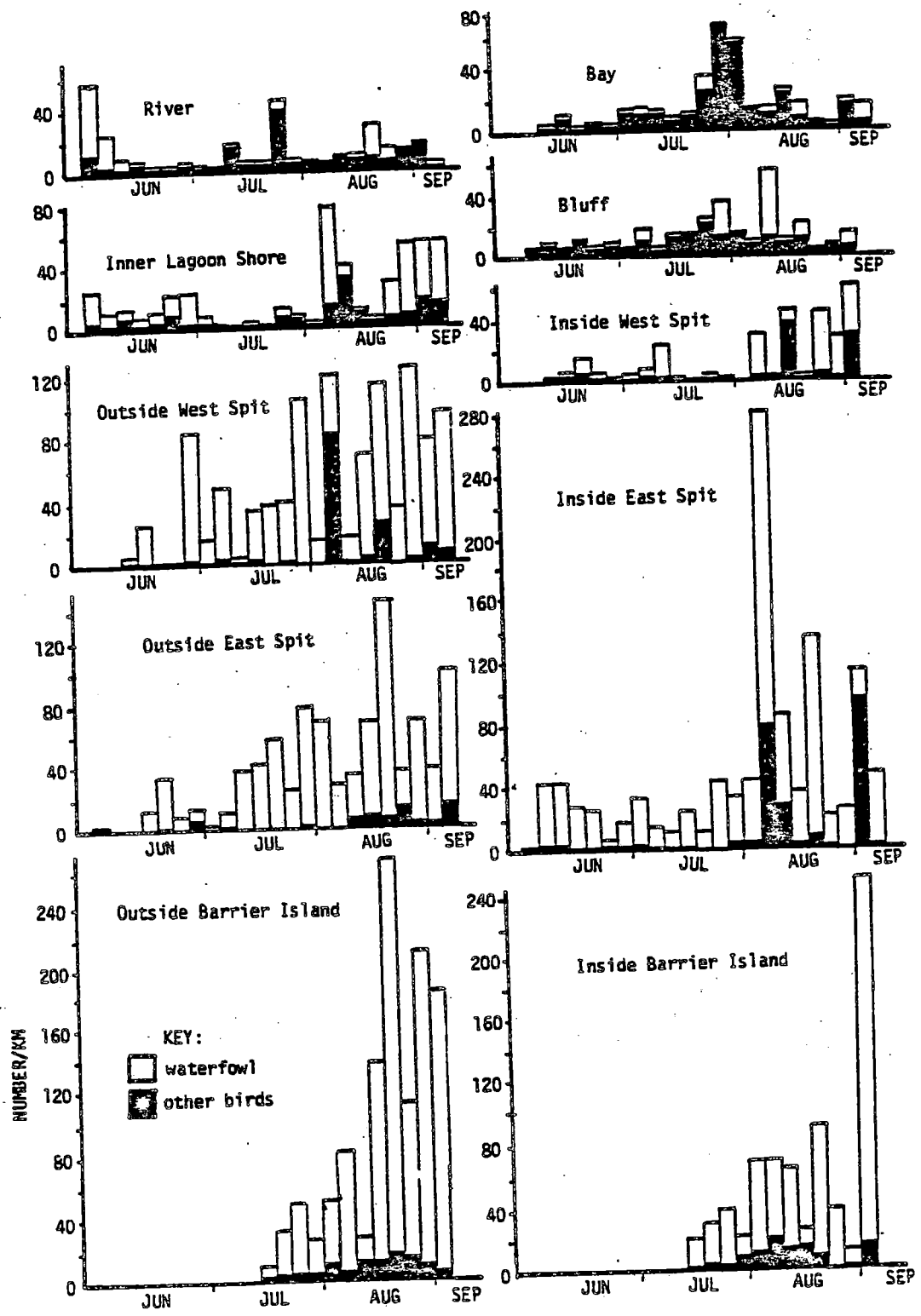


Figure III-6. Bird use of shoreline habitats by transect, Canning River Delta, 1980.

exceptions, waterfowl were seen more on the spit and barrier island transects.

2) The river transect received heavy use by waterfowl early in the spring, when it provided the only open water. Flocks of Brant, Pintail, Wigeon, and King Eider were seen feeding and staging in this area. The lack of snow accumulation on the higher windswept "dunes" section of the river transect made this area important to shorebirds in early spring, as it was the first tundra habitat to be snow-free. Subsequent use of the river transect was low. The peak of "other birds" in mid-July corresponds to shorebird use of the mudflats at the river mouth.
3) The lagoon transect shows relatively little bird use, especially in July. Waterfowl were seen infrequently on this transect until late August and September, when migrating Brant used the saline meadow areas to stage and feed, and Oldsquaw sometimes sheltered from west winds in the lee of the shore bluffs. The "other bird" peak in mid-August corresponds to Phalarope migration. In general, the use of the lagoon transect by birds was similar to that of the bay transect, but use was less extensive due to the lesser amount of saline meadow habitat on this transect.
4) The bay transect received little use by waterfowl (although the adjacent ponds of the flats area sometimes received heavy use). The saline meadow area at the head of the bay received heavy use by staging and feeding shorebirds (such as Phalaropes, Pectoral Sandpipers, and Semipalmated Sandpipers) and Lapland Longspurs, especially in mid-July. Use was low during spring migration, as this area was largely still ice-covered.
5) The bluff transect was little used except by Lapland Longspurs, Snow Buntings, Baird's Sandpipers, and Ptarmigan. Occasionally flocks of waterfowl adjacent to the west spit were counted in this transect. However, one interesting facet of the bluff transect was its deep west-facing gullies which provided shelter from the prevailing east winds. These gullies were found to be havens for the occasional accidental Passerine blown off-course during migration. Our sightings included an Empidonax Flycatcher, a White-throated Sparrow, Rusty Blackbird, Yellow Warbler, and Tree Sparrow.
6) The inner west spit transect received sporadic use by birds. The "other bird" peak in August corresponds to Phalarope migration, and in September to Sanderling migration.
7) The inner east spit transect shows the same peaks of Phalarope and Sanderling migration. Oldsquaw numbers appear to fluctuate widely in August, according to the movements of the birds.
8) The two barrier island transects show less dramatic peaks of shorebird use during migration than do the spit transects.
9) In general, the three outer shore transects (lower three graphs on

left) show more use by waterfowl (especially Oldsquaw) than do the transects on inner shores of barrier islands (lower three graphs on right). Brownlow Lagoon and the eastern end of Flaxman Lagoon are quite shallow and probably are less preferred feeding areas for Oldsquaw, although the protection they provided was preferred for resting and molting periods.

10) Another interesting twist of the Phalarope question introduced in the discussion of lagoon surveys appears in these graphs. On 5 August (second shoreline transect for August) when the majority of Phalaropes were seen on the inside of the east spit and barrier island shores, Phalaropes were seen almost exclusively on the outside of the west spit transect. No explanation is offered at this time.

In general we believe our methods and timing for shoreline transects were adequate and appropriate for the type of information desired. Confining our study to areas easily accessible by foot made possible a systematic and frequent collection of data without undue interference from the vicissitudes of arctic weather. However, having here established areas and times of heaviest use by birds, it would be most appropriate to continue this study with more extensive and intensive sampling in those places and at those times to gain a more complete picture of habitat use patterns. Oldsquaw are by far the most abundant bird in shoreline habitats of this study area, but many gaps still remain in our knowledge of this species. Studies of Oldsquaw are probably more appropriately conducted by use of boats to cover an entire lagoon in one survey, rather than from shoreline transects.

PART IV. MIGRATION STUDIES

METHODS

An intensive migration watch was conducted in 1980 for a 10-day period in the spring (30 May to 8 June) and for a 20-day period in the fall (18 August to 6 September). Between these dates, migration data was obtained incidental to shoreline transects, by recording observations of flying birds (species, sex, number, direction, time) seen while walking the transects. Spring migration watch was conducted from the base camp site; fall migration watch was conducted from the abandoned DEW-line site at Brownlow Point (reasons for this choice elaborated in discussion) (see map, Figure III-1, for sites).

During the spring migration watch, ten random 1/2 hr count periods were chosen during each 24 hr day (midnight to midnight). These ten random count periods were supplemented by intensive (continuous) observation during hours of peak migration on 5 June. During the fall migration varying numbers of 1/2 hr count periods were selected opportunistically on each day that an observer was available to go to Brownlow Point. The number of 1/2 hr count periods of observation each day ranged from 0 to 14, averaging about 5 per day, with most intensive observation on the peak migration date of 1 September. No observations were made during hours of darkness.

Migration watches were generally conducted by a single observer, scanning 360 with 10x binoculars approximately once every two minutes, and using a spotting scope when necessary for identification. When necessary, two observers sometimes conducted watches during hours of peak migration. At the start of each 1/2 hr count period, pertinent weather and visibility data were recorded. Each observation of migrating birds was recorded by species, sex, number, direction, flight altitude, and position relative to the shoreline (offshore, over land, or over the shoreline). Any bird flying across an imaginary N-S line passing through the observer was counted. A sample data sheet and coding form is included in the appendix.

RESULTS AND DISCUSSION

A composite picture of migration in 1980 for five major species on the Canning Delta is given in Figure IV-1. Data for this graph were obtained from the three sources mentioned in the description of methods. For the spring and fall migration watch periods, an average birds/hr figure was calculated based on all count periods for that day. For the intervening summer period, birds/hr were calculated from birds seen flying while conducting shoreline transects, by dividing the total number of flying birds seen by the length of time spent on the transect (usually about two hours). Since different species of birds were more likely to be seen on different transects, averages were calculated only from those transects on which a particular species was seen. On certain days (notably 28 July, the peak Eider

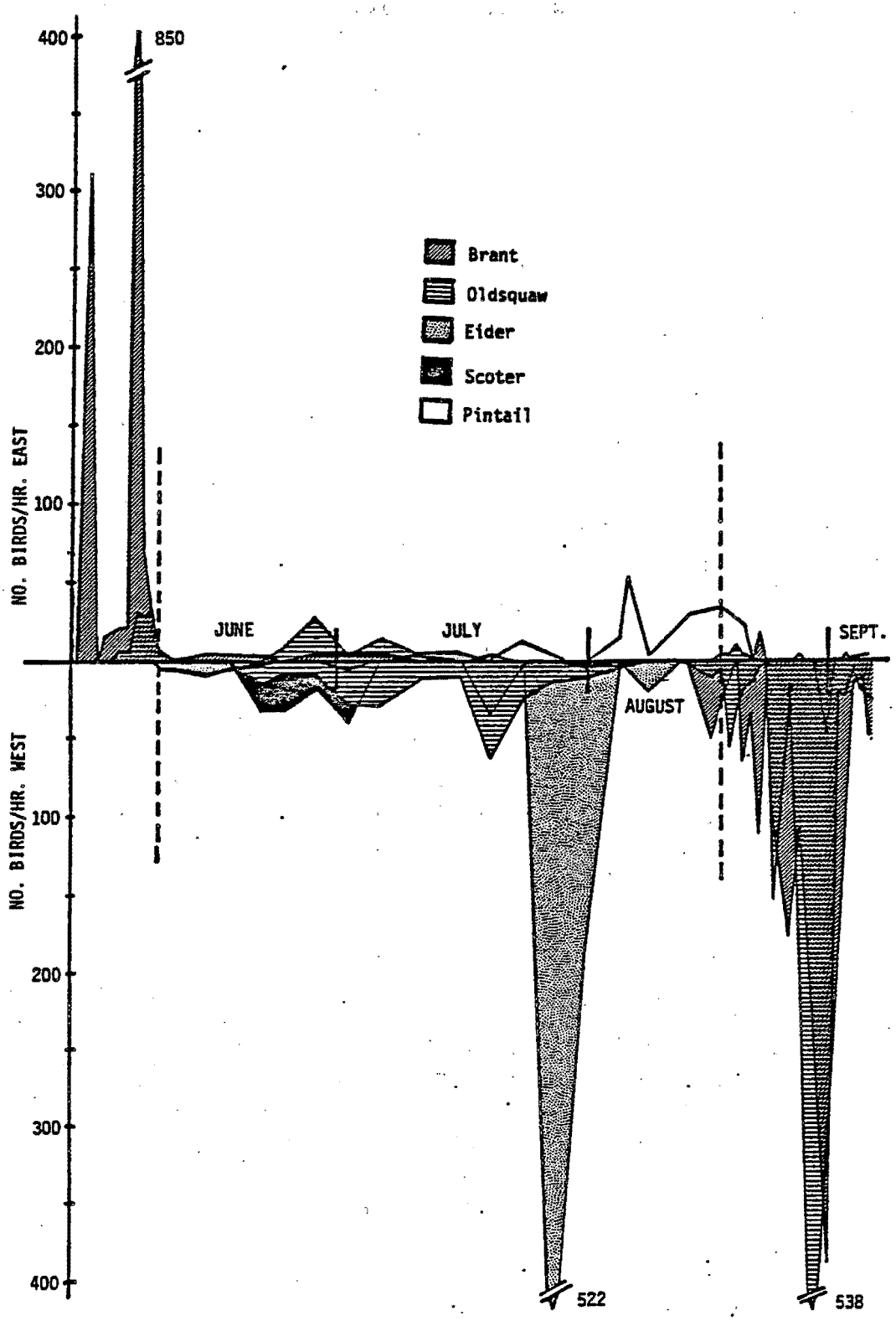


Figure IV-1. Migration movements of five major species, Canning River Delta, 1980.

Table IV-1. Summary of migration data, Canning River Delta, 1980.

SPECIES	FLIGHT DIRECTION (TIME)	MAJOR MIGRATION DATES	PEAK MIGRATION DAYS AND #s/HR a	NUMBER SEEN b	ESTIMATE OF TOTAL c	COMMENTS
Brant	east (spring)	29 May-8 June	30 May:310/hr 5 June:850/hr	10,864E 15W	26,000	80% of migration on 2 days with west winds. Flight paths and altitude highly variable so estimate probably low. Many flocks flying inland up W. Branch Canning R.
Brant	west (fall)	17 Aug-mid Sept?	1 Sept:390/hr 10 Sept: ?	98E 5,926W	35,000	Steady increase in numbers to 1 Sept, only day with east winds. Flocks flying very low, most along inner lagoon shore.
Oldsquaw	east (spring)	2 June-8 June	5 June:30/hr	542E 19W	2,000	Major movement may have been offshore.
Oldsquaw	west (mid-summer)	21 June-27 July	20 July:60/hr	—	—	(data from shoreline transects)
Oldsquaw	west (fall)	17 Aug-mid Sept?	30 Aug:540/hr 1 Sept:320/hr 10 Sept: ?	108E 4,938W	32,000	Steady increase in numbers to 30 Aug. Most movement offshore.
Eiders	east? (spring)	—	—	14E 4W	—	Almost none observed, suspect major movement offshore.
Eiders	west (mid-summer)	26 July-1 Aug	28 July:520/hr	—	—	90% male Common Eiders, flying low along barrier islands and offshore. (data from shoreline transects)
Eiders	west (fall)	—	1 Sept:45/hr	7E 355W	—	Females.
Loons	east (spring)	3 June-7 June	5 June:4/hr	80E 3W	300	Probably offshore.
Loons	west (fall)	22 Aug-mid Sept?	1 Sept:150/hr	11E 1,278W	5,700	Mostly flying in small loose flocks, high and offshore.
Pintail	east? (spring)	5 June-6 June	6 June:9/hr (E)	109E 23W	200	Directional movement not clear. (unexpected direction)
Pintail	east (mid-summer & fall)	24 July-21 Aug	6 Aug:50/hr	—	—	Flying med. high, mostly overland. (data from shoreline transects and migration watch)
Scoters	west (mid-summer)	21 June-2 July	2 July:40/hr	—	—	Flying med. high, most offshore. (data from shoreline transects)
Red-breasted Merganser	? (fall)	28 Aug-mid Sept?	1 Sept:18/hr (W)	82E 147W	—	Directional movement not clear.
White-fronted Goose	east (fall)	—	29 Aug:—	—	—	Flying overland.
Jaegers	east (spring)	29 May-8 June	5 June:13/hr	404E 78W	1,500	85% Pomarine, flying high, probably more offshore. After 6 June, net movement was west, approximately one fifth of total.
Jaegers	west (fall)	1 Sept-mid Sept?	1 Sept:18/hr	1E 218W	1,000	Flying high, offshore, most unidentified.
Arctic Tern	west (fall)	mid Aug-mid Sept?	1 Sept:40/hr	3E 340W	1,400	Offshore.
Black-legged Kittiwake	west (fall)	1,2,3 Aug	—	4E 470W	2,000	After a storm with strong west winds.

a. Mean numbers per hour on peak migration date.
b. Migration watch data only
c. Estimate of total birds flying over observation post during migration watch period:
mean birds/hr x 24 (net movement)

migration day) shoreline transect data were supplemented with additional migration watch periods to give a more accurate estimate. No confidence intervals are given for the figures represented by this graph. It seems that statistical calculation of confidence intervals would be invalid for the types of data collected in most migration watches, due to the non-independent movement of birds migrating in flocks. Hence, more attention should be given to the qualitative aspects of these data than to their quantitative aspects; we feel these data are quite reasonable in demonstrating timing and relative magnitude of migrational movements, but calculations of total number of birds passing over Canning Delta should be interpreted with some caution. In some cases sampling was inadequate to give great confidence in their accuracy. However, estimates of numbers for some species are presented in Table IV-1. These estimates are derived from spring and fall migration watch data by multiplying the average birds/hr figure mentioned above by 24 hrs. (On peak migration days the hours of peak migration were separated into a separate stratum, for more accurate estimation). No estimates of total numbers were made from shoreline transect data, as sample size was deemed insufficient. For fall migration the assumption was made that migration activity would be similar in hours of darkness as in hours of daylight, but we cannot give supporting evidence for this assumption. Figure IV-1 and Table IV-1 summarize the migration data obtained at Canning Delta in 1980.

Spring migration was largely confined to two days (30 May and 5 June), and in fact was largely contained within just a few hours out of those two days (Figure IV-1). The spring period was marked by nearly constant strong winds from the east or northeast, and since most of the birds were flying east, their movement was limited to those few hours of calm or of west winds. Migration movement did not appear to be correlated with time of day: when the wind was favorable, the birds flew, no matter what the time of day. Most migrating birds seen during the spring watch were Brant; presumably other birds such as Eiders and Oldsquaw were moving farther offshore where we could not see them.

The summer migration data obtained from shoreline transects reveals a westward migration of Scoters in late June and early July; a gradual westward movement of Oldsquaw throughout July; a major peak of westward Eider movement in late July; and an eastward movement of Pintails in late July and the first half of August. Johnson and Richardson (1981) reported a peak of westward Oldsquaw movement in early July, which does not appear in our data. Otherwise, the timing of our Oldsquaw molt migration corresponds with their data for 1977 and 1978 for Simpson Lagoon. The Scoter migration we observed in 1980 included mostly Surf Scoters; one flock of 50 Black Scoters was observed; and there were scattered sightings of White-winged Scoters, but without any clear directional movement. Johnson and Richardson (1981) reported no observation of Scoter migration in 1977, and reported a westward migration of mainly Surf Scoters with a few White-winged Scoters in 1978, at a time slightly later (early to mid-July) than our observed Scoter

migration (mid-June to early July). Perhaps timing of Scoter migration varies between years, or perhaps Scoters take a considerable time to move between Canning Delta and Simpson Lagoon. Andersson (1973) observed flocks of 50 to 100 male Surf Scoters passing over Nuvagapak Point during the last days of June in 1970; most had left this area by 2 July.

We observed a major westward movement of Eiders on the 28 July shoreline transect when only male Common Eiders were observed, with a lesser movement on 1 August when about 30% male King Eiders and 70% male Common Eiders were observed. No Eider movement was observed on the shoreline transects four days preceding and following these dates. The total extent and percent composition of Eider migration cannot be accurately assessed, lacking data on the intervening days. However, the predominance of male Common Eiders is not in accordance with observations by Johnson at Barrow (1971) who observed 95% King Eiders during midsummer molt migration, nor with Quinlan and Lehnhausen (pers. comm.) who also observed a majority of male King Eiders during midsummer molt migration past Icy Cape in 1980. Johnson and Richardson (1981), however, reported King:Common Eider ratios of 42%:58% or 62%:38% (depending on their interpretation of their data) for westward Eider migration observed 26 June through 31 July over Simpson Lagoon in 1977 and 1978. The reason for this apparent reversal of King:Common Eider ratios on an east-west gradient during their westward molt migration is as yet unclear.

The eastward migration of Pintails in August occurred mainly over land; and was observed mainly from the river and bay transects, as the Pintails used the flats as a feeding and staging area. In late August flocks were also sometimes observed resting on the lagoon shore of the barrier island. Flocks of Scoters and Oldsquaw were also seen stopping to rest in the lagoon and offshore during their westward molt migration, but the Eiders were not seen to stop.

The fall migration period was also marked by nearly constant unfavorable winds (this time from the west), but despite the adverse conditions, migration of Oldsquaw and Brant was more spread out over time than in the spring, as indicated by the graph in Figure IV-1. A major peak of movement occurred with a favorable east wind on 1 September; our graph is incomplete because another major peak of movement apparently occurred on 10 September, the day after our departure from our study site (Spindler, pers. comm.). During the 1 September migration watches, large numbers of Arctic Terns and Black-legged Kittiwakes (as well as two Common Murres and a Horned Puffin) were seen flying westward: presumably they were blown off course by the strong west winds of the 29 August storm.

Migrating Oldsquaw flocks frequently stopped to rest in Brownlow Lagoon or just outside the barrier islands, and numbers sometimes built up to over 2000 while waiting for a favorable wind (such as on 30 August). Migrating Brant frequently stopped to feed and rest in saline meadow areas and adjacent tundra on the lagoon and bay shores. Oldsquaw flocks were generally seen migrating offshore while Brant flocks flew low along the inner shore of

the lagoon. An incidental note on Figure IV-1 is that it clearly shows the peak of Oldsquaw molt to be the first two weeks of August, when virtually no Oldsquaw were seen flying.

An additional note should be added concerning migration of White-fronted Geese. Large numbers were seen flying overland to the east on 29 August, but an impending storm prevented us from obtaining any quantitative migration data. Spindler (pers. comm.) has observed flocks of 30-200 White-fronted Geese migrating eastward in late August and early September in 1978, 1979, and 1980.

Few direct observations were made of shorebird migration (that is, of flying flocks), because migrating shorebirds generally tended to move in a leapfrog fashion along shorelines, with frequent stops for feeding. Thus, migrating shorebirds were more often recorded in the shoreline transects on shore rather than flying, and were discussed in the previous section of this report.

Some interesting and valuable information can be obtained by means of migration watches, although its value may be questioned in light of the intensive sampling effort required and the difficulty of statistical analysis of the data obtained. Realistic estimates of numbers can only be obtained in a few favorable locations where topography funnels the birds through a narrow area (such as Eider Pass, Pt. Barrow), and even then estimates are clouded by problems of sampling design (unless a constant watch can be kept) and variability in visibility. At most locations, such as at Canning Delta, migration routes may be spread out over a wide area, or may change over time. For example, we found Brownlow Point to be an excellent location for observing fall migration of Brant. The Brant generally flew in large flocks very low along the inner shore of the lagoon, and hence passed directly over Brownlow Point. However, this location did not prove adequate for observing spring migration of Brant. During spring migration the Brant were spread over a wide area and flew at a variety of altitudes, but it seemed that the majority were following the coastline and turned inward up the west branch of the Canning River (see map, Figure IV-2), perhaps because of the open water available. From there they passed overland to the east; hence we discovered our base camp location to be better suited to observing spring migration of Brant, although it did not permit us to observe any birds moving along the outer coast.

Such difficulties notwithstanding, a continuation of effort by North Slope bird researchers to document migrational movement may eventually supply some of the missing information that would explain migration routes and patterns more accurately.

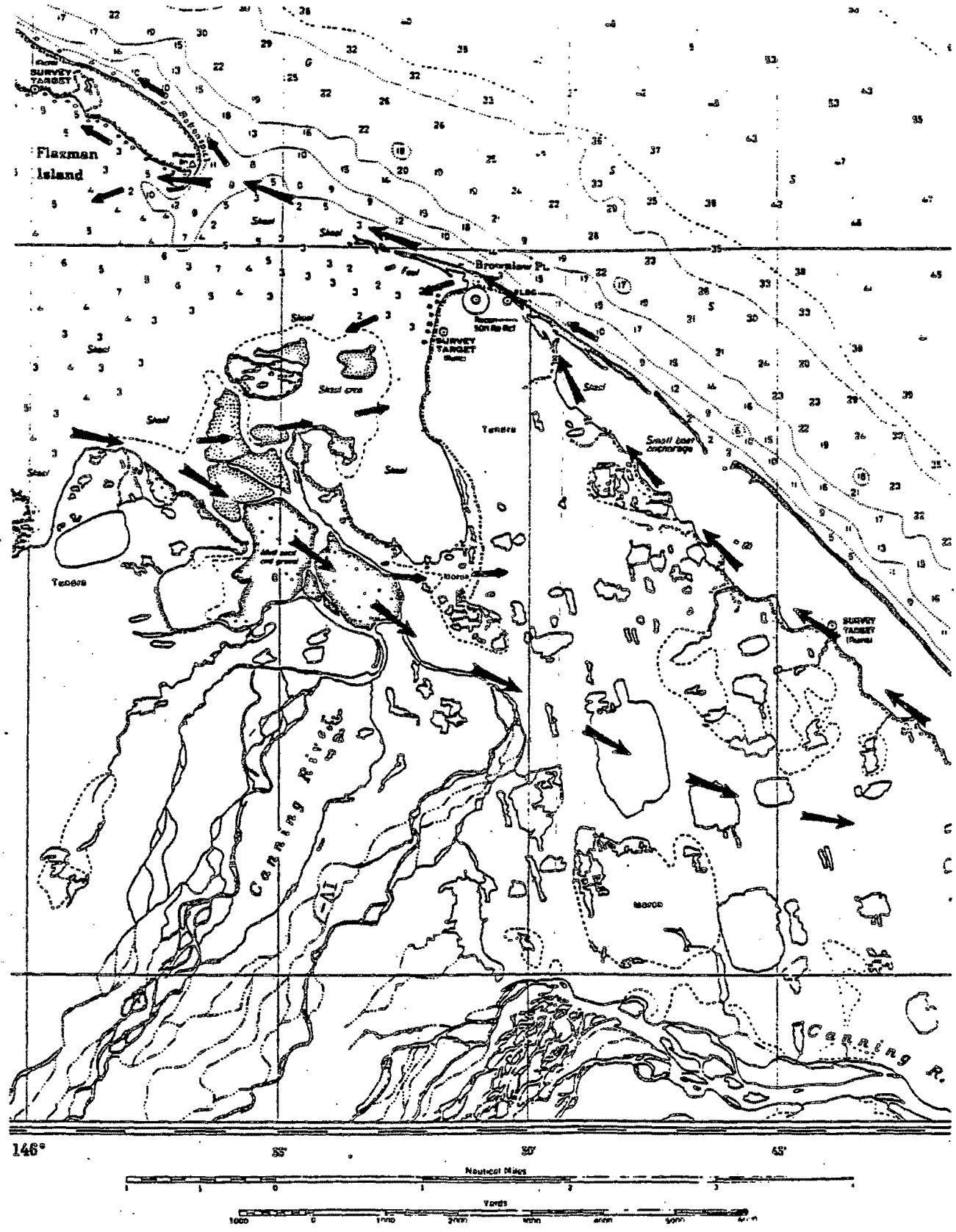


Figure IV-2. Map of Brant migration routes along Canning Delta shoreline. Arrows show routes of spring migration (east) and fall migration (west).

PART V. SPECIES ACCOUNTS

INTRODUCTION

The following species accounts are based on the collective field notes of all field personnel involved in the Canning River Delta study 1979-1980. The accounts summarize available information pertaining to status, habitat use, chronology of breeding, and migration activities on the Canning River Delta.

Accounts are arranged in taxonomic order (after Gibson 1977) and are divided into sections for easy reference. "Regional Status and Distribution" summarizes published (and some unpublished) information on the status of the species in the region adjoining Canning River Delta. The "region" is defined loosely although in general we refer to the Arctic Slope of Alaska and the Yukon. This section is intended to put bird observations at Canning River Delta in the context of our knowledge of bird distribution in northern Alaska, not as an exhaustive compilation of all references in the literature. "CRD Status" briefly categorizes the status and abundance of the species at the Canning River Delta study area. Terminology for these categories follows Kessel and Gibson (1978) and their definitions are listed below.

Abundant - species occurs repeatedly in proper habitats, with available habitat heavily utilized, and/or the region regularly hosts great numbers of species.

Common - species occurs in all or nearly all proper habitats, but some areas of presumed suitable habitat are occupied sparsely or not at all, and/or the region regularly hosts large numbers of the species.

Fairly common - species occurs in only some of the proper habitat, and large areas of presumed suitable habitat are occupied sparsely or not at all and/or the region regularly hosts substantial numbers of the species.

Uncommon - species occurs regularly, but utilizes little of the suitable habitat, and/or the region regularly hosts relatively small numbers of the species; not observed regularly even in proper habitats.

Rare - species within its normal range, occurring regularly but in very small numbers. "Very" rare is used for a species which occurs more or less regularly, but not every year, and usually in very small numbers.

Casual - a species beyond its normal range, but not so far but what irregular observations are likely over a period of years; usually occurs in very small numbers.

Accidental - a species so far from its normal range that further observations are unlikely; usually occurs singly.

Resident - a species present throughout the year.

Migrant - a seasonal transient between wintering and breeding ranges; in spring, includes species that have overshot their normal breeding range.

Breeder - a species known to breed; prefixed by "possible" or "probable" if concrete breeding evidence is unavailable.

Visitant - a nonbreeding species; also, in fall, a species not directly en route between breeding and wintering ranges.

Obviously, status designations (particularly of the less common species) based on only two seasons of field work must be considered tentative.

For the less common species, all information is summarized in a single section entitled "General". Accounts for species for which we gathered more detailed information are divided into a number of sections (titles self-explanatory) on migration and breeding.

Abbreviations used throughout the text are:

ACP -- Arctic Coastal Plain
ANWR -- Arctic National Wildlife Refuge
CRD — Canning River Delta
NPR-A -- National Petroleum Reserve, Alaska.

YELLOW-BILLED LOON

Regional Status and Distribution --This species does not seem to be common anywhere on the ACP. Breeding has been recorded in interior ACP sites in NPR-A (Derksen et al. 1979), near Franklin Bluffs and in the Ribdon Valley in the Sagavanirktok River drainage (Sage 1971), in the Lake Schrader area (Bee 1958) and in the Killik Valley (Irving 1960).

Non-breeding birds appear on coastal lagoons in ANWR in late July. Schmidt (1973) and Martin (unpublished) recorded single birds at Beaufort Lagoon in 1970, 1974, and 1976. R.M. Burgess (pers. comm.) saw up to seven at Demarcation Point 9-22 July 1979 and one or two birds were recorded there 10 July, 1 August, and 2 August 1979 (D. M. Troy, pers. comm.). Isolated summer records exist for the Brooks Range as well: one or two birds were seen on Eagle Lake in the Canning River valley in 1972 on 22 July, 18 August and 25 August (Valkenburg et al. unpublished), one was seen at Timber Lake in the Junjik River valley 10 July 1975 (B. Kessel, unpublished), and this species was seen repeatedly at Anaktuvuk Pass (Irving 1960). Salter et al. (1980) reported eastward migration along the Yukon Beaufort Sea coast in late May and early June and westward migration 10 July - 17 September, and Johnson et al. (1981) reported small numbers migrating past Simpson Lagoon in early June.

CRD Status --One was observed 5 June 1979 traveling east and flocks of nine and eleven birds were seen traveling east 19 June 1979 and 20 June 1979, respectively. No comparable movement was noted in 1980.

Summer --Yellow-billed Loons were seen regularly but were never common in mid-summer and late summer. In 1979 we recorded one to four birds on four dates in late June and one to three individuals on five dates each in July and August. In 1980 we did not see this species until 24 July. One to three birds were seen on seven dates in July and August and five were seen flying southeast over camp 19 August 1980. Only one record was from tundra wetland habitat, all other sightings were on the lagoon, in the sea off Brownlow Point, or in the air over the study area.

ARCTIC LOON

Regional Status and Distribution --Widespread and common over all portions of the ACP from NPR-A (Derksen et al. 1979) to the Yukon territory (Salter et al. 1978). Abundance relative to that of the Red-throated Loon varies from site to site. In ANWR, Brooks (1915) and Dixon (1943) reported this species to be the more common at Demarcation Point as did Spindler (1978a) at the Okpilak River Delta. Andersson (1973) and Schmidt (1973) reported Red-throated Loons to be the more common species in the Beaufort Lagoon area. Many authors (Andersson 1973; Bergman and Derksen 1977) discuss a habitat difference between the two species; Arctics use larger ponds than Red-throats and the relative density of large and small ponds may account for local differences in relative abundance.

CRD Status --Common breeder and migrant.

Spring Migration —Arrival dates reported from the eastern Beaufort Sea range from 31 May 1975 in the Yukon (Salter et al. 1980), 3 June 1915 at Demarcation Bay (Brooks 1915), 7 June 1979 at Demarcation Point (R. M. Burgess pers. comm.), 7 June 1978 at Okpilak River Delta (Spindler 1978a), 7-12 June 1971-1973 at Storkersen Point (Bergman and Derksen 1977). Date of first observation at CRD was 3 June in both 1978 and 1979. During the first week of June, tundra lakes and ponds may not be available, and loons are reliant on overflow water at river mouths. Groups of six and 17 were seen 4-5 June 1979 in open water at West Branch Flats and around 20 were seen landing at the mouth of the West Branch 4 June 1980. Very few loons were seen on spring migration watches in comparison to fall movement; peak movement in 1980 occurred 3-7 June.

Breeding —By about 10 June in both years of study loons were able to move onto tundra ponds and lakes, although pairs were still seen using the West Branch up to 12 June 1980. First eggs were laid in nests around 21 June in both 1979 and 1980. First hatching was noted in the third week of July, although (in 1979) adults were seen incubating as late as 29 July. Nests were invariably on islands in lakes surrounded by deep water, and seldom concealed by vegetation. Nest density was estimated at 0.55 nests per square kilometer in 1979 and 0.75 nests per square kilometer in 1980. Young were present on lakes and ponds until our departure during the first (1979) or second (1980) week in September. Use of the lagoon and estuary by loons was low from late June to late July during the incubation period. In late July use increased dramatically, probably for a combination of reasons: 1) family groups moved from tundra ponds to Brownlow Lagoon and the West Branch estuary, 2) adult loons made frequent feeding flights out onto the Beaufort Sea and were seen flying inland with fish, and 3) non-breeders or failed breeders probably also added to the numbers.

Post-breeding —In 1979 presumed non-breeders or failed breeders congregated in flocks of 12-20 individuals on Finger Lake from 23 July to 18 August. Peak counts were in early August. Groups of five to eight were seen there during the same period in 1980. Finger Lake contained numerous Notostracans (tadpole shrimp) which may have been the attractant for these birds (see Bergman et al. 1977).

Fall Migration —Heavy westward movement began 28-30 August 1979 when 143 Arctic Loons were counted in 19.75 hours of observation (7.2 Loons per hour). In 1980 westward movement was noted from 18 August through the last observation day, 6 September. Many loons could not be identified to species; peak movement of all loons combined was on 1 September, when over 1000 were seen passing west at a rate of 147 per hour. Heavy movements were also noted 27and 28 August and 4-6 September. Migration undoubtedly continued after field work was terminated in fall.

RED-THROATED LOON

Regional Status and Distribution —Common and widespread breeder coastally on the ACP, outnumbering Arctic Loons in some localities. Sage (1974) reported that this species becomes more scarce inland than on the coast. Valkenburg et al. (unpublished) recorded more Red-throated Loons than Arctic Loons along the Canning River in the Brooks Range and Red-throats are much less common in interior ACP sites in NPR-A (Derksen et al. in press).

CRD Status —Common breeder; common migrant.

Spring Migration —Arrival dates reported from the ACP are 30 May in the Yukon (Salter et al. 1980), 7 June 1978 at Demarcation Point (R. M. Burgess pers. comm.), 7 June 1978 at the Okpilak River Delta (Spindler 1978a), 5-11 June 1971-1974 (Bergman and Derksen 1977). Dates of first observation at CRD were 7 June 1979 and 11 June 1980, the lag probably due to a slightly later break-up in 1980. Low volume eastward movement was noted during migration watches in 1980, with a peak 4-7 June.

Breeding —Nests were constructed in mid-June and incubating birds were seen from 23 June through the end of July, when the broods hatched. Red-throats used smaller ponds for nesting than did Arctics. Nests were either anchored to grasses in emergent Arctophila beds or on pond shorelines. In 1979 we recorded one incident where strong circumstantial evidence pointed to a renest attempt after the first nest was flooded. The same pond was used in 1980 for nesting.

Adults fed the young with fish brought back from the estuary, lagoons, and the Beaufort Sea. We did not see Red-throated Loon broods on inshore waters, however, as we did Arctics.

Nesting density was estimated at 0.45 nests per square kilometer in 1979 and 0.60 nests per square kilometer in 1980.

Fall Migration —No flocks were seen on tundra lakes but six were seen on the West Branch 31 July 1980 and an increase in numbers seen on lagoon surveys in late July and August may be attributable to both local birds feeding in the marine waters and an influx of post-breeding and non-breeding birds. Although outnumbered by Arctics in migration watch counts, timing of movement seemed similar in the two species. The dominance of Arctic Loon in migration watch counts (ratio of 2:1 in 1980) may be an artifact of technique; the markings of Arctic Loons are more striking than those of Red-throats, so the former species is more likely to be identified with certainty, whereas more Red-throats may be recorded as "unidentified loons".

WHISTLING SWAN

Regional Status and Distribution —King (1970) estimated that 800 Whistling Swans summer on the Alaskan ACP. Welling and Sladen (MS) determined densities of swans from Harrison Bay to the Sagavanirktok River Delta and found highest densities in the Fish Creek area (west of the Colville River Delta) and on the Colville River Delta. In ANWR, Jacobson (1979) determined that the swan population on the refuge was concentrated at the Canning River

Delta and the Aichilik-Kongakut River Delta, with the wetlands near Demarcation Point and southwest of Barter Island also important. He estimated that in some years the number of adult swans in ANWR reached 200-220. The CRD contained about 49% of the ANWR population in 1979; densities there (in swans per square mile) were 0.6, 1.4 and 0.8 respectively, in three years of aerial survey 1977 to 1979.

CRD Status — Common breeder.

Spring Migration —Date of first observation was 26 May 1979 and 25 May 1980. While flooded tundra was available for grazing when swans arrived in 1979, in 1980 there was only a little open water formed by overflow in the West Branch when swans arrived and little tundra was available until about 8 June. Very little obvious migration movement was noted; the only large flock was 25 flying west, low over the tundra on 8 June 1980.

Breeding —Ten active nests were located during the study and many old nest mounds were found. Most nests were built near moderate or large sized lakes, usually not on islands. In 1980 two of our nests in the primary study area were next to the lagoon or estuary (see Part III, this report). It is possible that these nests were located by the lagoon instead of lakes because the early open water was only available on the marine and estuarine waters. In 1979 clutch completion dates were during the first week of June. In 1980 with a later break-up swans were still present on the West Branch, not on territories, as late as 7 June and unsettled pairs were still seen on the tundra 12 June. In fact, it appeared that there were more non-breeders present in the area in 1980; for instance a pair was present on Finger Lake the entire season but did not attempt to breed. Two of five nests in the Primary Study Area in 1979 were unsuccessful and one of four nests in 1980 was unsuccessful. Nesting density was estimated at 0.25 and 0.20 nests per square kilometer in 1979 and 1980, respectively.

After hatching, swan families were observed most often in lakes with dense Arctophila beds. They were also seen in the West Branch Flats and estuary and on Brownlow Lagoon.

In 1979 much of the study area east of base camp was surveyed on foot 11-12 August. Combined with our knowledge of the swan population west of base camp we estimated that at minimum there were 27 adults and 26 cygnets present at that time in the approximately 25 square mile area between the West Branch and the Canning River. This density compares favorably with even the densest ACP populations near the Colville River Delta. Doubtless we missed some swans since the survey was undertaken on foot and not all wetlands were adequately scrutinized.

Fall Migration —Swans were present until our departure from the area in both years. Little definite migratory movement was detected, but a flock of six landed on the West Branch 23 August 1980 and small flocks (three or four individuals) were seen flying east 24 and 27 August and 2 September 1980.

CANADA GOOSE

Regional Status and Distribution —Canada Geese have been reported as nesting in few locations on the ACP. Although more than 14,000 have been counted in the Teshekpuk Lake area where they spend the molt period, none have been reported as nesting on the coastal plain in NPR-A (Derksen et al. 1977). Kessel and Cade (1958) found 200-300 pairs breeding along the Colville River. A few pairs nest on islands (Howe Island, Duck Islands, Tigvariak Island) near Prudhoe Bay (Gavin 1976) and a nest was found at Storkersen Point in 1978 (Derksen et al. in press). To the east, Salter et al. (1980) termed this species a "rare summer resident" on the Yukon ACP and did not have any positive evidence of breeding. In ANWR, Spindler (1978a) reported "two pairs probably nested in the study area" at the Okpilak River Delta.

CRD Status —Fairly common breeder, common migrant.

Spring Migration —First date of observation at CRD was 27 May 1979 and 26 May 1980. At the Sadlerochit River in 1979, a flock of 20 was seen 26 May (M.A. Robus pers. comm.). They seem to arrive in small groups of two to twenty individuals and small groups are seen throughout June.

Breeding —All nests found in the two years of study (n=12) were on islands in basin-complex wetlands surrounded by deep water. The nests were relatively inaccessible and since the birds were slow to return to nests after disturbance we visited them seldom. The first incubating goose was seen 12 June 1979 and a nest with only three eggs was visited 15 June 1980. Since the clutch is normally larger than this (Johnson et al. 1975) it is likely that the geese were still in the egg laying stage at this time, but we have little data bearing on chronology of nesting. First brood was noted 5 July 1979 in Lagoon Marsh. All other brood sightings were made on saltwater: four adults with four young on Brownlow Lagoon, 11 July 1979; three pairs with a total of ten young on West Branch Flats, 25 July 1979; two pairs with three and five young, respectively, at Ruth Island, 17 July 1980. Latest record of an incubating adult was 23 July 1979.

Canada Geese were not seen on the tundra in July or August, and these observations taken as a whole suggest that they regularly take their broods out to lagoon and estuarine waters from their natal ponds and lakes.

Non-breeders, Molt and Molt Migration —In both 1979 and 1980 Canada Geese were most numerous on the tundra in late May and June. In late June, while incubation is well under way there seems to be considerable movement of non-breederss. From 20 June to 7 July we recorded many small flocks on the tundra and flying over the study area. Direction of travel was not always apparent but in many cases the birds were flying west: flock of 9, 20 June 1980; flock of 12, 24 June 1979; flock of 11, 24 June 1980, flock of 22, 7 July 1980. Numerous other records of flocks of seven to 20 individuals were obtained during this period in the summer. After about the first week in July few were seen on the tundra until mid-August. There are two likely explanations for this mid-summer disappearance: 1) non-breeding birds travel to the Teshekpuk Lake area to molt after initial dispersal over the ACP

(sightings of westward flying birds cited above and the observations of two flocks totalling 190 birds seen flying west past Nuvagapak Point, Beaufort Lagoon 29, June 1970 (Schmidt, 1973) support the hypothesis that some molt migration occurs along the Beaufort Sea coast), and 2) birds gather locally in favorable spots and spend the wing molt period in areas such as river deltas. In 1979 a large flock numbering 65 to 90 birds was present on West Branch Flats 25 July - 2 August. Only 30 remained during the period 5-11 August. In 1980 a flock of 18 was seen on the west side of Ruth Island, 17 July. These observations suggest that Canada Geese use the West Branch estuary consistently during the wing molt period.

Fall migration --Beginning 14 August 1979 and 18 August 1980 flocks of 12-50 Canada Geese were seen in the study area, with numbers tapering off toward the end of August. They used a variety of habitats including wet tundra, but in particular used the West Branch Flats area and Lagoon Marsh. Our last record is on 31 August. Fall migration was predominantly in an eastward direction, and was more conspicuous than spring movement.

BRANT

Regional Status and Distribution --Brant breed sparingly on the Alaska Beaufort Sea coast, apparently more commonly to the west than to the east. Derksen et al. (in press) reported nesting at four outer coastal plain sites with a colony of 98 nests found at Island Lake (Derksen et al. 1979). Gavin (1972; 1975) reported that Brant nest in river deltas and on some offshore islands in the Prudhoe Bay area. In ANWR Spindler (1978a) found a colony of 15 pairs at the Okpilak River Delta. To the east, Salter et al. (1980) reported only one breeding locality on the Beaufort Sea coast.

Brant are found in large numbers in the Teshekpuk Lake area, where they congregate while they undergo molt. Up to 32,000 have been counted there in mid-July (Derksen et al. 1979).

Brant are commonly seen on the Alaskan ACP in migration. Spring migrants have been recorded from Anaktuvuk Pass (Irving 1960), and well inland on the ACP (Kessel and Cade 1958; S. Blackhall unpublished notes, ANWR files). In fall they appear to be confined to a narrow corridor along the Beaufort Sea coast and a fall passage of 3-15,000 has been recorded in various studies from the Yukon to Point Barrow (see summary, Johnson et al. 1981).

CRD Status --Uncommon breeder, common to abundant migrant.

Spring Migration --Brant were first recorded at CRD 26 May in both 1979 and 1980. Brooks (1915) recorded first arrival 20 May 1914 at Demarcation Point and R. M. Burgess (pers. comm.) saw two 15 May 1979. Clearly, though, peak movement eastward along the Beaufort Sea coast is generally in the last week of May and first two weeks of June (Spindler 1978a; Johnson et al. 1981). At CRD, peaks of migration were observed 26 May - 1 June 1979 and 29 May - 5 June 1980. In spring of 1979 with only incidental observations made, about 3400 Brant were seen flying east. In 1980 when more intensive migration

watch was undertaken, 10,864 Brant were seen (over 7200 on 5 June alone) and over 26,000 were estimated (conservatively) to have passed Canning River Delta in the ten day period 30 May through 8 June. This estimate is well above estimates of numbers past Simpson Lagoon in 1977 (Johnson et al. 1981) but very similar to the numbers estimated passing the Yukon Beaufort Sea coast in 1975. Brant were not common spring migrants past Icy Cape on the Chukchi Sea in 1980 (W. Lehnhausen pers. comm.). These data suggest that Brant may fly overland in spring, reaching the Beaufort Sea coast somewhere between Simpson Lagoon and the Canning River.

Breeding —No Brant nests were located at CRD. However, broods were seen on several occasions. On 9 July 1979 a pair with four young were seen nine km east of base camp. On 1 August 1979 a pair with four young were seen on the Bay shoreline across from Ruthless Island. On 26 July 1980 three pairs with a total of eleven young were seen near Ruthless Island. They swam across the bay when they detected the observer. These observations indicate that breeding may occur on one of the islands at the mouth of West Branch.

Non-breeders, Molt, and Molt Migration —Like Canada Geese, Brant were most numerous on the tundra in June. In 1979 flocks of seven to 30 birds were in coastal wetlands 9-25 June and flocks of up to 30 birds were seen flying over the study area up until about 21 June 1980. In both years several pairs were consistently seen in a basin- complex wetland northeast of the mosaic study plot but in neither year did breeding actually occur there. In 1979 flocks of 200 were seen traveling west 25 and 30 June. Nothing comparable was noted in 1980, but other observers in ANWR have reported similar observations: Schmidt (1973) reported 325 birds in five flocks flying west, 22 June 1970, and 425 birds in four flocks flying west, 23 June 1970, all past Nuvagapak Point; D. M. Troy (pers. comm.) recorded an influx of Brant at Demarcation Point 24-27 June 1978. These records may represent a limited molt migration toward the Teshekpuk Lake area. Certainly, general numbers in the study area declined in July, and unlike Canada Geese, no large flocks of Brant were observed on the West Branch estuary. Three presumably flightless Brant were seen with Canadas at Ruth Island, 17 July 1980 but we have no evidence of large numbers of Brant molting at CRD.

Fall Migration —In 1979 Brant were first noted migrating west, 17 August. Table V-1 below summarizes observations of Brant at Brownlow Point made during migration watches. A total of 24,627 Brant were counted during this period. If rate per hour is expanded by 24 hours for each day and the daily estimated totals summed over the thirteen days, an estimate of 83,700 is obtained. Obviously, this is a tenuous estimate since none of the observations were made during night-time hours and although Brant were heard passing by on one night, flocks were also seen to put in for the night in coastal wetlands, leaving the next morning.

In 1980 Brant were first seen migrating west 18 August and continued through 6 September, when observations ceased. However, migration was light and on only two days did rate exceed 200 per hour and at no time did it exceed 400 per hour, based on one and a half to seven hours of observations on

Table V-1. Number of Brant seen in westward migration, Canning River Delta, late August of 1979. Most records are from Brownlow Point, made during the period 0800-2000 hr.

Date	# of Brant	Hours of Observation	Birds per Hour
17 Au	1018	2.7	377
18 Au	120	5.9	20
19 Au	3846	8.0	436
20 Au	364	5.0	73
21 Au	90	6.0	15
24 Au	6806	9.0	756
25 Au	1785	3.0	595
26 Au	8292	12.0	691
27 Au	9	4.5	2
28 Au	362	6.5	56
29 Au	1029	7.0	147
30 Au	596	6.0	99
31 Au	670	3.0	223
Total	24,627		

each 15 days during this period. Total estimate (derived as described above) for this period is only 35,465. However, west winds prevailed during the entire two week period and several authors (Schmidt 1973; Johnson et al. 1977) have noted the correlation between migratory movements of Brant and favorable tail winds. In late August and early September 1980, east winds did not prevail at CRD on any day after 21 August (although NE winds occurred on 1 September). On 10 September the wind shifted to the east and Spindler (pers. comm.) recorded a heavy flight of Brant flying west past Barter Island.

In contrast to spring migration, when Brant were seen several kilometers inland, fall migration was confined to a narrow zone right along the lagoon shore with no movement noted inland. Many more Brant stopped on the study area in fall than in spring. On 24 August 1979 at least 1200 spent the night along the three kilometers of lagoon shoreline east of Brownlow Point. On 3 September 1980 over 600 were seen in widely scattered flocks from West Branch to Brownlow Point. On 4 September 200 were seen in this area and flocks of 20-50 were present along West Branch up until 7 September 1980. Coastal wetlands were the most favored feeding areas although some use was made of other habitats, particularly in 1980 when flocks of Brant appeared to be waiting out periods of unfavorable winds and were seen on river terraces and wet tundra.

WHITE-FRONTED GOOSE

Regional status and Distribution —Fairly common breeder from the central arctic slope to the west. Sage (1974) reported nesting between Franklin Bluffs and White Hills (in the Sagavanirktok River drainage) and Derksen et al. (in press) reported nesting at Storkersen Point and from all their study sites in NPR-A. White-fronted Geese molt in small flocks throughout much of the ACP, although they are most concentrated at a few lakes near Teshekpuk Lake, where up to 1900 have been counted during the molt period (Derksen et al. 1979; Derksen et al., in press). In the eastern section of the ACP this species seems to be much less common. In ANWR Spindler (1978a) at the Okpilak River Delta, Schmidt (1973) at Beaufort Lagoon, R. M. Burgess (pers. comm.) at Demarcation Point all recorded this species in spring but found them absent in mid-summer. Salter et al. (1980) found a similar pattern on the Yukon ACP. Eastward migration in fall is pronounced, however, in the eastern section of the ACP (Salter et al. 1980; J. Levison pers. comm.).

CRD Status —Uncommon to fairly common spring migrant, common fall migrant.

Spring Migration —Date of first observation at CRD was 27 May 1979 and 26 May 1980. Small numbers (up to 13 birds per day) were seen on seven dates in the period 27 May through 29 June 1979. In spring of 1980 they were more numerous, seen on eleven dates during the period 26 May through 15 June. They were seen on migration watch during the period 3-6 June 1980; a total of 40 flew west and 12 flew east. No predominant direction of movement

could be discerned during this period; small flocks (two to six birds) were seen grazing on the tundra or flying low over the study area. No White-fronts were seen in July of 1979 or 1980.

Fall Migration --Beginning 16 August 1979 and 12 August 1980, White-fronted Geese began to return to CRD. In 1979 flocks scattered widely in wet tundra areas and were seen practically daily from 16-31 August. Small areas of tundra were found where they had pulled up Carex plants and virtually stripped the vegetation. Numbers seen daily ranged from three to 73 with unusually large numbers seen on the following days: 160, 20 August; 140, 21 August; 160, 25 August; 200, 26 August; 197, 28 August; 116, 30 August; 325, 31 August.

Lesser numbers were seen in 1980. On 12 August a group of 13 was seen flying west. A total of 58 in four flocks was seen 14 August and comparable numbers were seen through 18 August. A flock of about 100 was seen 19 August and comparable numbers were seen through 25 August. On 28 August strong west winds seem to have prompted migration; over 350 were seen flying east between 1500 and 1600 hour. The westerly gale continued 29 August and despite limited observation, over 200 were seen migrating east. On 30 August migration activity diminished with the winds, but 50 were on West Branch Flats and a flock of 150 was 1 km south of camp along the West Branch 2 September. On 3 September a flock of four and a flock of 16 were seen, our last record.

SNOW GOOSE

Regional Status and Distribution --The only known breeding colony of Snow Geese in the United States is at the outer Sagavanirktok River delta in the Prudhoe Bay area, where approximately 60 pairs nest (Welling et al. 1980). Scattered pairs are found nesting in other locations such as Meade River, Colville River, and Sagavanirktok River (Johnson et al. 1975), at East Long Lake (Derksen et al. in press), and at Flaxman Island (Gavin 1976). In ANWR there are typically small flocks (five to 75 birds) noted in June with net direction of movement often uncertain (Schmidt 1973; Spindler 1978a; R. M. Burgess pers. comm.). In fall there is a massive influx of Snow Geese into the coastal plain of ANWR from the Anderson River Delta in Northwest Territories (Spindler 1978b). The most consistently used areas in ANWR are east of Barter Island. Salter et al. (1980) termed this species an "uncommon spring migrant", "very rare summer visitor" and "abundant fall migrant" on the Yukon ACP, similar to the pattern in ANWR.

CRD Status --Uncommon spring migrant, rare summer visitant, common fall migrant.

Spring Migration --M.A. Robus (pers. comm.) saw a flock of about 50 flying northwest over the Sadlerochit River 25 May 1979. R. M. Burgess (pers. comm.) recorded eight flying east 26 May 1979 at Demarcation Point. Spindler (1978a) first recorded this species 3 June 1978 at the Okpilak River Delta. At CRD, date of first observation was 1 June in 1979 and 1980.

In 1979 there were three June records of two to five birds. In 1980 there were nine June records of one to five birds and a flock of 50 landed on the east shore of Flaxman Lagoon 21 June 1980. Those flocks for which direction of travel was apparent were headed west or northwest.

Non-breeding —One was seen 10 July 1979 on the mud flats at the mouth of the Canning River. On 5 August 1980 one was seen on the barrier spit between Brownlow Point and the mouth of the Canning River; this bird was apparently flightless at the time.

Fall Migration —The Canning River is west of the major staging areas in ANWR (Spindler 1978b). In 1979 a flock of 175 was seen heading southeast along the lagoon shore 26 August; 250-300 landed in mesic tundra north of the upland study plot 26 August; and flocks of 45 and 85 were seen on the tundra 31 August. One to three birds were seen on three other dates during this period. No large flocks of Snow Geese were seen in 1980: two flew west 24 August; 16 were on west spit at Brownlow Point 25 August; 45 were grazing on wet tundra near Brownlow Point 28 August; a flock of 40 and another flock of 20 was seen 31 August; a flock of 16 fed with Brant on West Branch Flats 9 September.

ROSS' GOOSE

Regional Status and Distribution —There are two recent records from ACP, both obtained about 15 km northeast of Teshekpuk Lake. An adult female was banded 15 July 1976 and four were seen 18 August 1977 (Kessel and Gibson 1978).

CRD Status —Casual spring migrant.

General —One was seen 13 June 1980 and studied at close range (less than 50 m). It was with Canada Geese and was later seen flying with a Snow Goose. Identification was based on size, call, short neck, lack of black "grin line" on bill and gray area at base of upper mandible.

MALLARD

Regional Status and Distribution —Appears to be an occasional breeder on ACP. Gavin (1972) reported one or two sightings of broods in the Prudhoe Bay area 1970-1972 and there is a breeding record from Umiat 20 June 1950 (Gabrielson and Lincoln 1959). Mallards occur as casual visitors in NPR-A (Derksen et al. in press) and are uncommon spring migrants in ANWR. Two to three were seen on three dates in 1970 at Nuvagapak Point (Andersson 1973) and in the Beaufort Lagoon area (Schmidt 1973). At Demarcation Point R. M. Burgess (pers. comm.) saw two, 22 May 1979, and five, 3 June 1979. M.A. Robus (pers. comm.) reported a drake at Sadlerochit Springs, 22 May 1979. To the east Salter et al. (1980) termed this species a "rare summer resident" and reported a female with brood on the Yukon ACP.

CRD Status —Rare spring migrant and visitant.

General —Only one record in 1979; a pair seen 2 June in a shallow-Arctophila lake. In 1980 Mallards were seen on seven occasions. Two females were seen flying east 5 June; one female was feeding with Wigeons on West Branch 7 June; a drake was seen at Finger Lake 30 June; a female or eclipse plumaged male was with Pintails in the West Branch 26 July; two females were seen at Brownlow Point 5 August and five were there 13 August; two were seen at Finger Lake 14 August.

PINTAIL

Regional Status and Distribution —Derksen et al. (in press) considered this the most numerous duck on the ACP, although in ANWR it is not as common as the Oldsquaw (Schmidt 1973; Andersson 1973), at least in some years. On the ACP drakes generally outnumber hens by a wide margin and most birds appear to be non-breeders. In years of drought in the southern prairies, Pintails occur in higher numbers in the arctic (Derksen and Eldridge 1980). Nesting seems to be more frequent in the western portion of ACP than the east (Pitelka 1974) however Schmidt (1973) did see broods in the Beaufort Lagoon area in ANWR. On the Yukon ACP Salter et al. (1980) term this species a "fairly common summer resident, common migrant" less abundant than Oldsquaw or Scaup on tundra lakes and they found active nests in 1972 and 1973. In eastern ACP this species is more abundant as a migrant than a summer resident although this duck's secretive behavior during molt probably gives a false impression of scarcity during mid-summer.

CRD Status —Very common migrant, common summer resident, rarely breeding.

Spring Migration —Date of first observation at CRD was 27 May 1979 and 26 May 1980. M. A. Robus (pers. comm.) recorded this species 14 May 1979 at the Sadlerochit River; R. M. Burgess (pers. comm.) first recorded it 22 May 1979 at Demarcation Point; Spindler (1978a) reported a first date of 2 June at the Okpilak River Delta in 1978. At CRD the initial observation was followed several days later (31 May 1979 and 5 June 1980) by a more pronounced influx. In both years the early open water of West Branch attracted Pintails in late May and early June: e.g., 41 males with four females 31 May 1979; 61 males with six females, 5 June 1980. As soon as tundra pools of melt water were available by 5 or 6 June Pintails scattered widely and were very common wherever water was available on the tundra. In 1979 Pintails were seen daily 1-10 June and on eight June dates thereafter. During this period males outnumbered females by a ratio of seven to one (n=202). Pintails were more numerous in 1980 than in 1979 and were seen daily in June. Flocks of up to 30 birds were seen flying over the study area and in tundra ponds, up until about 9 July 1980. No predominant direction of travel was apparent at this time.

Breeding —Two Pintail nests were found in 1980, neither of which were successful. One was in dry hummocky tundra near West Branch Flats; it was found 24 June with six eggs and was destroyed the same day, presumably by a fox. A second nest was found 28 June with eight eggs in a grass clump in a dune near Brownlow Point. This nest was destroyed by a predator by 2 July.

No broods were discovered although a "broody" female was seen 3 August 1980 near Finger Lake.

Non-breeding, Molt —During mid- to late July relatively few Pintails were seen; although more were in evidence in 1980 than in 1979. During the molt period West Branch Flats, the West Branch estuary, and especially wetlands with extensive beds of Arctophila were used most by Pintails. It was difficult to gauge the population at this time because of the secretive habits of molting Pintails.

Fall Migration —By the end of July and the beginning of August Pintails were seen in increasing numbers. In 1979 from ten to 70 birds were seen on nine days during the period 29 July to 14 August. A flock of 36 was traveling east 15 August 1979 and a flock of 45 was seen traveling southeast 16 August.

After 20 August there was a general decline in numbers although a few were present through the end of August.

The eastward migration of Pintails was more dramatic in 1980. On 3 August 124 Pintails in five flocks flew over the study area; 21 were seen on West Branch Flats that day. On 7 August 164 Pintails in loose flocks were seen feeding and resting on West Branch Flats. Migration continued on 12 August and on 14 August a major exodus was noted; over 900 were seen flying east in flocks ranging from 2-100 birds in eight hours of casual observation. This was the heaviest movement noted, but Pintails continued to migrate east through 20 August, after which migration tapered off. A few were still present using the lagoon on 2 September, when a flock of 30 - was seen on the east spit.

GREEN-WINGED TEAL

Regional Status and Distribution —Breeds in the interior ACP to the west: at Umiat (West and White 1964) and at Anaktuvuk Pass (Irving 1960). To the east, it has been recorded as breeding in the interior ACP in the Sagavanirktok River drainage (Sage 1974) and on the Yukon ACP (Salter et al. 1980). In ANWR it has been recorded frequently in spring in many locations. At Beaufort Lagoon (Schmidt 1973; Andersson 1973) a maximum count of 16 was made on the Aichilik River Delta 24 June 1970. At the Okpilak River Delta one drake was seen 7 June 1978 (Spindler 1978a); at Sadlerochit Springs a pair was present 22 May 1979 and another was seen 16 km up Sadlerochit River 27 May 1979 (M. A. Robus pers. comm.). At Demarcation Point, Green-winged Teals were fairly common in both 1978 (D. M. Troy pers. comm.) and 1979, and were confirmed breeding there in 1979 (R. M. Burgess pers. comm.).

CRD Status —Rare visitant.

General —We have only three records: one drake flying over the dunes at the mouth of West Branch 4 June 1980; one drake flying west 12 June 1979; a female or juvenile in a basin-complex wetland, feeding in a shallow -Carex pool 15 August 1979.

NORTHERN SHOVELER

Regional Status and Distribution --Irregular and uncommon on the ACP. West and White (1964) documented breeding in the Umiat area in 1964. It has been reported from the Colville River Delta where it may also have bred (Kessel and Gibson 1978) and Derksen et al. (in press) termed this a casual visitant at the East Long Lake, Meade River and Singiluk study sites in NPR-A. Gavin (1972) called this species "scarce", not recorded every year, but found a brood 7 August 1971. Bergman et al. (1977) reported occurrences in 1973 (up to ten seen during June) but not in the other years of study 1971-1975. In ANWR Schmidt (1973) reported a drake at the Aichilik River delta 24 June 1970. One to three individuals were seen on four occasions 1-22 June 1979 at Demarcation Point (R. M. Burgess pers. comm.). A pair was observed 22 May 1979 at Sadlerochit Springs (M. A. Robus pers. comm.). Salter et al. (1980) termed this a "rare summer resident" on the Yukon ACP, but confirmed breeding near Phillips Bay approximately 100 km east of the Alaska-Yukon border.

CRD Status --Rare visitant.

General --Not recorded at CRD in 1979, but recorded fairly frequently in 1980. First record was 7 June 1980 when two drakes and a hen were seen flying east-southeast over the upland study plot. A drake flew east 11 June. Shovelers were seen several times in Corner Marsh (on the northwest corner of Finger Lake): one to two pairs were there 17-20 June, what appeared to be a drake coming out of eclipse plumage was seen 29 July across Finger Lake and a drake was seen again in Corner Marsh 3 August. We believe that at least a few Shovelers spent the summer in the area, using the dense Arctophila beds for cover during the molt. Three drakes were on West Branch Flats 5 July and one was seen flying over the bay 14 August.

AMERICAN WIGEON

Regional Status and Distribution --Termed a "casual visitor" at the NPR-A study sites by Derksen et al. (in press). West and White (1964) termed this species "fairly numerous" in Umiat area in 1964 and recorded several brood observations. Gavin (1972) described this species as having a "widely scattered light population" with most of his sightings in the Colville River area. Bergman et al. (1977) indicated irregular occurrence at Storkersen Point; it was recorded there in four of five years of study with a maximum count of 145. In ANWR Wigeons appear to be frequent migrants. Schmidt (1973) recorded three flocks in June 1970 in the Beaufort Lagoon area, with a maximum of 50 seen just east of the Kongakut River Delta 24 June 1970. Up to 13 were seen on nine dates 25 May - 10 June 1979 at Demarcation Point (R. M. Burgess pers. comm.) and two pairs were at Sadlerochit Springs 22 May 1979 (M. A. Robus, pers. comm.). Salter et al (1980) termed this species a "rare summer resident" on the Yukon ACP.

CRD Status --Uncommon to fairly common migrant.

General --Wigeons were rarely seen in 1979 but were more common in 1980. A single drake was seen flying over the lowland study plot 1 June 1979; five

drakes were in Lagoon Marsh 10-25 June 1979; two were seen flying south along the West Branch 16 August 1979.

Date of first observation in 1980 was 29 May, when a pair was seen flying over camp with Pintails. A drake was in West Branch 5 June and 14 drakes with nine hens were feeding in West Branch 7 June. Two pairs were seen 8 June in West Branch; several near Brownlow Point 8 June; 30 were seen flying up West Branch 13 June; five were on the Brownlow Lagoon shoreline 14 June; four drakes and two hens were in Lagoon Marsh 16 June; seven wigeons were in Lagoon Marsh 21 June. None were seen in July.

Fall movement was very slight: a flock of eight and a flock of 12 were seen traveling east 19 August.

GREATER SCAUP

Regional Status and Distribution —In interior ACP to the west a fairly common to common breeder. Breeds in interior sites in NPR-A (Derksen et al. in press) and is probably "the most numerous breeding duck" in the interior coastal plain of the Sagavanirktok River drainage (Sage 1974). On the Beaufort Sea coast itself it is only a "straggler" at Barrow (Pitelka 1974) and seen only in three of five years of study at Storkersen Point (Bergman et al. 1977). In the Yukon ACP, however, it is "second only to the Oldsquaw in abundance" and breeding has been confirmed (Salter et al. 1980). Small numbers are also seen with molting Oldsquaw and scoters south of Herschel Island (Salter et al. 1980). In ANWR spring records are common: at Okpilak River Delta, four drakes and a hen were observed flying east 6 June 1978 and a group consisting of two drakes and a hen remained in the area through June (Spindler 1978a). Three flocks numbering ten, 16, and 23 were seen in the Beaufort Lagoon area 24 June 1970 (Schmidt 1973); at Demarcation Bay small groups of unidentified scaup were seen several times in June 1979 (R. M. Burgess pers. comm.). At the Aichilik River Delta in Beaufort Lagoon 50 scaup sp. (probably this species) were seen with scoters during the last week in June 1970 (Andersson 1973).

CRD Status —Uncommon visitant.

General —Scaup were seen only once using tundra wetlands — five males were found in Corner Marsh (at Finger Lake) 6 June 1979. All other records are either birds in flight or on the Beaufort Sea or lagoon shore. On 7 June 1980 two drakes and a hen flew southeast over the study area and an additional pair flew east past camp. On 15 June 1979 three drakes were seen in Brownlow Lagoon; four drakes were seen in Brownlow Lagoon 21 July 1979 and later in the day a group of five and a group of six (all drakes) flew east past Brownlow Point. Five drakes were seen with Oldsquaw about 200 m seaward of the Brownlow Lagoon barrier island 22 July 1980. One drake flew west past Brownlow Point 20 August 1979; one drake flew east past the east spit 21 August 1981. Apparently a few scaup are present on the lagoons throughout the summer; some males may spend the molt period in the lagoons.

OLDSQUAW

Regional Status and Distribution —This is the most numerous breeding duck across the outer ACP from NPR-A (Derksen et al. in press) to the Yukon (Salter et al. 1980). In ANWR and to the east it is the most numerous duck (Schmidt 1973; Andersson 1973; Salter et al. 1980), but to the west it is outnumbered by Pintails in some sites. Widespread breeding is recorded across the ACP and into the Brooks Range (Irving 1960).

Oldsquaw are abundant during the molt period on the coastal lagoons (Spindler 1979; Johnson et al. 1981) and on large lakes of ACP (E. J. Taylor pers. comm.).

CRD Status —Common breeder; abundant migrant.

Spring Migration —Date of first observation 22 May 1979 when one was heard flying over camp in the night and 24 May 1980 when a flock of about 20 was seen from an airplane in a patch of open water at the mouth of the Canning River. Oldsquaw were seen using overflow water of the West Branch as soon as it was available in both 1979 and 1980. A total of 65 was on Flaxman Lagoon 31 May 1979 and 15-30 were on the West Branch Flats 1-4 June 1979. In 1980, 35-60 were seen in West Branch 29 May - 5 June. Eastward Oldsquaw movement was noted 2-8 June 1980 with peak movement on 5 June. Numbers were low, however, with only 2000 estimated to have passed the study area (on the basis of systematic migration watch). However, many Oldsquaw fly low over the sea ice and the lagoons (Johnson et al. 1981) and we would have been unable to see these birds from our observation post for migration watch.

Breeding —By 9 June 1979 and 10 June 1980 pairs were able to move on to tundra ponds. A pair was seen dabbling in a shallow pond 10 June 1980, probably feeding on chironomid (midge) larvae that were already active at that time. A total of 14 nests were found during the two years of study, in a variety of habitats. Five were in wet tundra with small discrete shallow -Carex ponds 15-100 m away used for escape when the hen was disturbed from the nest. Three were on narrow peninsulas or islands in the West Branch Flats area within 2 m of the water and two were in similar sites within basin-complex/ wetlands; three nests were on barren ground near the river or on the Brownlow Lagoon barrier island; one nest was on dry tundra adjacent to Finger Lake. Only two of the nests were known to be successful, nine were judged failures due to the absence of post-hatch membranes and shells or due to disappearance of the clutch. Fate of three of the nests was unknown. Egg laying began as early as 14 June in 1979 and in 1980 four nests for which we gathered reasonably complete information indicated that egg laying peaked in the last week of June and first week of July. First broods were seen 18 July 1979 and 23 July 1980. Some nests were later, however; a nest was still incubated 24 July 1979 and a nest on the barrier island was still incubated 28 July 1980. In both years of study several broods were observed on Finger Lake. Broods were also observed in smaller ponds and lakes, with and without beds of emergent vegetation. Minimum nest densities were estimated at 0.4 and 0.45 nests per square kilometer in 1979 and 1980, respectively.

Non-breeders, Molt, Molt Migration --Males largely disappeared from tundra lakes and ponds by 5 July, presumably moving out onto the lagoons for the duration of the molt period. Apparently non-breeding males were present in Brownlow Lagoon as soon as open water developed in spring. A group of 80-100 was present at the gap between east spit and the barrier island from 10-21 June 1980. Oldsquaw were abundant on the lagoon and on the Beaufort Sea throughout the summer. Details of abundance and distribution of Oldsquaw in marine littoral waters and timing of molt and molt migration are presented in Part III, this report.

Although numbers were much less than on the lagoons, large deep-open lakes were also used by Oldsquaw flocks in late summer. Finger Lake, the large lake southeast of Finger Lake, and the large lake just west of the Canning River mouth all attracted Oldsquaw flocks. The flocks did not seem to build up on the lakes until late July and August: 66 Oldsquaw were counted on Finger Lake 14 August 1979; 140 were there 17 August 1979; in 1980 Oldsquaw on Finger Lake increased steadily from about 40 on 29 July to 110 on 18 August. Often sex ratio could not be determined, but there is limited evidence to suggest that the lakes were used more by females than males. For instance, of 110 Oldsquaw on Finger Lake 18 August 1980 only 25-30 were males, at a time when Oldsquaw flocks on the lagoons were still heavily skewed towards males.

Fall Migration --In 1979, during 68 hours of migration watch conducted at Brownlow Point 18-31 August a net westward movement of 4728 Oldsquaw was recorded. Extrapolating from mean rate of movement for each day and summing the daily estimated totals over the days a grand total of 20,800 Oldsquaw are estimated to have flown west past the study area during this period.

In 1980, migration watches conducted at Brownlow Point 18 August through 6 September yielded an estimate of 32,000 Oldsquaw in westward passage during this period. Many Oldsquaw remain in Beaufort Sea lagoons and offshore in September (Johnson et al. 1981; Spindler 1979) and the migration we observed was likely only the early portion of total migratory movement west along the Beaufort Sea coast.

More than other waterfowl, Oldsquaw were noticed using the study area during migration rather than just flying past. Often a "leapfrog" type of movement was seen, with Oldsquaw rafting just offshore at Brownlow Point and a constant stream of individuals joining and leaving the group. This behavior contrasted with that of Brant and Eiders which rarely landed when in migratory flocks.

COMMON EIDER

Regional Status and Distribution --Abundant spring and fall migrant past Point Barrow (Johnson 1971), rare or absent in the interior ACP (Sage 1974; Derksen et al. in press). Common Eiders are found nesting on barrier islands, spits, and beaches along the entire Alaska Beaufort Sea coast (Johnson et al. 1975) nesting colonially on barrier islands (Sowls et al. 1978). Small numbers are sometimes seen on the tundra in spring (Spindler 1978a)

and small flocks have been seen flying west in mid- to late June in ANWR (Schmidt 1973; Andersson 1973).

CRD Status —Uncommon breeder, fairly common migrant.

Spring Migration —At CRD date of first observation was 27 May 1979 and 31 May 1980. With the exception of a flock of about 50 seen flying southeast 30 May 1979, few spring migrants were noted in either year of study. Pairs and small flocks were frequently seen on Brownlow Lagoon in June.

Breeding —In 1979 nine nests were discovered on the barrier spit west of Brownlow Point, eight of which contained down but appeared to have been recently depredated. Three nests were found in this area in 1980; seven nests on the Brownlow Lagoon barrier island, and one nest on Ruth Island at the mouth of the West Branch (See Part III, this report for details). Nest initiation was generally in the last two weeks of June and first few days of July. First broods were noted 17 July 1980. Broods were seen in the Beaufort Sea off Brownlow Point in mid- to late August 1979. Only five brood sightings were made in 1980 despite intensive shoreline surveys.

Non-breeders, Molt, Molt Migration —In late June 1979 a lead in the sea ice developed in the pass between Brownlow Point and Flaxman Island and large rafts of ducks used this area. Although too distant for positive identification in some cases, we believe most were male Common Eiders. At least 500-800 birds were present in this lead 27-30 June. As the shore lead developed in July moderate numbers of Eiders were near Brownlow Point; about 200 were present 10 July 1979. Comparable use of the area did not occur in 1980.

In both years a westward movement of Eiders (at least 90% male Common Eiders) was noted at the end of July and the first ten days of August. At Barrow the Eider pass begins in early July and continues on through August with the peak of male movement in the third week of July (Johnson 1971). This movement is predominantly of King Eiders and the numbers are in the hundreds of thousands. In contrast, we saw predominantly Common Eiders and in much lower numbers. Peak movement was noted on 28 July 1980 when Eiders were passing at a rate of over 500 per hour, but this was an exceptional occurrence. In 1979, peak movement was noted 21 July with a rate of 150 per hour.

Fall Migration —As noted at Barrow (Thompson and Person 1963) females migrate much later than the males. During the period 14-31 August 1979 small numbers (700 seen in 74 hours of observation) were observed traveling west past Brownlow Point, primarily females and immatures. Most were not identified to species. Fewer were seen in 1980 but small numbers of female Eiders flew west past Brownlow Point 19 August - 1 September, with a maximum rate of 45 per hour on 1 September.

KING EIDER

Regional Status and Distribution —Abundant migrant at Barrow (Johnson 1971) but principle breeding areas on the ACP appear to be between the Colville River and the Alaska-Yukon border. This species was found nesting in low densities at the Square Lake and Singiluk study sites in interior NPR-A but not nesting at all in outer coastal plain sites there (Derksen et al. in press). Salter et al. (1980) termed this species "uncommon migrant" in the Yukon ACP. At Storkersen Point, however, King Eiders are common breeders (Derksen et al. in press) and in ANWR breeding records exist for the Okpilak River Delta (Spindler 1978a), Beaufort Lagoon area (Schmidt 1973; Martin unpublished), Humphrey Point (Brooks 1915). King Eiders were probably not nesting at Demarcation Point in 1979 (R. M. Burgess pers. comm.) and Brooks (1915) did not find them nesting there either.

CRD Status —Common breeder, uncommon migrant.

Spring Migration —Beginning in late April, King Eiders migrate east past Barrow in the hundreds of thousands (Johnson et al. 1975). However, arrival dates at sites on the Alaska Beaufort Sea coast are generally much later. The record from 15 May 1914 at Humphrey Point (Dixon 1943) is relatively early; other arrival dates from Storkersen Point to Demarcation Bay range from 30 May to 10 June (Brooks 1915; Bergman et al. 1977; Spindler 1979a; R. M. Burgess pers. comm.). Judging by the paucity of spring records of migrating eiders from Alaskan Beaufort Sea coast sites migration must take place well offshore. Since King Eiders arrive in the Canadian arctic during the last two weeks of May the Alaska breeders must either wait in offshore leads for the tundra to melt off and/or there is a secondary movement of local breeders along the Beaufort Sea coast in late May or early June. During migration watch at Simpson Lagoon in 1977 eastward King Eider movement peaked 7-13 June, supporting the second hypothesis. No definite spring migration was observed at CRD. Pairs and small groups were seen flying over the study area daily from 1 June 1979 and 4 June 1980. The overflow water of the West Branch was used by pairs until tundra ponds melted off around 10 June. Pairs were especially numerous in both years during the period 12 June to 22 June. Males began to decrease on the tundra during the last week in June and virtually disappeared by the end of the first week in July.

Breeding —Seven nests were located during the two years of study in a variety of habitats ranging from wet tundra with pools nearby to mesic tundra with shallow -Carex pools over 100 m away. Limited data on nest initiation indicates that laying begins in the second week of June. The completed clutches were all of five eggs. None of the nests located were successful—predators destroyed them all. The first brood sightings were made 20 July 1979 and 22 July 1980 and females with broods were seen as late as 24 August 1979 and 31 August 1980. Broods were seen mostly on shallow -Carex ponds and in deep- Arctophila portions of basin-complex wetlands. Based on nest and brood observations, minimum nest density was 0.45 and 0.30 nests per square kilometer in 1979 and 1980, respectively.

Molt Migration —A few male King Eiders were seen passing west, 1 August 1980.

Fall Migration —See comments under Common Eider.

SPECTACLED EIDER

Regional Status and Distribution --Spectacled Eiders are "occasional breeders" at Barrow (Pitelka 1974) and "common breeders" at study sites in the outer coastal plain of NPR-A (Derksen et al. in press). Breeding has also been recorded at Storkersen Point (Derksen et al. in press) and in the Prudhoe Bay area (Gavin unpublished). In ANWR, Schmidt (1973) recorded a pair on a pond in the Aichilik River Delta 6 July 1970 and occasional small flocks along the barrier spits of Beaufort Lagoon in late June. Brooks (1915) collected five at Humphrey Point 12-26 June 1914. A pair and a group of two females and one male were seen in mid-June 1979 at Demarcation Point (R. M. Burgess pers. comm.). To the east Salter et al. (1980) reported no records for the Yukon ACP.

CRD Status --Uncommon breeder.

General --Dates of first observation were 1 June 1979 and 5 June 1980. One to two were seen on many dates in the first half of June during both years of study. Drakes left the area by 21 June. Eight females were seen in Chain Lakes 8 July 1979. First brood sighting was 28 July 1979. Three broods were located in 1979 but only one was found in 1980. Females with broods were seen in shallow -Carex and deep -Arctophila wetlands. The last brood sighting was 24 August, 1980.

WHITE-WINGED SCOTER

Regional Status and Distribution --Breeding observed in the interior ACP at Square Lake (northwest of Umiat) (Derksen et al. in press) and Anaktuvuk Pass (Irving 1960). Breeding was not confirmed for the interior coastal plain in the Sagavanirktok River drainage but groups of up to 18 were seen on lakes in late July and early August (Sage 1974). At coastal sites this species is observed as a migrant at Simpson Lagoon (Johnson et al. 1981) and on the Yukon Beaufort Sea coast (Salter et al. 1980). In ANWR there are scattered records from mid-June through early August. In the Beaufort Lagoon area six flew northwest 17 June 1970 (Andersson 1973); single birds and a pair were at Angun Point July 1976 (Martin unpublished); four flew west with Surf Scoters 14 July 1976 (Martin unpublished) and a group of six males and a group of four males were on Beaufort Lagoon 6 and 7 August, respectively. Spindler (1978a) saw four flying west 1 July 1978 at the Okpilak River Delta.

CRD Status --Uncommon migrant.

General --One was seen 1 June 1979 flying east. A pair was seen flying east 5 June 1980 and a male flushed from West Branch 9 June 1980 and flew east. Three males and two females were on West Branch 16 June 1980. On 30 June 1979 nine drakes were seen at the gap in the Brownlow Lagoon reef. On 10 July 1979 a high count of 100-150 was made at Brownlow Point. In 1980, one to five individuals were seen 6-24 July flying along the barrier spits or in the lagoon or Beaufort Sea waters. Direction of flight for these birds is uncertain.

In 1979 there were three records at the end of August: three drakes flying west past Brownlow Point 20 August; five drakes flying east past Brownlow Point 28 August; and one hen flying west 29 August. On 1 September 1980 a drake flew west past Brownlow Point. These data are insufficient to describe the movements of this species along the Beaufort Sea coast (but see Surf Scoter account).

SURF SCOTER

Regional Status and Distribution --More commonly seen in coastal sector of ACP than either of its congeners (Pitelka 1974). Inland in NPR-A a casual visitor (one recorded) at Square Lake (Derksen et al. 1977). Gavin (unpublished) has reported "scoter broods" (not assigned to species) along the Beaufort Sea coast but nesting is not well documented for this species on the ACP. Most records are of migrants: at Storkersen Point they were seen in four of five years of study (Bergman et al. 1977). In ANWR Surf Scoters seem to be regular at Beaufort Lagoon: Andersson (1973) recorded 980 drakes foraging on the lagoon 28 June 1970 and saw flocks of 50-100 passing northwest past Nuvagapak Point at the end of June. Martin (unpublished) saw small numbers of Surf Scoters on four occasions 13 July - 2 August 1974 with a maximum count of 15 flying west past Nuvagapak Point 13 July. There were 70 at the mouth of the Kogotpak River 3 July 1976; six were at Angun Point 16 July 1976; and flocks were seen passing west at Nuvagapak Point 11-18 July (Martin unpublished). Heavy westward movement has been noted on the Yukon coast with over 6200 estimated 10-25 July 1972 going west past Nunaluk Spit (Salter et al. 1980) and Surf Scoters are also locally abundant in flocks in the Canadian Beaufort Sea during the summer (Salter et al. 1980).

CRD Status --Uncommon migrant.

General --In 1979 only one mid-summer record was made, of 18 drakes at Brownlow Lagoon 10 July. However, large flocks of ducks suspected to be scoters were seen flying west over the sea in early July. In 1980 more time was spent watching the coastline during this period and it is clear that there is a westward molt migration of scoters at this time. On 21 June 1980 12 drakes were seen in Brownlow Lagoon; two drakes were seen flying west over the lagoon 24 June 1980; a flock of 35 flew west 28 June; a flock of 53 flew west 2 July. In addition, large flocks of unidentified scoters were seen flying west during this period: two flocks totalling 100 birds 26 June; and about 150 on 2 July. Unidentified scoters in flight were less likely to have been White-wings than Surfs because of their markings. The possibility that they were Black Scoters exists, although this species is less common than the Surf Scoter on the Beaufort Sea coast.

Scoters did not remain at CRD for the molt period. They have been seen infrequently on aerial surveys of Simpson Lagoon in any significant numbers, although 750 south of Pingok Island 25 July 1978 stands out as a notable exception. Hall (1975) observed 200-300 in Harrison Bay in August 1971. We believe that the numbers of scoters passing west of ANWR, based on casual

observation at CRD and records from Beaufort Lagoon (Andersson 1973; J. Levison pers. comm.), are too large to be accounted for by these few observations of Scoter flocks west of Prudhoe Bay.

BLACK SCOTER

Regional Status and Distribution --Status poorly known. Derksen et al (in press) reported four flocks totalling 127 birds flying west past Point McIntyre (Prudhoe Bay) 30 June 1976. On the Yukon Beaufort Sea coast single males were seen at Nunaluk Spit 11, 12, and 28 July 1972, and a flock of four at Clarence Lagoon 21 June 1975 (Salter et al. 1980).

CRD Status --Rare migrant.

General --On 24 June 1980 a flock of 50 flew northwest past the study area. On 10 July 1980 at least one Black Scoter (and probably more) was present among White-winged Scoters swimming in the sea off Brownlow Point. On 29 August 1979 two groups were seen flying west past Brownlow Point: a group of four (three males and a female) and a single male.

RED-BREASTED MERGANSER

Regional Status and Distribution --Breeds on the north side of the Brooks Range in ANWR. Martin (unpublished) recorded a female with brood on the Kongakut River in 1976 and Valkenburg et al. (unpublished) saw a female with young on the Canning River. Salter et al. (1980) reported that this species was an "uncommon summer resident" on the Yukon ACP and confirmed breeding at three sites on the Yukon ACP. In ANWR, on the coastal plain, M. A. Robus (pers. comm.) reported four at Sadlerochit Springs 22 May 1979 and Andersson (1973) saw them frequently in streams in the Beaufort Lagoon area in 1970.

CRD Status --Uncommon visitant, probably rare breeder.

General --Date of first observation was 25 June 1979 when a male and two females were seen flying west over Brownlow Point and 15 were seen loafing on the west spit on the Flaxman Lagoon shore. In 1980 a pair was seen 16 June in the West Branch south of camp and two to three individuals were seen 17-19, 21 June 1980 on the lagoon or on West Branch Flats. On 24 June 1980 five were seen on west spit. There is only one July record in 1979 but this species was seen on four dates in July 1980 with a maximum of ten in the lagoon near West Spit 6 July 1980.

On 14 August 1980 a hen with three downy young was seen on West Branch, just downstream from camp. It is not certain whether the bird nested in the study area or floated downstream from an inland site.

In late August of both years there was an influx of mergansers on the Beaufort Sea and lagoon shores. At this time sexes were difficult to distinguish unless the birds were in flight, but most birds identified to sex were males. On 25 August 1979 a single bird, apparently flightless, was flushed out from under the bank of the Brownlow Lagoon shoreline. This

indicates that a few mergansers, at least, spend their wing molt period along the Beaufort Sea and lagoon shores, fishing or loafing along the barrier spits and islands. Small groups of males were seen flying both east and west in the period 28 August to 5 September in both years. On 1 September 1980 125 were recorded flying west and 55 east; on 2 September 24 flew west and none east; but on 5 September 14 flew east, none west. These probably represent local movements.

ROUGH-LEGGED HAWK

Regional Status and Distribution —Breeds commonly on the Colville River (Kessel and Cade 1958), rarely in Anaktuvuk Pass (Irving 1960) and five pairs were found in the Sagavanirktok River valley in 1970 (Sage 1974). In the Yukon ACP this species nests both on the mainland and on Herschel Island (Salter et al. 1980). In ANWR intensive surveys in 1973 indicated about 20 active nests north of the divide but nesting populations of this species are known to fluctuate widely between years and enough nesting habitat is available so that the population could reach double that number in a "high year" (D. G. Roseneau pers. comm.). Nest sites are located in the Brooks Range and northern foothills, but sightings on the outer ACP are not uncommon in ANWR. One was seen at Humphrey Point 13 May 1914 and one at Demarcation Point 24 May 1914 (Brooks, 1915); one or two were seen 16 km up the Sadlerochit River on three occasions 16-22 May 1979 (M. A. Robus pers. comm.); single birds were seen at Demarcation Point 14, 18, and 20 May 1979 (R. M. Burgess pers. comm) and Spindler (1978a) reported two on 4 June 1978 at the Okpilak River Delta. Although most records are from early summer, both Andersson (1973) and Martin (unpublished) observed Rough-legged Hawks in the Beaufort Lagoon area in July.

CRD Status —Rare visitant.

General —One light phase bird was seen 9 June 1980.

MARSH HAWK

Regional Status and Distribution —Kessel and Gibson (1978) termed this species a "rare migrant, summer visitant, and possible breeder in the Brooks Range and northern foothills." Evidence for breeding on the ACP is slight; a defensive pair was observed at Sagavanirktok/Lupine Rivers 31 July 1975 (Kessel and Gibson 1978). Salter et al. (1980) termed this species an "uncommon visitor" to the Yukon ACP and reported no nesting. In ANWR it appears to be an infrequent spring visitor to the coastal plain near the mountains. At Demarcation Point two were seen 20 May and one or two were seen on four more occasions up until 8 June; one was seen 21 July and single birds were seen on eight days during the period 9-24 August (R. M. Burgess pers. comm.). Andersson (1975) recorded seven observations in the Beaufort Lagoon area from mid-June to early July 1970, all female or immature. On 12 May 1979 one was seen at 1 km Sadlerochit River; a male was seen at Sad-

lerochit Springs 22 May 1979 and on 27 May 1979 two were seen between 16 km Sadlerochit River and Sadlerochit Springs (M. A. Robus pers. comm.).
CRD Status —Rare visitant.
General —One female or immature was seen 23 August 1979 and a female or immature was seen 15 August 1970. Both birds appeared to be moving through the study area.

GYRFALCON
Regional Status and Distribution —Widespread breeding bird across the arctic slope. In 1973 approximately 12 active nests were located in ANWR north of the continental divide (D. G. Roseneau pers. comm.). Gyrfalcons are known to breed on the Canning River near Red Hill and in the vicinity of Sadlerochit Springs. In the Yukon ACP Salter et al. (1980) located 22 nests in their study area and found Gyrfalcons "regularly along the coast in fall." Andersson (1973) recorded a single bird at Pokok Lagoon 2 July 1970.
CRD Status —Uncommon fall visitant.
General —One was seen 8 August 1979 but in 1980 we obtained more records. Single birds were seen on eight dates in the period 2 August - 5 September 1980. It is impossible to determine whether these were different birds or not. In most cases our observations suggested that the bird was using the area—it was seen perched and hunting over the West Branch Flats—so a single bird may have been involved.

PEREGRINE FALCON
Regional Status and Distribution —Well documented breeding areas on the arctic slope include the Colville River and the Sagavanirktok River at Franklin Bluffs. In ANWR there is relatively little suitable nesting habitat (D. G. Roseneau pers. comm.). There are perhaps 20 known historical nest sites in ANWR but in intensive surveys in 1973 the only active nests found were three on the Canning River, which were not used in subsequent years (D. G. Roseneau pers. comm.).
CRD Status— Rare summer visitant and uncommon fall migrant.
General —All of our 1979 records and most of our 1980 records are from late summer and fall. In 1980, however, we had three June sightings: one flying east across the barrier spit at Brownlow Point 2 June; one adult which landed briefly on the east side of Finger Lake 17 June; and one flying west across West Branch Flats 21 June. We had only one definite July record; a bird startled from below the river bluff of the West Branch 22 July 1979. An adult was seen 1 August 1979 flying along the bluffs on the east side of Flaxman Lagoon. An immature female was seen three times near Brownlow Point 19 August 1979 and a similarly plumaged individual (or individuals) was seen 28, 29 and 30 August at or near Brownlow Point; one was flying north along the West Branch 31 August 1979. In August and September 1980 four definite Peregrine sightings were made: one 20 August, one 25 August, and one

2 September were all juveniles and all flying east; an adult was seen 22 August flying upriver at the mouth of West Branch.

In aggregate, these sightings and others along the ANWR coast in fall (J. Levison pers. comm.) suggest that there is a coastal movement of Peregrine Falcons and that the coastal corridor is important for this species. The number of records far exceeds that which would be expected if only the small breeding population in ANWR were involved, so it is likely that some of these birds are from breeding areas farther west.

AMERICAN KESTREL

Regional Status and Distribution --Appears to be a rare straggler on the eastern ACP. One was seen inland on the Yukon ACP 4 May 1974 (Salter et al. 1980). One was seen at Nuvagapak Point (Beaufort Lagoon) in late May 1980 (J. Levison, pers. comm.).

CRD Status -Casual visitant.

General --A male was at Brownlow Point 27 May 1980. It used the DEW-line building as shelter and appeared to have caught one or two Snow Buntings.

WILLOW PTARMIGAN

Regional Status and Distribution --The relative abundance and distribution of Willow and Rock Ptarmigans on the eastern ACP is not well known. Pitelka (1974) citing T. J. Cade termed the Willow an "occasional breeder" coastally at the Colville River Delta and Pitt Point. In ANWR it appears to be less common on the immediate coast than Rock Ptarmigan, although where sedge tussock vegetation is present near the coast the Willow also seems to be common. At Okpilak River Delta the Willow was equal in abundance to the Rock on the upland sedge-tussock study plot (Spindler 1978a); Brooks (1915) found the Willow abundant at Camden Bay in August 1913 and Dixon (1943) found the Willow breeding at Humphrey Point where they were present until September or October, after which they left the area presumably for the mountains; Willow Ptarmigan were common along the Sadlerochit River in 1979 and broods were seen within 16 km of the coast (M. A. Robus pers. comm.). At Beaufort Lagoon, Willows were less common than Rocks in 1976 (Martin unpublished) but Andersson (1973) believed them to be nesting there in 1970. Brooks (1915) recorded Willows at Demarcation Point early April to mid-May after which they disappeared, presumably going inland. Salter et al. (1980) found this species associated with tussock-heath vegetation on the Yukon ACP and found it breeding wherever suitable habitat was present.

CRD Status --Uncommon visitant, possibly uncommon breeder.

General --Willow Ptarmigans were more abundant at CRD in 1980 than in 1979. In 1979 a male was seen 30 May and displaying males were recorded 13 and 22 June. These were the only spring records; on 28 and 30 August 1979 flocks of 30 and nine were seen about 1 km south of Brownlow Point. In 1980, single males, pairs, or small groups (up to four individuals) were

seen on numerous occasions 27 May through 20 July with most observations in late May and early June. On 29 July 1980 a hen ptarmigan with nine young, thought to be this species, was seen south of the mosaic study plot. No late summer flocking was observed in 1980.

Our observations in early and late summer 1979 and Brooks' observations (cited above) at Demarcation Point suggest that Willows may use the coastal area in early spring because the wind swept bluffs may provide easier forage than the snow-drifted riparian willow thickets in the interior coastal plain. In summer these birds may retreat inland a few kilometers to nest. If snow cover is a factor in early spring distribution on the ACP, then regional and inter-year differences in pattern of snow melt might account for inter-year differences in ptarmigan abundance at the Canning River Delta.

ROCK PTARMIGAN

Regional Status and Distribution —Pitelka (1974) termed the Rock Ptarmigan a "visitor coastally, regular breeder inland" and Bergman et al. (1977) termed it a "winter visitor" at Storkersen Point. In ANWR and to the east, the Rock is a common summer resident on the coast; it is less certain how commonly it breeds. It was found to be more common than Willow Ptarmigan at Okpilak River Delta (Spindler 1978a), Beaufort Lagoon (Andersson 1973; Martin unpublished), and "from Camden Bay to the MacKenzie River Delta" (Brooks 1915). None of these studies actually reported nests, with the exception of Spindler (1978a). In the interior coastal plain the Rock is apparently less numerous than the Willow, both in ANWR (Martin unpublished) along the Aichilik River and to the west in the Sagavanirktok River drainage (Sage 1974). In the Yukon ACP Rocks were less numerous overall than Willows but more coastal records were cited for Rocks than Willows, and Rocks tended to use steep hillsides whereas Willows used flat tussock-heath tundra (Salter et al. 1980).

CRD Status —Common visitant, uncommon to common breeder.

Spring —Rock Ptarmigans were present on the study area in both years by the time observers arrived. In both years they were recorded most often in June when males were conspicuous in display. They were found often on wind-swept coastal or lake shore bluffs in late May.

Breeding —Territorial display by males peaked during the last week of May and first ten days of June. Egg laying began by 8-10 June, based on two nests located in 1980 and a seven-egg clutch that hatched 9 July 1980 probably was initiated about 10 June (allowing 22 days for incubation and a one-day egg laying interval). No nests were found in 1979; in 1980 Rocks were generally more abundant and three nests were found: one in the upland plot with clutch of nine; one in the mosaic with clutch of seven; and one in a highly polygonized area near Finger Lake. One nest was not relocated, one was depredated and one hatched successfully 9 July 1980 (two of seven eggs remained unpipped). We saw no broods in 1979; in 1980 we saw broods 13-27

July, on the latter date the young were already fledged. Males molt and are very inconspicuous during July.
Fall —Flocking was observed by the first week in August, beginning with small flocks of six to 20 birds. By the end of August, flocks were sometimes quite large with groups of 35-50 seen 26-30 August 1979 and 1980. Ptarmigans seemed to increase at CRD at the end of summer. This observation may be due to a real influx on the coast or it may be due to increased conspicuousness of adults and juveniles as they flock together in fall.

SANDHILL CRANE
Regional Status and Distribution —Appears to be very uncommon over the eastern portion of the ACP. Not reported by Sage (1974) inland in the Sagavanirktok River drainage and termed a "casual visitor" at Island Lake, Meade River (one record), Square Lake (one record) in NPR-A and at Storkersen Point (Derksen et al., in press). In ANWR they are perhaps more common. At the Okpilak River Delta Spindler (1978a) recorded four on 2 June 1978, ten on 5 June 1978, and estimated that six spent the summer in the area. He also suspected breeding in the previous year based on the discovery of a weathered crane egg-shell. In the Beaufort Lagoon area groups of two to four have been seen in 1970, 1974, and 1976 (Andersson, 1973; Martin unpublished) in late June and early July. Cranes were present at Demarcation Point in both 1978 and 1979 and at least one pair bred there in 1979 (R. M. Burgess, pers. comm.). Salter et al. (1980) termed this species an uncommon visitor and had no evidence of breeding, although cranes were present throughout the summer near the Beaufort Sea coast.
CRD Status —Uncommon migrant, visitant.
General —In 1979 only one crane was seen, on 9 June as it flew northwest over the area. In 1980 we had nine records of one to two birds each during the period 3-30 June. Most were seen flying overhead, but they were seen on the ground in the flooded marsh of West Branch Flats and at Brownlow Point.

AMERICAN GOLDEN PLOVER
Regional Status and Distribution —Regular breeder across the arctic slope of Alaska (Pitelka 1974; Derksen et al. 1980). In wet tundra areas it generally is one of the least common shorebirds (Spindler 1978a; Myers and Pitelka 1980) but is more numerous in upland tundra (Sage 1974; Hanson and Eberhardt 1980; Myers and Pitelka 1980).
CRD Status —Fairly common breeder, very common migrant.
Spring Migration —Salter et al. (1980) reported a first arrival date of 17 May in the Yukon ACP. At CRD date of first observation was 26 May in 1979 and 1980. At Demarcation Point in 1979, Golden Plovers also arrived on this date (R. M. Burgess pers. comm.). Spring migration was subtle; no flocks were observed, only pairs and single birds on the tundra.
Breeding —Territorial display was first noted 27 May 1979 and 29 May 1980.

Copulatory behavior was noted 30 May 1980. Flight displays (the stiff-winged "bat-flight") were common until about 12 June.

Three nests found during egg laying and two additional nests back-dated from hatch indicate that incubation starts around 15-20 June with egg laying beginning as early as 9 June. Nine nests were located in the two years of study, most on upland tundra, especially frost boil sedge meadow. The two nests found in 1980 were on dry mounds, one of which was located in the mosaic plot. Four of six nests found in 1979 were on frost boils. Known hatching dates are 17 and 19 July in 1979 and 10 July 1980. Downy young were found as late as 28 July (1979) and first fledged young were found 3 August (1980).

The breeding population appeared to be much lower in 1980 than in 1979. None bred in or near the upland plot in 1980, where three nests were located in 1979.

Casual observation and quantitative data from the plot censuses indicate that habitat use changes between the nesting and rearing period. Golden Plovers use upland tundra and make very little use of lowland tundra early in the season and for nesting. However, broods were often found in low wet areas. Some use of dry areas continued post-hatching.

Fall Migration —Small flocks of adults were seen as early as 8 July (1979) and 27 June (1980). By mid-July, flocks of adults were very common and heavy eastward movement of small (eight to 20 individuals) flocks of adults was noted during the last week of July. In both years adults declined in abundance during the first week of August. A second peak in Golden Plover abundance and migratory movement consisting almost entirely of juveniles took place 8-20 August 1979 and 16-25 August 1980. The end of the movement was abrupt with few birds seen after those dates.

Interestingly, the relative magnitude of the "adult peak" and the "juvenile peak" is reversed in the two years. In 1979 the peak of adults which ended 30 July is barely perceptible in the plot census results, wereas the peak of juveniles after 10 August is marked. In 1980 the lowland plot had a peak of adult movement 25-31 July and a barely perceptible influx of juveniles in mid August. In upland, the 1980 peak of juveniles was still the larger but it was of short duration (one census date) and it was only two thirds the magnitude of the peak in 1979. On the whole it appears that less juveniles moved through the area in 1980 than in 1979.

The heavy use of low wet tundra habitat by both adults and juveniles in fall migration is striking in that most authors assign the Golden Plover to upland habitats only. At Barrow, late summer use of wet tundra was observed in 1979 but this phenomenon did not occur in 1976 (Myers and Pitelka 1980).

Date of last observation was 5 September 1980.

BLACK-BELLIED PLOVER

Regional Status and Distribution --Appears to be uncommon on the Alaska ACP, perhaps more common to the west and inland. Breeding has been recorded at all the NPR-A study sites (Derksen et al. in press) with highest seasonal densities at Meade River Delta and at East Long Lake in 1977. Black-bellies also nest at Atkasook (Myers and Pitelka 1980) and coastally at the Colville River Delta (Kessel and Cade 1958) and Storkersen Point (Derksen et al. in press) but nowhere are they reported in high densities. In the Yukon ACP, Black-bellies are described as uncommon migrants with no evidence to suggest breeding (Salter et al. 1980). In ANWR there is a scattering of early summer records on the coast. One was seen at Okpilak River Delta flying east, 4 June 1978 (Spindler 1978a); at Beaufort Lagoon one was seen 14 June 1970 (Andersson 1973); at Demarcation Point one to nine birds were seen on five dates 20 May to 7 June 1979 (R. M. Burgess pers. comm.).

CRD Status --Rare spring migrant and breeder, common fall migrant.

Spring Migration --Little or no evident spring movement. One or two individuals recorded 8, 9, 15 and 25 June 1979, and 4, 5, 8, 18 June 1980.

Breeding --On 12 July 1980 on the west side of West Branch an adult gave intense distraction displays including a broken-wing act. Prolonged observation failed to reveal young or nest but we have no doubt that this was a nesting bird. This constitutes the only breeding record for the study area.

Fall Migration --Starting in mid-July 1979 small flocks of adults (3-13) were seen in wet tundra areas and flying east over the study area. By 28 July numbers began to increase. In 1980, a few July records were made of three or four individuals, but numbers really began to increase 30 July. In 1979, peak movement was 30 July through 15 August. Maximum flock size of 40 was recorded 29 July and 42 flying east 14 August. Heavy eastward movement continued through 15 August. The movement was not reflected in the plot censuses since these birds were using mostly littoral habitat; flocks were commonly seen in West Branch Flats and on tidal mud flats near Ruth Island. After 20 August most birds in the area were juveniles; eastward movement continued through 31 August. Groups of 20 were seen on West Branch Flats and ten to 15 were on the lowland study plot (equals 30-55 per square kilometer) at the end of August.

In 1980 there was less of a flight of Black-bellies. Peak movement was in the first week of August for adults. They were seen on the lowland plot (37 per square kilometer on 2 August) and the West Branch Flats (20 per square kilometer on 3 August). There was a decline in mid-August and then a second peak 20-25 August. At this time juveniles were present but still outnumbered by adults. Again, littoral habitat such as West Branch Flats, tidal mud flats, and even the barrier beaches were heavily used and also wet tundra (as exemplified by the lowland plot). Highest density was 50 per square kilometer on West Branch Flats census 22 August. A few juveniles were still present 6 September. As in the case of Golden Plovers, there seemed to be far fewer juveniles moving through the area in 1980 than in 1979.

HUDSONIAN GODWIT

Regional Status and Distribution —Not previously recorded on the Alaska Beaufort Sea coast east of Barrow (Kessel and Gibson 1978). On the Yukon ACP it is a rare visitor, with "singles and pairs observed between the Blow River and Clarence Lagoon 30 May and 2 August, but no evidence of nesting" (Salter et al. 1980).

CRD Status —Casual visitant.

General —One was seen on West Branch Flats 5 July 1980. Rusty belly, bicolored bill, and slaty gray under-wings were all clearly visible.

BAR-TAILED GODWIT

Regional Status and Distribution —Nests fairly commonly in interior ACP in NPR-A, such as Singiluk and Square Lake (Derksen et al. in press) and perhaps on the Colville River Delta (Kessel and Cade 1958). Irving (1960) believed that they were regular migrants through Anaktuvuk Pass in small numbers. To the east they appear to be much rarer: two were seen at Storkersen Point in 1974 (Bergman et al 1977) and one in 1978 (D. B. McDonald unpublished notes). No documented records exist in the literature for ANWR. Salter et al. (1980) listed no records for the Yukon ACP.

CRD Status —Rare migrant and visitant.

General —Seven records over the two years of study at CRD. In 1979, one was observed 5 August as it fed on West Branch Flats. Two were seen flying low over Chain Lakes, 14 August 1979. In 1979, Bar-tailed Godwits were seen four times in June: one on 4 June, on exposed shoreline mud at the mouth of the West Branch; two flew south over West Branch Flats with a Whimbrel, 6 June; one was seen flying over Lagoon Marsh and one was seen flying southwest of camp, 16 June; one was seen flying over camp, 29 June.

WHIMBREL

Regional Status and Distribution —Uncommon in the western ACP, possibly breeding along the Colville River (Kessel and Cade 1958) and probably on the Colville River Delta (Hall 1972). It was only a casual visitor at Square Lake in interior NPR-A and went unrecorded at other NPR-A study sites (Derksen et al., in press). In the central ACP, Sage (1974) believed this species bred in the Lupine River Valley and Gavin (1973) believed breeding occurred south of Franklin Bluffs but did not record this species near the coast. In ANWR there are some coastal records: at Demarcation Point seven were seen 19 July 1978 and one 4 August 1978 (D. M. Troy pers. comm.); at Beaufort Lagoon in 1970 display was heard 20-29 June, a flock of five was seen 5 June, a flock of eight near Pokok Bay 2 July (Andersson 1973); at Beaufort Lagoon in 1974 two were seen 27 July and 3 August (Martin unpublished). In the Brooks Range at Mancha Creek Whimbrels were a common breeder in moist tussock meadow (Spindler 1980). In the Yukon ACP the species was observed inland and three nests were found in tussock heath tun-

dra; there were occasional records from coastal localities (Salter et al. 1980). This species may breed more commonly in the arctic foothills than records suggest—few ornithological observations have been made in these areas.

CRD Status —Uncommon migrant.

General —This species was more abundant in 1979 than in 1980. Our earliest record is of a single bird 6 June 1979 and one on 7 June 1980. In 1979 single birds were seen on six dates between 10 June and 2 July. In early July 1979 there was a notable influx. A flock of nine was seen flying over Brownlow Point 4 July; a flock of 16 and a flock of 15 was seen feeding in wet tundra 8 July. One to seven birds were seen daily 11-15 July and during the period 25 July to 20 August single birds were seen on five occasions.

In 1980 only a faint echo of this mid-summer movement was noted. At least two were heard flying overhead 26 June and 17 landed in the mosaic plot 27 June, flying in from the southeast; 12 flew west 10 July and an undetermined number was heard in flight 11 July and 15 August.

All ANWR records from the ACP center around late June to early August. This coastal movement of Whimbrels is not explicable in terms of what we currently know about their breeding range.

RUDDY TURNSTONE

Regional status and Distribution —Apparently a fairly common breeder coastally from Barrow (Myers and Pitelka 1980) to Colville River Delta (Kessel and Cade 1958) to the Prudhoe Bay area (Bergman et al. 1977) but is termed an "uncommon migrant" not breeder in the Yukon ACP (Salter et al. 1980). Inland, Turnstones are uncommon or absent; they were not recorded at inland sites in NPR-A (Derksen et al., in press) or in the Sagavanirktok River Valley (Sage 1974) although migrants were recorded at Anaktuvuk Pass (Irving 1960). In ANWR this species is fairly common at Beaufort Lagoon with apparently nesting pairs at the Aichilik Delta and on gravel bars in the lower Aichilik River (Martin unpublished) and at the Kogotpak River (Andersson 1973). Spindler (1978a) suspected breeding at the Okpilak River Delta, based on defensive behavior of adults.

CRD Status —Fairly common breeder, uncommon migrant.

Spring Migration —Turnstones are generally one of the first shorebirds to arrive on the Arctic Coastal Plain. Salter et al. (1980) recorded the first 18 May on the Yukon ACP. A flock of six was present at Lonely near Cape Halkett on the Beaufort Sea coast 25 May 1978 when the tundra and sea were completely frozen (Martin unpublished). At CRD, Turnstones were present by or before 27 May 1979 and 29 May 1980. No pronounced spring migration was noted. In late May and early June, Turnstone activity was concentrated on dunes and barrens adjacent to the West Branch.

Breeding —One nest was located in 1979 and eight located in 1980. Five of these eight nests were on barren floodplain of the West Branch; the other three were on a dry bluff overlooking West Branch, on a salt influenced bar-

ren adjacent to Brownlow Lagoon, and the last (which was at the same site as the 1979 nest) was on a dry hummocky slope with frost boils between West Branch Flats and the upland study plot. In 1980, copulatory behavior was seen 7 June and egg laying was in progress at this time. Incubation began 11-16 June and known hatch dates were between 3 and 8 July. One nest which was incubated beginning 30 June had only three eggs which hatched successfully 21 July; the late date of initiation and small clutch size suggest that this was a renest. Five of the eight nests found in 1980 were successfull; two were depredated; fate of one is unknown.

Ruddy Turnstones were extremely aggressive in defense of their nesting territory, especially against aerial predators such as Jaegers. In one case a Turnstone was seen to pursue a low flying aircraft.

After hatch adults and young Turnstones used the river shore and bay shore of the West Branch Flats. First fledged young were seen 2 August. In early August family groups and young dispersed along the Flaxman Lagoon shore and up to the barrier spits at Brownlow Point. On one occasion a family group was seen on a lake shore near West Branch Flats, but wet tundra was seldom used by this species.

Fall Migration —In both years small numbers of adults (groups of one to four) were seen flying east past the study area in late July and early August. In 1980 virtually all adults had left the study area by 3 August. Juveniles were present in small numbers up until the end of August and were primarily seen on the gravel beaches of Brownlow Point and the barrier spits. Last date of observation was 27 August 1979 and 25 August 1980.

NORTHERN PHALAROPE

Regional Status and Distribution ----Occasional breeder at Barrow (Pitelka 1974) and at Storkersen Point (Bergman et al. 1977). Inland in NPR-A they are more common than Red Phalaropes, breeding at Square Lake and Singiluk (Derksen et al. in press). Sage (1974) reported them breeding inland in the Sagavanirktok River Valley. They seem to be progressively more common to the east on the ACP. Andersson (1973) reported Northerns outnumbered Reds in ponds on the Aichilik River Delta but implied that Reds were more numerous in marshy tundra. Martin (unpublished) considered them slightly less common than Reds at Beaufort Lagoon in 1976. At the Okpilak River Delta, Northerns achieved the highest breeding density of any shorebird although seasonal density of Red Phalarope exceeded that of Northern Phalaropes (Spindler 1978a). At Demarcation Point in 1979, Northern Phalarope numbers equalled or exceeded Red Phalaropes in all habitats (R. M. Burgess pers. comm.). In the Yukon ACP Northerns are much more common than Reds (Salter et al. 1980).

Phalaropes use littoral habitat extensively in late summer and the east-west gradient in species composition of phalarope flocks is striking. At Barrow, Northern Phalaropes are rarely seen and the flocks are almost entirely composed of Red Phalaropes (Connors 1977). At Simpson Lagoon (John-

son et al. 1977) ratio of Northern to Red Phalarope averaged 1:4 during the month of August. In the Yukon Beaufort Sea coast, by contrast, Northerns outnumbered Reds by a ratio of 20:1 (Salter et al. 1980).

CRD Status —Uncommon to fairly common breeder, abundant migrant.

Spring Migration —Northern Phalaropes arrive in ANWR at the end of May or beginning of June. In 1979 at Demarcation Bay one was seen 21 May (R. M. Burgess, pers. comm.) and at the Okpilak River delta in 1978 first observation was 7 June (Spindler 1978a). At CRD date of first observation was 30 May 1979 and 5 June 1980. Meltwater pools and runoff streams became available for Phalaropes about 1 June in 1979 but not until about 8 June in 1980. Prior to general melt off, Phalaropes were often seen flying rapidly over the tundra.

Breeding —Eleven Northern Phalarope nests were found in the two years of study. Earliest known nest initiation date was a partially completed (one egg) clutch found 15 June 1979. Back dating from known dates of hatch (based on an incubation period of 20 days) for five other nests indicates clutch completion dates 18-26 June with a median of 22 June. Hatch dates were from 8-18 July. Northern Phalaropes nested in all three study plots, although only one nest was found in the upland and it failed to produce young. All other nests were in relatively wet areas. Three were on the edge of fairly deep (over 30 cm) ice wedge pools, two were in flat homogenous wet meadow, two were on the edge of shallow polygon troughs with standing water, two were on the edge of shallow ponds (one on a mossy islet in a polygon center pond), and one was on a dry rim of a polygon in a wet-dry mosaic area with deeply incised troughs. In general, Northerns were more apt to use "mosaic" area with deep ice-wedge pools than were Reds, which preferred marshy tundra with shallow ponds. Accordingly, more Northerns nested in the mosaic study plot than the lowland, and more Reds nested in the lowland than the mosaic. In general, Northerns seemed to be less numerous in 1980 than in 1979 and it would be interesting to see if the mosaic would support more Northerns in a "high year".

Post-breeding —Females began flocking in late June and early July. Large flocks (50-75) were seen on large deep -Arctophila lakes and on West Branch Flats. In 1979, ratios of Northerns to Reds taken from flocks seen in lakes in early July was estimated to be about 3:1. On five dates from 25 June to 12 July 1980, when large flocks of female Phalaropes were on West Branch Flats, average ratio of Northerns to Reds was 4:1. Peak use of the Flats was 27 June to 5 July when densities reached over 500 per square kilometer in this small area. These flocks diminished by 25 July in both years.

Following hatch of young, adult males and then fledged juveniles move to the sea coast and flock. Figure V-1 shows how numbers of Phalaropes changed at the Brownlow Point count area in 1979. The peak in late August consisted almost entirely of juveniles as has been reported for Red Phalaropes at Barrow. In 1980 the peak of Phalarope use of littoral habitat came early (5-11 August) and was of a much lesser magnitude than the concentrations seen in 1979.

On 8 August 1979 Northern Phalaropes were seen feeding on cnidarians which were in abundant supply on the Flaxman Lagoon shore. Similar massive die offs of these invertebrates were not noted in 1980. Two alternative hypotheses may be advanced for the virtual absence of juvenile phalarope flocks on the CRD coast in mid-late August 1980: 1) local food supply was not as abundant as in 1979 as indicated by the absence of the cnidarians which tend to be indicators of the presence of other zooplankton as well (G. Divoky pers. comm.) or 2) area-wide breeding failure resulted in very low production of juveniles. Our data are not conclusive, but do indicate lowered breeding effort in 1980.

Phalarope flocks dwindled by the third week in August although a few birds were present in the Beaufort Sea until observations ceased 4 September 1980 (see Red Phalarope species account).

RED PHALAROPE

Regional Status and Distribution —In coastal locations from Barrow to Prudhoe Bay the Red Phalarope is abundant and often is among the highest density breeding birds in ACP locations (Bergman et al. 1977; Myers and Pitelka 1980; Derksen et al. in press). Inland, however, it is much rarer although it probably breeds into the interior coastal plain in NPR-A (Derksen et al., in press). It also becomes progressively less common to the east. In ANWR, at the Okpilak River Delta nesting density in most favored habitat was estimated at 14 nests per square kilometer (Spindler 1978a) while at Beaufort Lagoon it was estimated at ten per square kilometer (Andersson 1973). Salter et al. (1980) termed it an "uncommon summer resident" in the Yukon ACP and cited only one nest (see also species account for Northern Phalarope).

CRD Status —Common to abundant breeder, common migrant.

Spring Migration —Date of first observation was 27 May 1979 and 5 June 1980. At Demarcation Bay it was first observed 3 June 1979 (R. M. Burgess pers. comm.) and at the Okpilak River Delta it was first observed 5 June 1978 (Spindler 1978a). Little definite migration activity was noted; in both years Phalaropes were seen flying over the tundra (in various directions) several days before general melt provided pools for foraging (this occurred about 7 June 1979 and 8 June 1980). In 1979, 86 were counted in a loose flock in an open lead which developed near the gap in the Brownlow Lagoon barrier spit on 10 June. This is the only occasion when pre-breeding staging was noted.

Breeding —A total of 42 nests was found in the two years of study. Nests were located in lowland tundra, both in low-relief polygonal area (e.g., the lowland study plot) and non-polygonized homogenous flooded meadow (as found in large drained lake basins). Lesser numbers were present in mosaic and upland tundra areas, density probably related to the amount of pond area. Red Phalaropes achieved the highest density of any shorebird. They were abundant nesters on the lowland plot, nearly doubling their numbers from 26

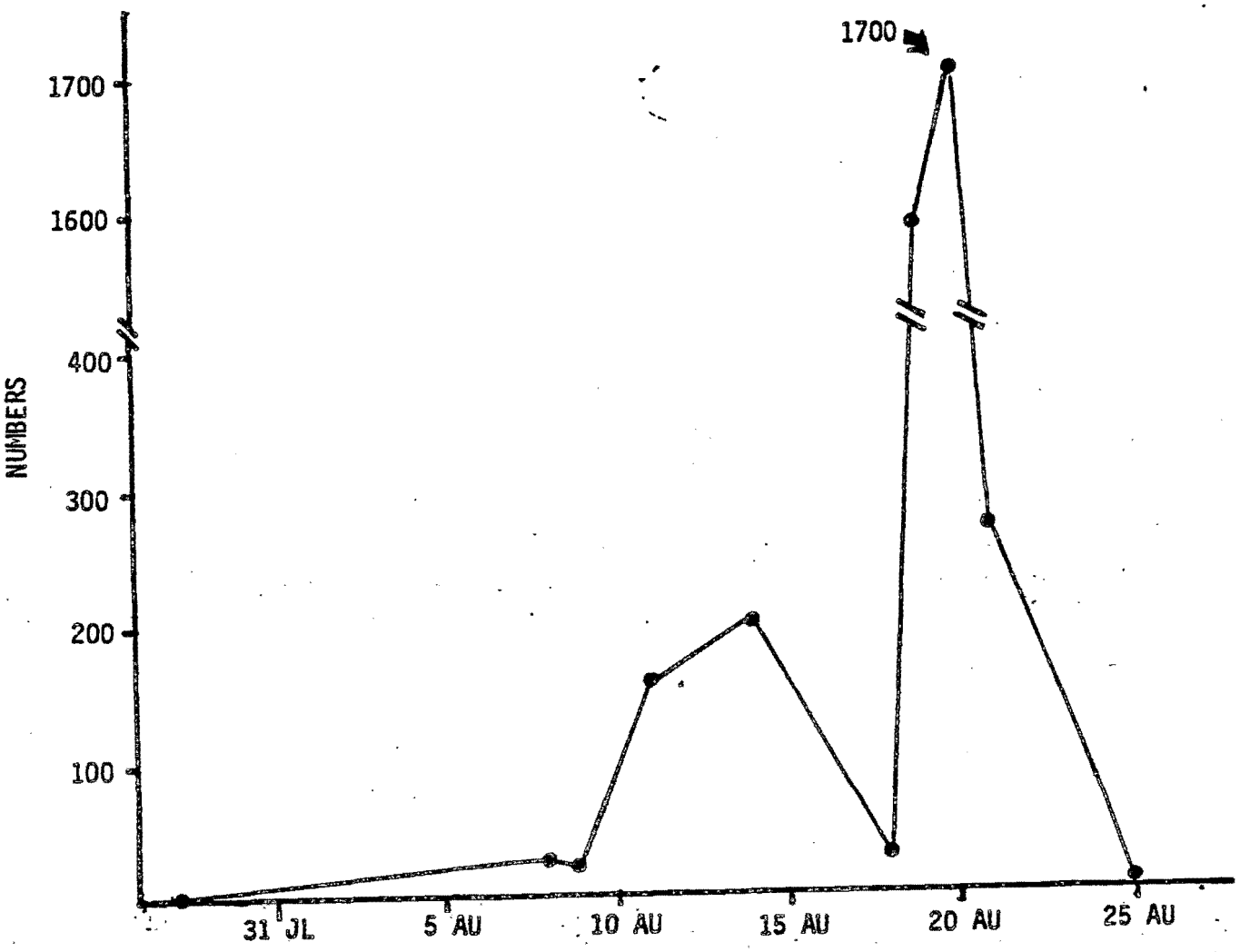


Figure V-1. Number of phalaropes (both species) seen on Brownlow Point coastal survey, Canning River Delta, July-August, 1979.

nests per square kilometer in 1979 to 42 nests per square kilometer in 1980. In 1979, courtship activity peaked 10-15 June. For eight nests in 1979 with known dates of clutch completion and/or hatch date known and clutch back-dated, clutch completion dates were 12 June to 2 July with a median date of about 19 June. In 1980, of eight nests for which we had good information, range of clutch completion dates was 13-30 June, with a median about 21 June. Dates of hatch were 1-21 July with peak of hatching in the second or third week of July. Hatch in Red Phalaropes seemed less synchronous than in such shorebirds as Semipalmated Sandpipers. First fledged juveniles were seen in early August and they were common on the lowland plot 2-10 August.
Post-breeding —Peak numbers of Red Phalaropes on the tundra occurred in mid- to late June. By early July females began to leave the tundra and flock with female Northern Phalaropes on lakes and on the West Branch Flats. Red Phalaropes were seen with Northerns in littoral habitats in late summer (see species account for Northern Phalarope) but in 1979 when large numbers of juvenile Phalaropes were present in the sea at Brownlow Point, only five to ten percent were Reds, in spite of the fact that Reds were much more numerous as breeding birds in the area. Canning River Delta appears to be near the eastern limit of the breeding area for Reds and most local breeders must stage in areas further west in late summer (Connors 1974; Johnson et al. 1981). Northern Phalaropes, on the other hand, appear to move mainly east in the fall along the Beaufort Sea coast (Salter et al. 1980) and it is likely that birds seen on the coast in fall come from breeding sites inland as well as locally.

COMMON SNIPE
Regional Status and Distribution —Breeds in the foothills in the Colville River area (Kessel and Cade 1958) and aerial display has been noted at interior coastal plain sites such as Square Lake (Derksen et al. in press; Martin unpublished) and Atigun River Valley (Sage 1974). In ANWR, flight displays were heard frequently at Eagle Creek/Canning River in the Brooks Range (Valkenburg et al. unpublished) and 22 miles up the Okpilak River (Spindler 1978a). Snipe were seen at Demarcation Point in aerial display 16-24 June 1979 (R. M. Burgess pers. comm.) and were common along the Sadlerochit River in 1979 (M. A. Robus pers. comm.). In the Yukon ACP, flight displays were seen at many coastal locations although no nests were actually found (Salter et al. 1980).
CRD Status —Rare visitant. Probably an uncommon but regular late summer visitant from breeding sites slightly inland.
General —Single birds were seen 15, 17, 23, and 28 August 1979; one was seen 21 August 1980.

LONG-BILLED DOWITCHER

Regional Status and Distribution —Occasional breeder at Barrow but very common late summer migrant (Myers and Pitelka 1980). Breeds inland at Square Lake (Derksen et al., in press), Umiat (Kessel and Cade 1958), Atkasook (Myers and Pitelka 1980) and coastally at the Meade River Delta and East Long Lake (Derksen et al., in press). Nests of this species are difficult to locate and breeding may be more widespread than believed. Sage (1974) recorded a pair with young south of Franklin Bluffs. In the Yukon ACP it is an "uncommon summer resident" and while no nests were found, distraction display by an adult indicated that nesting had occurred (Salter et al. 1980). In ANWR, Spindler (1979a) recorded a nest with two eggs found 16 July 1978.

CRD Status —Uncommon to rare spring migrant, rare breeder, common to abundant fall migrant.

Spring Migration —Arrived later than other shorebirds--first observation date was 8 June 1978 and 5 June 1980. Spindler (1978a) recorded the first 5 June 1978 at Okpilak River Delta and one was seen 1 June 1979 at 16 km Sadlerochit River (M. A. Robus pers. comm.). The pattern of abundance in spring at CRD was somewhat different in the two years of study. In 1979 a few birds were seen 9-13 June and display flight calls were heard during this period after which there was a hiatus when none were recorded until 23 June. At that time three were seen and a second wave of Dowitchers seemed to begin 28 June; four were seen on that date and display flight calls heard once again. From 29 June to mid-July this species was seen more frequently. Flocks of up to 23 birds were seen in wet tundra and small flocks were seen flying east 17 July.

In 1980 this species seemed to be present in low numbers 5-26 June. One or two were heard or seen on 13 days during this period; 22 were seen 27 June, most in flocks of two to eight flying east. Adult Dowitchers were still present in low numbers 30 June but the movement declined in the first days of July. The occurrence of a second influx at the end of June was apparent in both years but more obvious in 1979.

Breeding —A highly defensive adult undoubtedly with young near by was seen on the lowland study plot 19 July 1979, and what was probably the same bird was found with at least one downy chick 23 July in Corner Marsh.

Fall Migration —A small eastward flight of adults (see above) occurred in late June to mid-July in both years. In 1979 Dowitchers were present in moderate numbers in late July (e.g. a flock of 16 and flock of five, 29 July), but in 1980 few were seen in July. A slight increase was noted at the end of July 1980: a flock of ten 31 July; two adults on the mosaic plot 31 July.

In 1979, beginning about 10 August juveniles began to flood the area. Numbers peaked during the period 20-28 August when they were the most common shorebird on the tundra and up to 100 were seen in flooded tundra adjacent to camp. Small flocks were seen in wet tundra and flying east over the study area 10-29 August 1979.

In 1980 the flight of juveniles came later and was of lesser magnitude. Beginning abruptly 19 August, when about 100 were seen flying east, movement continued to be heavy until 25 August after which numbers diminished slightly.

By 29 August there were only a few flocks present. Total numbers seen on the lowland study plot were much less in 1980 than in 1979. Long-billed Dowitchers were seen almost exclusively in wet and flooded tundra and unlike other migratory shorebirds were not numerous on West Branch Flats in 1980, although fairly heavy use of coastal wetland was observed at Lagoon Marsh in 1979. The magnitude of the Dowitcher flight in the brief period in late summer may be illustrated by noting that in 1979 this species was recorded on only three censuses in the lowland, yet they achieved a seasonal mean density second only to Pectoral Sandpipers!

RED KNOT

Regional Status and Distribution —According to Kessel and Gibson (1978) this species is a "rare breeder at Barrow and Cooper Island, but unknown further east". However there are a number of recent records along the Beaufort Sea coast. One was at Storkersen Point 20 June 1978 (D. B. McDonald pers. comm.). Salter et al. (1980) termed this species a "rare visitor" on the Yukon Beaufort Sea coast with two records; single birds were seen 8 June 1972 and 19-21 June 1975.

CRD Status —Rare migrant.

General —Six records, all but one of them from June. One flew north along West Branch 2 June 1980; four were feeding in a pool on the West Branch floodplain 7 June 1979; one flew northeast over the upland study plot 11 June 1980; two were on the West Branch Flats 16 June 1979; one was on the West Branch Flats 24 June 1980.

The only fall record is of two (probably juveniles) feeding on the ocean side of the Brownlow Lagoon barrier island 21 August 1980.

SANDERLING

Regional Status and Distribution —According to Kessel and Gibson (1978) this species is a "very rare breeder at Point Barrow". Two defensive pairs were seen on the lower Aichilik River, 2 August 1974 (Martin, in Kessel and Gibson 1978). It is a rare visitor to the Yukon ACP, observed in westward migration in autumn (Salter et al. 1980). Sanderlings are "a common late summer migrant along ocean shorelines at Barrow" (Connors 1978). At the Okpilak River Delta in ANWR three were seen 2 June 1978 (Spindler 1978a).

CRD Status —Uncommon spring migrant, common fall migrant, restricted to ocean beach.

Spring Migration —In 1980, Sanderlings were seen on six dates in June. One or two birds were seen 3-7 and 9 June; most of these observations were made on the exposed snowless dunes by West Branch. No conclusion could be drawn

from these observations as to direction of travel.
Fall Migration —One was seen on the Brownlow Lagoon barrier island 9 August 1980 but most of our records were during the period 17 August - 6 September. In 1979, peak movements were noted 28 August, when 32 flew west past Brownlow Point in seven hours of observation, and 29 August, when six flew west in four hours of observation. Sanderlings were seen commonly on the ocean beach at this time, and flying low along the shoreline.

In 80 hours of observation 21 August to 5 September 1980, 105 were observed flying west and 28 were observed flying east past Brownlow Point. Peak movement was on 30 August when 40 flew west in six hours of observation. On the 1980 shoreline surveys, 19 were seen 21-22 August; 20 on 25-26 August; 137 on 30 August - 1 September; 56 on 4-6 September. During the peak of abundance on 1 September, 55 were found on the inside beach of east spit, a 2.5 km stretch. Sanderlings were most often seen on the sea side of the barrier island and spits, but were also seen on the inside (lagoon shore) of the spits, on the West Branch, and on the inner lagoon shoreline.

SEMIPALMATED SANDPIPER
Regional Status and Distribution —Abundant breeder and migrant across the ACP. Densities seem to be highest in coastal locations (Derksen et al. in press) but very high densities were also reported from Square Lake in the interior coastal plain (Derksen et al., in press). In the Yukon ACP it is the "most numerous shorebird" (Salter et al. 1980). Estimates of breeding density ranged from 22 to 42 nests per square kilometer at Prudhoe Bay sites (Norton et al. 1975; Hanson and Eberhardt 1980). At Barrow, densities are low in some habitats but range up to 38 pairs per square kilometer in others (Myers and Pitelka 1980). Density at Atkasook ranged from 20 to 40 pairs per square kilometer in three years of study (Myers and Pitelka 1980) and a site near Franklin Bluffs had only one or two nests per square kilometer 1979 and 1980 (Hanson and Eberhardt 1980). Myers et al. (1979) suggested that Semipalmated Sandpipers are more abundant in proximity to water courses at Barrow. At inland sites, the juxtaposition of upland tundra and lakes (as found at both Atkasook and Square Lake) may be correlated with high densities of this species (Myers et al. 1977; Martin, personal observation).

Densities reported from ANWR coastal plain sites vary from up to nine nests per square kilometer at the Okpilak River Delta (Spindler 1978a) to 20 pairs per square kilometer in sedge meadow at Nuvagapak Point (Andersson 1973) to 26-30 nests per square kilometer at Demarcation Point (R. M. Burgess pers. comm.). Although density of Semipalmated Sandpipers is subject to less variability than that of Red Phalaropes and Pectoral Sandpipers, two-fold differences in density between years at the study sites in Barrow and Atkasook is the norm (Myers and Pitelka 1980).
CRD Status —Very common breeder, abundant migrant.
Spring Migration —Date of first observation at CRD was 26 May 1979 and 29 May 1980. At Demarcation Point, arrival was 22 May 1914 (Brooks 1915) and

27 May 1980 (R. M. Burgess, pers. comm.). No spring flocks were observed at CRD.

Breeding —Flight displays were first heard 27 May 1979 and 30 May 1980, immediately upon the arrival of the birds. In both years numbers increased in the first week in June after the initial arrival in late May and display peaked around 6-15 June. A total of 21 nests was located in the two years of study. Nests were usually in dry microsites; often in flat-topped, well drained polygons or on the sides of polygon rims. None nested in the lowland plot; upland and mosaic areas were preferred, including river and lakeshore bluffs and coastal dry tundra adjacent to the lagoons. Density on the upland study plot more than doubled from 1979 to 1980. Changes of this magnitude are not uncommon (see above) on other tundra areas but we have no explanation for this variability; Semipalmated Sandpipers have usually been considered to have relatively stable populations (Pitelka et al. 1974). Nesting densities at CRD were estimated to be 0-24 nests per square kilometer in the three study plots.

Three 1979 nests for which we have good information indicate that clutch completion dates were 12, 13, and 16 June, respectively. In 1980, based on eight nests for which we have sufficient information, clutch completion dates ranged from 13-27 June with a median around 14 June, and a mode of 13 June. The 27 June date almost certainly represents a renesting attempt. Most young hatched 2-5 July in 1980. Last date of observation of downy young was 17 July 1979 at which time the first fledged juveniles were also seen. In 1980, first fledged juveniles were seen 19-20 July.

Post-breeding —Although upland and mosaic areas were used exclusively for nesting, a shift in habitat use occurred after the young hatched. This was especially noticeable in 1979, when the upland plot was deserted by Semipalmateds in mid-July with a coincident surge in sightings of this species on the lowland study plot. Wet tundra areas received moderate use by this species after nesting was over. There was a massive shift to marine littoral habitat during the same period (see below).

Fall Migration —Females of this species leave soon after the broods hatch out (Ashkenazie and Safriel 1979) and the first flocks, seen 17 July 1980 and 23 July 1979, were probably composed of adult females. By 24 or 25 July large flocks of Semipalmated Sandpipers congregated on West Branch Flats. On four censuses of the West Branch Flats 23 July to 7 August 1980, Semipalmated densities averaged 200 per square kilometer. Over 200 were seen on the West Branch Flats 24 July 1979, which is four times the peak numbers seen there in 1980. In general there were fewer Semipalmated Sandpipers present during the post-breeding season in 1980 than in 1979. Use of marine littoral habitat increased at the same time as large numbers were present on the West Branch Flats. In 1980, numbers were highest on the river and bay shoreline transects (see Part II, this report): four 20-22 July; 28 on 24-26 July; 188 on 29 July; 179 on 2 August; 48 on 6 August; 29 on 11 August; 31 on 14 August; four on 18 August. These birds were mostly juveniles.

Although marine littoral habitat was most heavily used, lake shores also attracted large flocks of Semipalmated Sandpipers. A flock of 73 was seen on the east shore of Finger Lake 3 August 1980. The birds were feeding on adult chironomids trapped on the surface of the water and blown on shore by west winds.

After 15 August, few Semipalmated Sandpipers were present anywhere, although two were seen on West Branch Flats as late as 22 Aguust 1980, our last date for this species.

WESTERN SANDPIPER

Regional Status and Distribution --Regular breeder at Barrow and occasional breeder at Atkasook (Pitelka 1974), and possibly at Camden Bay (A.O.U. 1957) although the latter record seems doubtful. Scattered records east of Barrow include two records of single birds at Square Lake (Martin unpublished), a pair in the Atigun River valley 20 June 1970 (Sage 1974), one at Storkersen Point 8 June 1978, and two there 1-2 July 1978 (D.B. McDonald pers. comm.). One was seen 20 July 1976 45 km up the Kongakut River in ANWR (Martin unpublished). Salter et al. (1980) listed no record for the Yukon ACP.

CRD Status --Casual spring migrant, uncommon fall migrant.

Spring Migration --One was seen 15 June 1979 on the shore of Brownlow Lagoon. It performed repeated aerial displays.

Fall Migration --In 1979 we recorded this species on three dates. In all cases the Western Sandpipers were mixed with Dunlin flocks feeding on the Flaxman Lagoon and Brownlow Lagoon shores. One was seen 21 August; five, 27 August; one, 29 August.

Westerns were recorded often in 1980, probably due to more intensive observation in shoreline habitat. On 14 August a total of nine was seen on the river and bay shoreline transects; one was seen in a tundra pool 17 August; three were on the river and bay transects 18 August. A flock of five and a flock of 13 were on the West Branch Flats 21 August and on 22 August a total of eight was seen on the river/bay shoreline transects and 14 were seen on West Branch Flats.

Since the breeding areas are well to the west of CRD there seems to be a minor eastward movement along the Beaufort Sea coast, peaking after the main movement of Semipalmated Sandpipers is over and restricted largely to marine littoral and estuarine habitats.

WHITE-RUMPED SANDPIPER

Regional Status and Distribution --Regular breeder at Barrow (Pitelka 1974) but uncommon. Hall (1971) reported a pair at Oliktok Point (Colville River Delta) but breeding status was uncertain. An adult with downy young was seen 12 July 1978 at Storkersen Point (D. B. McDonald, pers. comm.). In the Point Thomson area just west of CRD White-rumps were quite common in 1980, with five nests located (J. M. Wright, pers. comm.). In ANWR, Spindler

(1978a) believed that breeding had occurred at the Okpilak River Delta in 1978, based on defensive behavior of adults. At Beaufort Lagoon, two were seen in July 1974, believed to be on territory on the basis of behavior (Martin unpublished). In the Yukon ACP this species is a "rare migrant" (Salter et al. 1980). To summarize, breeding in the ACP seems to be localized and sporadic.

CRD Status --Uncommon to fairly common migrant, no evidence of breeding although breeding probably occurs in some years.

General --Observed much more frequently in 1980 than in 1979. One was seen 1 June 1979 near Lagoon Marsh; one was seen in the same area 9 June 1979, feeding and performing flight displays; two groups of three were observed flying west over the study area 10 June 1979; one was seen 17 August 1979 in Lagoon Marsh (rusty feathers on the back suggested it was a juvenile).

In 1980 there were three spring records: one on 4 June on dunes near the mouth of the West Branch; one flew over the mosaic study plot 8 June; one was seen at Lagoon Marsh 10 June 1980. There was a month-long hiatus in sightings but one or two individuals were seen on four dates 12-31 July on the West Branch Flats, the bay, and on the West Branch River bank upstream from camp. White-rumps were seen on eleven dates 6-18 August, most frequently on shoreline transects, although five were recorded on the tundra. A total of 11 was seen on the Brownlow Lagoon shoreline 9 August; six were seen along the West Branch River 1 km upstream from camp, one on the east spit; six on the bay shoreline transect 14 August; two were on the West spit 14 August. One to three were seen on the other dates for a total of 41 recorded during this period in August 1980.

Some of this apparent increase can probably be accounted for by the increased coverage given to shoreline habitat in 1980, but I am confident that it also reflects a real inter-year population difference, and the appearance of White-rumps on the plot census in 1980 testifies to this.

BAIRD'S SANDPIPER

Regional Status and Distribution --Common regular breeder at Barrow (Myers and Pitelka 1980) and at Storkersen Point in 1978 (D. B. McDonald pers. comm.). This species was not recorded in interior coastal plain sites in NPR-A (Derksen et al. in press), and did not breed at the Atkasook study site Myers and Pitelka 1980). In the interior coastal plain in the Sagavanirktok River valley it is "sporadically distributed as a breeding species from Franklin Bluffs southward" (Sage 1974). Salter et al. (1980) termed it a "fairly common summer resident" in the Yukon ACP. In ANWR, Brooks (1915) and Dixon (1943) recorded this species as breeding at Demarcation and Humphrey Point and it bred at Demarcation Point in 1978 (R. M. Burgess, pers. comm.). Andersson (1973) suspected breeding at Pokok Bay and Spindler (1979a) saw defensive pairs at the Okpilak River Delta in 1978. Coastally, this species appears to be more common to the west than it is in ANWR. They are also found in the interior of ANWR: Martin (unpublished)

found them common on dry river terraces by the Aichilik River in the foothills and they are the most common shorebird in the Canning River drainage in the Brooks Range where they were nesting and found in small flocks on river gravel bars in July and August (Valkenburg et al. unpublished). Broods were seen in high alpine meadows (ca. 5000′) in the upper Hulahula drainage in 1979 and 1980 (M.A. Spindler unpublished notes). Baird's Sandpipers are closely associated with dry tundra habitat which occurs along the Beaufort Sea coast, along rivers, and in the alpine meadows in the Brooks Range.

CRD Status —Fairly common breeder, uncommon migrant.

Spring Migration —This species seems to arrive somewhat later than Semipalmated Sandpipers at CRD. In 1979 one was observed 30 May but not again until 7 June. In 1980 the first record was 4 June, five days after the first Semipalmated Sandpiper was seen.

Breeding —Aerial display was first heard 5 June 1980. Display flights were seen and heard commonly until about 20 June, with peak of display noted around 15 June in both years, somewhat later than Semipalmated Sandpipers. A total of eight nests was found in the two years of study. Four were located on dry bluffs in the Flaxman and Brownlow Lagoon shores, one was located on dry tundra at the 1980 camp location, one was on a dry bluff of a lake shore, and one was in high relief polygonal terrain with high center polygons. The bluffs along the West Branch and the lagoons were the most heavily used habitat for this species, judging by the location of displaying birds. We have little information on timing of nesting. One nest in 1979 hatched 6 July, indicating a clutch completion date approximately 16 June. In 1980 clutch completion dates known and estimated through back dating from hatch were all during the period 21 and 27 June, which we believe is more typical than the timing of the 1979 nest. One known hatch date in 1980 was 16 July; fate of the other nests is uncertain. Defensive behavior of adults was noted 18-20 July 1979 and 22 July 1980, indicating presence of downy young at that time. Fledged juveniles were first seen 24 July 1979 and 26-27 July 1980.

Post-breeding, Fall Migration —Unlike Semipalmated Sandpipers and Dunlins, no significant flocking was observed in this species in late summer. This is true also in Barrow (S. F. MacLean pers. comm) and on the Yukon Beaufort Sea coast (Salter et al. 1980). However, many small flocks were observed on river gravel bars in the Canning River/Eagle Creek area in late July and first half of August (Valkenburg et al. 1977). It seems possible that Baird's Sandpipers move south along the rivers into the Brooks Range from their coastal nesting grounds, although observations of flocks from the Brooks Range might equally well be due to movement of local breeders down from alpine meadows onto the river bars. August records from CRD are all from the West Branch, West Branch Flats, and lagoon shorelines. They were seen in small numbers on the shoreline surveys (less than ten) up until 20 August 1979 and 22 August 1980.

PECTORAL SANDPIPER

Regional Status and Distribution —Common to abundant breeder across the ACP (Pitelka 1974; Derksen et al. in press). Between-year fluctuations in population is especially great in this species (Pitelka et al., 1974; Myers and Pitelka 1980) but it is consistently among the most common breeding shorebirds in most outer coastal plain study sites (Myers and Pitelka 1980; Derksen et al. in press; Hanson and Eberhardt 1980). Inland, it is less common and sometimes nearly absent as a breeding bird (Derksen et al. in press; Hanson and Eberhardt 1980; Sage 1974). Derksen et al. (in press) stated that this species "preferred drier sites on all study areas". This statement is misleading in that these authors considered "flooded tundra" to be a drier site, compared with other wetlands such as pond and lake shores which are not heavily used by Pectorals. In terms of use of tundra habitat, Pectoral Sandpipers (and Red Phalaropes) "are consistently the most lowland species at Barrow" based on detailed study of habitat use (Myers and Pitelka 1980).

In ANWR, Pectorals breed commonly at coastal sites, at least in some years. At Demarcation Point in 1978, nesting density was recorded at 37 nests per square kilometer but this fell to about seven nests per square kilometer in the same study plot in the 1979 (R.M. Burgess, pers. comm.). At Nuvagapak Point in 1970, nesting density in favorable (sedge-grass marsh) habitat probably exceeded 20 nests per square kilometer (Andersson 1973). At the Okpilak River Delta in 1978, maximum nest density was 8.0 nests per square kilometer (Spindler 1978a).

CRD Status —Common breeder, abundant migrant.

Spring Migration — Date of first observation at CRD was 27 May 1979 and 29 May 1980. M.A. Robus (pers. comm.) recorded a Pectoral Sandpiper 22 May 1979 at Sadlerochit Springs and three were at Demarcation Point 21 May 1979 (R.M. Burgess pers. comm.). In contrast to other shorebirds, some spring flocks were observed in both years: a flock of 20 females was seen to land in wet tundra 21 May 1979; large flocks (15-25 individuals) were seen flying east 6 June 1980. These dates also coincide with a marked influx in the two years, respectively, several days after the first arrival.

Breeding — Display commenced upon arrival of the males in 1979 and continued until mid-June. A lull in courtship activity was noted 21-27 June 1979 with a resurgence around 28 June. Pitelka (1959) suggested the occurrence of a second peak in courtship activity during the last few days of June and our 1979 observations tend to support this view. In 1980, however, courtship activity was in full swing until 20 June. By 24 June, courtship activity was stilled, and no comparable second peak was noted at the end of June.

Seven Pectoral Sandpiper nests were found in 1979 and fifteen in 1980. Pectorals nested in the lowland plot in 1979 and in all three plots in 1980, though only one nest was located in the upland plot. Nesting density increased on the lowland plot in 1980, and was even higher in the mosaic. The presence of a Pectoral Sandpiper nest in the upland was probably related to

the presence of small ice-wedge pools; at least six days after hatch the brood from the upland plot was still close to the nest site, and was relocated several times on the edge of polygon trough pools. In typical nesting habitat the inside slopes of low center polygon rims, low rims of low center polygons, and hummocks in flooded polygon centers were most commonly used nesting sites.

In 1979, known or estimated (through back dating from hatch) clutch completion dates indicate one clutch complete on each of the dates 11 June, 1 July, and 6 July, with two other clutches complete on or before 29 June. In 1980, based on 12 nests for which we have sufficient information, the range of clutch completion dates was 15 June to 12 July, with a median of about 28 June. The prolonged period of nest initiation is striking and, in general, Pectorals seem to nest later than Semipalmated Sandpipers, Dunlins, or even Red Phalaropes. The 12 July date is unusually late, but in 1979 a brood of downy young was observed 9 August, indicating a clutch completion date no earlier than 10 July, so late nesting is perhaps a regular event in this species. Known hatch dates in 1980 ranged from 8-22 July. First fledged juveniles were seen 27 July and 2-3 August.

Post-breeding, Fall Migration — Males leave their territories soon after mating (Pitelka 1959) and successive waves of transient adult males, then adult females, and then juveniles typically flood the coastal area at Barrow (Myers and Pitelka 1980). In 1979 large flocks, presumably adult males and unsuccessful females, were observed feeding in wet and flooded sedge meadows. Over 50 were seen in loose flocks near Finger Lake 8 July and on 13 July, 350-400 were observed traveling east past VABM Start between 0000-1100 hr. Such a pronounced movement was not observed in 1980; small flocks were seen flying east during early July with peak movement perhaps 11 July 1980, but total volume was much less than in 1979.

Movement picked up again in late July 1979 and by 1 August, juveniles began to flood the area. Peak numbers of juveniles were present during the first week in August, but remained high until 20 August.

In 1980, numbers rose throughout the latter half of July, probably due to an influx of adult females, but picked up sharply 8-20 August as large numbers of juveniles moved through. Although the mosaic plot had the highest nesting density, seasonal mean density was much higher in the lowland: the large flocks of juveniles seen in August made very heavy use of the lowland, achieving the highest densities (152 per square kilometer) of any shorebird on a census in the intensive study plots. In contrast to some other shorebirds, Pectorals made very light use of the West Branch Flats in late summer, and were rarely seen on the shoreline surveys in marine littoral habitats.

DUNLIN

Regional Status and Distribution —Common breeder at Barrow and Atkasook (Myers and Pitelka 1980) and at outer coastal plain sites, in NPR-A but less common at Prudhoe Bay (Norton et al. 1975; Hanson and Eberhardt 1980) and still less common inland in interior coastal plain sites such as Singiluk and Square Lake (Derksen et al. in press). To the east in the Yukon ACP, Dunlins are "rare visitors" in spring (Salter et al. 1980). In ANWR there are relatively few records. Flight display was seen near Nuvagapak Point in 1970 (Andersson 1973) and Martin (unpublished) suspected breeding near there in 1976, based on defensive behavior by adults. Dunlins were rarely seen at Demarcation Point in 1978-1979 (D.M. Troy pers. comm.; R.M. Burgess pers. comm.). At the Okpilak River Delta, single birds were observed on two June dates and flocks of 30 and seven were seen 17 and 21 July, respectively (Spindler 1978a). No breeding was suspected.

CRD Status —Fairly common breeder and migrant, apparently near the eastern limit of the arctic slope breeding range at CRD.

Spring Migration —Date of first observation was 27 May 1979 and 29 May 1980. No migratory flocks were observed in spring.

Breeding —Flight display was heard first 31 May 1979 and 3 June 1980. Courtship activity appeared to peak 8-11 June in 1980, and end by 19 June.

Six nests were located in the two years of study. Two were in the upland study plot, and two were in the mosaic study plot. None were found nesting in the lowland, although nesting was suspected there in 1980. Most of the nests were in poorly defined, flat topped polygonal terrain, although one was in a strongly polygonized area in the mosaic.

Clutch completion and/or hatch date is known for only three nests. Based on these, clutch completion dates were 16 June 1979, 10 and 11 June 1988, although a fourth nest in 1979 could have been initiated no earlier than 22 June, since incubation continued up to 14 July, before the eggs disappeared. Known hatch dates were 7 July 1979 and 2-3 July 1980. Pairs with broods were observed in early July in both years. First fledged juveniles were seen 15-20 July 1979 and 26 July 1980. Although Dunlins nested on the upland in both years, they did not use the area after the young hatched.

Post-breeding and Fall Migration —Adults and young were present on the tundra until the end of August 1979 but were very rarely seen on the tundra in mid- to late August 1980. In both years, they were most numerous in marine littoral habitats during August, although there were greater numbers present in 1979 than in 1980. Adults with young were seen on the West Branch Flats consistently from mid-July on, with a peak there in mid-August (about 10 August 1980 and 17 August 1979). Dunlins were noted frequently on the shoreline surveys; flocks of 15-60 birds were seen on the lagoon shore and flying east past Brownlow Point frequently during the latter half of August in 1979. In 1980, numbers were much lower. Peak count was of 56 seen on all shoreline surveys combined, 4-6 September. Dunlins linger on the Beaufort Sea coastal beaches much later than other shorebirds.

During the period 12-20 August 1979, many small shorebirds were seen feeding far out on tidal flats at the mouth of the Canning River and West Branch. It was impossible to identify many of these birds but it is likely that a large proportion were Dunlins. The autumn influx was not as large in 1980, but the question remains as to the origin and destination of these birds. If Canning River Delta is close to the eastern edge of the breeding range, we would not expect to see many migrants since most migrate west along the coast. Furthermore, Salter et al. (1980) did not report any fall movement along the Yukon portion of the Beaufort Sea coast. Yet, the numbers seen at CRD in August 1979 were too great to be accounted for by local breeders alone.

STILT SANDPIPER

Regional Status and Distribution —Termed "rare to uncommon migrant, summer visitant, and breeder in northern Alaska" by Kessel and Gibson (1978) but recent records indicate that this species is more common. Stilt Sandpipers were quite common at Square Lake in interior coastal plain NPR-A in 1978, and broods of downy young were encountered there (Derksen et al. in press; Martin unpublished notes). "Two young barely able to fly" were recorded at Prudhoe Bay 22 July 1974 (Kessel and Gibson 1978). In ANWR, defensive pairs were noted 2 July 1970 at Nuvagapak Point (Andersson 1973) and three defensive pairs were seen in that area in 1974 (D.D. Roby unpublished). A nest was located at the Okpilak River Delta in 1978, and at least five pairs were suspected to have nested in the study area (Spindler 1978a). Several broods were discovered at Demarcation Point in July 1978 (D.M. Troy pers. comm.). To the east, it is termed an "uncommon summer resident" in the Yukon Arctic Coastal Plain, with breeding confirmed through observations of nests and broods (Salter et al. 1980).

CRD Status —Uncommon to rare breeder, common migrant in fall.

Spring Migration —Date of first observation was 1 June 1979 and 5 June 1980. Stilt Sandpipers were not common in 1979 at CRD; after 1 June, only two spring birds were seen, both on 12 June. In 1980, Stilt Sandpipers were seen almost daily in small numbers from 5 June to the end of the month.

Breeding —Flight displays were heard 5-15 June 1980. No nests were found, but broods of downy young were seen 14 and 20 July. Based on sightings of adults, at least four pairs bred in the Primary Study Area in 1980. Broods were found in the lowland study plot and in Arctophila marsh at Finger Lake. First fledged juveniles were seen 31 July 1980.

Fall Migration —Stilt Sandpipers were a fairly common fall migrant, especially in marine littoral habitat and coastal wetlands. A fall flight of Stilts has been noted at other Beaufort Sea coast locations also. This species was common at Storkersen Point in early August 1978 (D.B. McDonald pers. comm.) and at Demarcation Point in late July to mid-August 1979 (R.M. Burgess pers. comm.). At CRD, Stilts were often seen on West Branch Flats; adults were present in small groups (two to six birds) from mid- to late

July. In 1979, juveniles were seen 5-31 August with peak movement around 8-13 August. Flocks of up to 13 were seen at Lagoon Marsh during this period.

BUFF-BREASTED SANDPIPER

Regional Status and Distribution —Termed "rare to uncommon migrant, summer visitant, and breeder along the Beaufort Sea coast" (Kessel and Gibson 1978). Eggs or young have been recorded from Barrow (Kessel and Gibson 1978) and this species was a common breeder at Storkersen Point in 1978 (D.B. McDonald unpublished). Inland, this species was an uncommon breeder at Square Lake (one nest found) in 1978 (Derksen et al. in press) and common breeder at Franklin Bluffs in 1979 and 1980 (Hanson and Eberhardt 1980). To the east, Buff-breasts are found nesting in tussock-heath tundra in the Yukon ACP (Salter et al. 1980). In ANWR, Spindler (1978a) found nests at the Okpilak River Delta in 1978. Brooks (1915) found no nests but observed males' lekking behavior at Demarcation Point in 1914.

CRD Status —Uncommon to locally fairly common breeder, uncommon migrant.

Spring Migration Date of first observation was 31 May 1979 and 5 June 1980. No migratory flocks were noted.

Breeding —Males engaged in elaborate posturing and display, during the period 8-30 June 1979 and 6-25 June 1980. In 1979 a loosely defined lek of four males was located at the western end of the upland study plot and two other males were seen regularly at the eastern end of the plot. In 1980 the upland plot lek shifted southwest a little and only two to three males were involved. In both years, displaying males were seen all along the bluff adjacent to the West Branch Flats. Other lek areas were found on ridges and dry lake shore bluffs and on the mosaic plot.

Six nests were found in 1979 and five in 1980. Nest sites seemed to be in slightly moister, less exposed sites than the leks, although still in relatively upland tundra. Frost boil sedge meadow, river bluff, and the dry sparsely vegetated area of West Branch Flats were all used for nest sites.

One nest was found 17 June 1979 with three eggs; the clutch was complete on the following day and hatched 13 July (for an incubation period of 23 1/2 days). Known hatch dates in 1979 were 10 and 17 July, which indicates clutch completion dates around 16 and 23 June. A third nest in 1980 was known to have had the clutch completed 29 June. In mid-July it appeared that the nest might be abandoned, as the eggs were cold on several of our visits, but on 20 July the eggs were warm, and "crackling" had begun to appear on the shells. However, all eggs were abandoned in various stages of hatch.

Broods were encountered 12, 19, 23, 25, and 29 July 1979, and 16 and 21 July 1980. First fledged juveniles were seen 8 August 1979 and 3 August 1980. Young were color-marked in 1979 and a downy young banded 25 July was seen again after fledging 8 August, 1.5 km from where it was banded. A second juvenile was relocated 9 August, 21 days after banding and only half a kilometer away.

Fall Migration —A rash of sightings 2-6 July 1979 may have represented a coastal movement of males after the leks broke up. During that time, displays were seen in many places not previously known as lek sites, and these may have been "last ditch attempts" by transient males. Flocks of adult females (presumably) and possibly fledged young were seen in early and mid-August. Peak movement took place 8-9 August 1979. A total of 17 was seen (in groups of one to eight birds) between Brownlow Point and the West Branch Flats and a total of 30-40 was seen by two separate observers between Brownlow Point and the lowland study plot 9 August. After this, numbers decreased. One to five birds were seen on eight days up to 19 August. A flock of 12 was seen on coastal dry tundra, 12 August, the last record in 1979. In 1980, there was a slight increase in sightings 8-19 August, but no more than four were seen daily. A few were seen on the lowland plot during this period, which was unusual in that this species consistently used upland tundra, even in late summer.

POMARINE JAEGER

Regional Status and Distribution —The correlation between high lemming density and breeding by Pomarine Jaegers has been well documented (Pitelka et al. 1955; Maher 1974). In a given location this species may breed at very high densities up to 20.5 per square mile have been documented at Barrow (Maher 1974). Elsewhere on the Alaska Beaufort Sea coast it is seen primarily as an eastward spring migrant (Bergman et al. 1977; Derksen et al. in press). In the interior ACP they may be less regular—observed at Square Lake (NPR-A) in spring 1978 (Derksen et al. in press), but Sage (1974) only recorded them once near Franklin Bluffs. Salter et al. (1980) reported no nesting on the Yukon ACP but this species was common in spring migration 29 May-12 June.

In ANWR breeding has been recorded in the Beaufort Lagoon area. In 1970 Andersson (1973) found them most common in mid-June after which lemming numbers decreased and most jaegers left the area without nesting, although at least one nest (which failed due to predation) was initiated. In the same area in July 1974 only one Pomarine Jaeger was seen (Martin unpublished) but in 1976 when lemmings were abundant there, five nests were found (approximately one per square kilometer) and Pomarines outnumbered Parasitics by a ratio of 4 or 5:1. At the Okpilak River Delta in 1978 they were a common spring migrant in late May or early June but did not breed (Spindler 1978a). In addition to migrating along the coast, Pomarines apparently migrate through the eastern Brooks Range in late May (Dean et al. 1976).

CRD Status —Common spring migrant, rare summer visitant, uncommon fall migrant.

Spring Migration —Date of first observation was 27 May 1979 and 28 May 1980. The peak migration period was 27 May-10 June 1979 and 28 May-9 June 1980. In 1980, based on migration watches conducted 30 May to 8 June, over

1200 Pomarine Jaegers are estimated to have flown east past the study area. Peak movement was 30 May and 5-6 June. From 5-8 June some westward movement was noted, with westward movement predominating on 7-8 June, although volume was small. We estimate that 160 Pomarines passed west during those four days. Salter et al. (1980) also recorded a westward migration following eastward migration 18-19 June 1975 on the Yukon Beaufort Sea coast.

Mid-Summer —In 1979, six were seen 20 June; after that only four were seen, one on each of the following days: 4, 5, 10 and 21 July. The latter three were all seen flying over the coastal lagoons. In 1980 there was a two week period in late June during which no Pomarines were seen but 30 June - 5 July small flocks (6-9 individuals) were seen flying east on three dates and two were seen flying east on 3 July. A similarly timed northward movement of Pomarines past Icy Cape was noted in 1980 (S. Quinlan and W. Lehnhausen, pers. comm.).

Fall Migration —A moderate westward movement of Jaegers was seen at Brownlow Point 1-6 September 1980. On 1 September, rate peaked at 18 Jaegers (all species combined) per hour. Although many Jaegers were unidentified a majority of those identified were Pomarines (109 of 219 Jaegers seen). Unusual weather conditions 31 August and 1 September may have caused Jaegers at sea to the west of Canning River Delta to have been blown inshore. About 1000 Jaegers are estimated to have flown west past Brownlow Point in the first six days of September.

PARASITIC JAEGER

Regional Status and Distribution —Appears to be present in low densities over the entire ACP (Salter et al. 1980; Derksen et al., in press; this study). In ANWR, nesting has been observed at Beaufort Lagoon (Andersson 1973; Martin, unpublished). In 1974 at Nuvagapak Point the Parasitics were common and two nests were found, but in 1976, when Pomarines were abundant, Parasitics were scarce (Martin, unpublished). Valkenburg et al. (unpublished) reported a downy young on the upper Sadlerochit River, and saw a few migrating with other Jaegers through the Brooks Range in late May. Spindler (1978a) termed this an "uncommon summer resident" at the Okpilak River delta; no nesting was confirmed and it was the least common of the three Jaegers in spring migration. Parasitics were the most common Jaeger at Demarcation Point, where they nested in 1979 (R. M. Burgess, pers. comm.).

Spring Migration —Date of first observation was 3 June 1979 and 30 May 1980. Very few were seen on spring migration watch in 1980 and no directional tendency was detected.

Breeding —In 1979 only one nest was found, several kilometers east of the Primary Study Area. On 10 July it contained one egg and when revisited on 18 July it contained a recently deceased chick. The adult Jaeger continued to defend the nest aggressively. A pair of highly defensive adults was encountered on West Branch floodplain 23 July, 1979; chicks were not located

but were certainly present. On 13 July 1980, perhaps the same pair was found in the same area (one member of the pair was recognizable by distinct wing markings) and a single chick located. A nest was found at Brownlow Point 24 June 1980 with a clutch of two eggs but this nest was apparently depredated and could not be relocated after 28 June.

Non-breeding, General —In both years Parasitic Jaegers seemed to be more numerous than nesting density would suggest and a sizable portion of non-breeders was probably present. Although numbers seemed greater in 1980, seasonal variation in numbers seemed slight. In mid-late August in both years a possible increase in local population was noted.

Parasitics were very conspicuous predators on birds during the latter half of the summer. They usually hunted in pairs and were seen in aerial pursuit and capture of adult and juvenile Pectoral Sandpipers, juvenile Long-billed Dowitchers, Northern Phalaropes, and Lapland Longspurs. Jaegers were also seen harassing Rock Ptarmigans although no kill was seen. On one occasion a Parasitic Jaeger was observed to harass an Arctic Loon carrying fish, forcing the loon to drop its catch, which was then retrieved in mid air by the Jaeger.

Fall Migration —Small numbers (total of 35) were seen flying west past Brownlow Point 19 August - 6 September.

LONG-TAILED JAEGER

Regional Status and Distribution —Breeds infrequently near the Beaufort Sea coast. Pitelka (1974) termed this a "visitor" at Barrow. Bred at Meade river Delta in 1977 (Derksen et al., in press) and at Storkersen Point in 1971-1973 and 1978 (Bergman et al. 1977; D. B. McDonald, unpublished). Also bred at Singiluk and Square Lake in interior ACP in NPR-A (Derksen et al., in press) and in the Sagavanirktok River Valley (Sage 1974), where there were scattered pairs which "undoubtedly breed in good lemming years." In the Yukon ACP the Long-tail is a "common summer resident" with nests found on the lower Babbage River (Salter et al. 1980). In ANWR no breeding has been reported from coastal sites. They are reported as fairly common to uncommon visitors at Beaufort Lagoon (Andersson 1973; Martin, unpublished), Okpilak River delta (Spindler 1978a), and Demarcation Point (R. M. Burgess, pers. comm.). Occasionally, large flocks are seen on the coastal plain: a flock of 50 was seen near the Kongakut River 2 July 1970 (Andersson 1973) and a flock of about 200 was seen about 32 km up the Aichilik River 20 July 1974 (Martin, unpublished).

CRD Status —Uncommon migrant and visitant.

General —In both years, Long-tailed Jaegers were seen most often in June. Date of first observation was 3 June 1979 and 1980. Very small numbers were seen flying west on spring migration watches. From one to ten birds were seen on 15 dates in June 1979 and 11 dates in June 1980. Occasional records were also made in August, with a maximum of five seen 17 August 1979. A total of 18 was seen migrating west past Brownlow Point 1 September 1980.

GLAUCOUS GULL

Regional Status and Distribution —"Migrant and visitor" at Barrow (Pitelka 1974) but regular breeder coastally to the east and inland. Breeding recorded at Square Lake, Meade River Delta, Island Lake and East Long Lake in NPR-A (Derksen et al., in press), "abundant" on the Colville River Delta (Hall 1971); at Storkersen Point (Derksen et al, in press), on many of the Beaufort Sea barrier islands (Gavin 1976), and inland to the Brooks Range (Irving 1960).

CRD Status —Common breeder; common to abundant migrant.

Spring Migration —Glaucous Gulls arrive early in spring on the Beaufort Sea coast. Spindler (1978a) reported an arrival date of 8 May at Kaktovik (Barter Island). On 23 May 1980, 380-400 were present at Kaktovik, feeding on whale carcasses left from the autumn hunt by the villagers. Flocks of up to ten birds were seen flying over the CRD study area in late May 1979, but no major migration movement was noted. In 1979 flocks of 15-30 were seen flying east on three dates in mid-June.

Breeding —Five nest sites were located on the tundra in both 1979 and 1980, and perhaps five more located on the islands in the lagoons in 1980. Tundra nests were almost invariably on islands in lakes, surrounded by deep water. A nest found in 1980 that was easily accessible by foot failed due to fox predation, and this may be a factor in placement of nests on inaccessible islands. Due to placement of nests, we gathered little information on timing of breeding. Earliest known dates of incubation are 14 June 1980 and 20 June 1979. Two known hatch dates are 17 July 1980 and 30 July 1980, indicating clutch completion dates of about 20 June and 3 July, respectively. The latter nest was being defended by adults as early as 22 June, although no eggs were present at that time. Downy young were seen on lakes containing nest sites and in Brownlow Lagoon, with first fledged juveniles noted 16 August 1980.

Post-breeding and Fall Migration —In late July and August, Glaucous Gulls flocked along the Beaufort Sea coast and especially in the Flaxman Lagoon/West Branch estuary. Numbers built up during August to a maximum in late August, e.g. 110 on 25 August 1979 and 200 on 31 August 1980; both counts made from Brownlow Point looking toward Flaxman Island. Information on age ratios is unfortunately not available. Low volume movement was noted on all migration watches 17 August - 6 September, however, much of this was apparently local traffic as no predominant directional tendency was evident. On 21 and 23 August and 1, 4, 5 September predominant westward movement was evident with peak movement of over 20 per hour on 4 September 1980.

HERRING/THAYER'S GULL

Regional Status and Distribution —Herring Gulls breed in interior Alaska north to the south slope of the Brooks Range (Irving 1960) and occasionally on the arctic slope (West and White 1966). Thayer's Gulls breed on Banks Island and other islands of the Canadian arctic archipelago (Johnson et al.

1975). Since the two forms were relatively recently recognized by the A.O.U. (1977) as distinct species, there is little information on their relative abundance in the Beaufort Sea area and due to difficulties in identification this report will have little to add— we are forced to treat these species together.

Herring/Thayer's Gulls have previously been reported from ANWR from the Beaufort Lagoon area and up to 31 km up the Aichilik River (Andersson 1973; Martin, unpublished).

General —Herring/Thayer's Gulls were recorded on eight dates in the two years of study. An adult and a subadult were seen 28 and 30 May, respectively and one subadult was seen 11 June 1980; one adult, 20 June 1979; a subadult, 21 June 1979; and five juveniles were seen flying west 1-4 September 1980.

BLACK-LEGGED KITTIWAKE

Regional Status and Distribution —Kittiwakes are classified as "visitors" to the Barrow region (Pitelka 1974) where they occur commonly in migration (Bailey 1948). They have been seen in the Beaufort Sea northeast of Barter Island during the period 20 August to 15 September (Divoky 1979) although they are much more common to the west near Barrow (G. Divoky, pers. comm.). Salter et al. (1980) listed records of a total of seven birds on two dates in August 1972, flying west past Numaluk Spit on the Yukon Beaufort Sea coast.

CRD Status —Irregular uncommon visitant.

General —A westerly storm on 29-30 August 1980 brought peak winds of 56 mph at Barter Island; by 1 September the winds had shifted to the north-northeast and a heavy westward movement of gulls, terns, loons, jaegers, and waterfowl was observed at Brownlow Point. Hundreds of adult kittiwakes were among these birds, flying in flocks of up to 30 birds. Peak movement came on 1 September, when 438 were counted in seven hours of observation (62 per hour). It is estimated that approximately 2000 Kittiwakes flew west past Brownlow Point 1-3 September. A few also rested on the beach at Brownlow Point. It is unclear whether these birds were offshore to the north or actually blown east by the strong winds from the richer marine areas near Barrow.

SABINE'S GULL

Regional Status and Distribution —"Regular breeder" at Barrow and at coastal sites (Pitelka 1974) but apparently not common over most of the ACP. Nesting has been reported at Meade River Delta and East Long Lake (Derksen et al., in press), about 110 km south of Barrow (Bee 1958), and at Colville River Delta (Gabrielson and Lincoln 1959). Also breeds in small numbers on the Beaufort Sea barrier islands (Gavin 1975). In the Yukon ACP, this is a "rare visitor" seen along the coastline (Salter et al. 1980). In ANWR,

records exist from many coastal localities but no breeding records exist in the literature.

CRD Status —Uncommon breeder and migrant.

Spring Migrant —Date of first observation was 31 May 1979 and 5 June 1980. The only possible migrating flock seen in spring 1980 was five flying west 6 June 1980. On 9 June 1979 a flock of six was seen flying overhead (direction unrecorded). Most records of this species are in June when they were seen in a variety of habitats, especially the West Branch estuary, but also on Brownlow Lagoon and around tundra lakes and ponds.

Breeding —Three nesting areas were located. Two nests were located in Chain Lakes in 1979, two nests were found in West Branch Flats in 1980, and a colony of five to six pairs was located on an island in a lake 7.5 km southeast of the 1979 base camp. All nests were located on islands in lakes, surrounded by deep water. Both the Chain Lakes and West Branch Flats area probably had nests in both years but it is unknown whether the larger colony was used in 1980. One of the nests in Chain Lakes hatched around 8 July, and back-dating indicates a clutch completion date around 15 June. Little is known about the West Branch Flats nests, due to their inaccessibility. One nest, at least, was being incubated by 25 June and hatched successfully. The second nest was unsuccessful and the same pair seems to have attempted a renest, also unsuccessful. Chicks were seen on West Branch Flats by 19 July 1980.

On the one visit to the larger colony on 19 July 1979, a nest with two eggs was found and fledgling Sabine's Gulls were seen simultaneously, indicating considerable asynchrony in nesting.

The young on West Branch Flats fledged by 2 August. On 13 August 1980, two pairs with two fledged juveniles each were seen near the gap in the Brownlow Lagoon barrier spit.

Post-breeding, Fall Migration —In July and August, Sabine's gulls were seen regularly in small numbers on the shoreline transect. In both years they were seen somewhat more frequently in August, but no large flocks were observed. A maximum of ten was recorded 17 August 1980 on the barrier island and east spit of Brownlow Lagoon.

ARCTIC TERN

Regional Status and Distribution —Widely distributed, nesting at Barrow (Pitelka 1974), both coastally and inland in NPR-A (Derksen et al., in press), inland on lakes and river gravel bars in the Sagavanirktok River Valley (Sage 1974), on Beaufort Sea barrier islands (Gavin 1975) and "abundant" on the Yukon ACP (Salter et al. 1980). In ANWR, breeding has been recorded on the Aichilik River Delta (Andersson 1973), on gravel reefs in the Beaufort Lagoon area and on Aichilik River gravel bars (Martin, unpublished).

CRD Status —Fairly common breeder and migrant.

Spring Migration —Date of first observation was 31 May 1979 and 4 June

1980. On 4 June 1979 a group of four and a group of seven were seen flying east, low over the tundra and fighting a strong east wind. A total of twelve Terns was recorded in migration watch 4-6 June 1980, all flying east. Migration appeared to continue until about 10 June but observed numbers were very low.

Breeding —Arctic Terns bred primarily on the gravel beaches of the barrier islands and spits, but also on islands in lakes and on river gravel bars. They nested singly or in small colonies on the beaches. Details on nests found along the shoreline are provided in Part III, this report. Little information was gathered on the tundra nests, due to their location on inaccessible islands in lakes. Incubation began at least as early as 17 June at a nest on West Branch Flats. Known hatching dates were in early July and first fledged juveniles were seen in mid-August.

Non-breeders, Fall Migration —An unusual concentration of 50 Terns was noted on West Branch Flats 30 June 1979. This was the largest flock noted that year. In late August 1979 there was a slight increase in numbers recorded on Brownlow Lagoon counts, but there was no conspicuous migration. In 1980, Arctic Terns were most numerous on Brownlow Lagoon 4-18 August and were virtually absent from the study area by 25 August. However, the same peculiar weather conditions that brought Kittiwakes to the area on 1-2 September also brought in Terns. Over 300 were seen flying west on those dates and we estimate that 1400 Terns flew west past Brownlow Point during those two days.

BLACK GUILLEMOT

Regional Status and Distribution —First recorded breeding on the Beaufort Sea coast by MacLean and Verbeek (1969) at Barrow, and numbers have increased since that time. Nesting Guillemots on the Beaufort Sea coast are dependent on man-made debris and structures for their nest sites, often using old oil barrels, foundations, etc. for nest burrows. Average numbers of pairs at major colonies are: Seahorse Island, five; Point Barrow, five; Deadman Island, 20; Cooper Island, 50; Igalik Island, five (Divoky and McElroy, in prep.). On the Yukon Beaufort Sea coast the Guillemot is a "rare summer resident"; there is a colony of about ten pairs on Herschel Island (Salter et al. 1980).

In ANWR, Guillemots have been seen infrequently on aerial surveys on the coastal lagoons (Spindler 1981) and breeding had not been confirmed prior to this study.

CRD Status —Rare breeder and uncommon visitant and migrant.

General —In 1979, Guillemots were recorded on seven dates in August, all records of one or two birds in the sea off Brownlow Point. In 1980, they were seen first on 17 June at the gap in the Brownlow Lagoon reef and were frequently seen in this area throughout the summer. A pair nested in a half-buried oil drum on the barrier island just east of the gap (see Part III this report). Up to nine Guillemots at a time were seen at the barrier island (28 July 1980).

(THICK-BILLED?) MURRE SP.

Regional Status and Distribution --Nearest breeding colonies of Thick-billed Murres are at Cape Parry, on the Parry Peninsula of the Northwest Territories, Canada (Johnson et al. 1975) and at Cape Lisburne in the Chukchi Sea (Sowls et al. 1978). Murres are seen very rarely on offshore transects in the Beaufort Sea (G. Divorky, pers. comm.). Bergman et al. (1977) reported 30 unidentified Murres at Storkersen Point, 20 July 1971 and Schamel (1978) reported Thick-billed Murres from Egg Island (eight kilometers northwest of Prudhoe Bay) but provided no details on number of sightings or individuals.

CRD Status --Rare migrant.

General --Three unidentified Murres were seen flying west past Brownlow Point, 1 September 1980.

HORNED PUFFIN

Regional Status and Distribution --Nearest major breeding colony is at Cape Lisburne (Sowls et al. 1978) but numerous sightings have been made 1976-1980 at Black Guillemot nesting colonies on Seahorse Island, Deadman Island, and Cooper Island (Divoky and McElroy MS).

CRD Status --Casual visitant.

General --One was seen flying low along the beach in a westward direction past Brownlow Point, 1 September 1980. This coincided with the sightings of Murres and Kittiwakes, all probably related to storm winds during the previous two days.

SNOWY OWL

Regional Status and Distribution --Breeding and density is closely tied to lemming abundance (Pitelka et al. 1955a). Snowy Owls concentrate and nest where lemming densities are high; they are widely distributed but uncommon on the ACP otherwise. Breeding reported from Barrow (Pitelka 1974) and Pitt Point (Gabrielson and Lincoln 1959) and at Franklin Bluffs (Sage 1974).

In ANWR, nesting reported from Nuvagapak Point (Beaufort Lagoon area) in 1976, when two nests were located (Martin unpublished), and observed along the Beaufort Sea coast in summer with varying abundance at Demarcation Point (Brooks 1915; R. M. Burgess pers. comm.), Nuvagapak Point (Andersson 1975) and Okpilak River Delta (Spindler 1978a).

CRD Status --Uncommon visitant.

General --In 1979 recorded on only four occasions. Single birds were seen 27 May, 1 June, 9 June and 14 July. In 1980 this species was much more common, recorded 28 May - 2 September. Peak numbers were recorded at the end of May and the first week of June when up to five were seen daily. However, at least two birds may have spent the summer in the area. Snowy Owls were seen daily in June, only three times in July, but frequently in August. No nests were suspected.

SHORT-EARED OWL

Regional Status and Distribution --Reported commonly on the ACP, but few nests have been found. Bailey (1948) lists four nests in the Barrow region. Bred at Square Lake (interior ACP, northwest of Umiat) in 1978 (Derksen et al. in press) and at Clarence Lagoon, Yukon Territory in 1975 (Salter et al. 1980). Many observers have noted that this species is commonly seen on the ACP in June and then often decreases in numbers (Andersson 1973; Spindler 1978a; R. M. Burgess, pers. comm.; Salter et al. 1980).

In ANWR, a nest was located on Barter Island in 1976 (D. M. Roseneau, pers. comm.). Andersson (1973) estimated that there were 1.9 per square kilometer at Nuvagapak Point in 1970. None were seen 12 July-7 August 1974 near Nuvagapak Point, but nine were seen there 4-17 July 1976, a year when lemmings were abundant (Martin unpublished). This species is also recorded from the Brooks Range, on the Aichilik River (Martin, unpublished) and the Canning River (Valkenburg et al. unpublished).

CRD Status --Uncommon to common migrant.

General --Date of first observation at CRD was 27 May 1979 and 29 May 1980. Short-ears were first seen at Demarcation Point 12 May 1979 (R. M. Burgess, pers. comm.) and at 16 km Sadlerochit River 13 May 1979 (M. A. Robus, pers. comm.). In 1979 one was seen on 28 May, three on 27 May and one each day 29 May through 1 June. One was seen 10 June, the last record for that year.

In 1980, Short-ears were present for the same period but were more numerous, especially 5-8 June. It was difficult to gauge how many individuals were in the study area at any given time, since they hunted back and forth across the tundra. Three were seen simultaneously from camp 7 June 1980. No predominant direction of travel was noted. None were seen after 11 June 1980.

EMPIDONAX SP.

Regional Status and Distribution --Members of this genus that have been recorded on the ACP include Alder Flycatcher (Empidonax alnorum), Hammond's Flycatcher (Empidonax hammondii), and Dusky Flycatcher (Empidonax oberholseri). All three are accidental or casual on the Arctic Coastal Plain (Kessel and Gibson 1978).

CRD Status --Accidental visitant.

General --An unidentified Empidonax flycatcher was found 17 June along the bluffs on the east shore of Flaxman Lagoon. The wing bars (lower one brighter than upper one), indistinct cream colored eye-ring, and light lower mandible were seen. The back was quite greenish and the throat was pale gray to white, contrasting somewhat with a slightly grayer chest which faded into a pale yellowish wash on the belly.

HORNED LARK

Regional Status and Distribution —Rare but regular spring migrant in northeast Alaska coastal locations. Bergman et al. (1977) reported two sightings in 1973 and termed "not particularly numerous and confined in the breeding season to dry elevated foothills" in the central ACP (Sage 1974). To the east, described as "uncommon" on the Yukon ACP, but probably breeding at Herschel Island and Babbage River (Salter et al. 1980). In ANWR, recorded from Demarcation Point 6 May-7 June 1914 (Brooks 1915) and two to four were seen there on five dates 18-30 June 1978 (D. M. Troy pers. comm.). Also recorded from Humphrey Point on 7 May 1914 (Brooks 1915) and two were seen 16 km up the Sadlerochit River, 15 May 1979 (M. A. Robus pers. comm.). Probably a fairly common breeder at high elevations throughout the Brooks Range within ANWR, recorded at Mancha Creek (Spindler 1980) and upper Hulahula drainage (Spindler unpublished notes), and in the upper Sheenjek drainage (see Kessel and Schaller 1960).

General —Single birds were recorded 26 and 27 May 1979; first record in 1980 was 28 May. Three more observations of single birds were made during the period 6-19 June, 1980.

CLIFF SWALLOW

Regional Status and Distribution —Casual in spring along the Alaska Beaufort Sea coast. To west, "straggler" at Barrow (fewer than five records) (Pitelka 1974), two records from the Colville River Delta (Kessel and Gibson 1978), and recorded in two of five years of study at Storkersen Point, both single birds seen in early June (Bergman et al. 1977). One was recorded at Clarence Lagoon, Yukon Territory 14 June 1975 (Salter et al. 1980). Breeding has been recorded on the North Slope of the Brooks Range in the Sagavanirktok River drainage (Sage 1974), Canning River (Kessel and Gibson 1978), Aichilik River (Martin, unpublished) and Kongakut River (Martin unpublished). Salter et al. (1980) suspected breeding along the Babbage River, Yukon Territory and Cache Creek, Northwest Territories.

CRD Status —Casual migrant.

General —One was seen 1 June 1979.

COMMON RAVEN

Regional Status and Distribution —Along coast, uncommon to the west, e.g. "straggler" at Barrow (Pitelka 1974) but more common to east, termed "regular summer visitor" at Storkersen Point (Bergman et al. 1977), and termed a "fairly common permanent resident" in the Yukon ACP (Salter et al. 1980). In ANWR, recorded at the Okpilak River Delta (Spindler 1978a), Beaufort Lagoon (Martin unpublished) and Demarcation Point (R. M. Burgess pers. comm.).

General —Appears to be of regular occurrence at CRD in summer, but always in small numbers and without apparent pattern with respect to season. In

1979 they were recorded 27 May - 3 September. In 1980, Ravens were recorded on seven days in June, four days in July, and five days in August and early September. All records are of one or two individuals. Ravens are not important scavengers or predators at CRD.

VARIED THRUSH

Regional Status and Distribution —Rare spring migrant, recorded annually in recent years on the Beaufort Sea coast, from Barrow eastward. In ANWR, there are records from Sadlerochit Springs, where one was seen 22 May 1979 (M. A. Robus pers. comm.) and Demarcation Point, where one was seen 23 May 1979 (R. M. Burgess, pers. comm.). Salter et al. (1980) termed it "rare summer resident" at the upper Babbage River. This species occurs on the south slope of the Brooks Range in ANWR, e.g. Upper Sheenjek River (Kessel and Schaller 1960) and at Mancha Creek (Spindler 1980).

CRD Status —Casual visitant.

General —Two records, possibly representing a single bird: one, 31 May 1979 and one, 5 June 1979, seen on the Brownlow Lagoon and Flaxman Lagoon shoreline.

GRAY-CHEEKED THRUSH

Regional Status and Distribution —North of the Brooks Range, recorded breeding at Umiat (Kessel and Cade 1958) and probably breeds on the upper Babbage River in the Yukon (Salter et al. 1980). Common to abundant summer resouth sident in ANWR on the side of the Brooks Range (Kessel and Schaller 1960; Spindler 1980). One was heard singing in tall willows along Eagle Creek in the Canning River drainage, 16 June 1972 (Valkenburg et al. unpublished) and an unidentified thrush, probably this species, was seen at Kaktovik 22 May 1980 (Martin unpublished).

CRD Status —Probably rare migrant.

General —One was seen 12 June 1979 along the Brownlow Lagoon shoreline.

YELLOW WAGTAIL

Regional Status and Distribution —Kessel and Gibson (1978) termed this species "rare" in the Brooks Range and northern foothills east of 148 W, however, recent records suggest that this species may be more common, at least locally. They were seen "along 6 km of river bank 10-16 km from the coast, Okpilak River" on 16 June 1978 (Spindler 1978a). Locally "very common" along the Sadlerochit River in 1979, nesting between 16 and 30 km inland from the coast (M. A. Robus pers. comm.). Also recorded from Canning River, Aichilik River, and Kongakut River (Kessel and Gibson 1978) and breeds east to Babbage River area in the Yukon Territory (Salter et al. 1980). Rare at coastal locations on ACP, recorded at Storkersen Point, where one was seen 5 July 1972 (Bergman et al. 1977) and one was seen on the

Okpilak River Delta, 19 June 1978 (Spindler 1978a).
CRD Status —Rare migrant and visitant.
General —Five records, all but one in June: two, 1 June 1979; one, 6 June 1980; one, 7 June 1979; one, 28 June 1980; and two, 12 August 1979.

WATER PIPIT
Regional Status and Distribution —Rare visitor to coastal locations of Alaskan ACP. To the west, recorded at Barrow (Pitelka 1974); one, 7 June 1975 at Storkersen Point (Bergman et al. 1977). To the east, termed "uncommon" possibly breeding on the Yukon ACP (Salter et al. 1980). Very common breeding bird in eastern Brooks Range within ANWR, with nesting recorded in the upper Hulahula drainage in 1980 (Spindler unpublished notes) and in the Canning River drainage (Valkenburg et al. unpublished) and recorded on the coast at the Okpilak River Delta on 5 June 1978 (Spindler 1978a).
CRD Status —Very rare visitant, post-breeding.
General —Four August records: one, 16 August 1979; two, 25 August 1979; one, 20 August 1980; one, 28 August 1980.

ORANGE-CROWNED WARBLER
Regional Status and Distribution —Recorded casually north of the Brooks Range, east to the Sagavanirktok River (Kessel and Gibson 1978).
CRD Status —Casual migrant.
General —One was found 30 May 1980, on the bluff along the Flaxman Lagoon shoreline, just south of Brownlow Point.

YELLOW WARBLER
Regional Status and Distribution —Rare breeder in northern foothills of Brooks Range in Colville River drainage (Kessel and Cade 1958; West and White 1966) and in Brooks Range to east in ANWR. An adult was seen feeding fledglings on 3 August 1976 in the mid-Kongakut River drainage (Martin unpublished) and a single bird was seen within 25 km of the coast on the lower Kongakut River, 21 July 1976 (Martin unpublished). Termed an "uncommon summer resident" in tall brush habitat in the Yukon ACP (Salter et al. 1980).
CRD Status —Casual migrant.
General —One, 21 July 1979, feeding in a low center polygon near Finger Lake!

RUSTY BLACKBIRD

Regional Status and Distribution —Breeds in the south side of the Brooks Range, e.g. "fairly common" summer resident at Mancha Creek (Spindler 1980) and "not common" but breeding in the upper Sheenjek River Valley (Kessel and Schaller 1960). Casual migrant and visitant on the Beaufort Sea coast, recorded from Barrow, Colville River Delta, and Prudhoe Bay (Kessel and Gibson 1978) and "very rare visitor" on Yukon ACP, with one spring record and two fall records (Salter et al. 1980).

CRD Status —Casual migrant.

General —One female was seen 8 June 1980 at Brownlow Point.

REDPOLL SP.

Regional Status and Distribution —Uncommon at coastal locations in ANWR. Seen on "several occasions" at Nuvagapak Point in 1970 (Andersson 1973) and a nest was found there in 1974, in a light fixture on the exterior of an abandoned DEW-line building (Martin unpublished). One was seen at the Okpilak River Delta, 5 June 1978 (Spindler 1978a) and seen in small numbers (up to five) at Demarcation Point in June 1978 (D. M. Troy pers. comm.). Common inland as little as 20 km from the coast, along the Okpilak River (Spindler 1978a) and the Sadlerochit River (M. A. Robus pers. comm.) and "most abundant bird" in the Canning River Valley in the Brooks Range (Valkenburg et al. unpublished).

CRD Status —Uncommon migrant, visitant; rare breeder.

Spring Migration —Most records from CRD are during May and June. Date of first observation was 27 May 1979 and 29 May 1980. Single birds flying overhead were recorded on six dates 27 May - 29 June 1979. In 1980 they were seen almost daily from 3 June - 25 June, with flocks of up to 12 birds at Brownlow Point.

Breeding —A nest was found 13 July 1980 with two young hatched and three eggs, in a prostrate Salix arctica plant near base camp. The nest was destroyed the next day by a predator. We have few other July records for this species.

Fall Migration —Seen more frequently in August than July, but not as commonly as in June.

SAVANNAH SPARROW

Regional Status and Distribution —Fairly common summer resident on the ACP with breeding recorded from Meade River and the Colville River Delta (Bailey 1948) and from the Brooks Range at Anaktuvuk Pass (Irving 1960). "Widely distributed inland and (less commonly) along the coast" in the Yukon ACP (Salter et al. 1980). In ANWR, recorded from northern sector of the Brooks Range in the Kongakut River (Martin unpublished) and Canning River (Valkenburg et al. unpublished) and from coastal locations, i.e. three seen at Demarcation Point, 18 June 1978 (D. M. Troy pers. comm.), single birds seen

10-13 June 1979 at Demarcation Point (R. M. Burgess pers. comm.), and one seen at Nuvagapak Point, 13 July 1974 (Martin unpublished). At the Okpilak River Delta in 1978, one was seen at VABM Mars 1 July, and one was heard singing just 5 km inland along the Okpilak 20 July; this species was common 20-26 km inland on the Okpilak 15-16 June (Spindler 1978a).
CRD Status —Rare visitant.
General —All records are from the post-breeding season. One was seen at base camp 22-23 August 1979. Four records were obtained from Brownlow Point: one, 17 August 1980; one, 20 August 1980; one, 25 August 1980; two, 28 August 1980.

DARK-EYED JUNCO
Regional Status and Distribution —Summer resident on the south side of the Brooks Range, termed "common breeder" at Mancha Creek (Spindler 1980) and recorded on the upper Sheenjek River (Kessel and Schaller 1960). May breed in poplar forests and tall willow thickets of the Brooks Range to the North Slope; recorded in small numbers (one to five, daily) 1-5 August 1976 in the mid-Kongakut River Valley (Martin unpublished). To east, "very rare visitor" in the Yukon ACP (Salter et al. 1980) at coastal locations. Rare on the Alaska Beaufort Sea coast: one, 5 June 1974 at Storkersen Point (Bergman et al. 1977); one, 12 July 1976 at Nuvagapak Point (Martin unpublished).
CRD Status —Rare spring migrant and fall visitant.
General —One, 8 June 1980, at Brownlow Point, and one, 28-29 August 1979 at Brownlow Point.

TREE SPARROW
Regional Status and Distribution —Common in eastern Brooks Range on Kongakut River (D. M. Troy pers. comm.; Martin unpublished), Aichilik and Kongakut Rivers (Martin unpublished), Hulahula River (Spindler unpublished notes) and Canning River (Valkenburg et al. unpublished). To east, nests "probably in suitable habitat north to the coast" in the Yukon ACP (Salter et al. 1980). In ANWR and west, "suitable habitat" consisting of medium shrub does not reach the coast, and coastal records are few. Bergman et al. (1977) record three observations from Storkersen Point, of one to two individuals each: 4 June 1972, 5 June 1972, 2 June 1972.
CRD Status —Rare migrant.
General —One, 20 May 1979; one, 30 May 1980; one 10 June 1980. All records from Brownlow Point.

WHITE-CROWNED SPARROW

Regional Status and Distribution —Breeds in the Brooks Range and into the northern foothills on the ACP, closely associated with tall shrub habitat (Kessel and Cade 1958; Sage 1974; Salter et al. 1980). Rare but regular visitor on the coast, recorded regularly from Barrow, where it has also nested (Bailey 1948), one coastal record from the Yukon ACP, at Komakuk on 28-29 May 1975 (Salter et. al. 1980); one was seen at Demarcation Point, 10-11 June 1979 (R. M. Burgess pers. comm.).

CRD Status —Rare visitant.

General —One juvenile was seen at base camp, 16 August 1979.

WHITE-THROATED SPARROW

Regional Status and Distribution —Recorded at Colville River Delta, 5 June 1973 (Kessel and Gibson 1978).

CRD Status —Casual to accidental visitant.

General —One was present 9-28 August at Brownlow Point. It was a winter plumaged adult and all field marks were well studied at close range, including white throat and dull yellow lores, and striped crown.

LAPLAND LONGSPUR

Regional Status and Distribution —Ubiquitous, abundant breeder at all ACP localities.

CRD Status —Abundant breeder and migrant.

Spring Migration —Longspurs are one of the earliest birds to arrive on the ACP in spring. A male was seen 17 May 1979 at Kaktovik, and first observation at 16 km Sadlerochit River was 14 May 1979 (M. A. Robus pers. comm.). In 1980, a year of later break-up than 1979, first Longspurs were seen 25 May, although some individuals were undoubtedly in the area prior to our arrival 24 May. Mass arrival occurred during the last week of May. In 1979, females arrived generally on 27 May, a week after the first males were seen in the area.

Breeding —Aerial flight displays were performed by males almost immediately upon arrival. We heard aerial flight songs 21 May 1979 and 26 May 1980, although reflocking and temporary abstinence from territorial display seemed to be the response of this species to inclement weather in 1980. On 29 May we noted much display activity, but along with new snow and strong winds on 1 June, flight display ceased and flocks had reformed.

Nest initiation occurred as early as 2 June in 1979; in 1980 the first nest was discovered in the process of building on 6 June. Eleven nests in 1980 for which we gathered adequate data indicate clutch completion dates of 11-21 June, with the late ones probably representing renest attempts. In 1979, eight of 13 nests with good data hatched out 19 June or earlier while in 1980, no nestlings were found prior to 21 June and ten of 13 nests for which the data are adequate hatched out on or after 25 June. This suggests

that phenology of snow-melt may have a substantial effect on timing of Longspur nesting, since 1979 snow-melt was much more advanced than in 1980.

Fledged juveniles were first seen 27 June 1979, but not until 4 July 1980. Results of the intensive study plot surveys show that upland tundra and mosaic habitats are preferred over wet, lowland tundra for nesting, with highest density in the mosaic.

Post-breeding —By 20 July, large flocks began to appear on the study plots. During the period late July to September, increased use of the lowland areas was noted, while use of the upland and mosaic plot remained high also. Peak numbers are present at CRD 25 July - 25 August. Longspurs were still present in late August and September, especially along the West Branch, bay, and lagoon shorelines.

SNOW BUNTING

Regional Status and Distribution —Common breeder along Beaufort Sea coast, wherever nest sites are available, either driftwood or man-made debris, or structures. Also nests in rock crevices in alpine tundra in the Brooks Range.

CRD Status —Common breeder.

Spring Migration —Snow Buntings are very early migrants, arriving in the Beaufort Sea coastal areas in mid-April (Spindler 1978a) or early May (Brooks 1915). Both sexes were present at CRD prior to our arrival in late May of both 1979 and 1980.

Breeding —Nesting activity and almost all sightings were confined to the immediate vicinity of the coast. Nests were located in driftwood and under refuse in the drift-line along the tidally influenced shores or in buildings and oil barrels at Brownlow Point. For details of nesting activity for 1980, see Part III, this report.

Post-breeding, Fall Migration —Fledged juveniles were first seen in mid-August and were common along the coastal bluffs and beaches and at Brownlow Point by 1 August 1979, and late August 1980. A maximum of 50 was recorded at Brownlow Point, 2 September 1980, and undoubtedly this species was present in fair numbers in the study area after our departure in early September. All flocks were found right along the beach or on the coastal bluffs, and Brownlow Point was the most consistently used area.

PART VI. DISCUSSION AND CONCLUSIONS

DISCUSSION AND CONCLUSIONS

In general terms, these are the conclusions that may be drawn from the Canning River Delta bird population study.

(1) Bird use of tundra habitat varies with the species and with the season. We suggest that both (1) mixed wet and dry and (2) wet to flooded tundra are more valuable habitats for nesting birds than are mesic to dry tundra, although bird species composition differs between the two types. During late summer wet to flooded tundra habitat is by far the most heavily used. Bird use of coastal wetland (*sensu* Bergman et. al. 1977) with salt marsh vegetation is very high throughout the season, although we lack quantitative data on nesting density for this habitat.

(2) Breeding densities of large birds (loons, waterfowl, larids, etc.) are low, but local favorable areas exist where densities were at least an order of magnitude above that of the region as a whole. In particular, deep-*Arctophila* wetlands and basin-complex wetlands (*sensu* Bergman et. al. 1977) were attractive nesting and rearing areas.

(3) Use of shoreline habitats is low during the early portion of the season although early open water from river overflow attracts fair concentrations of loons and waterfowl in late May and early June, prior to break-up on the tundra. Beach habitat is used very little in early summer.

(4) Use of shoreline habitats rises dramatically in mid-July and August. Migrating shorebirds use beach habitats and Oldsquaws become abundant on lagoon and nearshore waters. Limited observations suggest that the mud flats associated with the river delta are used extensively by some shorebirds during migration.

(5) Shorebirds exhibit a shift in habitat use in late summer. In general, bird activity in August is concentrated in marine littoral and wet tundra areas; mesic to dry tundra is deserted by all but a few species.

(6) The increased use of both shoreline and wet tundra habitats is not only the result of switching by locally breeding birds. Rather, there is a massive influx of birds, presumably from inland areas, concentrating on the coastline for staging and/or migration. It is possible that for many species the entire North Slope breeding population moves coastward during the post-breeding and migration period.

Although we did not systematically gather data specifically on human disturbance of birds, certain species seem vulnerable at certain periods because of their dispersion or behavior.

(1) Loons, oldsquaw, pintails, eiders, and other waterfowl may have very limited areas of open water available to them upon their arrival on the Beaufort Sea coast in late May and early June. During this time the river mouths and estuaries are heavily used. In 1979 we observed large flocks (hundreds) of eiders between Brownlow Point and Flaxman Island in a lead extending out from the West Branch, and in 1980 we observed many migrating waterfowl and loons stopping briefly on the West Branch river in spring.

(2) Oldsquaws (and to a lesser extent, phalaropes) occur in large numbers on the lagoon and nearshore waters. Further studies of molting and post-molt Oldsquaws are needed to assess their vulnerability to disturbance through construction and industrial activity on the coast. Lacking knowledge of residence times, turnover rate, and pattern of movement within lagoons, it is difficult to interpret

census data. Intensive observation of Old-squaws during the molt period, preferably using marked individuals, would help solve these questions. Juvenile phalaropes appear in large numbers along the barrier islands and spits but for shorter duration than Old-squaws and probably with a more patchy distribution.

(3) Migrating geese feed in large flocks on the tundra in fall. White-fronted Geese, in particular, seemed highly sensitive to aircraft flying overhead at any altitude. Aircraft disturbance studies are specifically needed in order to guide any possible regulation of air traffic for the benefit of wildlife.

(4) Arctic Terns, Common Eiders, and Glaucous Gulls all nest colonially on the barrier spits and islands. Human disturbance of beach colonies in northeastern United States has been cited as a major factor in the decline of the Least Tern (Sterna albifrons) and Piping Plover (Charadrius melodus) so there is precedent for concern over these populations.

In terms of resource management, the question must be raised whether Canning River Delta is an exceptionally rich area for birds, and if so, why? Whatever the answer to the first question, one must also shift the frame or reference and ask whether some portions of the Canning River Delta are more valuable to birds than others. On a broad scale, it is apparent that the whole Beaufort Sea coast is of above average importance to birds in comparison with areas inland. The coastal vs. inland dichotomy is most strongly expressed in the relative importance of the coastal zone for migrating birds, not in breeding bird densities. Documentation of late summer immigration of birds to the coastal area of the North Slope is is scanty, but the phenomenon has been noted at least as far west as Barrow (Myers and Pitelka 1980). Canning River Delta is within this coastal zone and certainly receives heavy late season use by many shorebird and waterfowl species.

Beyond this, it is not clear whether, within this important coastal zone, deltas are particularly favorable areas. There are some habitat factors that would argue for the importance of deltas: spring overflow waters from rivers provide early open water habitat in spring, tending to hasten the development of leads at the mouths of the rivers before most of the sea

ice is melted; also, mud flats and shorelines associated with river deltas seem to be used heavily by shorebirds in migration. In addition, there are several species of birds that seem particularly associated with delta areas. These include Canada Geese (as breeders on the Arctic Coastal Plain), Glaucous Gulls in late summer seem to congregate at estuaries, and Whistling Swans also seem to be most common in delta areas. It seems likely that delta areas, in general, are more productive than average Arctic Coastal Plain tundra for birds.

Canning River is unique in the Arctic National Wildlife Refuge in its high number of moderately large-sized lakes and other extensiive wetlands. These wetlands provide breeding habitat for loons, waterfowl, phalaropes and molting Oldsquaws.

The probable answer to the first question posed is that Canning River Delta is indeed an above average area for birds. However, it is also evident that some portions of the study area were more attractive to birds than others. The following habitats seemed most important:

(1) lagoon and barrier island systems,
(2) low-center polygonal wet to flooded tundra,
(3) coastal wetland (salt marsh),
(4) deep -Arctophila and basin-complex wetlands, and
(5) mosaic wet/dry tundra (probably).

There are a number of critical research questions to be asked regarding the value of these areas to birds. Oldsquaws are the most numerous species using the lagoon systems. What are favorable and unfavorable areas for these ducks? Are certain areas consistently good from year to year? If not, is it because of variability in the prey base? What is the role of morphology of the barrier islands in concentrating food, or providing cover, or in other factors affecting the attractiveness of a given area for Oldsquaws?

Coastal wetland is a valuable and probably limited habitat heavily used by migrating shorebirds, ducks, and Brant. Areas of coastal wetland should be inventoried, mapped, and deserve special protection.

Wet low center polygonal terrain is also heavily used by migrant shorebirds but is more extensive than coastal wetland. We do not know whether migrating and staging shorebirds "commute" between tidal mud flats and marshy tundra areas according to tidal stage. If so, then delta areas assume additional importance in that they provide a juxtaposition of these habitats in close proximity.

The high breeding densities in the Canning River Delta mosaic plot may or may not represent a general trend. Further research on habitat use is needed, probably best accomplished using a multivariate approach to habitat description and identification of physical and biological correlates of differential use of habitat by birds (see Myers and Pitelka 1980).

Currently, the sources of variability in bird population data from Arctic Coastal Plain sites are largely unknown and not understood: weather, geography, season, fluctuation in food supply are all presumed to play a part. Without a better understanding of the cause and effect relationships, or at least some empirically proven correlations between environmental fluctuation and fluctuation in bird populations, accurate predictions of development related impact must be based on somewhat tenuous biological grounds.

It is a cliche' of arctic biology that the arctic ecosystem is characterized by high inter-annual variability Few studies have attempted to analyze or verify this assumption, a notable exception being recent work on shorebirds on the Arctic Coastal Plain by Myers and Pitelka (1980). They found that inter-annual variability in arctic shorebird communities was not markedly higher than temperate bird communities. However they found great inter-annual variability in the abundance of certain species, and inter-annual variability was expressed mainly in late summer, i.e. during the fall migration period rather than breeding season. They also found that shifts in population size for a given species were expressed in a patchy, localized fashion. Thus a local (i.e. within a study plot) abundance of a given species might not reflect an area-wide increase.

The two seasons of work at Canning River Delta were inadequate to fully analyze inter-annual differences in abundance, or even of bird use of the study plots. Nevertheless, comments appear throughout the text on differences noted in 1980 from the "base year" of 1979. Table VI-1 lists some species for which we are confident that 1980 patterns of abundance differed from those in 1979. For further details, refer to species accounts and plot studies.

It is important to recognize the implications of inter-annual variability and the "patchiness" of variability mentioned above. If the natural variability of bird populations is high, then short-term (one to two year) studies are uninterpretable as baselines with which to gauge the effects of development activities. Many recent studies undertaken as "environmental impact" research were working under such time constraints. The results of these studies could best be used in conjunction with longer term research. Study design must include replicate sampling within a season to estimate the variance in tundra bird populations. Furthermore, it is crucial to maintain ongoing research programs based at specific sites in order to investigate the extent and environmental correlates of inter-annual variability. Canning River Delta would be a good choice for such work because this study provides a ready data base for expansion and also because the site is located near oil fields currently being developed.

Having explicitly stated the limitations of this study (and most North Slope bird population studies) in handling the spatial and temporal variability in bird populations, the general conclusions above are not invalidated. Available data suggests that, in terms of protection of bird populations, caution should be exercised in industrial development in

Table VI-1. Species with abundance that differed in the two study years 1979 and 1980, Canning River Delta. Comments refer to status in 1980, compared with status in 1979. See text for further details.

Species	Change in Status, Breeders	Change in Status, Non-breeders
Whistling Swan	---	more non-breeding summer residents
Canada Goose	---	fewer spring migrants
White-fronted Goose	---	more migrants, spring and fall
Mallard	---	more records
Pintail	breeding occurred	more migrants
American Wigeon	---	more migrants
American Golden Plover	fewer breeding	fewer juveniles
Whimbrel	---	fewer migrants
Northern Phalarope	fewer breeding	fewer juveniles on coast
Red Phalarope	more breeders	fewer juveniles ?
Long-billed Dowitcher	no breeding	fewer migrants
Semipalmated Sandpiper	more breeding?	fewer migrants
White-rumped Sandpiper	---	more migrants
Pectoral Sandpiper	more breeders	---
Stilt Sandpiper	breeding occurred	---
Snowy Owl	---	more non-breeding summer residents
Short-eared Owl	---	more spring migrants

Seastedt, T.R. and S.F. MacLean. 1979. Territory size and composition in relation to resource abundance in Lapland Longspurs breeding in arctic Alaska. Auk 96: 131-142.

Sowls, A.C., S.A. Hatch, and C.J. Lensink. 1978. Catalog of Alaska sebird colonies. U.S. Fish and Wildlife Service, Biological Services Program.

Spindler, M.A. 1978a. Bird populations and habitat use on the Okpilak River delta area, Arctic National Wildlife Range, 1978. Xerox report in files of U.S. Fish and Wildlife Service, Arctic National Wildlife Refuge, 101 12th Ave., Fairbanks, Ak. 83 pp.

Spindler, M.A. 1978b. Fall staging of lesser Snow Geese on the north slope of the Arctic National Wildlife Range. Xerox report in files of U.S. Fish and Wildlife Service, Arctic National Wildlife Refuge, 101 12th Avenue, Fairbanks, Alaska. 11 pp.

Spindler, M.A. 1979c. Bird populations utilizing coastal tundra, coastal lagoons and nearshore waters of the Arctic National Wildlife Range. Xerox report in files of Arctic National Wildlife Refuge, 101 12th Avenue, Fairbanks, Alaska, 99701.

Spindler, M.A. 1981. Bird populations and distribution in coastal lagoons and nearshore waters, Arctic National Wildlife Refuge, Alaska. U.S. Fish and Wildlife Service Arctic National Wildlife Refuge Report Series 81-4. Arctic National Wildlife Refuge, 101 12th Avenue, Fairbanks, Alaska.

Spindler, M.A. 1979. Bird populations in coastal habitats, Arctic National Wildlife Range, Alaska: results of 1978 and 1979 aerial surveys. Xerox report in files of U.S. Fish and Wildlife Service, Arctic National Wildlife Refuge, 101 12th Ave., Fairbanks, Alaska. 23pp.

Stefansson, Vilhjalmur. 1913. My life with the Eskimo. MacMillan Co. 538 pp.

Truett, J. 1981. Physical processes. pp. 52-108 in: Vol. 7 "Biological Studies of Envir. Assess. Alaskan Cont. Shelf. NOAA/BLM, Boulder, Colorado.

Thompson, D.Q. and R.A. Person. 1963. The eider pass at Point Barrow, Alaska. Journal of Wildlife Managment 27: 348-356.

Tryon, P. and S.F. MacLean. 1980. Use of space by Lapland Longspurs breeding in arctic Alaska. Auk 97: 509-520.

U.S. Department of Commerce. 1978. Local climatological data, annual with comparative data, Barter Island, Alaska. U.S. Dept. of Commerce, National Climatic Center, Asheville, N.C. 28801.

U.S. Department of Commerce. 1979. Local climatological data, annual summary with comparative data, Barter Island, Alaska. U.S. Dept. of Commerce, National Climatic Center, Asheville, N.C. 28801.

Valkenburg,P., A.J. Magoun, and F.C. Dean. unpublished. An annotated list of birds of the Canning River area; summer 1972. Xerox report in files of U.S. Fish and Wildlife Service. Arctic National Wildlife Refuge, 101 12th Ave., Fairbanks, Ak. 31 pp.

Walker, D.A., K.R. Everett, P.J. Webber and J. Brown. 1980. Geobotanical atlas of the Prudhoe Bay region, Alaska. CRREL report 80-14. U.S. Army Corps of Engineers Cold Regions Research and Engineering Laboratory. Hanover,N.H.

Welling, C.H., S.R. Johnson, and W.J.L. Sladen. 1981. A study of Lesser Snow Geese (Chen caerulescens) in the Sagavanirktok River Delta, Alaska. Prepared for ARCO Alaska, Inc., P.O. Box 360, Anchorage, Alaska. 99510. 25 pp.

Welling, C.H. and W.J.L. Sladen. unpublished manuscript. Densities of Whistling Swan populations of the central Alaskan arctic slope. 13 pp.

Wentworth, Cynthia. 1978. Battle for the Beaufort Sea: natives document subsistence use in the Point Thomson area. Arctic Coastal Zone Managment Newsletter No. 14.

West, G.C. and C.M. White. 1966. Range extensions and additional notes on the birds of Alaska's arctic slope. Condor 68: 302-304.

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