ARCTIC NATIONAL WILDLIFE REFUGE COASTAL PLAIN
RESOURCE ASSESSMENT

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# BASELINE STUDY

## Fish, Wildlife and Their Habitats

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# INITIAL REPORT

Section 1002c
Alaska National Interest Lands Conservation Act

U. S. Fish and Wildlife Service
Arctic National Wildlife Refuge
Fairbanks Alaska
1981

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## Chapter I

## INTRODUCTION

The Alaska National Interest Lands Conservation Act (ANILCA) became law on 2 December 1980 (Public Law 96-487). In addition to the numerous other provisions contained in the act, Title X (Federal North Slope Lands Studies, Oil and Gas Leasing Program and Mineral Assessments) included provisions for an assessment of the resources on the coastal plain of the Arctic National Wildlife Refuge (Section 1002 - Arctic National Wildlife Refuge Coastal Plain Resource Assessment). The following materials are a summary of the provisions of Title X, with the complete text of Title X presented in Appendix I:

> The Secretary is to conduct a comprehensive and continuing study of the fish and wildlife resources and their habitats on the coastal plain of the Arctic National Wildlife Refuge (1002c). The Fish and Wildlife Service has been designated the lead Interior Agency for conducting the baseline study. In conducting the study, the Service will consult with the State of Alaska, Native Village and Regional Corporations, the North Slope Borough within the study area, and interested parties. Special emphasis is to be placed upon caribou, wolves, wolverine, grizzly bears, migratory waterfowl, musk oxen, and polar bears. The baseline study will address 5 subject areas.
>
> (a) assess the size, range, and distribution of the populations of the fish and wildlife;
> (b) determine the extent, location and carrying capacity of the habitats of the fish and wildlife;
> (c) assess the impacts of human activities and natural processess on the fish and wildlife and their habitats;
> (d) analyze the potential impacts of oil and gas exploration, development, and production on such wildlife and habitats; and
> (e) analyze the potential effects of such activities on the culture and lifestyle (including subsistence) of affected Native and other people.
>
> An initial report on the results of the baseline study to date is legislatively mandated on 2 June 1982; however, the Secretarial deadline for the initial report is 31 December 1981. Supplemental annual progress reports on the baseline study are required as new information becomes available. The information contained in the initial report is to form the basis for development of the guidelines required in section 1002d.
>
> The Secretary is required to establish initial guidelines (Regulations) governing oil and gas exploration activities on the Arctic Coastal Plain of the Arctic National Wildlife Refuge. The guidelines must be accompanied by an Environmental Impact Statement and both are due by 2 December 1982 (1002d). The guidelines are to be based on the results of the Baseline Study (1002c) and shall include prohibitions, restrictions and conditions on carrying out explortory activities which are necessary or appropriate to ensure that the activities do not significantly adversely affect the fish and wildlife, their

habitats, or the environment. The guidelines may include, but are not be limited to:

1. A prohibition on the carrying out of exploratory activity during caribou calving and immediate post-calving seasons or during any other period in which human activity may have adverse effects;
2. Temporary or permanent closing of appropriate areas to such activity;
3. Specification of the support facilities, equipment and related manpower that is appropriate in connection with exploratory activity; and
4. Requirements that exploratory activities be coordinated in such a manner as to avoid unnecessary duplication.

The guidelines must be accompanied by an Environmental Impact Statement which considers the impacts to the resources of the coastal plain of seismic exploration activities conducted under alternative levels of guideline restrictions. The NEPA procedures for writing an EIS will be followed. The initial guidelines will be periodically revised to reflect changes necessary as a result of new information becoming available from the Baseline Study and other appropriate information.

After the initial Guidelines (regulations) are established, any person or entity may submit one or more Exploration Plans for exploratory activity on the Arctic Coastal Plain to the Secretary for approval. This process will begin on 2 December 1982, and not before. (1002e). The Exploration Plans must include information that the Secretary may require to determine if the plan is consistent with the guidelines, including, but not limited to:

1. A description and schedule of the exploratory activity proposed to be undertaken;
2. A description of the equipment, facilities, and related manpower that would be used in carrying out the activity;
3. The area in which the activity would be undertaken; and
4. A statement of the anticipated effects that the activity may have on fish and wildlife, their habitats, and the environment.

The Secretary shall promptly publish notice and the text of the Exploration Plans received in the Federal Register and local media. Within 120 days the Secretary shall approve the Exploration Plans if they are consistent with the Guideline established by Section 1002d. At least one public hearing is required before approval for an Exploration Plan. As a condition of approval of any Exploration Plan, the Secretary:

1. May require any modifications to the Exploration Plan necessary to make it consistent with the Guidelines;
2. Shall require that all data and information (including processed, analyzed and interpreted information) obtained as a result of carrying out the plan shall be submitted to the Secretary; and
3. Shall make such data and information available to the public except that any processed, analyzed and interpreted

information shall be held confidential by the Secretary for a period of not less than 2 years following any lease sale including the area from which the information was obtained.

The U. S. Geological Survey may submit one or more Exploration Plans for exploratory activity. However, the plans may not be approved unless the Secretary determines that:
1. No other person has submitted a plan for the area involved which meets established Guidelines; or
2. The information which would be obtained is needed to make an adequate report under Section 1002h.

The Secretary may suspend the carrying out of exploration activities and/or make modification to the exploration plans approved under Section 1002e if he determines that the activities will significantly advsersely affect fish and wildlife, their habitat, or the environment. The Secretary may also levy a civil penalty on any person found to have violated any provision of a plan approved under Section 1002e. The process will logically begin at the onset of exploration activities (1002f and 1002g). If the Secretary determines at any time on the basis of information available to him that continuation of further activities under the exploration plan or permit will harm fish and wildlife, their habitat, or the environment, the Secretary may suspend those activities for such time, make such modifications to the plan or to the terms and conditions of the permit (or both suspend and modify) as he determines necessary.

The Secretary may levy a civil penalty, after notice and opportunity for a hearing (in accordance with section 554 of Title 5, U.S. Code) on any person found to have violated any provision of a plan approved under Section 1002e, of any condition of a permit issued under Section 1002f, or to have committed any at prohibited under Section 1002d. Any person against whom a civil penalty is assessed may obtain review of the case according to detailed steps outlined in this section.

The requirements of these 2 sections imply that a field monitoring program must be established which will:
1. Monitor compliance of permittees with approved Exploration plans and subsequent Refuge Special Use Permits;
2. Conduct surveillance of activities which may potentially cause significant adverse impact to fish and wildlife, their habitats, or the environment; and
3. With the authority of the Secretary, suspend activities, modify plans and permits, and initiate procedures for assessing civil penalties.

The Secretary is to prepare and submit between 2 December 1985 and 2 September 1986 a report to Congress on oil and gas production potential and its impact on the fish and wildlife resources on the Arctic Coastal Plain (1002h). The report will address 6 subject areas in this discussion of the resources of the Arctic Coastal Plain.

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(1) the identification by means other than drilling of exploratory gas production potential and an estimate of the volume of oil and gas concerned;
(2) the description of the fish and wildlife, their habitats, and other resources that are within the areas identified under paragraph (1);
(3) an evaluation of the adverse effects that the carrying out of further exploration for, and the development and production of, oil and gas within such areas will have on the resources referred to in paragraph (2);
(4) a description of how such oil and gas, if produced within such area, may be transported to processing facilities;
(5) an evaluation of how such oil and gas relates to the national need for additional domestic sources of oil and gas; and
(6) the recommendations of the Secretary with respect to whether further exploration for, and the development and production of, oil and gas within the coastal plain should be permitted and, if so, what additional legal authority is necessary to ensure that the adverse effects of such activites on fish and wildlife, their habitats, and other resources are avoided or minimized.

Information for the first 3 subject areas will be derived from the results of the baseline studies (1002c) and the seismic exploration activities. Information on potential transportation facilities and assessment of the national need (subject areas 4 and 5) will need to be developed prior to or during preparation of the report. The content of subject area 6 should be developed from an analysis of the first 5 subject areas.

Information presented in the following report was derived from a synthesis of available information on the resources of the coastal plain of the Arctic National Wildlife Refuge (ANWR) and limited field studies during the spring, summer and fall of 1981. The information synthesized included published sources (professional journals, progress reports, environmental review documents, etc.) and unpublished data and reports in the various agency files. Sources of information are cited throughout the text as appropriate and the reader is referred to the appropriate literature cited section for further information. Field investigations in 1981 included the following:

Caribou - Distribution, numbers, age, sex were derived from photocomposition counts of the Porcupine herd - A joint effort with the Alaska Department of Fish and Game and the Yukon Territorial Game Branch. FWS also developed more detailed caribou studies under contract with Alaska Department of Fish and Game.

Migratory birds - a) Baseline studies were conducted to determine migratory bird use of coastal lagoon areas. These studies included a survey of their invertebrate prey species using the lagoon system.

b) Snow goose use patterns, age/sex ratios were determined from a photocensus conducted in September.

c) Whistling swan distribution and productivity surveys were conducted in August.

Polar bears - Ongoing studies are documenting distribution, densities and timing of polar bear denning use on the ANWR coastal plain. This study is using radio telemetry to track females to den sites on the Coastal plains.

Muskox - Studies documented distribution, composition, productivity, and use of the ANWR coastal plain.

Fisheries - Reconnaissance surveys were conducted on the Hulahula and Salderochit Rivers for depth profiles related to overwintering fish populations, water chemistries and fish species distribution.

Similar reconnaissance studies were conducted on the Canning River with additional studies of age/sex growth rates and some telemetry work to determine overwintering fish distributions and fish migration patterns.

Habitat mapping - A detailed habitat classification effort and a map are being prepared using available LANDSAT imagery, augmented by natural color and infrared aerial photography. Natural color photography of the study area was obtained in August 1981.

Existing archeological and subsistence use inventories will be augmented by additional surveys.

Caribou and muskox data, snow goose census data, whistling swan survey data, lagoon studies for migratory bird use, fisheries data available at this time and habitat mapping from LANDSAT imagery have been incorporated into this report.

The following studies and surveys are planned for the Study Area on the ANWR during 1982. Detailed study plans should be developed by February 1982 for those projects being conducted by Fish and Wildlife Service personnel.

- Musk ox calving ground studies - Arctic National Wildlife Refuge staff
- Musk ox habitat interrelationship - University of Alaska - Alaska Cooperative Wildlife Research Unit (ACWRU)
- Musk ox spring composition surveys - Refuge staff
- Central Arctic Caribou studies along the Canning River - Alaska Department fo Fish and Game (ADF&G) and Refuge Staff
- Porcupine Caribou studies on the calving grounds and wintering grounds - ADF&G and Refuge staff
- Porcupine Caribou studies of calf mortality on the calving grounds - ADF&G and Refuge staff
- Caribou migration studies - University of Alaska - ACRWU
- Caribou calving ground habitat studies - Research Division, Fish and Wildlife Service (FWS)

- Porcupine Caribou photo census and composition survey - ADF&G and Refuge staff and Yukon Wildlife Branch
- Coastal lagoon studies of trophic structure - Refuge staff
- Coastal lagoon bird use surveys - Refuge staff
- Ecological studies of a "closed" coastal lagoon - OCS/BLM contractor
- Upland bird use surveys - Refuge staff
- Whistling swan surveys - Refuge staff
- Aerial survey of snow goose staging areas - Refuge staff
- Fisheries studies on the Canning River and other coastal plain rivers - FWS Fisheries field station personnel.
- Polar bear denning studies - FWS Research
- Archeological Reconnassance Survey - FWS/USGS personnel
- Vegetation (Habitat) mapping project - CRREL, INSTAR and NASA-Ames contractors
- Subsistence use surveys - ADF&G personnel.

Data from these and other studies/inventories will be utilized to meet ongoing information and monitoring needs, for incorporation into the annual progress/update reports of the baseline study, and for use in developing certain sections in the Report to Congress.

This report organizes information about the resources of the coastal plain into several categories. The first category provides a general description of the study area including the physical environment and human history (see Chapter II). The second category presents the state of knowledge about the fish, wildlife, habitat, and human culture and lifestyle resources of the study area (See Chapters III, IV, V, VI and VII). The third category summarizes the potential impacts of geophysical exploration and further exploration, development and production of the oil and gas resources on the study area (See Chapter IX and X). Chapter VIII contains the exploration assumptions provided to the Service by U.S. Geological Survey and forms the basis for the analysis of potential impacts of the geophysical exploration programs presented in Chapter IX. Each chapter contains literature cited sections that is specific to that chapter, or subsection of a chapter.

Information contained in this volume constitues the initial report for the baseline study of fish, wildlife and their habitats, and cultural and subsistence resources required under Section 1002c of ANILCA. Because the majority of this information is intended for use primarily by professional biologists and resources managers in the development of the guidelines (regulations) and environmental impact statement for the seismic exploration programs on the coastal plain, the reference citations follow the style recommended by the CBE Style Manual Committee (1978). Other conventions contained in this report were standardized to conform with the general style of the Journal of Wildlife Management, unless otherwise noted in the text and tables in this report. Unless otherwise indicated (See Chapter VIII), usage and spelling for place names follows those of Orth (1967). The reader is referred to this source of to the specific U.S. Geological Survey topographic map on which the place is located for further information. Maps have been included throughout this report which include those place names mentioned in the text (especially Inupiat place names) that are not listed in Orth (1967).

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## Literature Cited

CBE Style Manual Committee. 1978. Council of Biology Editors style manual: a guide for authors, editors, and publishers in the biological sciences. 4th ed. Amer. Inst. of Biol. Sci., Arlington, Virginia. 265 pp.

Orth, D.J. 1967. Dictionary of Alaska Place Names. Revised ed. U.S. Geol. Surv. Prof. Pap. 567. U.S. Govt. Printing Office, Washington, D.C. 1084 pp. and maps.

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# CHAPTER II

# DESCRIPTION OF THE STUDY AREA

## Physical Environment

### Location

The study area is an irregularly shaped portion of the northern coastal plain of the Arctic National Wildlife Refuge (ANWR), lying between 142° and 146° W and north of 69°34'N, and covering approximately 570,000 ha. It includes 135km of Beaufort Sea coastline between the mouths of the Canning and Aichilik Rivers, and excluding lands held by the Kaktovik Inupiat Corporation (Figs. 1 and 2), approximately 50km of coastline and about 26,700 ha. of coastal plain surrounding Barter Island. The village of Kaktovik and an adjacent U.S. Air Force Distant Early Warning (DEW) site on Barter Island represent the only permanent settlement in close proximity to the study area.

The ANWR study area is covered by the following USGS 1:63,360 topographic maps: Barter Island A-3 through A-5; Flaxman Island A-1, 3 and 4; Mt. Michelson D-1 through D-5 and C-1 through C-4; Demarcation Point D-2 through D-5 and C-3 through C-5.

### Physiographic Setting

Two of the major physiographic provinces of North America extend into northern Alaska - the Interior Plains and the Rocky Mountain System. The Arctic Coastal Plain is the only portion of the Interior Plains in Alaska, while the Brooks Range and Arctic Foothills represent the northernmost extension of the Rocky Mountain System (Wahrhaftig 1965). The entire area lies north of the Arctic Circle, between 141o and 166o West.

The Brooks Range is an arcuate belt of rugged mountains extending nearly 1000km from the Canadian border to Cape Lisburne on the Chukchi Sea, and rising in elevation to over 2700m in its eastern sections. The Romanzof Mountains of the eastern Brooks Range curve north to within 30km of the Arctic Ocean. The range forms an abrupt scarp on the north side, where it faces the low, rolling plateaus and mountains of the Arctic Foothills, which in turn range from 180 to 1700m in elevation. In the eastern arctic, the belt of foothills is more restricted and the Romanzof Mountains front almost directly on the coastal plain of the study area.

The 600 foot (180m) contour is generally considered to represent the break separating the Arctic Foothills from the Arctic Coastal Plain. From this point the coastal plain drops imperceptibly to sea level, with its shore generally rising less than 15m, and frequently less than three meters above the Beaufort Sea. The Arctic Coastal Plain province is narrow (15-25km) and not well defined at its eastern end, widens to approximately 160 km south of Point Barrow, then converges with the Arctic Foothills at Cape Beaufort. Wahrhaftig (1965) divides the Arctic Coastal Plain province into the flat, lake-dotted Teshekpuk section on the west and the gently undulating White Hills section to the east. The narrow coastal plain of the ANWR study area lies entirely within the latter section, displaying somewhat more relief than is typical of most of the coastal plain.

Fig. 1. Northern Alaska, showing the study area in relationship to other geographical locations.

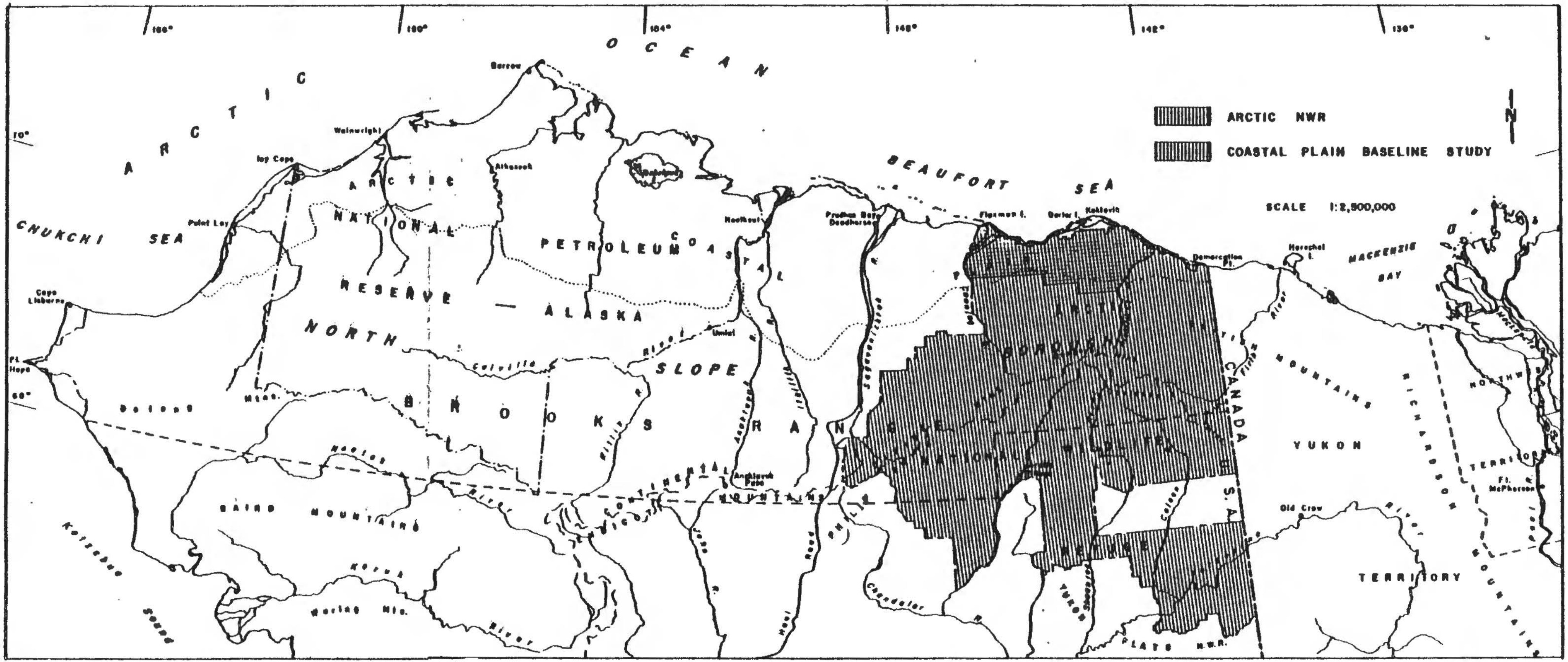

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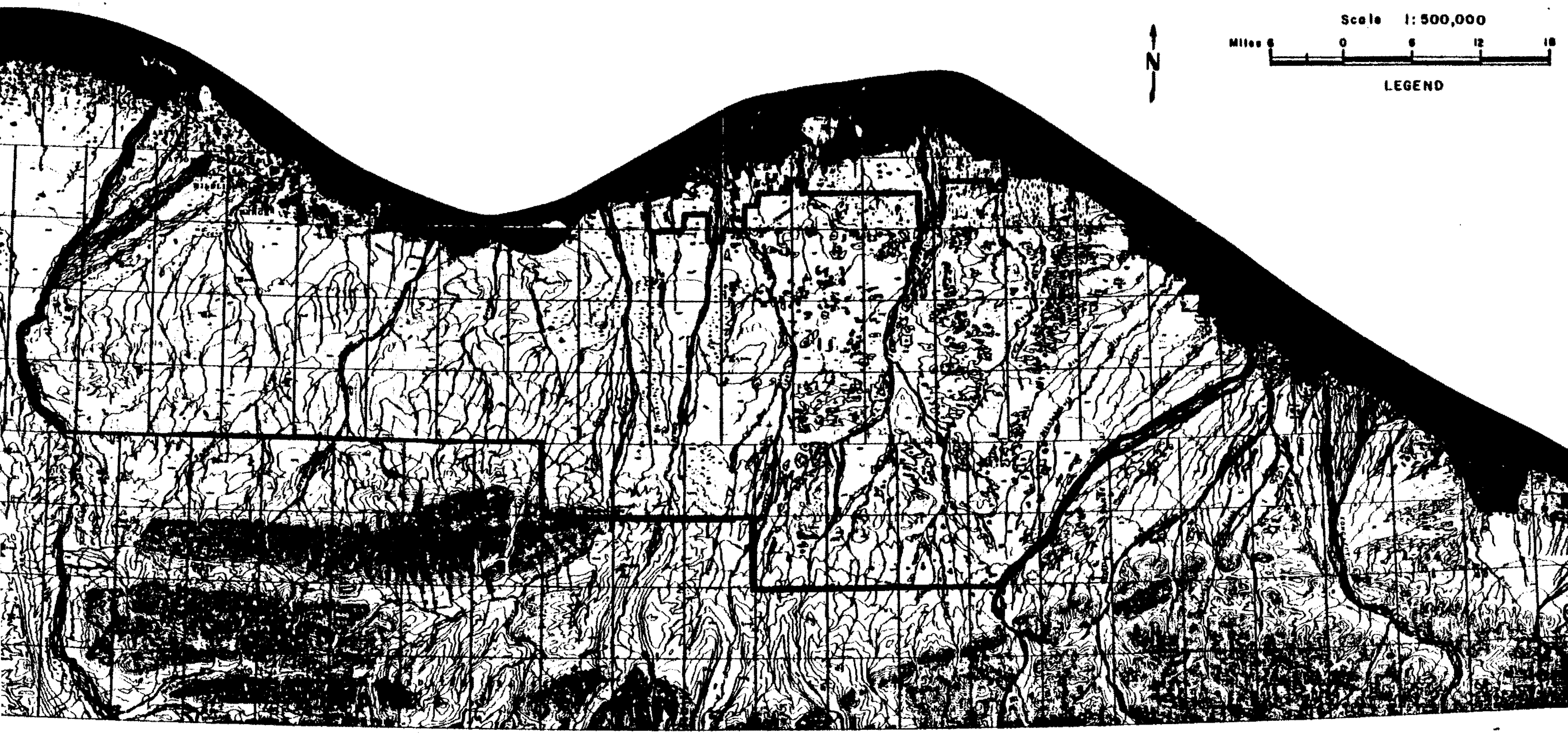
Fig. 2. ARCTIC COASTAL PLAIN BASELINE STUDY AREA



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The Arctic Coastal Plain is poorly drained, and crossed by rivers of generally low gradient which head in the highlands and mountains north of the Arctic Divide. While rivers of the western coastal plain (such as the Colville and Meade Rivers) tend to be meandering and deeply incised, those to the east run more directly north and display the braided channels and broad gravel floodplains characteristic of glacial streams. The eastern rivers, draining the higher, glacier-clad mountains of the Brooks Range, are actively building deltas into the Arctic Ocean. Within ANWR, the largest drainages are those of the Canning and Kongakut Rivers, the latter flowing entirely within the ANWR Wilderness east of the study area. The principle drainages within the study area are the Canning, Hulahula and Jago (Fig. 2).

The coastline of the Beaufort Sea is irregular and characterized by a series of barrier islands and lagoons, beaches, submerged bars, spits and river deltas resulting from the longshore erosion, transport and deposition of fluvial and marine sediments. This is in contrast with the Chukchi Sea coast to the west of Pt. Barrow, which is more regular with fewer islands, inlets and bays.

## Bedrock Geology

The regional geology of the Arctic Coastal Plain has been reviewed by Adkison and Brosge (1970), Mast, et al. (1980) and the U.S. Navy (1977). Descriptions of rock units within the eastern coastal plain can be found in Reiser, et al. (1971, 1980). The following discussion is derived largely from these sources.

The coastal plain of the Arctic National Wildlife Refuge is located in an area of stratigraphic and structural complexity, where three regional sedimentary provinces (the Arctic Platform, Colville geosyncline and Camden-Demarcation Basin) and three major structural features (the Brooks Range fold belt, Barrow Arch and Barrow Platform edge) converge and overlap. This rock sequence has been further complicated by a series of erosional unconformities which have removed portions of the sequence during the geologic past. Beneath this sequence is a basement of pre-Mississippian age, an extension of meta sedimentary rock units exposed in the Brooks Range.

The Arctic Platform is a product of an early major depositional episode, which began in pre-Mississippian time and continued through the Jurassic (400 to 150 million years ago). The rocks of this sedimentary group consist of marine or fluvial clastic and carbonate deposits (shales, siltstones and sandstones) which formed when northern Alaska lay beneath a shallow sea and the source of sediments was a major land mass to the north.

A second major depositional period occurred during the Cretaceous Period (130 to 70 million years ago), when folding, overthrusting and general uplift along the Brooks Range geanticline to the south and the Barrow Arch to the north formed the Colville geosyncline, a depositional basin filled by fluvial and marine clastic sediments to form calcareous sandstones, siltstones and shales. These deposits are very thick under the western arctic, and are thin and truncated to the east.

Underlying most of the eastern Arctic Coastal Plain are deposits which filled the Camden-Demarcation Basin. These range from Upper Cretaceous and Tertiary fluvial and marine clastics such as calcareous sandstone, siltstones and shale, and nonmarine strata of conglomerate, sandstone, micaceous and carbonaceous siltstone and shale. Closer to the coast, these are overlain by Upper Tertiary sediments of the Sagavanirktok Formation.

While nearly all of the oil and gas discoveries made in NPR-A, at Prudhoe Bay, and other locations in the western Arctic have been in deep strata of Cretaceous age, the majority of oil and gas reserves of the eastern Arctic are thought to occur in Tertiary strata which do not extend to the west. The largest potential oil and gas field located within the ANWR study area is thought to be beneath the coastal plain just south of Camden Bay, in a 60,000 ha area of uplift known as the Marsh Creek anticline. Mast, et al. (1980) have concluded that the probable potential reserves in these and adjacent Tertiary rocks may contain most of the total oil and gas resources present within the ANWR, and that quantities of oil per square mile may be close to eight times those of NPR-A.

## Quaternary Geology

Glaciers covered about half of the area of Alaska during the Quaternary period: Most of the ice was concentrated in the two major mountain belts: the Alaska Range and coastal mountains in southern Alaska and the Brooks Range to the north. Largely due to lower precipitation and elevation in interior and northern Alaska, these areas remained unglaciated, and the northern and southern ice masses did not coalesce (Coulter, et al. 1965; Flint 1971). This left the Brooks Range ice distinct from the Cordilleran Glacier Complex. During Illinoian and Wisconsinian and Holocene time, the system of valley and piedmont glaciers was considerably more extensive on the south flank of the Brooks Range than on its northside, evidence that the primary source of moisture came from air masses moving north and northeast from the Pacific Ocean, a pattern similar to that of the present day (Hamilton and Porter 1975; Pewe 1975). Somewhat more area was covered by Illinoian and pre-Illinoian glaciers than Wisconsin glaciers, particularly in the western Brooks Range, but also in the northeast portion of the range. Late Wisconsin and Holocene age glaciers were successively less extensive (Coulter, et al. 1965).

Although most of the Arctic Coastal Plain remained unglaciated during the Pleistocene, glacial moraines of early or middle Pleistocene age do extend to within 30km of the present coastline on portions of the narrow eastern coastal plain where the high mountains are in closer proximity. All of the coastal plain is covered by a mantle of Quaternary age glaciofluvial and marine deposits known as the Gubik Formation, which ranges in thickness from a few to 50 meters and consists of slightly consolidated brown gravels, sand, silt and clay (Detterman, et al. 1958; O'Sullivan 1961). This formation consists of interbedded fluvial and marine sediments deposited during alternating periods of glacial outwash and marine transgression. In the ANWR a broad area of fluvatile - deltaic sediments extends onto the coastal plain, thus these fluvial deposits tend to predominate within this formation. To the west, the Gubik deposits are primarily marine (O'Sullivan 1961; Pewe 1975).

Recent fluvial and colluvial processes have eroded and reworked earlier Quaternary deposits. Alluvial deposits on the eastern coastal plain consist of well worked, poorly to well sorted silt and gravel on floodplains and low terraces. Well developed alluvial fans are present near the coast on most of the larger rivers within the study area, and some (most notably the Canning River) are actively building deltas into the Beaufort Sea. Further inland, where there is more topographic relief, colluvial deposits resulting from landslides, frost action and sheetflow are common (Reiser, et al. 1980).

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## Periglacial Features

The term periglacial was originally introduced to describe the climate and climatically controlled features of an environment adjacent to glacial ice. Washburn (1973) and Pewe (1975) have since expanded this definition to include any environment which has a cold climate and is characterized by perennially frozen ground and intense frost action. The latter definition can therefore be applied to the environment of the Arctic Coastal Plain and the ANWR study area; a region in which continuous permafrost, frost action, mass-wasting of frozen ground and thermokarst erosion are widespread and significant factors in governing geomorphic processes within surficial deposits.

Permafrost is defined as any earth material, soil or rock, within which the temperature remains below 0°C for two or more years, regardless of the amount of moisture present (Muller, 1947). The Arctic Coastal Plain and the ANWR study area lie entirely within the zone of continuous permafrost (Ferrians 1965). In this zone permafrost occurs everywhere beneath the surface except under a few deep lakes, deep rivers and some coastal areas where surface water remains unfrozen throughout the year. Permafrost is present under the coastal waters of the Beaufort Sea, although its extent and characteristics in this area are unknown. Some relictual subsea permafrost is also known to exist in areas of coastal retreat (Lewellen 1974).

The thickness of permafrost layer is thought to exceed 650m under some parts of the coastal plain, although the average depth is 200 to 300m in areas of flat coastal lowland underlain by thick, unconsolidated sediments (Pewe 1975). On the eastern coastal plain, where there is more relief, deep deposits are not as extensive, thus the average permafrost thickness is likely to be considerably less.

The layer of seasonally frozen ground overlying permafrost is termed the active layer. During the weeks between breakup and freezeup on the coastal plain, the depth of thaw can vary from less than a foot to more than 10 feet, depending upon topography, microclimate, vegetation, the presence of surface water and the thermal characeristics of the soil (Washburn 1973; Pewe 1975).

Frost action is a collective term describing a number of distinct processes brought about mainly by freezing and thawing (Washburn 1973), such as frost wedging, heaving and sorting. These processes are active near the surface on the Arctic Coastal Plain and are responsible for distinctive patterned ground features such as polygons.

One of the most important and widespread frost processes operating on the coastal plain is the formation of ice wedges, foliated ice masses which occur as wedge-shaped, vertical or inclined sheets or dikes 1cm to 3m wide and 1 to 10m deep (Pewe 1975). In general, they are formed when surface deposits exposed to subfreezing temperatures contract and crack, usually in a polygonal pattern. These cracks are filled with meltwater during the following thaw season, and then once again freeze and expand. Repeated expansion eventually causes the uplift of soil material to the surface and formation of elevated ridges on each side of the ice wedge. The resulting form is that of a "low centered" polygon (Washburn 1973). These ridges may impede drainage from within the polygons, leading to the formation of small ponds.

Another conspicuous feature of the Arctic Coastal Plain resulting from frost action is the presence of pingos; isolated, conical ice-cored hills, 20 to 400m in diameter and up to 70m high (Pewe 1975). These tend to form on nearly level ground (usually a draining lake bed) when unfrozen ground water migrates under pressure to a site where it then freezes and expands, heaving the ground to form a mound. Continued annual migration and heaving increases the size of the mound. On the flat, lowland sections of the coastal plain, pingos usually represent the sole relief features, thus they can be of biological as well as geomorphic significance.

The term thermokarst refers to topographic depressions resulting from the thawing of ground ice (Washburn 1973). Thermokarst features found on the Arctic Coastal Plain include polygonal troughs and pits, beaded drainages and thaw lakes. All are important erosional processes resulting from naturally induced thermal instability, although thermokarst erosion can also be initiated by anthropogenic surface disturbance.

Polygonal troughs and pits develop over degrading ice wedges. Thawing of ice wedges may result from climatic change, but more often they are caused by alteration of vegetation cover or changes in drainage patters. When thermokarst pits formed at the intersection of polygonal troughs become interconnected, the result is a beaded drainage (Washburn 1973).

The most widespread thermokarst features on the Arctic Coastal Plain are thaw lakes, relatively small bodies of water which are formed or enlarged by the thawing of frozen ground. These lakes are dynamic features which go through a cyclic process of thawing, erosion and expansion, drainage and, ultimately, rejuvenation of ground ice (Billings and Peterson 1980).

Because the topography of the ANWR study area is more heterogeneous than that of the western Arctic Coastal Plain, thermoerosional features typical of arctic uplands are probably more widespread. Among these would be frost heaving and sorting and resulting patterned ground phenomena, as well as mass wasting processes such as solifluction and frost creep.

Solifluction is the gradual downslope movement of fine-grained water-saturated surficial deposits (both mineral and organic), usually over bedrock or a shallow permafrost table, which appears as lobelike or sheetlike flows on slopes with gradients as low as $1^{o}$ and may move at rates of up to 6cm per year on slopes of 10 to $14^{o}$ (Washburn 1973).

Frost creep is the downslope movement of material through a process of alternate frost heaving and settling. It may act together with solifluction or alone in areas of relatively low soil moisture or poor soil development. Rates of downslope movement through frost creep are generally comparable to those resulting from solifluction (Washburn 1973).

One other periglacial feature typical of braided streams and commonly encountered on most of the major rivers within the study area is auifes, or overflow ice. After freezeup, aufeis may develop when the hydrostatic pressure which results as freezing approaches the stream bed forces repeated overflow of unfrozen water onto and around older ice, after which it freezes to form a new layer of ice. Aufeis may also accumulate in the vicinity of natural seepages or springs in the same manner. The result is a massive sheet of ice which usually persists on the river floodplain well after breakup and may be several hectares in area and up to 4m thick (Washburn 1973). On many rivers within the study area, aufeis is a conspicuous feature on deltas and on floodplains below springs throughout the summer season.

Climate

Sources for most of the following discussion of general climatic conditions on the Arctic Coastal Plain are National Weather Service data and summary publications by Searby (1965) and Searby and Hunter (1971).

The climate of Alaska north of the Brooks Range is classified as arctic; summers are short, cool and generally cloudy, with temperatures of the warmest month (July) averaging about 5°C and maximum temperatures rarely exceeding 30°C. Subfreezing temperatures and snow may occur at any time during the summer months. Winters are very cold, with temperatures of the coldest month (February) averaging about -20°C. Extreme lows frequently drop below -40°C. Since high surface winds are common throughout the year, the combination of wind and temperature results in equivalent chill temperatures well below the actual temperatures.

Within the arctic zone, there is a trend toward increasing continental and diminishing marine influence on temperature with distance from the coast. The arctic coast experiences more frequent cloudiness and fog, with higher winds; while inland, clear skies are more common and winds are variable, thus temperature ranges and extremes tend to be greater. This contrast is intensified during late summer and fall months when there is open water along the coast, although even in winter when the Arctic Ocean is frozen over, air temperatures reflect some marine influence.

Based on precipitation alone, the Arctic Coastal Plain can be considered arid, with the average annual precipitation being less than 25cm, including the water equivalent of 30 to 120cm of snowfall. Most of the total is in the form of summer rainfall. However, due to low evaporation rates and the effects of permafrost and generally level terrain on drainage, soils in summer are usually saturated, thus available moisture is considerably greater than the low annual precipitation would indicate. In general, precipitation is slightly higher on the eastern coastal plain than to the west.

Relatively high surface winds prevail along the arctic coast throughout the year. At Barter Island, a calm condition exists only four percent of the time. Average wind speeds are generally 15 to 25kph with occasional intense storms generating winds in excess of 115kph. The winds are predominantly northeasterly, although most of the strongest winds (greater than 40kph) are westerly.

Of considerable importance in determining patterns of temperature, precipitation and wind is the position of the arctic front, a belt of maximum frontal frequency marking the transition from a warmer, low pressure southern air mass characterized by westerly winds to a cold, high pressure polar air mass with easterly winds. In Alaska, the mean summer position of the arctic front is over the Arctic Coastal Plain. During the winter, the frontal belt is less intense and generally lies over southern Alaska (Reed 1960; Hare 1968). It has been suggested that the thermal contrast which develops in summer between the strongly heated land surface and the cool, ice-filled Arctic Ocean contributes to intensification of the front (Reed 1960).

Table 1. Temperature and precipitation data for Barter Island, Alaska (from Searby 1968).

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Latitude: 70°8'N Longitude: 143°35'W Elevation: 12m

Temperature (°C)

| | J | F | M | A | M | J | J | A | S | O | N | D | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| max | -23.3 | -25.2 | -22.1 | -13.0 | -3.4 | 3.9 | 8.6 | 7.3 | 2.2 | -5.2 | -14.2 | -19.8 | -8.7 |
| min | -30.9 | -32.2 | -30.1 | -21.6 | -9.2 | -1.5 | 1.7 | 1.5 | -2.1 | -11.3 | -21.2 | -27.3 | -15.3 |
| mean | -27.1 | -28.7 | -26.1 | -17.3 | -6.3 | 1.2 | 5.2 | 4.4 | 0.1 | -8.2 | -17.7 | -23.6 | -12.0 |

Precipitation (mm)

| | J | F | M | A | M | J | J | A | S | O | N | D | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10.2 | 8.9 | 5.1 | 4.3 | 6.4 | 13.0 | 22.4 | 26.7 | 23.9 | 21.3 | 10.2 | 7.4 | 159.5 |

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There are few long term climatic records available for the Arctic Coastal Plain, except Barter Island, a station close to the ANWR study area and the only continuously maintained weather recording station in the eastern Alaskan arctic. Climatic data from Barter Island are summarized in Table 1. Although Barter Island is close to the study area and can be considered a good example of general climatic conditions, the data presented should be viewed in light of the station's atypical geographic position; it is located at the northern end of an island which projects nearly four miles north into the Beaufort Sea at the apex of a north-trending coastline. Therefore in summer it is more likely to experience high winds, fog and correspondingly lower temperatures than an average location on the eastern coastal plain.

## Hydrology

The rivers flowing into the Beaufort Sea between the Itkillik River and the Canadian border represent approximately 28 percent of the total streamflow within the arctic drainage (H.J. Walker 1974). These streams flow almost directly north on narrow floodplains and have few tributaries. Annual precipitation and glacial discharge are low, thus total runoff is low. The size and relative streamflow of the principle rivers within the ANWR study area are summarized in Table 2. Very little information is available on discharge rates of arctic rivers, and apparently no data have been collected on streams within the study area.

Table 2.
Selected drainage and streamflow data for principle rivers within the ANWR study area (from U.S. Army 1957).

| River | Drainage Area (sq. km) | Length of Main Stream (km) | Estimated Average Annual Flow (cfs) |
|---|---|---|---|
| Canning | 5,843 | 188 | 1,125 |
| Tamayariak | 873 | 60 | 170 |
| Katakturuk | 728 | 68 | 140 |
| Sadlerochit | 1,971 | 113 | 380 |
| Hulahula | 2,023 | 140 | 390 |
| Okpilak | 1,109 | 113 | 215 |
| Jago | 2,587 | 127 | 500 |
| Aichilik | 616 | 63 | 120 |

The extreme arctic climate of the coastal plain results in wide seasonal fluctuations in stream discharge. During winter, streamflow virtually ceases. In the deltas, the absence of fresh water flow allows sea water to move upstream under the river ice and leads to vertical zonation of salinity, with the lowest layers being most saline. In the Colville River, this salinity gradient may extend up to 60km inland (H.J. Walker 1974), although the low volume of rivers within the study area would prohibit penetration on this scale. Within the deltas, freshwater is entirely replaced by seawater.

In spring (May and June), melt water begins to accumulate and flow over the surface of the ice inland and on the deltas. As the river ice fractures and breakup begins, meltwater combines with the increasing downstream flow of freshwater to rapidly flush the seawater from the lower rivers and deltas. As breadkup continues, extensive flooding permits rapid movement of ice toward the sea, where floodwater and block ice move onto and beneath the sea ice to a point just beyond the seaward limit of bottomfast ice. Sediment loads are at their peak during flooding, and considerable deposition (several centimeters) of fine material may occur on the sea ice surface. The fresh water and sediments are soon drained through cracks and holes in the sea ice which develop with changes in the thermal regime (H.J. Walker 1974).

Following breakup, flooding drops off rapidly. Due to the low summer rainfall of the arctic slope, there is little chance of summer flooding.

The numerous small thaw lakes typical of the western coastal plain are much fewer in number to the east. Within the ANWR study area they are most common on the broad, nearly level deltas of the Canning and Jago Rivers. Except for a few larger lakes on the deltas of the Canning and Hulahula Rivers, nearly all of the lakes within the study area are less than one square mile (259 ha) in area. Most of these lakes are less than two meters deep and freeze to the bottom in winter. There are no lakes of glacial origin within the study area.

Due to the widespread occurrence of permafrost, ground water supplies are probably nonexistant in the study area except in thaw zones under the deeper lakes and rivers. Permafrost is impermeable, and limits recharge, discharge, movement of ground water and the formation of shallow aquifers, thus little or no ground water storage is available (Williams 1970). Ground water occuring beneath the permafrost zone is likely to be saline (D.A. Walker, et al. 1980).

In winter, springs and related icings are active and conspicuous hydrologic features at higher elevations along the southern boundary of the study area, where less permeable sedimentary strata are overlain by limestone. Three major springs have been documented within the study area by the USGS (Childers et al. 1977) on the upper Sadlerochit, Hulahula and Okerokvik Rivers. The Sadlerochit Spring at the east end of the Sadlerochit Mountains is the largest known spring in the study area. At its source, it has a fairly constant discharge of 37 cfs at a temperature of 13°C, and maintains an open channel for nearly 80km downstream during the coldest part of the year.

## Coastal Environment

The Beaufort Sea coastal zone within the ANWR study area is defined here as the area between the terrestrial limit of marine influence and the 10m depth contour, including all barrier islands, reefs and bars. This corresponds to the beach and nearshore zone described by Short, et al. (1974). The 10m depth contour is generally considered to represent the inshore limit of the winter shear zone between shorefast ice and offshore ice (Reimnitz and Barnes 1975).

Although the Beaufort Sea is ice-covered most of the year, coastal morphology is largely determined by open water influences (from mid-July to mid-September) such as wind-generated waves, currents and surges superimposed upon the lesser effects of an astronomical tide of 15cm. Since the arctic ice pack usually lies only a few tens of kilometers offshore, the potential wind fetch is small, thus wave energy is limited (wave heights rarely exceed 2-3m). The geomorphic processes controlled by these meteorlogical factors include beach erosion, longshore transport, offshore bar formation and barrier island migration (Short et al. 1974).

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Beach and bluff erosion and sediment transport does not begin until winter snow and ice cover has melted, and the open water allows the wind to generate waves and currents. Coastal erosion starts with the thawing of previously eroded bluff sediments and saturated soil flow. Thermal erosion proceeds with the undercutting and thawing of exposed ground ice features such as ice lenses and vertical ice wedges, frequently leading to thermokarst collapse of massive soil blocks (Lewellen 1977; Hopkins and Hartz 1978). Ice push, and the accumulation and incorporation of sea ice into beach sediments during the summer and fall may contribute significantly to beach erosion.

Coastal erosion rates of 20m or more per thaw season have been measured, although coastal retreat between Demarcation Point and Brownlow Point has averaged 1.5m per year over the last 23 years (Lewellen 1977). Periodic storms of greater than average intensity can cause more erosion and movement of sediments in a few hours than would normally occur over several years (Hume and Schalk 1967; Reimnitz and Maurer 1978). Where coastal bluffs are protected by deltaic deposits, retreat is much less rapid than on coastal segments adjoining deeper water (Barnes and Hopkins 1978).

The prevailing northeasterly winds generate west-setting nearshore currents which reach velocities of 50cm per second and, when combined with the northeast wave set, result in net longshore sediment transport to the west. Longshore transport of sediments has been measured on the order of 5,000 to 10,000m3 per year. However, longshore transport, particularly of coarser sediments, may be limited by the low-energy coastal circulation characteristic of this area, with deep lagoons or inlets acting as barriers to long distance movement of deposits (Short _et al_. 1974; Hopkins and Hartz 1978; Truett 1981).

One of the characteristic features of the arctic coastline is an extensive and continuous system of offshore bars. These develop in the shallow nearshore environment in response to wave action directed by the prevailing northeast winds and west-setting longshore current. The bars migrate onshore at rates up to 70m per year and alongshore up to 300m per year (Wiseman and Short 1976). The net westerly movement of sediments within bar systems of the Beaufort Sea has been estimated as approaching 400,000$m^3$ per year, two orders of magnitude greater than rates of sediment transport within the beach zone (Short _et al_. 1974). Offshore bars have a significant influence on the movement of sea ice, which frequently grounds on the bars and can form breakwaters protecting the beach from wave action.

The islands of the arctic coast play an important role in determining the nature of the coastal environment. They affect water circulation and sediment transport, anchor sea ice and extend the zone of shorefast ice. Islands on the Beaufort Sea coast fall into three general categories: emergent depositional shoals on the outer fringes of river deltas, erosional remnants of the coastal plain which have become separated from the mainland by rapid thermal erosion, and recent constructional islands of unconsolidated sand and gravel, some of which have developed around cores of Pleistocene barrier island remnants. Constructional islands forming barrier chains are a prominent morphologic feature of the study area coastline; the island chains are made up of broadly arcuate island groups separated by passes which are sites of strong currents and water exchange between shallow lagoons and the open ocean. They are typically low (less than 2m above sea level) and narrow (less than 2km), and are likely to be breached or innundated by storm surges or flooding during breakup (Hopkins and Hartz 1978).

Migration of islands, filling of old passes and development of new ones occur rapidly; westward and landward migration rates of barrier islands have been estimated as ranging up to 30m per year and 7m per year, respectively. Since landward migration rates of islands and coastal erosion rates (above) are comparable, lagoon widths tend to remain relatively constant for long periods (Short et al. 1974; Truett 1981).

Recent evidence indicates that the barrier islands are migrating with little loss of area or mass, but the sand and gravel sources from which they were derived are assumed to have largely disappeared, thus it is likely that any material removed from them would not be replaced through natural processes (Hopkins and Hartz 1978; Truett 1981).

The lagoons and lagoon systems lying inshore of the barrier islands are typically shallow (less than 3m in depth) with flat, featureless bottoms composed primarily of fine sediments. The mainland shorelines of most lagoon systems in the study area are characterized by stretches of low, eroding bluffs broken by river deltas of varying size.

Much of the information available on the physical processes of arctic lagoons is derived from research conducted in Simpson Lagoon on the western Beaufort Sea coast. It is assumed that the processes described by Truett (1981) and Craig and Haldorson (1981) for this area are also operating within the lagoons of the ANWR study area, thus the following summary is based on these sources.

In the lagoons, as elsewhere, the summer ice-free period is short, normally lasting from early July to late September or early October. Breakup in the lagoons begins in June with an influx of fresh, relatively warm water originating from stream runoff. By mid-July, lagoon waters are nearly ice-free and largely fresh (salinities usually less than 10ppt). Water temperatures rise rapidly from -2°C to 10°C by mid-summer. As breakup of coastal marine ice proceeds during late July and early August, there is an influx of marine water through lagoon inlets and lagoon waters become increasingly brackish, reaching 25-30ppt by late August. Freshwater input is low during the open water season due to low stream discharge rates.

Although exchange of lagoon and marine waters is dominated by longshore currents, local meteorological conditions play an important role in determining circulation patterns within the lagoons. In Simpson Lagoon, flushing rates are normally 10 to 20% per day, but may reach 100% per day when winds are strong (greater than 65kph). Turbidity and dissolved oxygen levels also increase significantly with increasing wind speed.

Winter freezing of lagoon waters generally begins in late September or early October, several weeks ahead of the sea outside the barrier islands. Ice cover is usally complete by early November, with ice thickness steadily increasing until approximately 90% of the lagoon volume is frozen. Unfrozen water near the centers of the lagoons and in deeper channels becomes hypersaline, reaching levels of 60ppt by late winter.

Although the lagoon systems of the ANWR study area can be expected to display similar patterns of circulation, exchange and water conditions to those of

Simpson Lagoon, such factors may vary with changes in location, lagoon morphology and the relative input from freshwater sources.

## Offshore Marine Environment

The ANWR study area fronts entirely on the Beaufort Sea, that portion of the Arctic Ocean which extends east from Pt. Barrow to the Candian Arctic Archipelago. The Beaufort Sea has a shallow, relatively narrow continental shelf which generally extends from 50 to 100km off the northern Alaska coast to a well-defined shelf break at the 100m isobath (USDI-BLM 1979).

The Beaufort Sea, and the Arctic Ocean in general, can be divided vertically into three water masses: arctic surface water, Atlantic water, and arctic bottom water. Arctic surface water occupies the upper 200m and covers most of the continental shelf; the upper 50m of this layer originates primarily from terrestrial runoff and is characterized by relatively low salinities (28.5 to 33.5 ppt) and temperatures (° to -1.5°). Atlantic water is injected into thge Arctic Basin through the passage between Greenland and Spitsbergen and is found from 200m to 900m in depth. It is of higher salinity and temperature (greater than 0°C) and highlyt saline (35 ppt) Herlineveaux and de Lange Boom 1975; O'Rourke 1974).

The principle component of the generaly circulation pattern of surface water in the Beaufort Sea is the Beaufort Gyre, which rotates clockwise over the Canada Basin and reaches a velocity of 10cm per second along the outer shelf of northern Alaska (Herlinveaux and de Lange Boom 1975). Neashore currents are most strongly westerlies (see discussion of coastal environment), but may also include an eastward component resulting from an intrusion of Bering Sea water (Namtvedt et al. 1974; Herlinveaux and de Lange Boom 1975). Tidal currents are weak, with the mean lunar tide ranging between 15 and 30cm (Reimnitz and Barnes 1974), thus nontidal factors are of greater significance.

The continental shelf waters of the Beaufort Sea are generally ice-free for no more than three months of the year (mid-July to mid-October), during which time the polar pack ice usually moves offshore 50 to 65km north of the coastaline. The dates of breakup, freezeup and the distance the ice moves offshore are extremely variable from year to year; heavy ice may be pesent on the coast at any time during the open water season, particularly during periods of northerly winds (Namtvedt et al. 1974; NARL 1979). In October, the pack ice moves southward toward the coast, and by the end of month it has joined with newly formed ice near the coast to create a nearly continuous cover.

In winter, three major zones of sea ice can be recognized: landfast ice, deformed and dynamic ice of the transition or "shear" zone, and the pack ice beyond (Namtvedt et al. 1974; USDI-BLM; NARL 1979). The distance which landfast ice extends outward from land is dependent upon water depth, interation with pack ice and the degree of protection provided by the shoreline (Kovacs and Mellor 1974). The seaward limit of landfast ice is generally over depths of 10 to 30m and it is often bottomfast out to depths of 2 to 3m. The outer boundary is influenced significantly by the degree of pressure exerted upon it by the expanding pack ice in late fall. Pressure of sufficient intensity and duration will cause the ice to buckle and form hummocks, pressure ridges and keels. If pressure continues, the keels may eventually ground, leading to further deformation and ice gouging of the sea floor (Kovacs and Mellor 1974; Reimnitz and Barnes 1974). This zone of deformation and shearing is also an area where intermittent leads and patches of open water may occur, particularly in spring (USDI-BLM 1979).

Beyond the shear zone is the pack ice zone, which consists of seasonal and multiyear floe ice. The seasonal pack ice extends from the shear zone to the toe of the continental shelf, is highly mobile, and contains a large proportion of first year ice which has formed over open water between the limit of landfast ice and the polar ice pack. Seasonal pack ice normally reaches an average thickness comparable to that of the seasonal landfast ice (approximately 2m) and may also undergo some deformation (Kovacs and Mellor 1974).

To the north of the seasonal pack ice and beyond the continental shelf lies the polar pack ice, which consists of thick (average 2 to 10m) multiyear floes which is almost fresh (0 to 6 ppt) and considerable stronger than seasonal ice (Kovacs and Mellor 1974; USDI-BLM 1979). The polar pack ice is constantly in motion, with leads opening and closing throughout the year.

In spring (July) major leads begin to appear in the vicinity of the shear zone, particularly in area offshore of the principle river drainages. In the Beaufort Sea, the most prominent of these occurs between the Mackenzie River delta and Banks Island (NARL 1980). During late July and early August, the pack ice moves northward and open water extends along the coast to the west towards Pt. Barrow. The landfast ice usually persists along the coast, becoming thinner and weaker, until it is broken up under the influece of wind, currents and the influx of fresh water (Namtvedt et al. 1974).

Due to the influence of fresh and relatively warm water discharge from terrestrial sources into the coastal waters of the Beaufort Sea, there is a strong gradient of decreasing seawater temperature and increasing salinity with distance from shore during the open water season. This relationship may vary alongshore according to source proximity, coastal morphology and meteorological effects, and has a significant effect upon freezing rates, ice conditions and the pattern of breakup (Wiseman et al. 1974, NARL 1979).

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# Human History

## The Eskimo

The Inupiat Eskimo of northern Alaska are descendents of proto-Mongoloid peoples who migrated across the Bering Land Bridge at the close of the Pleistocene Epoch. The Inupiat are composed of two distinct, but interacting ethnological groups: the Nunamiut and the Tagiugmiut. The Nunamiut were nomadic, and ranged over the northern slopes and foothills of the Brooks Range following the migrating caribou upon which they subsisted. The Tagiugmiut occupied small villages along the coast from which they hunted marine mammals, principally bowhead whales and seals.

Although the two groups of Inupiat depended primarily upon distinct resources, there was significant overlap of resource utilization and considerable cultural interaction (Gubser 1965; Schneider and Libbey 1979). The Tagiugmiut regularly traveled inland along the major river drainages to take fish, caribou and other furbearers. Likewise, the Nunamiut journeyed along the same rivers to the coast, where they traded caribou meat and hides for food and materials produced by the coastal people from their marine resources.

Prior to 1885, the inland Nunamiut are thought to have been more numerous than the coastal Tagiugmiut, reaching a peak of more than 1,000 in scattered bands of 50-150 people in the river valleys of the arctic mountains and foothills (Gubser 1965). However, as the effects of an expanding white culture increased (see below), their numbers dwindled. By 1920, the lure of employment in whaling and trapping, the effects of disease and declining caribou herds had reduced the Nunamiut population to less than 20, and these soon moved to the coast. In the late 1930's, several Nunamiut families returned inland to settle at Anaktuvuk Pass in the central Brooks Range. At present, this village is the sole remaining Nunamiut settlement.

The coastal Tagiugmiut faced similar problems during this period, and those that remain are now concentrated in a few larger villages, principally Point Hope, Wainwright, Barrow and Kaktovik (Barter Island) (Fig. 1)

## Euro-American Contact

The search for a northwest passage first brought European explorers to the arctic coast of Alaska. In 1826, Sir John Franklin traveled from the Mackenzie River west along the Beaufort Sea coast intending to rendezvous with Capt. F.W. Beechey, who was sailing east towards Pt. Barrow. While members of Beechey's crew did reach Pt. Barrow, Franklin was forced to turn back after reaching the Return Islands near Prudhoe Bay (Franklin 1828). Nevertheless, the Beechey and Franklin expeditions provided the first accounts of the coastal environment and its inhabitants. Many of the geographic features along the Beaufort Sea coast were described and named by Franklin (Leffingwell 1919).

In 1837, P.W. Dease and Thomas Simpson of the Hudson's Bay Company followed Franklin's route west from the Mackenzie River and completed the survey of the coast between Prudhoe Bay and Pt. Barrow.

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When a later Franklin expedition disappeared in the arctic in the early 1840's, several searches of the region were initiated (Leffingwell 1919; Gubser 1965). Of these, the observations of Capt. R. Collinson during his three winters (1851-1854) in the arctic probably had the most far-reaching effects. Although he found no sign of Franklin, his information on anchorages and the abundance of bowhead whales in the Beaufort Sea, together with similar reports from other investigators, spurred the expansion of American and European whaling efforts into the Arctic Ocean east of Pt. Barrow (Leffingwell 1919).

The growth of the arctic whaling industry had profound economic and social effects on the native inhabitants of the area. Opportunities for employment on whaling ships and the introduction of trade goods altered the economic base of the coastal Inupiat, while the introduction of disease and alcohol had significant social and cultural consequences. The use of firearms acquired from white traders and whalers permitted the Eskimo to take increasingly large numbers of caribou, thus seriously depleting the herd. This, together with the sudden increase in whale harvests, in many instances led to starvation (Spencer et al. 1979) or migration east to Canada.

As the arctic whaling industry declined in the late nineteenth century, several white whalers settled along the Beaufort Sea coast to open permanent trading stations, primarily for furs. Men such as Ned Arey on the Canning River delta and (later) Tom Gordon at Barter Island and Demarcation Point eventually became important figures in Eskimo life. In many cases, these men were the first whites to travel inland in the eastern arctic, but they left little permanent record of their observations.

Although the Alaskan gold rush never really extended north of the Brooks Range, some prospectors did search the drainages of the arctic slope. Two such men, F.G. Carter and S.J. Marsh, wintered at Camden Bay in 1901 and spent most of the following two years prospecting the Canning River as far south as Cache Creek (Leffingwell 1919). Their lack of success led them back to interior Alaska via the upper Canning and Chandalar Rivers. Many geographic features along this route were first named by or after Carter and Marsh.

The most extensive early survey of northeast Alaska was conducted by E.deK. Leffingwell, a geologist with the U.S. Geological Survey who established a permanent camp on Flaxman Island between 1907 and 1912. During this period he collected data on the geology and geomorphology of the Canning River area and explored the drainages of the Okpilak and Hulahula Rivers. He also made important observations on native history and culture (Leffingwell 1919). His original camp on Flaxman Island was placed on the National Register of Historic Places in 1972.

## Early Oil Exploration

The presence of oil seeps on the Arctic Coastal Plain had long been known to the native inhabitants of the region, and this information was duly noted in early geological surveys (Leffingwell 1919). This information, together with an increasing demand for oil to fuel the Navy's ships, led President Warren G. Harding to issue an executive order on February 27, 1923 withdrawing 23 million acres north of the Brooks Range and west of the Colville River as Naval Petroleum Reserve No. 4.

There was little activity in NPR-4 until after the Department of the Interior issued Public Land Order 82, which closed NPR-4 and an additional 25 million acres to the west and east (including the present area of ANWR) to appropriation under any public land laws and reserved mineral rights for use by the Secretary of the Interior in the "the prosecution of the war". Between 1944 and 1953, first the Navy and then a civilian contractor (ARCON) conducted exploration for oil and gas on lands set aside by PLO 82. Although several minor and a few larger discoveries were made, the high potential costs of development and transportation led the Secretary of the Navy to discontinue the exploration program in 1953 (U.S. Navy 1977). Apparently, no seismic exploration or drilling was carried out within the present ANWR area, although between 1947 and 1953 geologic mapping was conducted on the Canning River, Marsh and Carter Creeks, the Sadlerochit Mountains, the upper Katakturuk and Tamayariak drainages, and the Kongakut and upper Firth Rivers (Reed 1958).

Naval oil exploration also prompted scientific investigations to begin in the Alaskan arctic. The Arctic Research Lab (ARL) began operations in 1947. An ARL field station was established at Peters and Schrader Lakes to provide support for geologists and biologists working in the eastern arctic (Ritchie and Childers 1976).

### Post-War Military Development

World War II and early oil exploration activity seems to have had little effect upon the northeastern Alaskan arctic and its inhabitants. However, during the military defense buildup which followed the war, a Distant Early Warning (DEW Line) system was constructed at intervals along 3,000 miles of Alaskan and Canadian arctic coastline. Barrow was the main supply base during construction, and Barter Island was selected as a site for one of the larger DEW Line installations.

Construction and support of the DEW Line stations had a significant effect upon both the arctic coastal environment and its people. Specifically, establishment of the 4,500 acre DEW Line site on Barter Island resulted in three relocations of Kaktovik Village between 1947 and 1964 to accomodate changes in the layout of the installation (Wentworth 1979).

DEW Line construction and operation brought social and economic changes to the native residents of the arctic coast on a scale not experienced since the decline of the whaling industry. Increased job opportunities once again caused immigration and concentration of the nomadic native populations in villages such as Kaktovik (Wentworth 1979).

The effect of DEW Line construction and operation on the Beaufort Sea coastal environment was also significant. Between the Canning River delta and Demarcation Point, one principal DEW Line station (Barter Island) and two intermediate stations (at Camden Bay and Beaufort Lagoon) were constructed, as well as lesser structures at Brownlow and Demarcation Points. Only the Barter Island installation remains active today, the remaining structures and accompanying abandoned equipment having been transferred to the Fish and Wildlife Service by the Navy in 1971. Abandoned materials include over 25,000 rusting steel fuel drums located primarily at Camden Bay and Beaufort Lagoon, but also scattered along the coast and inland within the boundaries of ANWR (Thayer 1979). The debris, along with cat trails and gravel removal around the abandoned sites, provide reminders of this period.

## Establishment of the Arctic National Wildlife Refuge

In 1949, while the Navy was searching for oil and gas in NPR-4 and adjacent areas, the National Park Service began a survey of Alaska's recreational potential. The survey was directed by George L. Collins, Chief of the State and Territorial Recreation Division for Region Four of the NPS. In 1954, following aerial surveys, field verification and consultation with prominent conservationists such as Olaus Murie and A. Starker Leopold, Collins recommended to the National Park Service that the northeast corner of Alaska be preserved for its wildlife, wilderness, recreational, scientific and cultural values. At the same time, however, he proposed that exploration for and extraction of locatable and leasable minerals be permitted. This apparent inconsistency seemed to be justified in order to lessen potential opposition from development interests. Furthermore, it was felt that the chances for commercial mineral development in this area were slight. Collins also recommended that the area be an international park, to include contiguous lands between the Alaska-Canada border and the Mackenzie Delta (Ritchie and Childers 1976; Spencer et al. 1979).

During the next seven years there ensured a political struggle over the future of the arctic wilderness. Conservationists such as the Muries traveled to the eastern Brooks Range to make biological observations and then met with various influential outdoor and political groups around the state to enlist their support for a wildlife range. While there was considerable support for such an action, there was strong opposition amongst those concerned with future industrial development in the territory and the restriction

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Among conservationists and federal representatives there was some disagreement over which agency should manage the land. George Collins had originally proposed a park, while Olaus Murie felt that rather than promoting "mass recreation" and related economic development, the area should be managed as wilderness by the U.S. Fish and Wildlife Service. It was also felt that there would be opposition to a new park by industrial developers, that the new park would be too inaccessible, and that Alaskans would favor USFWS jurisdiction. It was ultimately agreed that USFWS management should be sought (Ritchie and Childers 1976).

On November 20, 1957, Secretary of the Interior Fred A. Seaton announced plans to repeal Public Land Order 82 of 1943. The action would leave NPR-4 and neighboring areas open for development, but also specified that some nine million acres of Alaska's northeastern arctic be considered for establishment of a national wildlife range. Development-minded Alaskans and other industrial interests had been lobbying for revocation of PLO 82, and Seaton's order linked the sought after opening of PLO 82 lands with ~~the~~ creation of the Arctic National Wildlife Range.

During the next three years, public support for establishment of ANWR continued to grow, while opposition from mining interests who desired entry and Alaskan politicians who feared a growing federal role in Alaska also increased. Early in 1950 the Department of the Interior presented to Congress its own draft of legislation to create ANWR. It was introduced to Congress by Senator Warren Magnuson as Senate Bill 1899, and brought immediate opposition from Alaska's congressional delegation over its provisions to restrict mineral rights to the subsurface estate, a move which mining interests felt would prohibit mineral development. Although a companion measure passed the house early in 1960, Alaska Senators Ernest Gruening and E.L. "Bob" Bartlett continued to block the Senate version (Ritchie and Childers 1976; ~~Naske~~ Spencer et al. 197~~0~~9).

When the national elections of November 1960 brought eight years of

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Republican administration to an end, Secretary Seaton acceeded to increasing public pressure during his final days in office and signed two public land orders: PLO 2214 created the ANWR and closed it to entry under existing mining laws, and PLO 2215 revoked PLO 82 of 1943.

The Alaska delegation hoped that the new Democratic Secretary of the Interior, Steward Udall, would revoke Seaton's executive order, and offered a proposal that would turn ANWR over to the state to be managed as public recreation land. Udall agreed to consider their proposal, but in the end he gave his support to Seaton's action.

After failing in their bid to overturn PLO 2214, Gruening and Bartlett continued to fight ANWR through the appropriations process. Over the next eight years they successfully blocked the appropriation of funds to manage ANWR. It was not until after Bartlett's death in 1968 and Gruening's defeat the following year that funds were finally appropriated in 1969 for the management of ANWR.

## Expansion of the ANWR

The Alaska Statehood Act was ratified on January 3, 1959, and provided for the transfer of 104 million acres of federal land to the state. During the next few years, native protests over land entitlements made it nearly impossible to convey these lands. For this and other reasons, by 1968 the state had selected only 26 million acres.

In 1969, Public Land Order 4582 was enacted to freeze further land conveyances until native claims could be settled. The land freeze continued until December 18, 1971, when the Alaska Native Claims Settlement Act (ANCSA) was enacted. In spite of strong opposition from development interests, Congressm~~a~~en Morris Udall and John Saylor succeeded in inserting two additional sections into ANCSA: Section 17(d)(1) revoked PLO 4582 and withdrew all unreserved public lands in Alaska from all forms of appropriation; Section 17(d)(2) specified that up to 80 million acres of unreserved lands could be reserved for additions to or creation of units in the National Park, National Forest, National Wildlife Refuge, and ~~the~~ National Wild and Scenic Rivers Systems. Most of the lands within the Arctic withdrawal area surrounding the existing 8.9 million acre ANWR were withdrawn only under 17(d)(1) of ANCSA. Congress specified a deadline of December 1978 for final action on proposed withdrawals.

In 1973, after two years of extensive studies, Interior Secretary Rogers C.B. Morton submitted recommendations to Congress for designations of withdrawn Alaskan lands which included an addition of 3.7 million acres to the 8.9 million acre Arctic National Wildlife Range and designated the entire unit as a National Wildlife Refuge (USDI 1974). Dissatisfaction with the proposals was expressed on both sides of the lands issue, and no legislative action was taken on them.

In January 1977, legislative deliberation on the ANCSA withdrawals began with the introduction of H.R. 39 by Congressman Udall. Several months of debate and compromise resulted in passage of H.R. 39 by the House of Representatives in May of 1978. With only six months remaining before the expiration of Section 17(d)(2), the measure was passed on to the Senate, where the Committee on Energy and Natural Resources, under pressure from Alaska Senators Mike Gravel and Ted Stevens, reduced the total protected acreage and the portions assigned to wilderness by H.R. 39. This substitute measure did not designate any wilderness in the

ANWR and directed the Secretary of the Interior to conduct oil and gas exploration on the north slope, including the arctic coastal plain within the ANWR. Continued debate stalled the measure in the Senate, and Congress eventually adjourned without enacting the legislation.

One month before the expiration of Section 17(d)(2), Secretary of the Interior Cecil Andrus invoked an emergency withdrawal of 110 million acres of public lands in Alaska that were being considered for addition to the national park, refuge, forest, and wild and scenic rivers. The withdrawal was authorized under Section 204(e) of the Federal Land Policy and Management Act (FLPMA) of 1976, but could remain in effect for only three years. Most of the proposed additions to ANWR were covered under Sections 17(d)(2) of ANCSA and 204(e) of FLPMA.

On December 1, 1978, President Carter used the Antiquities Act of 1906 to proclaim 54 million acres of ANCSA Section 17(d) lands as National Monuments. This action extended the duration of protection for these lands from the three years authorized by 204(e) of FLPMA to an indefinite period, and could only be reversed by Congress. The ANWR and its proposed additions were not included in the Antiquities Act withdrawals.

In order to provide long-term protection for those lands not included in the Antiquities Act withdrawals, Secretary Andrus designated and additional 40 million acres be withdrawn under Section 204(c) of FLPMA, which extended the period of protection to twenty years, and superceded the temporary Section 204(e) withdrawals (USDI 1980).

In 1979, new legislation similar to the original H.R. 39 was drafted in the House by Representatives Udall and John Anderson and once again it was passed. Several months of negotiation followed in the Senate, and eventually a compromise bill was developed and passed in August, 1980. The Senate version retained the additions to the ANWR specified by ANCSA and FLPMA but also included the provision permitting oil and gas exploration on the arctic coastal plain of ANWR. The compromise bill was reluctantly accepted by the House in November, and on December 2, 1980 President Carter signed into law the Alaska National Interest Lands Conservation Act (ANILCA). The ANILCA legislation created an 18 million acre Arctic National Wildlife Refuge which encompassed the existing 8.9 million acre Arctic National Wildlife Range and an additional 9.1 million acres of adjoining lands west to the Trans-Alaska Pipeline and south to the Yukon Flats. An area of approximately 8 million acres, comprising most of the original Arctic National Wildlife Range, was designated wilderness, while 1.4 million acres of arctic coastal plain within the refuge was opened to exploration for oil and gas (Fig. 2 ).

## Status of Lands Adjacent to the ANWR

The Arctic National Wildlife Refuge is bordered on the east by the Yukon Territory, Canada. Adjoining lands along the western and portions of the southern boundaries of ANWR were selected by the State of Alaska under the provisions of the Statehood Act and ANCSA. Also adjacent to the southern extent of the refuge is the newly designated Yukon Flats National Wildlife Refuge.

Within the boundaries of ANWR along the ~~A~~arctic coast to the north are lands withdrawn by the Kaktovik Inupiat Corporation under the provisions of ANCSA. Approximately 66,000 acres of coastal plain between Camden Bay and Oruktalik Lagoon were selected by Kaktovik (Fig. 2 ). An additional 23,000 acres of deficiency lands were selected from public lands adjacent to the refuge west of the Canning River. ANILCA directs that these deficiency lands be conveyed to the Department of the Interior in exchange for all the lands in the Barter Island group (3,577 acres) not occupied by the military (800 acres) or the village of Kaktovik (141 acres). This conveyance has not yet been completed. Native land entitlements within the refuge include surface rights only, while subsurface rights remain with the refuge. Also excluded from native claims within this area are rights of way such as trail and survey easements for transportation of energy, fuel and natural resources (e.g., oil and gas).

In addition to the above lands, the status of land occupied by two abandoned DEW Line stations remains undetermined. These sites, 456 acres on Camden Bay and 420 acres on Beaufort Lagoon, are both within the ANWR study area. While the property on these lands was transferred from the Navy to the Fish and Wildlife Service in 1971, the land has yet to be accepted by the Fish and Wildlife Service.

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## Chapter III

## VEGETATION

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### Introduction

The development of a body of knowledge about vegetation, habitat types, and habitat use by wildlife species for the coastal plain of the Arctic National Wildlife Refuge (ANWR) has developed slowly since the formation of the refuge in 1960. The earliest studies of plant species occuring in northern Alaska were the result of exploratory parties along the north slope. The first major attempt to compile and present a unified approach to Alaskan flora was provided by Hulten (1968). This effort was followed by Anderson (1974). The result of these two works has been to provide the basic framework for the current knowledge of the vascular plant taxa within the Alaskan arctic. A preliminary list of plants of the ANWR is currently being developed and the vascular members of this flora are listed in Appendix 2.

Within recent years, the studies of arctic plant communities have steadily increased. More is being learned annually about the community composition, taxonomy, and energetics of arctic plant life. The more detailed discussions of plant communities in the north have come from Britton (1957), Johnson et al. (1966), Sigafoos (1952), and Spetzman (1959). A number of more geographically restricted community descriptions have been developed by Batten (1977), Churchill (1955), Hanson (1953), Hettinger (1974), Meyers (1981), Murray (1974), Wiggens (1951), and others. A major undertaking by Viereck (1981) to produce an exhaustive bibliography for the vegetation of Alaska has resulted in an annotated list of references that currently contains 308 literature citations. This bibliography is currently accessible by users through the University of Alaska computer system in Fairbanks. Also, a preliminary bibliography of literature citations that are relevant to the Alaskan arctic are included in Appendix .

Certain reports dealing with successional processes within tundra are worthy of review, namely that of Churchill and Hanson (1958), Churchill (1955), Spetzman (1959).

Very few studies have been reported for the coastal plain of the refuge and most community descriptions for the study area have addressed very limited community ranges. Murray (1974) discussed the flora and vegetation at several sites within the refuge that lie within the study area, including Beaufort Lagoon, Shublik Springs and the vicinity of Cache Creek. The flora of the Beaufort Lagoon coastal environment is being finalized by Meyers (1981).

Hettinger (1974) included 4 sample sites in or adjacent to the study area and assumed that the coastal plain physiographic province included 6 major vegetation types. The most abundant type was the wet sedge meadows which was composed of 5 associations differing by their composition:

1) dwarf willow - mountain avens and sedge (*Salix ovalifolia* - *Dryas integrifolia integrifolia* - *Carex bigelowii*),
2) netted willow - sedge - moss (*Salix reticulata* - *Carex bigelowii* - *Tomenthypnumnitens*),
3) willow - sedge (*Salix planifolia pulchra* - *Carex aquatilis*),
4) sedge (*Carex bigelowii* - *C. rariflora* - *C. saxitilus laxa*), and
5) dwarf birch - sedge (*Betula nana exilis* - *Carex aquatilis* - *C. bigelowii*).

The remaining vegetation types recognized for the coastal plain were as follows:

a) low shrub - sedge meadow and hummocky tundra
b) tussock tundra
c) riparian willow shrub
d) dwarf shrub - Dryas meadow
e) heath-sedge tussock tundra

From these vegetation studies, Hettinger estimated that the seral development to the early climax stage for river terraces may take at least 40 years; and for certain communities on river alluvium and riparian sites up to 90 years or more is required to reach certain stages of composition.

Vegetation Classification and Mapping

The classification of resource values (or vegetation types) requires the arranging of similar entities into groups or sets demonstrating certain relationships. The identification of these entities or groups and their proper placement within an orderly visual portrayal entails the development of a mapping scheme.

The current state of the art for developing a unified vegetation classification system for the north slope is confounded by the differing needs of users combined with the intricate details of the biotic and abiotic environment of the area. State and federal agencies are seeking the means for managing wildlife and critical habitats, satisfying permitting requirements, and maintaining environmental quality, to name a few. At the same time, industry is seeking answers to exploration and development issues. On a different plane, impacts of activity upon the wildlife and habitat resources result in events that affect local, state, national, and even international decision making processes. The eventual answer to this problem will be an integration of the taxanomic classification with the processes of identification, mapping, and regionalization (Bailey et al. 1978).

A number of classification and mapping systems have been developed over the years and some have been applied to the coastal plain. None have yet met with a broad scale acceptance due to one or more factors like terminology, methodology, or conceptual framework. Several have presented interesting approaches in limited areas of the slope. To a large degree, much of the work thus far has been performed to the west of the refuge in the areas of Barrow and NPR-A, along the Trans-Alaska Pipeline System, or in the region near Prudhoe Bay.

The Barrow and NPR-A areas have received coverage through the studies by Walker (1977), Komarkova and Webber (1978, 1980), Webber (1978), Wiggins (1951), Spetzman (1951, 1959), Churchill (1955) and others. Markon (1980) has provided a mapping system for terrestrial and aquatic habitats along the Alaska National Gas Pipeline System. Brown (1978) has reported on ecological baseline studies along the haul road. For the area around Prudhoe Bay are the works by Everett et al. (1978), Webber and Walker (1975), Walker et al. (1979) Everett (1975), Everett and Parkinson (1977), and Bergman et al. (1977).

A classification scheme that has been considered for Alaska vegetation, but generally viewed of less utility than that of Vierick et al. (1981) is the UNESCO structural-ecological system published by Ellenberg and Mueller-Dombois (1966) and Mueller-Dombois and Ellenberg (1974). The purpose for the UNESCO system is to provide a mapping tool for the world's vegetation at scale in the range of 1:1,000,000.

Two problems with the system that have prevented its application to the coastal plain are (1) the incompatability of the scale(s) for which it was designed and (2) the limited degree to which the pertinent tundra communitites are addressed. Both problems combine to preclude the use of the system for many highly site-specific situations facing land and resource managers.

The system by Bergman et al. (1977) was designed for the wetland areas at Storkersen Point near Prudhoe Bay. This system of classification is applicable to the study area of the refuge because the 8 wetland categories developed were related to habitat values for waterfowl and shorebirds.
The wetland categories were:
Class I - Flooded Tundra
Class II - Shallow *Carex* ponds
Class III - Shallow *Arctophila* wetlands
Class IV - Deep *Arctophila* wetlands
Class V - Deep open lakes
Class VI - Basin complex wetlands
Class VII - Beaded streams
Class VIII - Coastal wetlands

While this system has not been applied widely within the study area, the obvious desirability of the approach lies in the relationship developed between vegetation, certain abiotic factors, and habitat value to an important class of resources.

Of a more general nature, but relevant to the development of classification systems for the state are the works of Viereck et al. (1981) and Murray and Batten (1977). The latter system presented a provisional method for classifying the tundra landscapes throughout the state of Alaska and provides a useful reference to the major floristic units and the literature sources for local and regional studies where these units are addressed.

The preliminary system of Viereck et al. (1981) is by far one of the more comprehensive and controversial approaches to date for a state-wide vegetation classification tool. Within the system as currently presented, the entire state vegetation is assembled in a 5 level hierarchy that methodically treats known communities from the general to very site specific. In the current revision of the system, the tundra communities that occur within the study area are placed at level III of the shrubland and herabeous vegetation major fomations. This treatment of tundra communities has resulted in criticism by some field workers in the state who feel that tundra assemblages should be represented at level I, however, the system in general has received fairly widespread interest by the state, federal and private sectors. As the Viereck et al. system continues to evolve, a major companion effort that must be addressed is the development of efficient cross-walk capabilities with other systems currently in use (eg. NWI, Walker et al., Bergman).

The attempts at mapping the vegetation of the coastal plain and the study area in particular have been limited. This has been partly caused by the factors of accessibility and economic interest in the past. With the growing effort to develop the resources of the eastern coastal plain, the need to provide detailed data bases and mapped products shall accelerate. A discussion of some of the relevant efforts to date is warranted.

In an attempt to portray the potential natural vegetation of the Alaskan land mass, Küchler (1966) listed 10 phytocenoses or vegetation groups. For essentially all of the study area, the potential vegetation is characterized as cottensedge tundra with Eriophorum representing the principle dominant genus. The only exception to this approach that Kuchler presents is a narrow band of the watersedge tundra assemplage, characterized by Carex, that runs along the coast from the Canning River east to about the Katakuruk River and inland for about 5 miles.

A common problem with Küchler's approach remains the distinction between his mapped "potential vegetation" and the occurring "real vegetation". This is particularly true in those areas of Alaska (and the conterminous United States) where there have been significant influences by man upon the landscape. While this is probably a real consideration for parts of Alaska (eg. the Anchorage bowl, the Kenai Peninsula, etc.), the distinction between "real" and "potential natural" vegetation within the study area is far less pronounced. The obvious problem encountered in the Kuchler approach, is the lack of information concerning the miriad of subdominant communities that are apparently critical for the needed habitat diversity required by the wildlife of the study area. The categorization of the vegetation of the area as being cottonsedge tundra does not allow for management guidelines to be developed except to the very broadest levels.

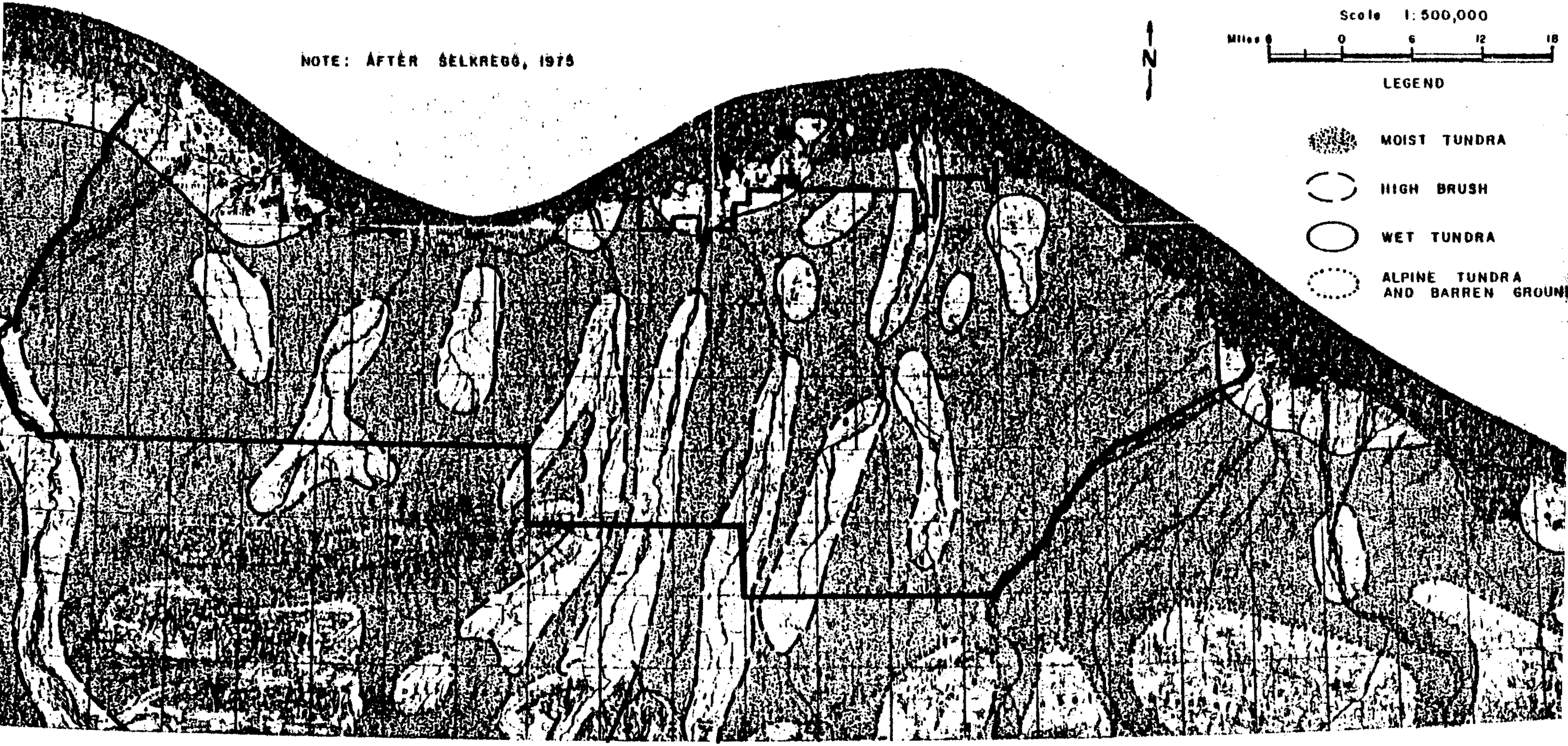
The ecosystem maps for the state of Alaska in the Alaska Regional Profiles (Selkregg, 1975, Arctic Region) provided a very generalized classification system for the major plant community types. The approach that was taken employed a series of maps at a scale of 1=1,000,000 upon which were superimposed the generalized boundaries of the four major community types (Fig. 1):

1. Alpine Tundra
2. Moist Tundra
3. High Brush
4. Wet Tundra

Fig. 1.

# ARCTIC COASTAL PLAIN BASELINE STUDY

## MAJOR PLANT COMMUNITIES



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In addition to the 4 terrestrial plant communities presented, 2 aquatic communities were identified, the freshwater and marine. The commonly occurring plants of each of these 6 communitites were listed in the atlas (Selkregg, 1975). The communities represented follow those of the earlier map Major Ecosystems of Alaska (Joint Federal-State Land Use Planning Commission, 1973). The Joint Federal-State Land Use Planning Commission for Alaska which was formed as a result of the Alaska Native Claims Settlement Act (P.L. 92-203) in December 1971 and guided the development of the profile series was operating under a mandate to recommend alternatives for the use and management of state and federal lands and assist the newly formed Native corporations. As a result, the plant community information presented (Fig. 1) lacks the detail necessary to be of significant use in the development of the site specific management plans for wildlife resources or habitat requirements to be utilized on the refuge lands.

A method of classification developed by the Fish and Wildlife Service for wetlands is the National Wetland Inventory (NWI). The basis of this system is presented by Cowardin et al. (1979) with additional information presented in the 1978 Interagency Task Force Report: Our Nations Wetlands (Horwitz, 1978).

At the present time, there are probably several drawbacks to the use of the NWI system for mapping within the study area:

1) the NWI classification is designed for wetland habitats, not for upland drier environments,
2) the time delay encountered in the production of usable products,
3) the scale at which products are produced for Alaska.

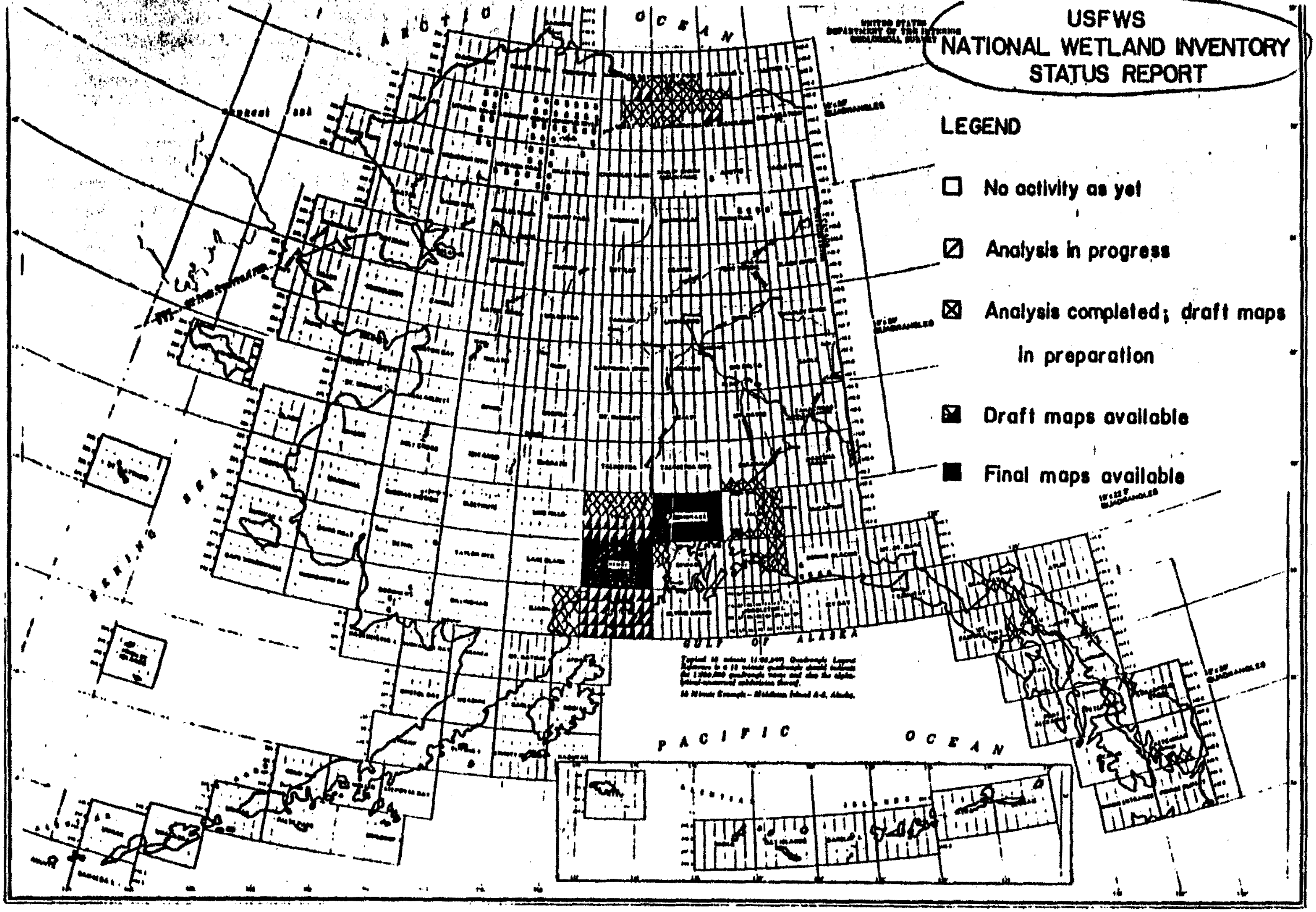
In the first situation, the study area designated in Section 1002 of ANILCA contains not only coastal and inland wetland habitats, but additionally many miles of inland habitats that are not wetlands in the normal sense of the word. The problems of applying the NWI heirarchy to mesic and semi-xeric habitats is self defeating. Many of the wildlife resources that require recognition in this and other studies do not routinely inhabitat wetland situations throughout their annual cycles.

Presently, only 2 (Mt. Michelson C4 and C5) NWI maps in draft format are available for the study area; an additional 5 (Flaxman Island A3-5 and Mt. Michelson D4-5) are in various stages of draft preparation (Fig. 2). No definite plans are yet made for the completion of the Barter Island and Demarcation map areas.

The use of 1:63,360 scale base maps for the Alaskan products from the inventory places the level of needed information in parts of the study area at a detail that is insufficient for many management purposes.

The basis of the mapping system, as discussed by Walker, Webber, and Komarkova (1979) and later in the Prudhoe Geobotanical Atlas (Walker et al., 1980), lies in the production of master maps that relate landforms, soils, and vegetation in a correlated manner. Such a method is particularly useful in areas like the arctic coast where the occurrence of vegetation assemblages is closely tied to variations in the patterns of

Figure 2



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the ground features. The data placed on the master maps are gathered from independent vegetation and soil studies carried out in the field. When finally intergrated on the master maps, the soils and vegetation information for specific sites are represented as fractions in which the code is translated as:

> Numerator: Dominant vegetation type followed by subdominat vegetation types, each of which compose at least 20% of the unit.
>
> Denominator: Dominant soil, landform and slope class (the last is not included if slope is less than 2%).

From the coding scheme thus far developed by these workers, large numbers of highly descriptive map codes can be developed (see examples of descriptive codes). Likewise, by translating the information within the master map codes, a number of special purpose maps can be generated, eg. soil depths, off-road vehicle sensitivity, etc. The sequence of steps utilized in developing the master maps and special purpose maps is outlined in Fig. 3.

## Current Habitat Typing Effort

Recognizing the need for baseline management information and the legal mandates set forth in Section 1002 of ANILCA, the Arctic National Wildlife Refuge has undertaken an effort to obtain detailed updated information about the vegetation and habitat occurrence within the coastal plain study area.

At the beginning of the 1981 summer season, the only vegetation map that was available for the coastal plain study area was the 1977 Landsat product produced by LaPerriere (1977) for the refuge. This product depicted 13 vegetation classes by 11 colors (Table 1). The product has been used on several occasions in the field to determine if there existed a close correlation between habitat usage and vegetation classes that were portrayed. To date it has generally been found that there did exist a reasonably good correlation between the coastal and riverine tundra areas characteristically utilized by waterfowl. However, the upland sedge tundra and upland tussock tundra classes did not appear to correlate well with observed use by such species as caribou.

To determine if this observed discrepancy could be rectified with a more in-detph analysis of the satellite imagery, it was decided that an updated and expanded classification system would be sought that would utilize the latest scenes that were available. To accomplish this, the refuge called upon the experience of the Cold Regions Research and Engineering Laboratory (CRREL), the Institute of Arctic and Alpine Research (INSTAAR), and the U.S. Geologic Survey's mapping branch at the NASA facility in Moffett Field, California. The combined effort of these groups was selected because each participant had contributed to the current mapping program of similar arctic coastal areas to the west of the refuge around Prudhoe Bay.

The USGS laboratory secured the latest high quality satellite imagery tapes that were available. A field crew of personnel from the CRREL-INSTAAR program visited numerous ground sites within the study area and collected information on the vegetation communities that occurred along with soils and surface geology data. The field visits were correlated

Examples of descriptive codes.

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Example 1. Single plant community.

$$\frac{S_d\;23}{1,1,0} = \frac{\text{(Dwarf shrub physiognomy)(community code 23)}}{\text{(featureless landform),(microrelief \quad 25 cm),(slope \quad }2^{o}\text{)}}$$

Example 2. Vegetation complex.

$$\frac{G11,S_d\;23}{2,2,0} = \frac{\text{(Graminoid physiognomy)(community code 11),(Dwarf shrub physiognomy)(community code 23)}}{\text{(low-centered polygons),(microrelief 25-50 cm),(slope \quad }2^{o}\text{)}}$$

Example 3. Forest community

$$\frac{T_o\;B3,23}{1,1,1} = \frac{\text{(Open forest) (}\underline{\text{Picea}}\ \underline{\text{mariana}}\text{) (Tree 5-15 cm dbh),(understory: community code 23)}}{\text{(featureless),(microrelief \quad 25 cm),(slope 2-}5^{o}\text{)}}$$

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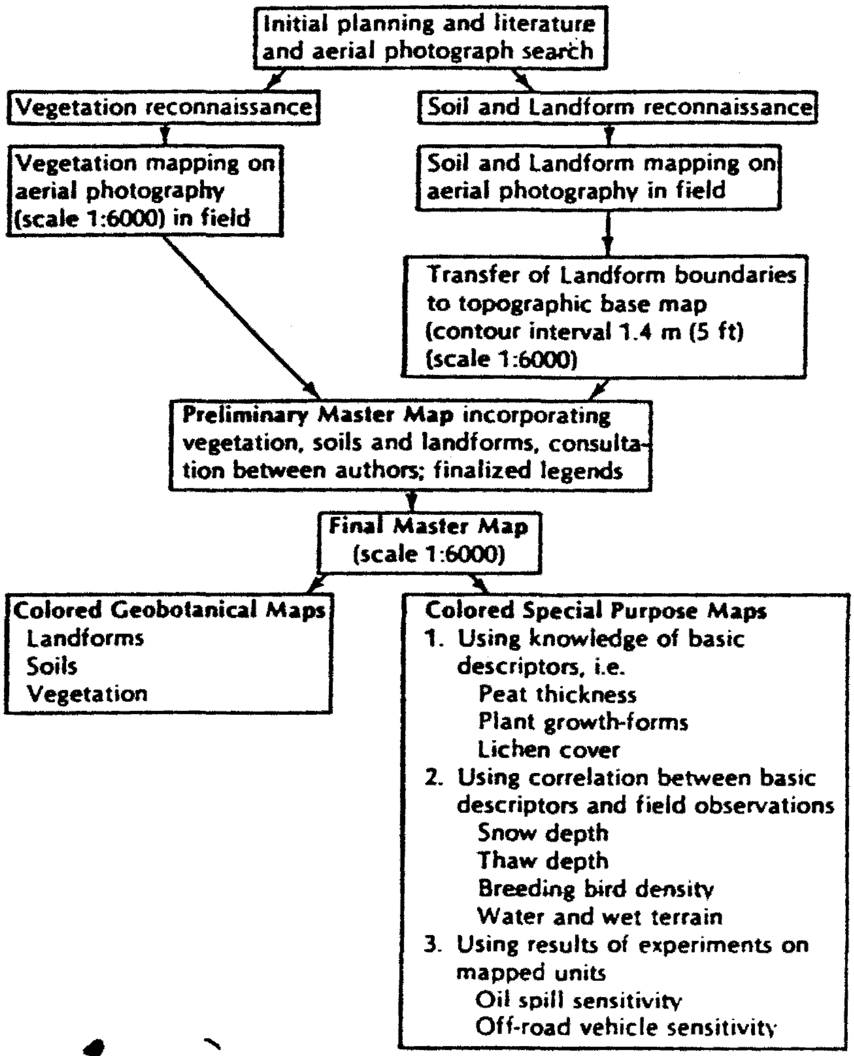

**Figure 3. Flow diagram indicating procedures used in preparation of master, geobotanical, and special purpose maps,** (from Walker et al., 1980).

Table 1. Color Key and Vegetation Descriptions for LANDSAT Scene 1698-20470 (by LaPerrier, 1977).

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| Color | Unit(s) |
|---|---|
| WHITE | I. ICE, SNOW, AUFEIS |
| BLUE | II. WATER: SHADOWS |
| GRAY | III. BARRENS |
| YELLOW | IV. PARTIALLY VEGETATED GROUND |
| MEDIUM GREEN | V. WET TUNDRA; SHADOWS<br>A) Wet Sedge Meadows<br>B) Salt Grass Meadows |
| DARK GREEN | VI. FLOODED TUNDRA; SHADOWS<br>A) Shallow Water Communities<br>B) Flooded Wet Sedge Meadows<br>C) Flooded Salt Grass Meadows<br>D) Areas Temporarily Flooded by Spring Runoff |
| YELLOW GREEN | VII. INTERMEDIATE WET-MOIST TUNDRA |
| ORANGE | VIII. UPLAND *DRYAS*-HEATH TUNDRA<br>A) *Dryas*-Heath Meadows<br>B) *Dryas* Terrace Community |
| OCHRE | IX. UPLAND SEDGE TUNDRA<br>A) Sedge Meadows (moist to dry)<br>Sedge Meadow (boggy to moist)<br>B) MOSAIC Tussock Meadow (moist to dry) < 50% |
| DARK BROWN | X. UPLAND TUSSOCK TUNDRA<br>A) Tussock Meadow (moist to dry)<br>Tussock Meadow (moist to dry) > 50%<br>B) MOSAIC Sedge Meadow (boggy to moist) |
| " " | XI. ERICACEOUS SNOW BED COMMUNITY |
| " " | XII. HUMMOCKY FROST HEAVED GROUND |
| RED | XIII. DRY TUNDRA |

with signatures observed on the high altitude (1:60,000) imagery flown by NASA in 1978 and 1979.

The results of the summer field effort was utilized by the USGS-INSTAAR teams to construct a new land cover map from 2 recent satellite tapes for the area that were obtained during the summer of 1981. To supplement the information on the high altitude imagery, a series of low altitude photographs were also obtained by the FWS during the same summer period that corresponded to the in-field studies that were made. The newly generated land cover map is scheduled for completion within time to be included in the initial report for the baseline study.

The preliminary LANDSAT cover classification maps (Fig. 4) have been produced and are currently being edited. The following materials are preliminary descriptions for the land cover categories and the associated subdivisions depicted in Fig. 1:

*Insert ①

The cover maps that were produced were derived from 3 LANDSAT scenes of the coastal plain study area:

1. Scene 20420, Barter Island, 22 July 1980.
2. Scene 20531, Flaxman Island, 13 July 1979.
3. Scene 20462, Flaxman Island, 14 August 1976.

The cover types identified in each scene, the map color assigned, and the spectral categories included in each cover types are listed in Tables 2-4. The summaries for the cover types, the number of acres of each type in each scene, and the number of scene pixels for each type are shown in Tables . The cluster analyses employed for the three scenes to derive the grouped categories of Tables 5-7 are included in Appendix , and show the results of the comparisons made between bands 2, 3, and 4 of the Landsat data.

The field verification of the Landsat cover categories remains to be accomplished and is scheduled for the summer of 1982. Habitat use by cover class for wildlife species will also be attempted during the 1982 field season.

During the early part of the 1981 summer season it was determined that an essential inventory tool needed by the refuge was a current set of low level photography of the coastal plain and the study area. This photography was requested in true-color at a scale of 1:18,000. In addition, the imagery was to provide stereo coverage of the entire area.

In July of 1981 a contract was awarded to obtain the aerial coverage of the study area, approximately 1500 lineal miles of coverage. An evaluation of the interactions of wildlife resources within the study area and the adjacent foothills and drainages of the northern Brooks Range made it apparent that additional coverage should be obtained during the same period if possible. As a result, in early August of 1981, the original contract was amended to include an additional 1700 miles of coverage. The weather over the coastal plain during the first half of August was unusually clear allowing a complete set of flight lines to be flown and coverage obtained.

①

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I. Dark Blue - Water Larger water bodies generally greater than 1 acre in size, Ocean, lakes and rivers.

II. Aqua - Pond Complex or Aquatic Tundra IIa. Pond Complex - very wet tundra areas that have numerous small bodies of water such as in drained lake basins with small ponds, polygons, and strangmoor. Relatively well-drained tundra of varying character may cover up to 50% of the unit. Low-centered polygon complexes with standing water in their centers are usually included in this unit.

IIb. Aquatic Tundra - Emergent communities that cover areas greater than 1 acre. The primary taxon in deeper water, up to 1 m deep, is Arctophila fulva (Pendent Grass). In shallow water, less than 30 cm deep, the main taxa are Carex aquatilis (Aquatic Sedge), Eriophorum scheuchzeri (Common Cottongrass).

III. Dark Green - Wet Sedge Tundra IIIa. Wet Sedge Tundra (non-complex) - Relatively wet tundra with little or no standing water and only a few well-drained micro-sites associated with polygon rims, strangmoor, hummocks, etc. Much of this tundra is flooded in early summer, but it gererally drains of standing water by mid-summer and remains saturated throughout the summer. Relatively large areas of non-complex wet tundra occur in the deltas of the larger rivers, particularly the Canning River, and in drained lake basins and along some river channels. The primary taxa are numerous sedges, including Carex aquatilis (Aquatic Sedge), Eriophorum angustifolium (Common cottongrass), E. russeolum (Russet Cottongrass), C. rotundata (Round-fruited Sedge), C. saxatilis (Rocky Sedge); a few herbs, including Pedicularis sudetica ssp. albolabiata (Sudetan Lousewort) Saxifraga hirculis (Bog Saxifrage), Melandrium apetalum (Nodding Lychnis) Caltha palustris (Marsh Marigold), and Potentilla palustris (Marsh fivefinger). Mosses are mainly Drepanocladus spp., Scorpidium scorpioides, Campylium stellatum, Calliergon spp. and sphagnum spp.

IIIb. Wet Sedge Tundra (very wet complexes) - Complexes of Wet tundra with up to 50% water or emergent vegetation. Low-centered polygon complexes, areas with extensive thermokarst pits, or complex thermokarst areas in the Foothills are common areas with this vegetation subunit. Non-aquatic portions of the complex may be tundra of varying character including moist-non-tussock- (Va) moist tussock-drarf shrub tundra (VI), dry sedge-crustose lichen tundra (see Va), and wet saline tundra (IIId).

IIIc. Wet Sedge Tundra (moist complexes) - Complexes of wet tundra with up to 40% moist tundra of varying character. Low-centered polygon complexes with well-developedd polygon rims, and string-bogs with closely spaced strans are common areas with this vegetation sub-unit.

IIId. Wet Sedge Tundra (wet saline tundra) - Areas near the coast that are periodcally inundated with salt water. The primary taxa are Carex subspathaceae, (Hoppner Sedge), Puccinella Phryganodes (Creeping Alkali-grass), C. ursina (Bear Sedge), Stellaria humifusa (Low Chickweed), and Cochlearia officinalis (Common Scurvy Grass). Some saline areas have numerous ponds and are likely to be calssed as Pond Complex (II.

IV. Light Green Moist/Wet Sedge Tundra Complex IVa. Moist/Wet Sedge Tundra Complex - Areas of moist sedge tundra mixed with up to 60% wet sedge tundra. Flat areas with low or flat-centered polygon complexes (common in drained lake basins) or strangmoor (more common in river delta systems and on gentle slopes) usually have a large percentage cover of wet tundra in the polygon troughs, basins, thermodarst pits and inter-strang areas. The spectral signature of these areas are likely to vary depending on the season and the summer rainfall. Moist areas may or may not have cottongrass tussocks, depending on proximity to the coast. Common taxa in moist tundra areas include the sedges, Eriphorum triste (Common Cottongrass), E. vaginatum (Sheathed Cottongrass). Carex bigelowii Bigelow's Sedge, C. membranacea (Fragile Sedge); the prostrate shrubs Dryas intergrifolia (Arctic Avens), Salix reticulata, (Net-veined willow), S. arctica (Arctic Willow), S. pulchra (Diamond-leaf Willow), S. lanata (Wolly Willow); and the forbs, Pedicularis lanata (Woolly Lousewort), Polvgonum bistorta (Bistort), Stellaria laeta (Long-stalked Stitchwort) and Senecio atropurpureus ssp. frigidus (Arctic Senecio). Common bryophytes include Tomenthypnum nitens, Hylocomium splendens, Ptiliduem ciliare, Orthothecium chryseum, and Ditricluim flexicaule. Common lichens are Thamnolia subuliformis, Cetraria ssp., Dactylina arctica, Cladonia spp. and Cladina spp.

IVb. Dry Prostrate Shrub-Forb Tundra (Dryas river terraces) - River terraces that have a dense prostrate mat of Dryas intergrifolia with numerous small forbs and prostrate shrubs. This unit is quite dark on aerial photography and Landsat data and has a spectral signature similar to either Wet Sedge Tundra (III) or Moist/Wet Sedge Tundra (IVa), although this unit is physiognomically very different from either of these other units. This ia an extensive unit along rivers, particularly along the Canning River, and used heavily by ground squirrels, lemmings, and bears. It may be possible to distinguish these terraces in some other phinological stage on Landsat scenes taken later in the simmer. The primary taxa are the prostrate shrubs Dryas intergrifolia (Arctic Avens), Salix reticulata (Net-veined Willow), S. rotundifolia (Round-leafed Willow), and Salix ovalifolia (Oval-leafed Willow); the herbs Astragalus alpinus (Alpine Milk-vetch), Oxytropis nigrescens (Blackish Oxytrope), Equisetum arvense (Common Horsetail), Artemisia arctica (Arctic Wormwood), Silene acaulis (Moss Campion),Chrysanthemum integrifolium (Entire-leafed Chrysanthemum), Saxifraga oppositifolia (Purple Mountain Saxifrage), Carex membranacea (Fragile Sedge), and Eriophorum triste (Common Cottongrass); and the mosses Distichium capillaceum and Ditrichum flexicaule

V. Sand Moist Sedge-Prostrate Shrub Tundra or Moist Sedge/Barren Tundra Complex

Va. Moist-Sedge-Prostrate Shrub Tundra - Moderately well-drained areas, located primarily along the northern part of the Foothills and in drainages. Principle taxa are similar to those described for Moist/Wet Sedge Tundra Complex (IVa). These areas may have up to 20% cover of cottongrass tussocks. Wetter facies near streams are likely to have no tussocks and to have high percentages of prostrate shrubs including Salix arctica (Arctic Willow) and S. pulchra (Diamond-leaved Willow) and herbs such as Petasites frigidus (Lapland Butterbur), Saxifraga punctata (Cordate-leaved Saxifrage), Carex aquatilis (Water Sedge), Saxifraga hirculis (Bog Saxifrage), Valariana capitata (Capitate Valerian). Near the coast on slightly elevated microsites moist tundra areas areas are likely to contain large components of a prostrate shrub community including Dryas integrifolia (Arctic Avens, Salix pulchra (Diamond-leafed Saxifrage), Carex bigelowii (Bigeolow's Sedge), S. phlebolhylia (Vieny-leafed Willow), Luzula arctica (Arctic Wood-rush); with considerable ground cover of small hummocks with the moss Dicranum elongatum covered by white crustose lichens, (mainly Ochrolechia frigida and Lecanora epibryon).

Vb. Moist Sedge/Barren Tundra Complex (Frost-scar tundra) - Primarily well-drained areas with as much as 90% of the surface covered by frost-boils or frost-rings. Vegetation on the frost scars is generally sparse with such taxa as Juncus biglumis (Two-flowered Rush), Arctagrostis latifolia (Wide-leafed Arctagrostis), Petasites frigidus (Lapland Butterbur), Dryas integrifolia (Arctic Avens), Chrysanthemum integrifolium (Entire-leaved Chrysanthemem) and Saxifraga opositifolia (Purple Mountain Saxifrage), and the mosses Rhacomitrium lanuginosum, Bryum spp., Distichium capillaceum, Drepanocladus uncinatus etc. Inter-frost soar area near the coast are usually Moist Sedge Tundra (Va) dominated by Carex bigelowee (Bigelow's Sedge), Dryas integrifolia (Arctic Avens), Arctagrostis latifolia (Wide-leafed Arctagrostis), and the moss Tomenthypnum nitens. In the foothills frost-scar tundra occurs mainly on slopes and ridge tops and is likely to have scattered dwarf shrubs (10 to 40 cm tall) of Salix lanata (Wooly Willow) or S. glauca (Northern Willow). This unit is difficult to separate on the Landsat data. On the Flaxman scene it is most often classified as Unit V (sand), while on the Canadian scene, it often appears as Unit IV (light green).

VI. Light Brown Moist Tussock-Dwarf Shrub Tundra

VIa. Moist Tussock Dwarf Shrub Tundra (Upland tussock tundra, acidic facies) - Relatively well-drained Upland tussock tundra sites primarily in the Foothills with high percentage cover of cottongrass tussocks and dwarf or prostrate shrubs. In this unit the tussocks are usually dominant with about 20 to 70% cover. On acidic soils the dwarf shrubs include Salix pulchra (Diamond-leafed Willow) Betula nana (Dwarf Birch), Ledum decumbens (Narrow-leafed Labrador Tea), Vaccinium uliginosum (Bog Blueberry), V. vitis-idaea (Mountain Cranberry), Empetrum nigrum (Crowberry), Arctostaphylos rubra (Bearberry) and Cassiope tetragona (Four-angled Mountain Heather); and the bryophytes are mainly Hylocomium splendens, sphagnum spp. Aulacomnium palustre, and Ptilidium ciliare. Lichens are dominated by Cladonias and Cladinas.

VIb. Moist Tussock-Dwarf Shrub Tundra (alkaline facies) - On more neutral or basic soils, important taxa include Dryas integrifolia (Arctic Avens), Carex bigelowii (Bigelow's Sedge), Salix artica ( Arctic Willow), S. reticulata (Net-leafed Willow), S. lanata (Wooly Willow); the chief moss is Tomenthypnum nitens; and lichens are mainly cetrarias. The alkaline soils are most often a result of frost-stirring of basic parent materials, and barren frost-scars can cover a large percentage of this unit.

Both VIa and VIb may have up to 30% coverage of other vegetation types, mainly Moist Sedge-Prostrate Shrub Tundra (IVa) or Wet Sedge Tundra (III).

VII. Dark Brown Moist Dwarf Shrub Tussock Tundra or Moist Tussock-Dwarf Shrub/Wet Dwarf Shrub Tundra Complex.

VIIa. Moist Dwarf Shrub - Tussock Tundra (Upland-dwarf shrub tussock tundra) - This unit is similar to VI except here the shrubs, mainly Salix pulchra

(Diamond-leafed Willow) and Betula nana (Dwarf Birch), are dominant and may reach heights of up to 50 cm.

VIIb. Moist Dwarf Shrub-Tussock Tundra (Birch tundra - High-centered polygons and palsas with dwarf shrub communities dominated by Betula nana (Dwarf Birch) and Eriophorum vaginatum (Sheathed Cottongrass). These areas often occur in low thermokarst drainage areas in the Foothills. In some communities the birch is completely dominant and the cottongrass is absent. Other typical taxa in these sites are Rubus chamaemorus (Cloudberry), Ledum decumbens (Narrow-leafed Labrador Tea), Pedicularis labradorica (Labrador Lousewort), Vaccinium vitis-idaea (Mountain Cranberry); the mosses Sphagnum spp. dominate the ground layer with numerous Cladonia and Cladina lichens.

VIIc. Moist Tussock-Dwarf Shrub/Wet Dwarf Shrub Tundra Complex (Water track complex) - Many slopes in the Foothills with water tracks are classed as this unit. In these areas the tussock-dwarf shrub tundra forms a complex with more pure shrub communities in the water-tracks. Height and density of the water-track shrubs vary, but the dominant taxon is generally Salix pulchra (Diamond-leafed Willow). Other important taxa in water tracks include Salix arctica (Arctic Willow), Betula nana (Dwarf Birch) Carex aquatilis, (Water Sedge) Eriophorum angustifolium (Common Cottongrass), and other taxa typically found in Wet Sedge Tundra (IIIa).

VIII. Red Shrub Tundra

VIIIa. Shrub Tundra (non-complex) - South-facing slopes in the Foothills with communities dominated by dwarf and medium-height (up to 2 m tall) willows, birch and/or alders. These sites are relatively warm and often rocky with a variety of microsites which contribute to great species diversity. Typical taxa include Salix spp.(Willows) Betula glandulosa (Shrub Birch), Alnus crispa (Mountain Alder), Lupinus arcticus (Arctic Lupin), Artemisia tilesii, (Tilesius's Wormwood), A. arctica (Arctic Wormwood), Aconitum delphinifolium (Delphinium-leafed Monkshood), Delphinium brachycentrum (Northern Dwarf larkspur), Potontilla fruticosa (shrubby Cinque foil), Bromus pumpellianus (Arctic Brome-grass), Equisetum arvense (Common Horsetail), Festuca altaica (Rough Fescus), Senecio lugens (Black-tipped Groundsel), Castilleja caudata (Pale Paintbrush), Carex microchaeta (Small-bristled Sedge), Arnica frigida (Nodding Arnica), A. alpina (Alpine Arnica), Petesites frigidus (Lapland Butterbur), Saxifraga tricuspidata, (Three-toothed Saxifrage), Vaccinium uliginosum (Bog Blueberry), V. vitis-idaea (MOuntain Cranberry), Aster siberica (Siberian Aster), Ledum decumbens (Narrow-leafed Labrador Tea) and Empetrum nugrum (Crowberry).

VIIIb. Shrub Tundra (Water track complex) - This unit is very similar to ~~VIIc~~ VIIIc., except here the water track shrub communities dominate.

IX. Violet Partially Vegetated Areas This unit includes a wide variety of communities in diverse habitats;

IX a. River bars - Partially vegetated river bars have a side diversity of taxa that include Epilobium latifolium (River Beauty), Artimisia spp. (Wormwood), Salix spp. (Willow), Castilleja caudata (Pale Paintbrush), Hedysarum alpinum (Alpine Hedysarum), H. mackenzii (Mackinzie's Hedysarum), Arctostaphylos rubra (Bearberry), Oxtropis campestris (Yellow Oxytrope), Anemone parviflora, Equisetum arvense (Common Horsetail), Trisetum spicatum (Spiked Trisetum), Deschampsia caespitosa (Tufted Hairgrass) and Astragalus alpinus (Alpine Milk-vetch)

IX b. *Alpine Tundra* - Many alpine tundra areas appear as partially vegetated because of the large amount of barren talus and rocks. The character of alpine tundra varies considerably, but the more completely vegetated areas have extensive moss mats (mainly *Hylocomium splendens*) with numerous prostrate shrubs, such as *Dryas octopetala* (Mountain Avens), *Salix rotundifolia* (Round-leafed willow), *Salix Phlebophylla* (Vieny-leafed Willow) and *S. Chamissonis* (Chamisso's Willow), and herbs such as *Carex michrocheata* (Small-bristled Sedge), *Geum glaciale* (Glacier Avens), *Saxifraga bronchialis* (Spotted Saxifraga), *S. davurica* (Dahurian Saxifrage), *S. tricuspidata* (Three-toothed Saxifrage), *S. serpyllifolia* (Thyme-leaved Saxifrage); and many lichens including *Cladina* spp. *Cladonia* spp. *Nephroma expallidum*, *Cetraria* spp. *Dactylina arctica* and *Spharophorus globosus*.

IX c. *Sorted stone-nets* - Some extensive sorted polygons occur in the Jago and Okpilok drainages. These contain rocks covered by lichens such as *Umbillicaria* spp., *Lecanora* spp., *Licidea Rhizocarpon* spp. and *Alectoria minuscula* etc.

IX d. *Beaches* - Some coastal beaches and mud flats are sparsely vegetated with *Carex subspathacea* (Hoppner Sedge) and *Puccinellia phryganodes* (Creeping Alkali-grass) and other taxa similar to Wet Saline Tundra (IIId).

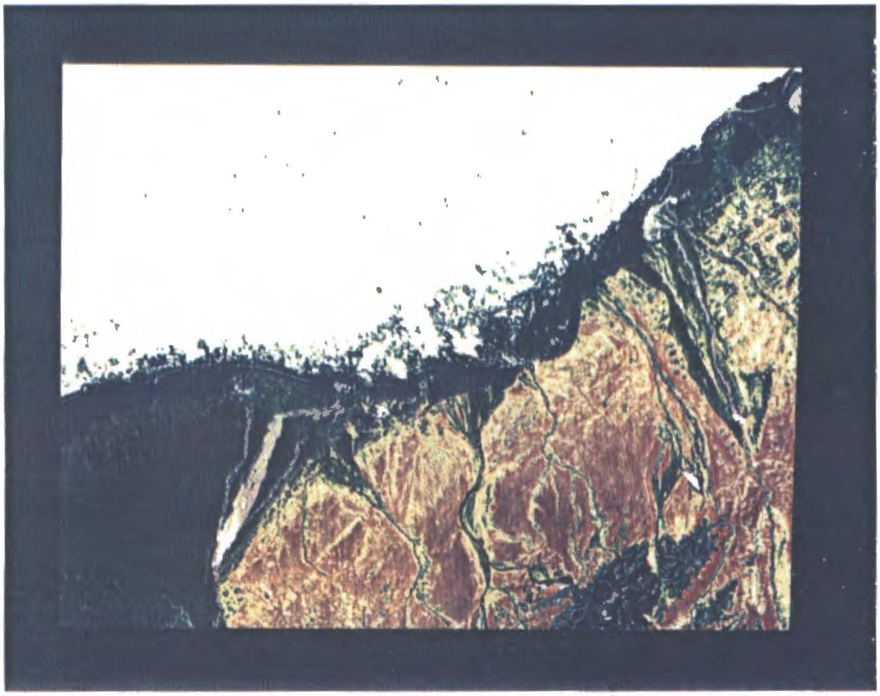
IX e. *Sand dunes* - Dune communities occur in the delta of the Canning River. Species are similar to those occurring on river bars (IXa). The most sparsely vegetated dunes are dominated by *Elymus arenarius*. More stable dunes have communities similar to the Dryas river terrace community (IVb).

X. *Black Barren Gravels of Rock* Light-colored barren gravel or rock occurs in a variety of places that include; bare river gravels, gravel and sand spits, alpine barrens (particularly dolomite), and cultural barrens such as the runway and roads at Barter Island. Some gravelly ridge tops in the Goothills are classed as this unit. These areas actually have a quite rich but sparse flora that includes *Potentilla biflora* (Two-flowereed Cinquefoil), *Dryas octopetala*, *Artemisia arctica* (Arctic Wormwood), *Dastilleia caudata* (Pale Paintbrush) *Pedicularis verticillata* (Whorled Lousewort), *Polimonium boreale* (Boreale Jacob's-ladder) and other taxa similar to gravel river bars (IXa).

XI. *Grey Barren Mud or Wet Gravel* This unit has a somwhat darker spectral signature than the Barren Gravel category (X). It includes extensive barren mud in the deltas of rivers and wet gravels in the rivers and beaches. Some dark colored barren rocks in the mountains are also classed as this unit.

XII. *White Ice River icings* (aufeis) occur in the braided stream channels of most of the larger rivers.

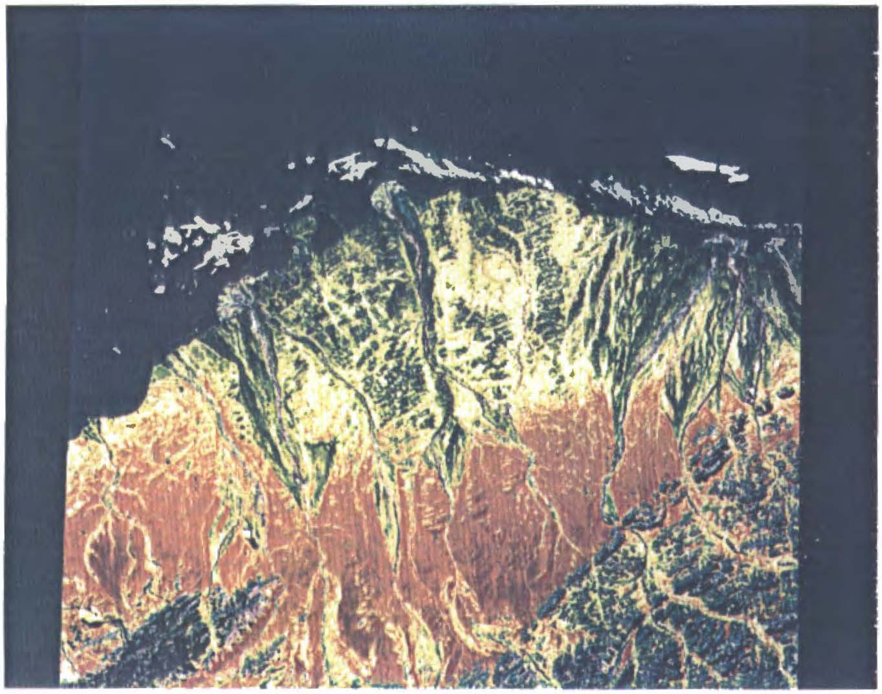
Flaxman Scene



Landsat Classification of the Artic National Wildlife Range

Prepared Oct 25 1981
William Acevedo & Skip Walker

Canadian Scene



Landsat Classification of Artic National Wildlife Range

Prepared Oct 25, 1981
William Acevedo & Skip Walker

Table 2. Land cover classes and assigned map colors for Landsat Scene 20420, Barter Island, Alaska (22 July, 1980).

| Dominant Land Cover | Dicomed Color | Spectral Category |
|---|---|---|
| Water, turbid. | dark blue | 1, 2, 3, 4, 5, 6 |
| Pond complex, aquatic vegetation.<br>Carex aquatilis, Arctophila fulva, up to 50% tundra. | aqua | 7 |
| Wet sedge tundra.<br>Wet/moist sedge tundra.<br>Wet/moist complex. | dark green | 15, 17, 19 |
| Moist sedge tundra.<br>Moist/wet sedge tundra.<br>Frostscar tundra*.(20420) | light green | 20, 22 |
| Moist sedge tundra.<br>Moist sedge prostrate shrub.<br>Frostscar tundra*.(20531) | sand | 21, 23, 25 |
| Tussock dwarf shrub tundra.<br>Tussock prostrate shrub tundra.<br>Moist sedge tundra with tussocks. | tan | 26, 27 |
| Dwarf shrub tussock tundra.<br>Complex of tussock dwarf shrub tundra with water tracks. | dark brown | 28, 29 |
| Shrub tundra in high density water tracks and on south facing slopes. | red | 30, 31 |
| Partially vegetated areas (river bars, lichen-covered mountain barrens, lichen-covered sorted stone nets).<br>Dryas integrifolia-forb tundra sand dune community.<br>Sedge prostrate shrub tundra along stream.<br>Prostrate shrub lichen-covered frostboil areas. | violet | 9, 18 |
| Bright gravel and bare rock barrens.<br>Gravel barrens on ridge tops.<br>Prostrate shrub lichen tundra barrens. | black | 10, 12, 14, 24 |
| Wet muds and silts forming deltas.<br>Wet river gravels. | dark grey | 8 |
| Ice | white | 11, 13, 16 |
| Background | black | 32 |

*Identification on single scene only

Table 3. Land cover classes and assigned map colors for Landsat Scene 20531, Flaxman Island, Alaska (13 July, 1979).

| Dominant Land Cover | Dicomed Color | Spectral Category |
|---|---|---|
| Water, turbid. | dark blue | 1, 2, 5 |
| Pond complex, aquatic vegetation.<br>_Carex aquatilis_, _Arctophila fulva_, up to 50% tundra. | aqua | 6 |
| Wet sedge tundra.<br>Wet/moist sedge tundra.<br>Wet/moist complex. | dark green | 7, 8, 11 |
| Moist sedge tundra.<br>Moist/wet sedge tundra.<br>Frostscar tundra* (20420). | light green | 12 |
| Moist sedge tundra.<br>Moist sedge-prostrate shrub.<br>Frostscar tundra*.(20531) | sand | 13, 14 |
| Tussock-dwarf shrub tundra.<br>Tussock-prostrate shrub tundra.<br>Moist sedge tundra with tussocks. | tan | 15, 16 |
| Dwarf shrub-tussock tundra.<br>Complex of tussock dwarf shrub. tundra with water tracks. | dark brown | 17 |
| Shrub tundra in high density. water tracks and on south-facing slopes. | red | 18, 19 |
| Partially vegetated areas (river bars, lichen-covered mountain barrens, lichen-covered sorted stone nets).<br>_Dryas integrifolia_-forb tundra sand dune community.<br>Sedge prostrate shrub tundra along stream.<br>Prostrate shrub/lichen-covered frostboil areas. | violet | 22 |
| Bright gravel and bare rock barrens.<br>Gravel barrens on ridge tops.<br>Prostrate shrub-lichen tundra barrens. | black | 9, 10 |
| Wet muds and silts forming deltas.<br>Wet river gravels. | dark grey | 3, 4, 20, 21 |
| Ice | white | 23 - 35 |
| Background | black | 36 |

*Identification on single scene only

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Table 4. Land cover classes and assigned map colors for Landsat Scene 20462, Flaxman Island, Alaska (14 August, 1976).

| Dominant Land Cover | Dicomed Color | Spectral Category |
|---|---|---|
| Water, wet mud and gravel.<br>Water, very wet tundra, wet tundra.<br>Pond complex, wet mud and gravel. | dark blue | 1, 2 |
| Wet sedge tundra, wet/moist tundra. | dark green | 3 |
| Moist/wet tundra, moist sedge tundra. | light green | 5 |
| Frostscar tundra (better breakout than 20531).<br>River barrens and frostscar tundra.<br>Moist tundra in stream channels. | sand | 6, 17, 18 |
| Tussock dwarf shrub tundra. | tan | 16 |
| Dwarf shrub-tussock tundra. | dark brown | 19 |
| Shrub tundra. | red | 15, 20 |
| Bright gravel barrens.<br>Mountain barrens. | black | 7, 8, 11 |
| River barrens, wet muds and silts, partially vegetated areas. | dark grey | 4 |
| Ice, clouds. | white | 9, 10, 12, 13, 14 |
| Background | black | 21 |

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Table 5. Surface areas for cover categories in LANDSAT Scene 20420, Barter Island, Alaska (22 July, 1980).

| Grouped Categories | Acres | Pixels* |
|---|---|---|
| Water (1-6) | 148,091.92 | 133,091 |
| Pond complex (7). | 9,500.33 | 8,538 |
| Wet sedge tundra (15,17,19). | 157,160.52 | 141,241 |
| Moist sedge tundra (20,22). | 203,350.30 | 182,752 |
| Moist sedge-prostrate shrub tundra (21, 23, 25). | 241,649.84 | 217,172 |
| Tussock-dwarf shrub tundra (26, 27). | 171,289.73 | 153,939 |
| Dwarf shrub tundra (28, 29). | 11,013.62 | 9,898 |
| Shrub tundra in water tracks and on south facing slopes (30,31). | 338.26 | 304 |
| Partially vegetated (9, 18). | 16,973.31 | 15,254 |
| Bright barrens (10, 12, 14, 24). | 16,933.25 | 15,218 |
| Wet mud and silts (8). | 10,892.34 | 9,789 |
| Ice (11, 13, 16) | 19,206.52 | 17,261 |
| Background (32) | 0.00 | 0 |
| Totals: | 1,006,399.90 | 904,457 |

*pixel = 79m x 57m
= $4503m^2$
= 1.11 acres

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Table 6. Surface areas for cover categories in LANDSAT Scene 20531, Flaxman Island, Alaska (13 July, 1979).

| Grouped Categories | Acres | Pixels* |
|---|---|---|
| Water (1, 2, 5) | 113,895.91 | 141,838 |
| Pond complex (6). | 7,760.19 | 9,664 |
| Wet sedge tundra (7, 8, 11). | 107,536.15 | 133,918 |
| Moist sedge tundra (12). | 58,553.15 | 72,918 |
| Moist sedge-prostrate shrub tundra (13, 14). | 174,380.28 | 217,161 |
| Tussock-dwarf shrub tundra (15, 16). | 196,116.69 | 244,230 |
| Dwarf shrub tundra (17). | 48,873.79 | 60,864 |
| Shrub tundra in water tracks and on south facing slopes (18, 19). | 3,543.64 | 4,413 |
| Partially vegetated (22). | 5,484.49 | 6,830 |
| Bright barrens (9, 10). | 14,016.37 | 17,455 |
| Wet mud and silts (3, 4, 20, 21) | 31,144.36 | 38,785 |
| Ice (23 - 35) | 26,786.47 | 33,358 |
| Background (36) | 0.00 | 0 |
| Totals: | 788,091.49 | 981,434 |

*1 pixel = 57m x 57m
= $3249m^2$
= .803 acres

Table 7. Surface areas for cover categories in LANDSAT Scene 20531, Flaxman Island, Alaska (14 August, 1976).

| Grouped Categories | Acres | Pixels* |
|---|---|---|
| Water, wet mud and gravel (1,2). | 961.38 | 864 |
| Wet sedge tundra (3). | 2,342.26 | 2,105 |
| Moist/wet tundra (5). | 1,103.81 | 992 |
| Frostscar tundra (6, 17, 18.) | 27,500.67 | 24,715 |
| Tussock-dwarf shrub tundra (16). | 30,540.60 | 27,447 |
| Dwarf shrub-tussock tundra (19). | 1,000.33 | 899 |
| Shrub tundra (15, 20). | 430.62 | 387 |
| Bright barrens (7, 8, 11). | 110.16 | 99 |
| River barrens, wet mud and silts, partially vegetated areas (4). | 2,557.01 | 2,298 |
| Ice, clouds (9, 10, 12, 13, 14). | 0.00 | 0 |
| Background (21) | 0.00 | 0 |
| Totals: | 66,546.84 | 59,806 |

*1 pixel = 79m x 57m
= $4503m^2$
= 1.11 acres

The low level photography shall be utilized in the following areas:

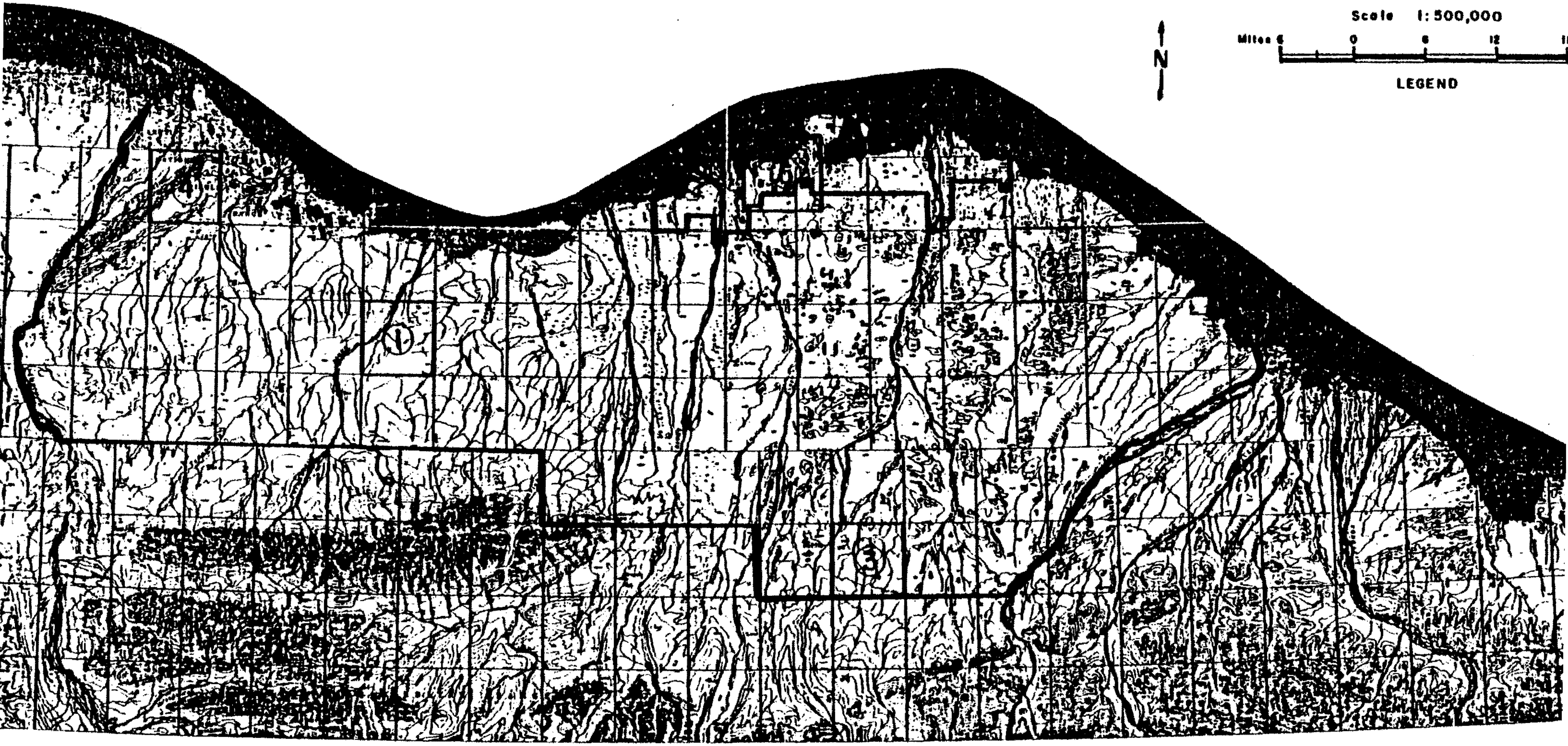
1. to supplement the existing 1978 and 1979 high altitude color infrared imagery for refuge operations,
2. to provide a comparative data base for the preparation of the updated satellite map of the coastal plain vegetation, and
3. to provide a needed tool for the development of the medium scale vegetation maps of selected study areas of the coastal plain.

## Data Gaps

Future vegetation and habitat information needs for the refuge will require the development of base map products (cf. #3 above) of a much greater degree of detail than that possible with the Landsat or other currently available mapped products. To meet this task, the refuge has initiated a study mapping program with CRREL and INSTAAR to evaluate the use of the mapping technique utilized in the development of the Prudhoe Bay Geobotanical Atlas (Walker et al., 1980). The mapped products that will be produced will represent the five study sites (Fig. 5) on the coastal plain that were intensively visited during the 1981 summer field season. The maps will be developed at a scale of 1:63,360 to determine if this scale is appropriate for the needs of the refuge biological staff and to evaluate the applicability of this scale with the mapping process employed. Additionally, further evaluations will be made to determine the feasibility of additional mapping at the LANDSAT scale and other scales in the order of 1:12,000. Field work during the summer of 1981 is anticipated to provide the needed verification of the mapping process to date.

# ARCTIC COASTAL PLAIN BASELINE STUDY

## FIG. 5 STUDY SITE AREAS FOR DETAILED MAPPING



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## Chapter IV

## BIRDS

### Annotated Species List

The following species list describes the currently known status, population level habitat use, and distribution of birds on the Arctic Coastal Plain of ANWR. Status/avundance catagories used are: abuandant, common, fairly common, uncommon, rare, casual, accidental, resident, migrant, breeder, and visitant, which were adapted from Kessel and Gibson (1978).

Status designations, particularly of the less common species, must be considered tentative because of the short period in which intensive bird studies on the ANWR coastal plain have been conducted (1970-1981). Additionally, most efforts were on the northern coastal plain, hence data from the interior coastal plain are scarce.

For the less common species all information is summarized in a single paragraph. Accounts for species that are more common, or for which we have more data, are organized into several paragraphs including information on status and distribution on ANWR and adjacent areas, spring migration and chronology, breeding, molting and staging, fall migration and chronology, and wintering on ANWR.

Where available, habitat use and population density information specific to the ANWR coastal plain or immediate surroundings are incorporated into the discussion. Habitat names of tundra types follow those provisionally identified by CRREL (this report) and names of wetland types follow Bergman et al. (1977). The equivalent habitat types originally identified by Nodler (1977) on the first ANWR LANDSAT map are identified (e.g., Very Wet Sedge Tundra Flooded Tundra). As with habitat and population data, migration routes, average arrival and departure dates and other life-history information specific to ANWR or its surroundings are given if available. Major data gaps in this type of information are also pointed out.

Each species discussion is specific to the ANWR coastal plain, and does not necessarily apply to the species for the entire North Slope because status, populations, arrival, departure, and nesting dates, and occasionally habitat use patterns, differ between specific areas on the North Slope. The source material for the species discussions therefore rely heavily on studies specific to the ANWR, many of which have not yet been published in the scientific literature.

COMMON LOON - Probable rare migrant or visitant. The species breeds on the Mackenzie River Delta, NWT. (Johnson et. al. 1975) and on the south side of the Brooks Range (Gabrielson and Lincoln 1959). It has been documented as an uncommon visitant to the Yukon North Slope (Salter et al. 1980) and a possible migrant on the Okpilak delta, ANWR (Spindler 1978). Olsen and Marshall (1950) provide evidence that human activities (including aircraft overflights) cause nesting failures and mortality of young. The species should be considered susceptible to disturbance.

3 YELLOW-BILLED LOON - Uncommon migrant along the coastal lagoons and nearshore waters; probable rare breeder on coastal plain lakes. Eastward migration along the Yukon coast in late May-early June and westward migration between 10 and July-17 September was observed by Salter et al. (1980). Yellow-billed loons were observed in low numbers (less that 5 per transect) in lagoon and nearshore aerial transects in July, August and September of 1978-1981 (Spindler 1981). Martin and Moiteret (1981) reported observations of 1 to 4 individuals along the coast near Brownlow Point in July and August of 1979 and 1980, although one observation was made in tundra wetlands. The nearest confirmed breeding record is at Schrader Lake (Bee 1958). J. Levison (unpubl. data) reparted 3 yellow-billed loons on 7 June 1980 at Beaufort Lagoon, and thereafter the species was observed several times a week in coastal lagoons and near shore Beaufort Sea waters between Demarcation Bay and Pokok Bay.

ARCTIC LOON - Common breeder in drained basin wetlands and some coastal plain lakes; common migrant along Beaufort Sea coastal lagoons and nearshore waters.

Arctic loons arrive from the west between 31 May and 12 June (Salter et al. 1980, Brooks 1915, R.M. Burgess, unpubl. data, J. Levison, unpubl. data, Spindler 1978a). Upon their arrival during the first week of June, tundra lakes and ponds are often unavailable, and loons rely on overflow water at river mouths (Martin and Moitoret 1981). Peak arrival was observed betwee 3 June and 7 June on the Canning River Delta in 1980 (Martin and Moitoret 1981). Loons were able to move onto tundra ponds and lakes by 7 June 1978 on the Okpilak Delta (Spindler 1978a) and by 10 June 1979 and 1980 at the Canning Delta (Martin and Moitoret 1981).

Arctic loons commonly nest on islands in the larger ponds of drained-basin wetland complexes (Johnson et al. 1975, Bergman et al. 1977, Spindler 1978a, Martin and Moitoret 1981). Nest building starts in mid-June and the first eggs were laid at the Canning Delta about 21 June in 1979 and 1980. Nest density was 0.55-0.75 nests/km$^2$ between 1979 and 1980 on the Canning Delta (Martin and Moitoret 1981) and 0.40 nest/km$^2$ on the Okpilak Delta in 1978 (Spindler 1978a). Schmidt (1970) estmated a total population density at Beaufort Logoon of 1.5/ km $^2$ in 1970.

Use of lagoon and estuarine habitats by arctic loons increases dramatically in late July as family groups move from tundra wetlands to coastal waters and, as adults, begin to make frequent flights to the lagoons (Spindler 1978a, Martin and Moitoret 1981). Arctic loons were observed at higher mean seasonal densities in lagoons (mean season density of 0.14 birds/km$^2$) than on nearshore Beaufort Sea waters (mean seasonal density of 0.11 birds/km$^2$) (Spindler 1981a).

Peak fall migration of arctic loons was observed from 28 August to 30 August 1979 on the Canning Delta, although westward movement occurred over a wider time range in 1980 (18 August to 6 September) (Martin and Moitoret 1981). Arctic loons were observed as late as 14 September 1978 and 18 September 1981 in coastal lagoon transects (Spindler 1981a, lagoon section, this report) and some probably occur in low numbers until the lagoons freeze over in late September (Spindler, unpubl. data).

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RED-THROATED LOON - Common breeder in drained-basin wetlands, beaded drainage wetlands, and flooded sedge wetlands, especially within 5 km of the coast. A common migrant over Beaufort Sea coastal lagoons and nearshore waters.

Arrival dates range from 30 May to 11 June (Salter et al. 1980, R.M. Burgess, unpubl. data, Spindler 1978a, Bergman et al. 1977, Derksen et al. in press and Martin and Moitoret 1981). Eastward migration past Canning Delta was noted by Martin and Moitoret (1981) with a peak between June 4 and June 7, 1981. As with the arctic loon, red-throated loons sometimes arrive before appreciable open water is available, and rely on overflow water on river deltas (Martin and Moitoret 1981).

Red-throated loons use smaller ponds for nesting than do arctic loons; nest construction begins in mid-June and incubation starts about 23 June (Spindler 1978a, Martin and Moitoret 1981). Nesting density on ANWR was observed to range from 0.45 nests/$km^2$ to 0.50 nest/$km^2$ on the Canning Delta (Martin and Moitoret 1981) and 0.32 nests/$km^2$ on the Okpilak Delta (Spindler 1978a). Estimated total population near Beaufort Lagoon in 1970 was 2.3 birds/$km^2$ (Schmidt 1970). Following the hatch in late July, adult red-throated loons are observed making regular feeding flights to nearshore Beaufort Sea waters (mean August-September density of 0.13 birds/$km^2$) where they appear to be more common than in coastal lagoon waters (mean August-September density of 0.09 birds/$km^2$) (Spindler 1981a).

The fall migration of red-throated loons occurred in 1980 between 18 August and 6 September, with peak a on about 1 September 1980 on the Canning Delta (Martin and Moitoret 1981).

RED-NECKED GREBE - Rare summer visitant to the Arctic Coastal Plain of ANWR. Schmidt (1970) rcorded one individual on the Kogotpak River (near Beaufort Lagoon) on 15 June 1970. Salter et al. (1980) reported sighting one individual each at Clarence Lagoon, Y.T., Komakuk Beach, Y.T. on 1 and 17 June 1975, and Bloomfield Lake in late August 1973.

HORNED GREBE - Possible rare summer visitant to the Arctic Coastal Plain of ANWR. One adult was collected near Flaxman Island in July 1930 (Bailey 1948). There are three records for the Yukon north slope, one for the mouth of the Firth River (Johnson et al. 1975) and one for Peat Lake (June 1972), two 6 km south of Pillips Bay (July 1973), and 1-3 birds daily at Bloomfield Lake (14-17 September 1973) (Salter et al. 1980).

SHORT-TAILED SHEARWATER - rare summer visitant to Beaufort Sea coastal waters offshore of ANWR. This species was observed near the ANWR coast at Flaxman Island, circa 1936 (Johnson et al. 1975), but the only records are flocks seen 112 km offshore of Barrow by Watson and Divoky (1974), and 40 km offshore east of Barrow (Divoky and Good 1979).

WHISTLING SWAN - Common breeder in river delta areas, especially ponds and lakes in and near drained-basin complexes. Swans arrived on the Canning River Delta on 26 May 1979 and 25 May 1980 (Martin and Moitoret 1981), at Beaufort Lagoon on 25 May 1980 (J. Levison, unpubl. data) and at the Okpilak Delta on 1 June 1978 (Spindler 1978a). Swans on the ANWR apparently arrive from the east and depart to the east (Martin and Moitoret 1981, Bellrose 1976, Salter et al. 1980).

Since whistling swans are conspicuous, easy to survey, and sensitive to disturbance (see section on Impacts to birds) it has been suggested by King and Hodges (1980) that they make an excellent indicator species. For these reasons the species will be discussed in detail below.

Whistling swans nest and reside in traditional concentration areas on the ANWR coastal plain. Jacobson (1979) identified the major concentration areas as the Canning-Tamayariak Delta, the Hulahula-Okpilak Delta Barter Island lakes, the Aichilik-Egaksrak-Kongakut Deltas, and Demarcation Bay lakes. These areas apparently offer the only highly desirable swan nesting and feeding habitat on the ANWR coastal plain. Fig-B-1 identifies the swan concentration areas as defined by plotting swan observations from aerial surveys 1977-1979 (Jacobson 1979 and 1981, Spindler 1981c).

Because their May arrival date is 1 to 2 weeks prior to break-up, swans seek out high ground that is blown free of snow. When such sites are adjacent to pond and lake wetlands that are often chosen as nest sites (Spindler 1978a, Spindler, unpubl. data, Martin and Moitoret 1981). Clutch completion on the Canning was during the first week of June, 1979 and about a week later in 1980 (Martin and Moitoret 1981). Nesting density was determined to be 0.25 and 0.20 nests/km$^2$ in 1979 and 1980, respectively, on the Canning Delta, and 0.12 nests/km$^2$ on the Okpilak Delta in 1978 (Spindler 1978a). Aerial surveys indicated that swan densities within concentration areas ranged from a low of 0.20 swans/km$^2$ at Demarcation Bay to 0.70 swans/km$^2$ on the Aichilik-Egaksrak-Kongakut Deltas for a total density of 0.30 swans/km$^2$ for all areas surveyed on the ANWR coastal plain in 1981 (Table B-1) (Spindler 1981c). Schmidt (1970) estmated adult density of 1.2 birds/km $^2$ between Pingokraluk Lagoon and Poko Bay.

Swans begin departing the ANWR coastal plain in mid-August. The non-breeders and failed breeders are the first to migrate (Jacobson 1979, Spindler 1981c, Martin and Moitoret 1981) in mid-August. Paired adults with young are not able to depart until the young can fly, which is probably as late as mid-or-late September, since swans with young have been seen on the coastal plain as late as 13 September (Jacobson 1979).

Mean swan densities on the entire ANWR coastal plain (including ideal concentration habitat and unproductive upland habitats) were 0.05 adult swans/km$^2$ in 1981 as compared to 0.08 and 0.12 swans/km$^2$ in NPR-A in 1977 and 1978, respectively (King 1979). Densities of 0.07 to 0.42 adult swans/km$^2$ have been observed for 6 sites between the Colville and Sagavanirktok Rivers (1970-1977 mean, Welling and Sladen, unpubl. manuscript 1981). From the above comparisons it is apparent that overall swan densities on the coastal plain of ANWR are lower than areas surveyed farther west. In contrast, densities within the ANWR concentration area are as high as or higher than elsewhere on the North Slope.

# ARCTIC COASTAL PLAIN BASELINE STUDY

## Fig. B-1. WHISTLING SWAN CONCENTRATION AREAS

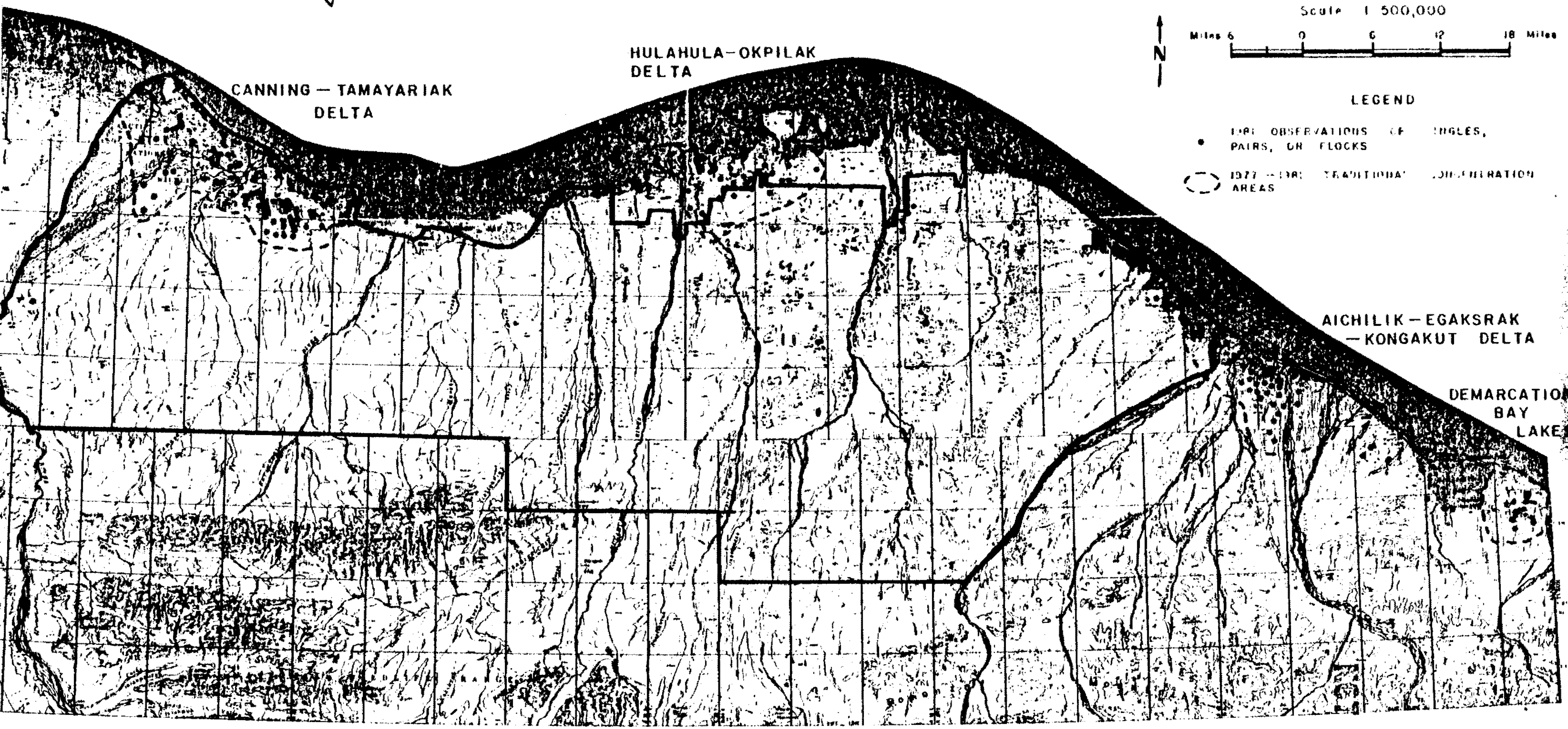

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Table 1. Comparison of whistling swan population statistics for the major swan concentration sites and other areas in between on the co
of the Arctic National Wildlife Refuge, Alaska, 4 August 1981. (See text and Fig. 1. for delineation of areas.)

| Statistic | Canning-Tamayariak Deltas | Hulahula-Okpilak Deltas | Jago Delta and Wetlands | Aichilik-Egaksrak-Kongakut Deltas | Demarcation Bay | Other |
|---|---|---|---|---|---|---|
| Total broods | 17 | 4 | 1 | 14 | 2 | 2 |
| Mean brood size | 2.7 | 3.3 | 4.0 | 2.3 | 3.0 | 1.0 |
| % pairs with young | 57 | 44 | 50 | 76 | 33 | 33 |
| % young in pop. | 25 | 16 | 33 | 19 | 25 | 13 |
| Total young | 46 | 13 | 4 | 32 | 6 | 2 |
| Total adults | 140 | 67 | 8 | 139 | 18 | 13 |
| Total swans | 186 | 80 | 12 | 171 | 24 | 15 |
| Swans/mi.$^2$ | 1.0 | 1.2 | 0.1 | 1.7 | 0.4 | 0.2 |
| Swans/km.$^2$ | 0.4 | 0.5 | - | 0.7 | 0.2 | 0.1 |
| No. of pairs | 30 | 9 | 2 | 17 | 6 | 3 |
| No. of singles | 3 | 0 | 1 | 2 | 0 | 2 |
| No. of flocks | 10 | 8 | 1 | 11 | 1 | 1 |
| Total swans in flocks | 77 | 49 | 3 | 101 | 6 | 5 |
| % paired birds in adult pop. | 43 | 27 | 50 | 24 | 67 | 46 |
| Cygnets: adult ratio | 1:4.0 | 1:5.2 | 1:2.0 | 1:4.3 | 1:3.0 | 1:6.5 |
| mi.$^2$ sampled | 189 | 65 | 138 | 100 | 61 | 66 |
| km.$^2$ sampled | 491 | 168 | 358 | 259 | 159 | 172 |

[a] A flock was considered to be 3 or more birds.

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Annual variation in swan density on North Slope habitats is substantial; over the 4 years of survey on the ANWR density on the Canning and Tamayariak Deltas has varied from 0.23 to 0.54 swans/km$^2$ which was more consistent than the 0.35-1.24 swans/km$^2$ variation observed at the Aichillik-Egaskrak- Kongakut Deltas (Spindler 1981c). Annual variation for 5 years data in the Colville Delta was 60%, whereas the 6 years of data on the tundra east of the Sagavanirktok Delta it was 300% (Welling and Sladen unpubl. manuscript 1981). With such sizeable annual variation in a species so conspicuous to aerial observers as the whistling swan, it is clear that population changes due to man's activities would be difficult to detect, and therefore refined population data before, during, after disturbances in swan concentration areas remains as major data gap.

CANADA GOOSE - Uncommon breeder in river deltas and drained-basin wetlands, common migrant on coastal plain. The species migrates into the area in spring from the east and departs in the fall to the east (Salter et al. 1980). Reported arrival dates are: at the Canning River Delta on 27 May 1979 and 20 May 1980; at the Sadlerochit River on 16 May 1979 (M.A. Robus, unpubl. data) at the Okpilak Delta 4 June 1978 (Spindler 1978a), and at Beaufort Lagoon on 6 June 1980 (J. Levison, unpubl. data).

On the ANWR coastal plain nesting is on islands in basin-complex wetlands surrounded by deep water (Martin and Moitoret 1981, Spindler 1978a). Incubation was intiated on 12 June 1979 at the Canning Delta; the first brood was observed on 5 July 1979 and nesting density was estimated at 0.25 and 0.30 nests/km$^2$ in 1979 and 1980, repectively, (Martin and Moitoret 1981). Parents with broods apparently seek large lakes and salt water in lagoons for protection shortly after the hatch, as most observations of adults with broods subsequent to the hatch at the Canning were in those habitats (Martin and Moitoret 1981).

Following the breeding season a molt migration to the west is apparent in late June-early July as non-breeders and failed breeders vacate tundra habitats and are seen migrating west, probably to the Teshekpuk Lake goose molting area (Derksen et al. in press, Martin and Moitoret 1981). Birds which do not reach Teshekpuk Lake before losing flight may end up spending the wing-molt period in July in river delta habitats on the ANWR coastal plain, as did the 65-90 flightless Canada geese observed at the Canning Delta in late July 1979 (Martin and Moitoret 1981).

Eastward fall migration began 14 August 1979 and 18 August 1980 and lasted until the end of August in both years at the Canning Delta (Martin and Moitoret 1981).

BRANT - Uncommon breeder in coastal plain basin-complex wetlands, locally abundant migrant along Beaufort Sea coast. Spring migration is eastward and peaks in the last week of May and the first week of June (Johnson et al. 1975, Spindler 1978a, Martin and Moitoret 1981, Johnson and Richardson 1980). In 1978 at the Okpilak Delta peak spring movement was 4-6 June, with about 10,000 birds (Spindler 1978a). In 1980 at Beaufort Lagoon J. Levison, unpubl data counted 2447 birds between 26 may and 11 June. At the Canning Delta in 1979 peak spring movement was 26 May-1 June and in 1980 it was 29 May-5 June (Martin and Moitoret 1981). The sharpness of the peak brant movements are borne out in migration watch data from the Canning Delta (Fig. B-2). During spring migration along the ANWR coast brant tend to follow lagoon shorelines and cut across points of land,

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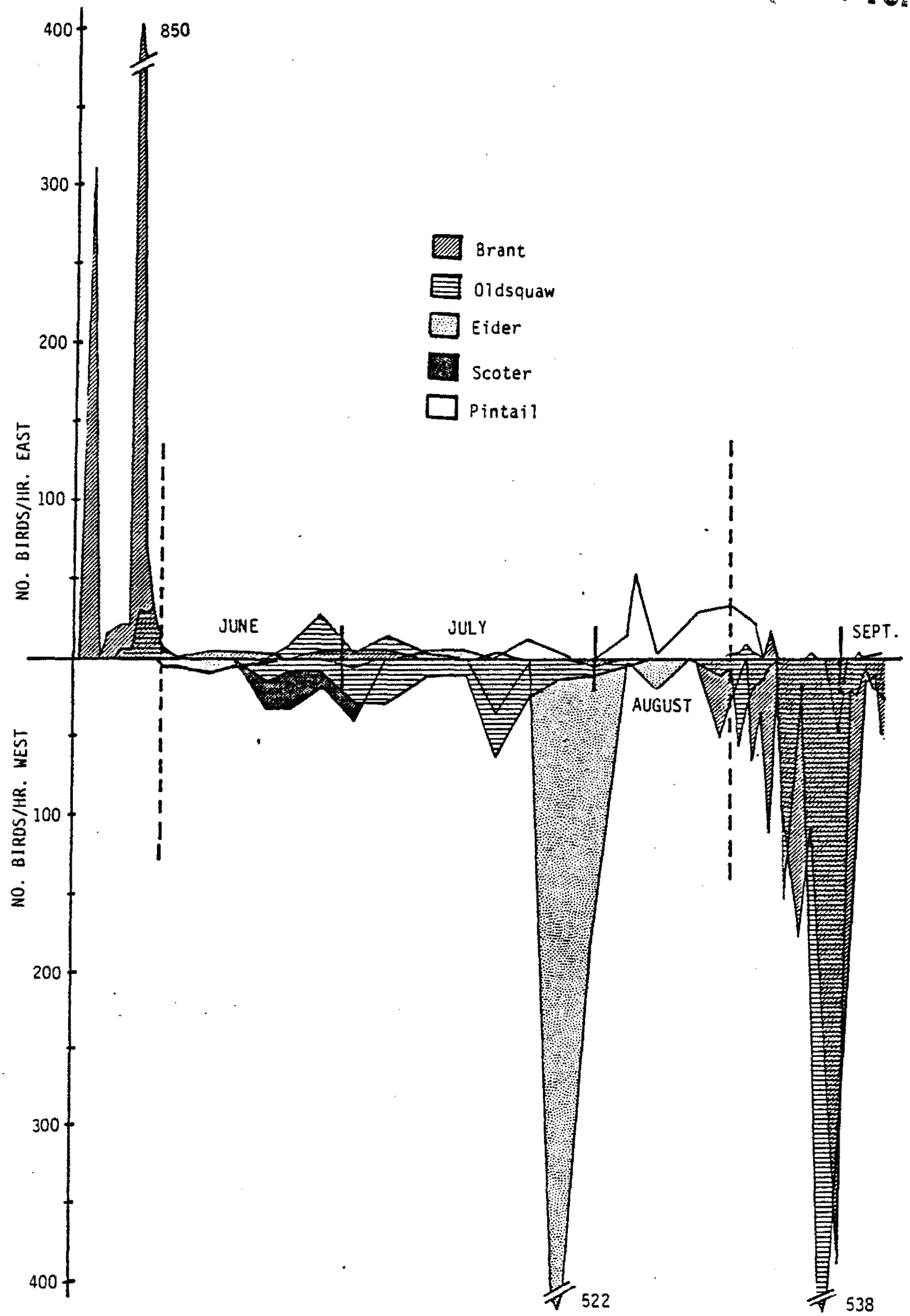

Figure ~~IV-1~~ B-2. Migration movements of five major species, Canning River River Delta, 1980.

sometimes leading them 1-5 km inland (Fig B-3 Spindler 1978a, Martin and Moitoret 1981 and Johnson et al. 1975). The tendency for brant to use the lagoon shorelines in spring may be related to their use of the wet saline Tundra(=coastal vegetated mudflats, Nodler 1977) which are usually located on gradually sloping lagoon shorelines. Brant were observed using these vegetated mudflats in early-mid-June near the Okpilak Delta where they grazed on *Puccinellia phyrganoides* and *Carex subspathacea* (Spindler 1978a). Coastal vegetated mudflats that are available and used by brant are shown in Map B-3. Such coastal vegetated mudflats may be critical to brant during spring migration since there are often extremely limited amounts of snow-free vegetation at this time, a condition that may be excaberated during prolonged headwinds which would necessitate delays and feeding prior to arrival on the breeding grounds (Spindler, pers. obs., Meehan pers. obs.). A major data gap in our brant knowledge is the frequency and fidelity with which brant use individual coastal mudflat areas and the energetic importance of these foraging areas the success of brant arriving at the breeding grounds or staging areas in a healthy condition.

Brant were found breeding on the ANWR coastal plain in a small colony of 15 pairs at the Okpilak Delta in 1978 (Spindler 1978a), and broods were seen at Beaufort Lagoon in 1970 (Schmidt 1970) and at the Canning River Delta in 1979 and 1980 (Martin and Moitoret 1981). As with Canada geese on the ANWR, brant nest on islands and penninsulas within basin-complex and flooded tundra wetlands (Spindler 1978a). Nesting density in 1978 was estimated to be 0.3 nests/km$^2$ at the Okpilak Delta, which represents the highest nesting density determined on ANWR to date (Spindler 1978a).

Late June observations of brant moving west by D. M. Troy at Demarcation Bay (unpubl. data) in 1978, Schmidt (1970) at Beaufort Lagoon in 1970, Spindler (1978a) at the Okpilak Delta in 1978 and Martin and Moitoret (1981) at the Canning Delta in 1979 lend supporting evidences for a limited molt migration towards a westerly location. The western destination of these brant is probably the Teshekpuk Lake area, where Derksen et al. (*in press*) have observed densities of up to 35 birds/km$^2$ of molting brant, along with white-fronted and Canada geese, in a flightless condition during their wing molt. Such densities and numbers of molting brant and other geese haven't been found elsewhere on the North Slope.

Fall migration past Beaufort lagoon began 22 August 1970 (Schmidt 1970) and 14 August 1980 (J. Levison, unpubl. data). Peaks of fall migration in 1980 occured 26, 29, 30, 31 August, and 1-3 September. On 1 September 16,482 Brant were counted migrating W past Pingokralnk Point. A Total of 28,863 Brant were counted during that fall migration watch (J. Levison, unpubl. data), which is the highes actual count ever made on ANWR.

Fall migration past Canning Delta was first observed 17 August 1979 nd 18 August 1980, and the duration of the migration in both years was about 3 weeks (Martin and Moitoret 1981) (Fig B-2). The peak of the fall migration in 1979 was 24-26 August, but in 1980 it was delayed by strong westerly winds until they ceased on 10 September (Martin and Moitoret 1981). In both years at the Canning Delta fall migration tended to be more evenly spread temporarily than the spring migration (Fig. B-2). The total count of brant passing Canning Delta in 1979 was 24,627, which was nearly double the previous eastern Beaufort Sea coastal fall count of 14,806 made by Schweinsberg (1974a) 25 August-6 September at Nunaluk Spit,

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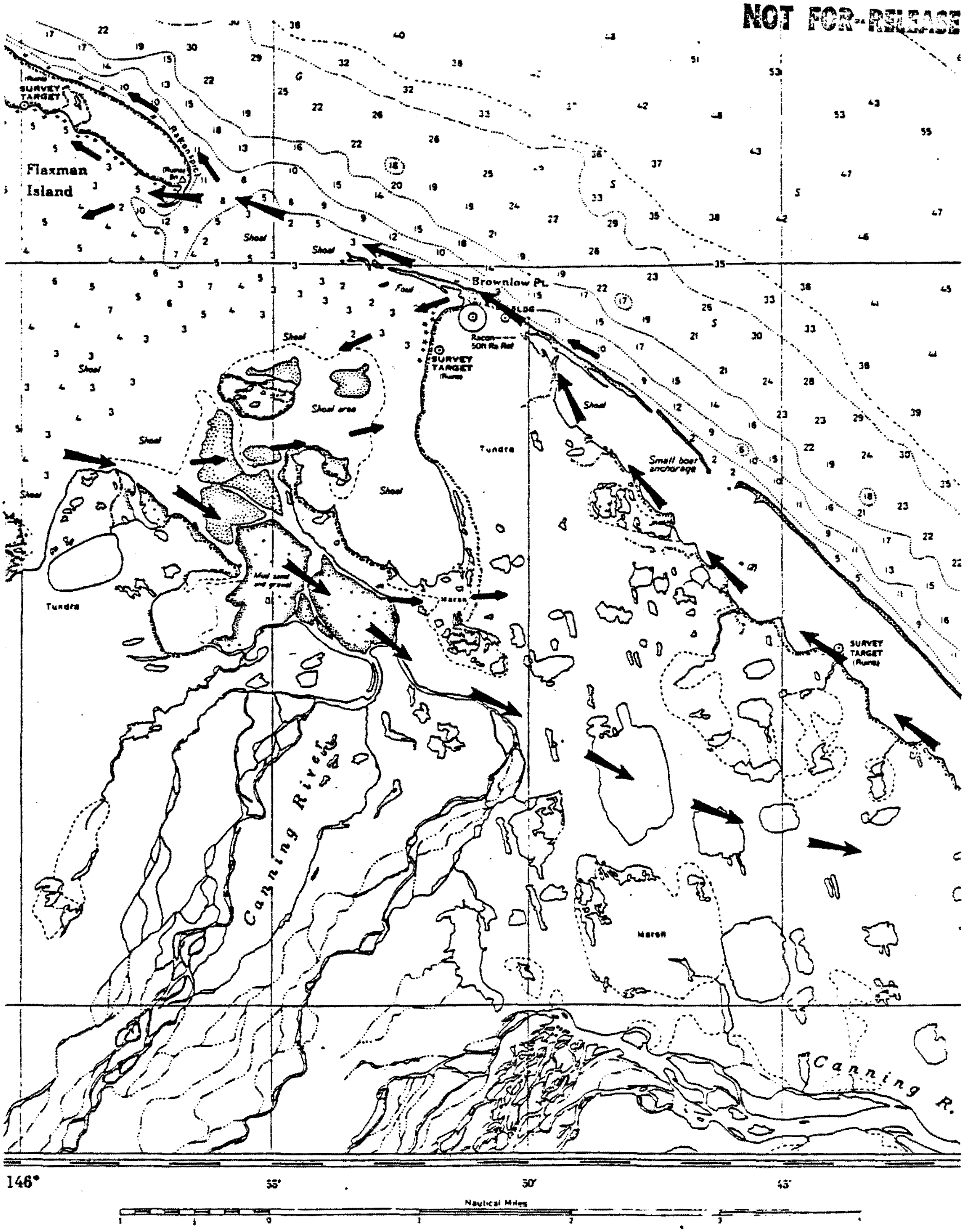

Fig B-3

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

Y.T., and nearly equals the estimated total of 26,000 for spring migration along the Yukon coast (Johnson et al. 1981). Canning Delta brant tended to migrate along the ocean shoreline in fall as compared to spring (Fig. B-2, Martin and Moitoret 1981). Johnson and Richardson (1980) point out that because brant migrate in spring and fall along or very close to the coast (from the MacKenzie River west to about Cape Halkett) where an overland route then becomes descernable, they are especially vulnerable to development of the nearshore zone because of the potential that high waters could carry spilled oil and contaminants onto the low-lying coastal vegetated mudflats upon which they depend for feeding areas.

WHITE-FRONTED GOOSE - Uncommon to fairly common spring migrant, common fall migrant over coastal plain tundra on ANWR. Spring migration is primarily westward (Salter et al. 1980), extending from late May to mid-June (Martin and Moitoret 1981, Spindler 1978a). At the Canning Delta arrival was on 17 May 1979 and 26 May 1980, and observations occurred until 29 June 1979 and 15 June 1980 (Martin and Moitoret 1981). At Beaufort Lagoon first arrival was 29 May 1980, and birds were seen fairly regularly throughout the month of June. Small groups were seen grazing on the tundra at the Okpilak Delta in June 1978 (Spindler 1978a) and on the Canning Delta in June 1979 and 1980 (Martin and Moitoret 1981).

There are no July observations of white-fronted geese on the ANWR coastal plain however, nesting (Sage 1974, Derksen et al. in press) and molting (Derksen et al. in press) occur commonly from the Sagavanirktok River west to Teshekpuk Lake.

White-fronted geese undertake a pronounced eastward migration over the ANWR coastal plain in fall, with totals of up to 25-150 having been observed in migration during snow goose staging surveys (Spindler 1978a, Koski and Gollop 1974, Koski 1977a, 1977b). Fall migration past Beaufort Lagoon/Pingokraluk Point began 21 August 1970 (Schmidt 1970) and 18 August 1980 (J. Levison unpubl. data). Peak movements occurred 29 August (6,334 birds) and 2 September (3,304 birds). A total of 10,228 birds were counted in to Beaufort/Pingokraluk migration watch. Fall migration on the Canning Delta was observed beginning 16 August 1979 and 12 August 1980. In 1979 flocks of from 3-325 birds scattered widely to graze on the tundra leaving small areas of uprooted Carex plants that were "virtually stripped" of vegetation (Martin and Moitoret 1981). Maximum numbers on the Canning Delta occurred on 30 August 1979, when a flock of 325 birds was seen, and on 25 August 1980, when a flock of 350 was seen flying east. Migration past the Canning Delta in 1980 was apparently complete by 3 September when the last flock was seen (Martin and Moitoret 1981), however, flocks have been seen as late as 14 September 1978 over the Katakturuk Delta (M. A. Spindler unpubl. data).

SNOW GOOSE - Uncommon spring migrant, very rare summer visitor, and abundant fall migrant on coastal plain of ANWR.

Snow geese are first observed during spring migration each year on or near the ANWR Beaufort Sea coast during the latter part of May and the first week of June (Johnson et al. 1975). The birds use several migration routes to reach their arctic coastal breeding areas. Perhaps the greatest numbers arrive by following the Mackenzie Valley northward (Barry 1967;

Campbell and Shepard 1973; Salter et al. 1974). Others have been seen migrating across interior Alaska over the Yukon Flats and Porcupine River basin (Gabrielson and Lincoln 1959), crossing the Richardson Mountains through Blow River pass (Koski and Gollop 1974) and the Brooks Range through Anaktuvuk Pass (Irving 1960). Early arrival dates on and near ANWR have been 13 May 1974 at Clarence Lagoon; 16 May (no year given) at Herschel Island; 19 and 25 May 1979 at 10 km Sadlerochit River; 26 May 1979 at Demarcation Bay; 26 May 1972 at Prudhoe Bay; 29 May 1971 at Prudhoe Bay; 1 June 1979 and 1980 at Canning River Delta; 1 June 1972 at the Firth River; 3 June 1978 at the Okpilak River; 4 June 1980 at Beaufort Lagoon; 4-8 June 1971-1973 at Storkerson Point (respectively, Johnson et al. 1975; Rand 1946; M.A. Robus unpubl. data; R.M. Burgess unpubl. data; Gavin 1971; Martin and Moitoret 1981, Gollop et al. 1974; Spindler 1978; J. Levison unpubl. data; Bergman et al. 1977). The peak date of egg-laying on the Anderson River delta colony is reported to be about 9 June, and in the second week of June near Barrow (Johnson et al. 1975).

The major nesting colonies along the Beaufort and Chukchi Sea coasts are (estimated number of breeding birds in parentheses) Banks Island, NWT (150,000), Anderson River Delta, NWT ( 2,500), Kendall Island, NWT (n50), Sagavanirktok River Delta, AK (n80) and Wrangell Island, USSR (60,000) (Welling etal. 1981). On the Alaska North Slope scattered pairs have been reported breeding irregularly near the Meade River, Teshekpuk Lake, East Long Lake, the Colville River and Flaxman Island (Johnson et al. 1975; Gavin 1976, Derksen et al in press). Snow geese once commonly nested in portions of the Alaska North Slope (Bailey 1948; Gabrielson and Lincoln 1959), but it has been hypothesized that introduced reindeer and their herdsmen destroyed geese and their nesting grounds (Bailey et al. 1933; Bailey 1948). There have been no recent reports of snow geese nesting or attempting to nest on ANWR.

Snow goose occurrence on ANWR in the spring is not clearly understood because the times and directions of movement do not clearly indicate a migration toward any one of the above-listed colonies. Observations which include information on direction of movement indicate both westerly and easterly movements. On 25 May 1979 50 birds flew NW along the Sadlerochit River (M.A. Robus unpubl. data). On 25 May 1979 8 birds flew E past Demarcation Point (R.M. Burgess, unpubl. data). Between 26 May and 1 June 1975 34 birds flew E and on 31 May 9 geese flew W past Clarence Lagoon, and between 31 May and 9 June westbound movement exceeded eastbound movement at Clarence Lagoon and Komakuk Beach (Johnson et al. 1975). Between 3 and 7 June 1978, 34 birds and on 19 June 14 birds flew E past the Okpilak delta (Spindler 1978). On 1 to 20 and 24 June 1970 45, 14 and 7 snow geese, respectively, flew NW near Beaufort lagoon (Schmidt 1970). Throughout June 1980 5 records of snow geese at the Canning Delta indicated mostly westerly movement (Martin and Moitoret 1981).

Summer records on ANWR are of lone stragglers or widely scattered flocks grazing on the tundra: on 21 June 1980, 50 snow geese were seen resting on the shore of Brownlow Lagoon; a single bird was seen resting on the mudflats at the mouth of the Canning River on 10 July 1979 (Martin and Moitoret 1981). On 27 June 1970, 2 birds were seen grazing on the tundra of the Aichilik Delta (Schmidt 1970). On 18 July 1980, J. Levison (unpubl. data) saw a single bird at Siku Lagoon. On 5 August 1980 Martin and Moitoret (1981) reported a single flightless bird on a barren spit near Brownlow Point.

The annual autumn staging of snow geese on the north slope of ANWR, Alaska and the Yukon Territory is perhaps the single-most spectacular migratory bird event occurring in the region each year. Total numbers of 706,277 birds in 1975 and 507,700 in 1976 have been estimated for the entire staging ground between the Canning River, AK. and the Parry Pennínsula, NWT. (Koski 1977). Johnson et al. (1975) summarized the chronology of fall staging on the Alaska and Yukon coastal plains:

> Adult geese and young of the year leave their nesting areas at the Anderson River delta at the end of August (Barry 1967) and probably leave the Banks Island nesting area at approximately the same time. They stop-over on the Parry Peninsula for approximately a week, where they exercise and feed ... They then move west, where, depending upon the season and weather, they either spread out along the section of the North Slope from the Mackenzie Delta westward (sometimes as far as the Canning River in Alaska) or, when poor weather hampers their movement onto this coastal plain they may stay in the Mackenzie Delta region... In this eastern portion of the Beaufort Sea, the initial westward movement of Snow Geese is generally noted around the third week of August. During a normal year, westward movement is followed by a one or two-week period of very little movement; during this period, birds spend a great deal of time feeding.

On the ANWR the first westerly migrating flocks have been sighted between 15 and 24 August, and the major influx has occurred 19 August to 1 September (Table B-2, Spindler 1980). The latest date snow geese have been seen on the ANWR has ranged from 9 September to 27 September (Table B-2, Spindler 1981a), however, A.S. Thayer (pers. comm.) has reported seeing snow geese as late as mid-October in the early 1970's. Johnson et al. (1975) reported that the main departure from the North Slope is gradual and occurs just ahead of freezing weather.

The maximum estimated numbers of snow geese occurring on ANWR was 325,760 in 1978 (Table B-3, Spindler 1978). During the period 1973-1981 there were three years in which the estimated numbers were greater than 190,000, there were three years in which they were between 20,000 and 50,000, and two years in which they were less than 20,000 (Table B-3, Spindler 1981a). There has been shown to be significant annual variation in the staging areas used, the numbers of snow geese using each area, and duration of use (Koski 1977, Spindler 1981a). Koski (1974) suggested that weather most likely exerted the major influence upon timing and extent of movements from the breeding areas to the staging areas.

Estimations of age-ratios are used as indicators of population productivity. Age ratios varied tremendously annually, from 1% immature birds in 1974 to over 100% immature birds in 1973 and 1975 (Table B-4, Koski 1977b; Spindler 1981a). Productivity of the western arctic snow goose populations is affected significantly by bad June weather (Barry 1962, 1967). Age ratio has been shown to vary spatially on the staging grounds and the suggestion in Table B-4 is that samples including the Mackenzie Delta area have a tendency to yield higher immature ratios than do samples including only the Alaska and Yukon north slopes. This pattern

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Table ~~B-2~~ Dates of arrival and departure of snow geese on the Mackenzie Delta, Yukon North Slope, and Eastern Alaskan North Slope, August and September 1971-1976 and 1978-1981. The 1978-1981 data are from Arctic National Wildlife Refuge only.

| Year | Date first flock sighted | Dates of Major arrival | Major departure | Date last flock sighted | Survey period[a] |
|---|---|---|---|---|---|
| 1971[b] | 15 Aug. | 31 Aug.-2 Sept. | 12-16 Sept. | 17 Sept. | 4 June-19 Sept. |
| 1972[c] | 17 Aug. | 27-29 Aug. | 7-10 Sept. | 15 Sept. | 10 July-17 Sept. |
| 1973[d] | 23 Aug. | 1-12 Sept. | 22-25 Sept. | 4 Oct. | 25 Aug.-29 Sept. |
| 1974[e] | 21 Aug. | 22-25 Aug. | 17-21 Sept. | 30 Sept. | 24 Aug.-30 Sept. |
| 1975[f] | 18 Aug. | 3-5 or 6 Sept. | 19-24 Sept. | 25 Sept. | 20 Aug.-25 Sept. |
| 1976[g] | 13 Aug. | 25-28 Aug. | 16-26 Sept. | 30 Sept. | 15 Aug.-2 Oct. |
| 1978[h] | 20 Aug. | 25 Aug.-1 Sept. | 16-27 Sept. | 27 Sept. or before | 10 June-5 Oct. |
| 1979[i] | 24 Aug. | 26-28 Aug. | 15 Sept. | N/D | 10 June-12 Sept. |
| 1980[j] | 15 Aug. | 19-21 Aug. | 1-2 Sept. | 9 Sept. | 5 June-12 Sept. |
| 1981[k] | 24 Aug. | 26-30 Aug. | 16-18 Sept. | 18 Sept. | 11 July-20 Sept. |

[a] Dates inclusive of aerial and gound observation period. Locations of ground observation and aerial survey coverage varied: 1971-1976 data emphasized Mackenzie and Yukon locations, while 1978-1981 data emphasized Alaskan locations. For details see respective sources:

[b] Schweinburg (1974)

[c] Gollop and Davis (1974)

[d] Koski and Gollop (1974)

[e] Koski (1975)

[f] Koski (1977a)

[g] Koski (1977b)

[h] Spindler (1978)

[i] Spindler (1979)

[j] Spindler (198~~0~~1a)

[k] This study

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Table ~~8-3.~~ B-3 Total numbers of Western Arctic Snow Geese counted during August-September staging surveys, 1973-1981.

| Year | Alaska | Yukon North Slope | Mackenzie Delta | Total | Survey Dates |
|---|---|---|---|---|---|
| 1973[a] | 44,037 | 126,960 | 86,520 | 257,517 | Sept. 2,3,5,6,11,12,18,22,23,25 |
| 1974[a] | 48,591 | 37,435 | 28,913 | 114,939 | Aug. 24,31, Sept. 5,11,16,25 |
| 1975[a] | 0 | 20,972 | 685,305 | 706,277 | Aug. 25-28, Sept. 8,10,11,13,17-18,20,23 |
| 1976[a] | 228,793 | 224,401 | 18,363 | 471,557 | Aug. 16-20,29-31, Sept. 4-6,10-13,18-21 |
| 1978[b] | 325,760 | N/D | N/D | N/D | Sept. 13-14 |
| 1979[c] | 195,000 | 41,000 | N/D | N/D | Sept. 6-7 |
| 1980 | 8,996[d] | 7,500[e] | N/D | N/D | Sept. 9 |
| 1981 | 20,000[f] | 80,000[f] | g | g | Sept 14,16,20 |

Sources:
[a] Koski 1977b, extrapolation from transects at several points in time, not all areas covered on each date.
[b] Spindler 1978, extrapolation from transects at one point in time.
[c] Spindler 1979; note Yukon count incomplete, Demarcation Bay to Phillips Bay, estimates of all flocks seen, and photograph counts, at one point in time.
[d] Ground counts by Jim Levison, estimates of all flocks seen continuous count during daylight hours.
[e] Estimated total; Actual photograph count was less; Demarcation Bay to Phillips Bay.
[f] Visual esitmates of flock, Yukon sample includes only area from U.S.-Canada border to Phillips Bay.
[g] Data not yet available.

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Table ~~[illegible]~~. Comparison of age ratios for western arctic snow geese staging on the Alaska and Yukon North Slope, and Mackenzie Delta 1973-1976 (Koski 1977b) and 1979-1981 (Spindler 1980).

| Year | Adults | Immature | % Immature | Area of Survey | Technique |
|---|---|---|---|---|---|
| 1973 | 4533 | 5399 | 119.1 | MD, YNS, AK[b] | Comp. count |
| 1974 | 28647 | 29 | 1.0 | MD, YNS, AK | Comp. count |
| 1975 | 12223 | 13638 | 111.6 | MD, YNS, AK | Comp. count |
| 1976 | 7375 | 5541 | 75.1 | MD, YNS, AK | Comp. count |
| 1979 | 4275 | 133 | 3.1 | YNS, AK | Photo |
| 1980 | 1046 | 37 | 3.5(3.3+1.2)[a] | YNS, AK | Photo |
| 1981 | [c] | [c] | [c] | MD, YNS, AK | Photo |

[a] Estimate in parentheses is thought to be a better estimator because it is weighted according to flock size of samples.

[b] MD- Mackenzie Delta; YNS-Yukon North Slope; AK-ANWR, Alaska

[c] Combined MD-YNS-AK data not yet available, data for YNS and AK were 3377 adults, 272 immatures for 6.5% immature (or 7.4 + 9.2 weighted mean + weighted std. dev.).

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would be expected if family groups with a large proportion of young do not migrate as far west as do those with a low proportion of young.

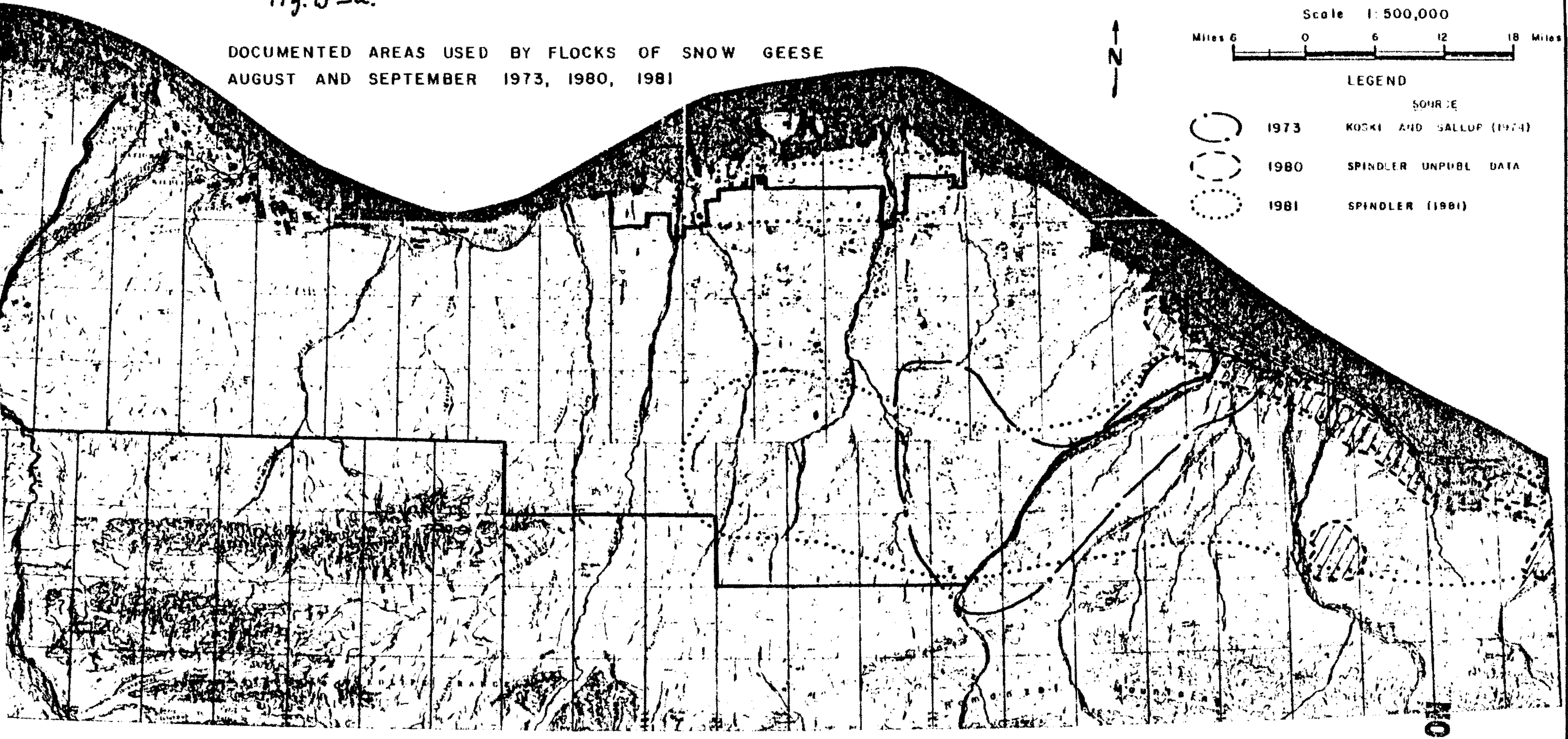
Distribution of fall staging snow geese has been extremely variable for the years we have data, 1973-1981 (Fig B-5). In 1974, 1976, 1978, and 1979 snow geese staged on a widespread portion of ANWR, generally east from the Hulahula River to the Aichilik River and extending from the coast inland to roughly the 305 m (1000 foot) contour line (Map B-4). Staging in other years was restricted to certain localities or portions of the coastal plain. In 1973 the use centered along the Aichilik River and extended NW to the Niguanak River. In 1975 no large concentrations were observed staging on the ANWR coastal plain (Koski 1977a). In 1977 no snow goose surveys were conducted. In 1980, snow goose distribution as determined from boat surveys in late August, along coastal lagoons extended from Demarcation Bay W to Beaufort Lagoon, however, it is not known how far inland the area was used (J. Levison unpubl. data). When the 1980 aerial survey was conducted (9-10 September 1980) the only snow geese observed on the ANWR coastal plain were north of VABM Dar near the Kongakut River and directly on the U.S.-Canada border; much of the population had staged on the Yukon North Slope (Spindler 1981a). In 1981 distribution of snow geese on ANWR was again fairly widespread, extending in a 20-25 km wide band N of the 305 m contour line from the Okpilak River east in the Yukon north slope. There was also a small aggregation close to the coast between the Hulahula and the Jago Rivers (Fig B-5).

As initially reported by Spindler (1978) when the years 1973-1978 were analyzed, and now corroborated by the additional years data 1979-1981, some "core" snow goose staging areas may be defined. In years of lower staging population on ANWR (e.g. 1973, 1974, 1980 - possibly, and 1981) staging occurred on limited portions of the ANWR coastal plain, but in all those years (except possibly 1980) two "core" areas were used: one between the Okerokovik and Jago Rivers north of the 305 m contour line, and the other between the Aichilik and Sikutaktuvik Rivers between the 122 and 305 contour lines (Fig B-5). These core areas were also used in years of high staging population (e.g. 1976, 1978, 1979), but in those years staging also occurred in more widespread areas over the entire coastal plain east of the Hulahula River. Significant staging was documented west of the Hulahula, only in two years 1976, 1979, although medium sized groups of snow geese have been observed during the staging period at the Canning delta (in 1975 and 300 birds on 26 August 1979, 45 and 85 birds on 28 August 1980, 40 and 20 birds on 31 August 1980 and 16 birds on 9 September 1980) (Martin and Moitoret 1981). In 1976, a large staging aggregation was documented in the Carter Creek area and between the Hulahula River and the Sadlerochit River. In 1979 staging occurred along the lower 10 km of the Sadlerochit River (Fig B-4).

Staging activities of snow geese on the eastern Alaska and Yukon North Slopes involve resting and feeding to allow accumulation of energy reserves sufficient to allow successful completion of fall migration (Patterson 1974). Significant gains in mean weight of adult and immature birds have been recorded between when the birds enter the staging area and when they depart it (Patterson 1974). Snow geese grazing on the outer coastal plain of ANWR have been observed feeding on sedge rootstocks. At the Okpilak Delta Spindler (1978) described an area several hectares in size in a homogeneous wet sedge-tundra habitat where 34 snow geese had been grazing overnight "...nearly every live <u>Carex</u> plant was uprooted and

# ARCTIC COASTAL PLAIN BASELINE STUDY

## Fig. B-5a. DISTRIBUTION OF FALL STAGING SNOW GEESE



DOCUMENTED AREAS USED BY FLOCKS OF SNOW GEESE
AUGUST AND SEPTEMBER 1973, 1980, 1981

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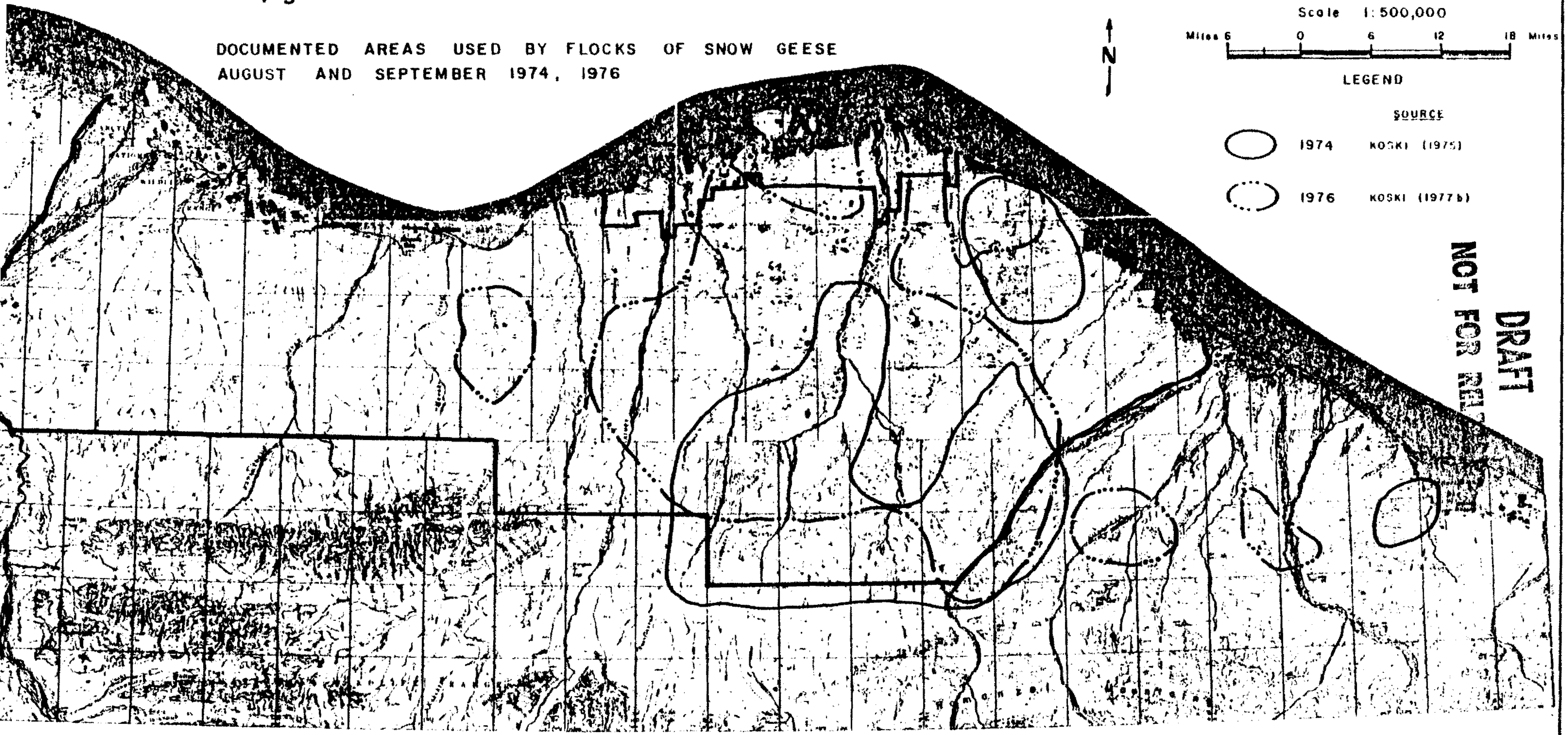
## ARCTIC COASTAL PLAIN BASELINE STUDY

Fig. B-56. DISTRIBUTION OF FALL STAGING SNOW GEESE



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# ARCTIC COASTAL PLAIN BASELINE STUDY

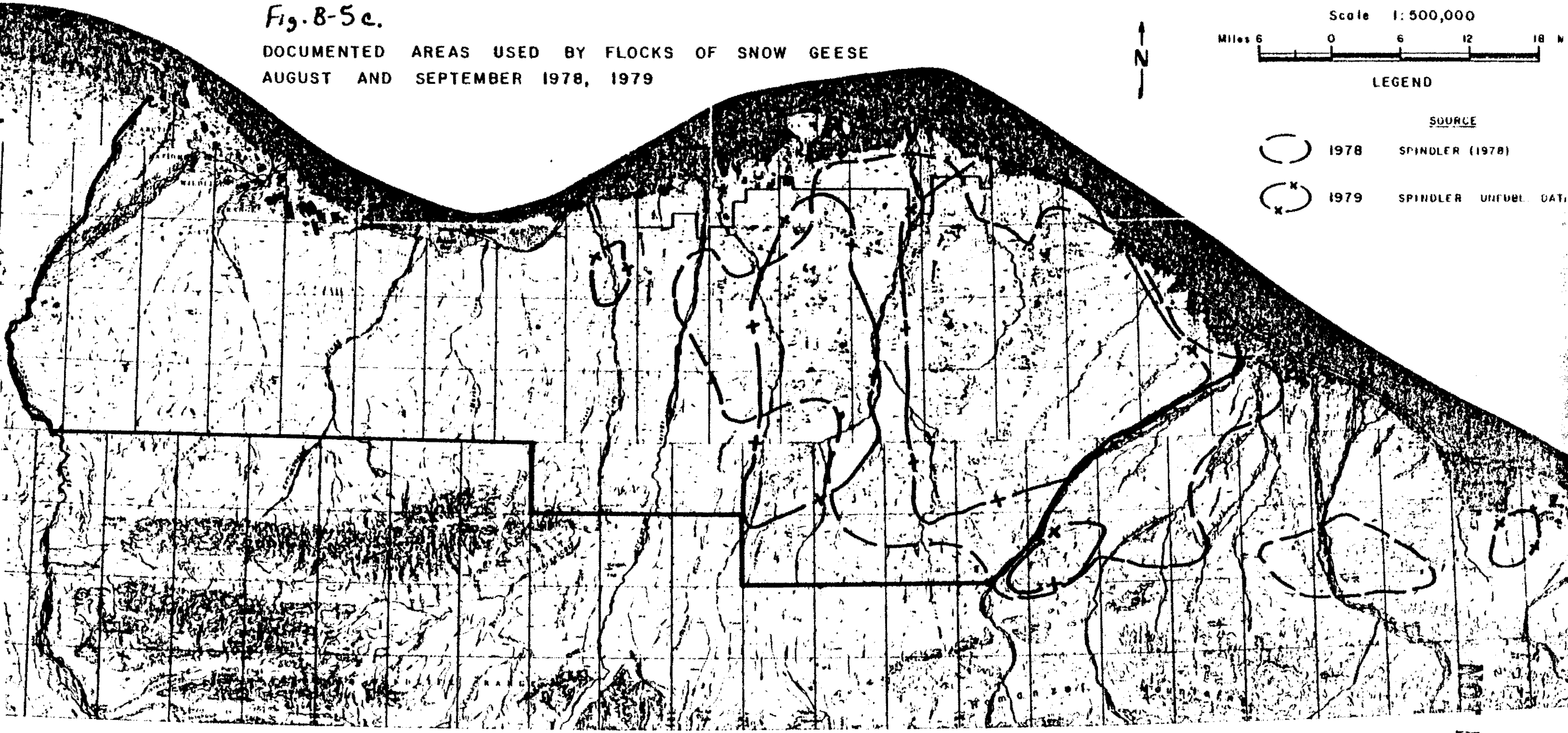

Fig. 8-5c.

DOCUMENTED AREAS USED BY FLOCKS OF SNOW GEESE AUGUST AND SEPTEMBER 1978, 1979

DRAFT NOT FOR RELEASE

the tuber and green shoots eaten, leaving only the actual roots and dead or dying leaves in scattered feeding sites several meters in diameter." Martin and Moitoret (1981) observed 300 snow geese grazing on mesic mosaic Wet Sedge-Dry Sedge Tundra and another flock of 45 grazing on Wet Sedge Tundra on the Canning Delta. J. Levison (unpubl. data) saw a flock of 180 birds feeding on Wet Sedge Tundra 0.8 km south of Pokok Bay, 26 August 1980. R. Lipkin (unpubl. data) observed snow geese clipping and uprooting Carex bigelowii in the Beaufort Lagoon area late August 1978. Schmidt (1970) reported thats now geese left the coastal tundra near Beaufort Lagoon in early September 1970 and migrated inland to feed primarily on berries (probably Empetrum nigrum) located on higher dry tundra. We do not know how the relative importance of inland berry food sources compares with coastal rootstock food sources, nor whether sedge rootstocks are also used in the interior coastal plain.

An examination of vegetation types within the "core" concentration areas showed that they were covered by Moist Tussock-Dwart Shrub Tundra (Upland Sedge Tundra and Upland Tussock Tundra Nodler 1977), with lesser amounts of Wet and Very Wet Sedge Tundra (Spindler 1978; Fig B-5). The areas receiving snow goose utilization in years of less confined and more widespread staging included additional amounts of homogeneous wet sedge tundra and flooded sedge tundra vegetation types owing to their proximity to the coast (Nodler 1977; Spindler 1978, Map B-4).

ROSS' GOOSE - Casual spring migrant on coastal plain tundra. One individual was observed by Martin and Moitoret (1981) on 13 June 1980 at the Canning River Delta. There are two other recent records of this species on the North Slope, both near Teshekpuk Lake, one bird on 15 July 1976 and 4 birds on 18 August 1977 (Kessel and Gibson 1978). The breeding range of this species occurs on Banks Island and eastward, so it is not surprising that a few individuals are recorded on the Alaska North Slope (Johnson et al. 1975).

MALLARD - Uncommon spring migrant, rare summer visitant and fall migrant in coastal plain wetland habitats. At the Canning Delta mallards were seen in small numbers on one occasion in 1979, and on seven occasions in 1980, all between 2 June and 13 August (Martin and Moitoret 1981). Two to three were seen on three dates in 1970 at Nuvagapak Point (Anderson 1973) and in the Beaufort Lagoon area (Schmidt 1970). At Demarcation Point R. M. Burgess (unpubl. data) saw two, 22 May 1979, and five, 3 June 1979. M. A. Robus (unpubl. data) reported a drake at Sadlerochit Springs, 22 May 1979. J. Levison (unpubl.data) observed mallards in groups of 1-15 on the following, 1980 dates near Beaufort Lagoon: 8, 9, 15 August. Mallards occur as casual visitors in NPR-A (Derksen et al. in press) and as a rare summer resident and very rare breeder on the Yukon North Slope (Salter et al. 1980).

PINTAIL - Very common migrant, common summer resident, and rare breeder in coastal plain tundra wetlands. Spring migration is probably both east to west (from the MacKenzie Valley west to the Alaskan North Slope) and south to north (from interior Alaska north across the Brooks Range to the North Slope), with ensuing dispersal along the North Slope in both easterly and westerly directions (Johnson et al. 1975). Arrival on the ANWR coastal plain occurs in late-May to early-June; 2 June 1978 at Okpilak Delta (Spindler 1978a), 2 June 1980 at Beaufort Lagoon (J. Levison, unpubl. data) 22 May 1979 at Demarcation Point (R. M. Burgess unpubl.data), and 27 May 1979 and 26 May 1980 at the Canning Delta (Martin and Moitoret 1981). The initial observations at the Canning Delta were followed by a pronounced influx several days later, 31 May 1979 and 5 June 1980. Open water at river delta mouths in late May-early June usually attracts and holds the first pintails until open water becomes available in wetland basin complexes in the first or second week of June (Spindler 1978a, Johnson and Richardson 1980, Martin and Moitoret 1981).

Summer resident population densities on the ANWR coastal plain have been observed at 7.7 birds/km $^2$ at Beaufort Lagoon in 1970 (Schmidt 1970) and at 3.6 birds/km$^2$ at the Canning River Delta in 1979 both of which are lower than densities other workers have found at Prudhoe Bay and in 2 of 3 NPR-A sites (Martin and Moitoret 1981). Population levels and breeding efforts fluctuate widely on the North Slope, apparently increasing in correspondence with drought conditions on the North American prairie potholes (Derksen and Eldridge 1980). Pintails were described as the most common duck species using the tundra habitats of NPR-A (Derksen et al. in press) and as the most common dabbler using tundra habitats of the Canning Delta (Martin and Moitoret 1981). Despite the abundance in some years, breeding has been documented on ANWR in the form of only two nests and a possible additional brood at the Canning Delta in 1980 (Martin and Moitoret 1981), and 2 broods in the Beaufort Lagoon/Aichilik Delta area in July 1970 (Schmidt 1970).

Perhaps more important than breeding habitat, the ANWR coastal plain provides molting and staging habitat in the form of basin-complex, beaded drainage, and flooded tundra wetlands used during migration, wing molt and premigratory staging (Spindler 1978a). In early July (July 8, 1978) flocks as large as 23 birds were observed on the Okpilak Delta, and in mid-to-late July birds undergoing wing molt were observed in flooded *Arctophila* and *Carex* habitats (Spindler 1978a). Martin and Moitoret (1981) noted that wetlands with extensive *Arctophila* were used by molting pintails on the Canning Delta.

Fall pre-migratory influxes of pintails were observed on the Canning Delta in late July and early August, and eastward migration was noted beginning by 3 August 1980 (Martin and Moitoret 1981). Peak migration of pintails from the North Slope occurred on the 14 August 1980, when over 900 birds were counted flying east at the Canning Delta (Martin and Moitoret 1981). Major fall migration past the Canning Delta ended by 20 August 1980, however, small flocks (up to 30) were seen as late as 2 September using Brownlow Lagoon waters (Martin and Moitoret 1981). At Beaufort Lagoon, J. Levison (unpubl. data) observed the first eastward migrants on 6 August, with peack movement of 783 flying east on 18 August, and the last group seen on 3 September 1980.

GREEN-WINGED TEAL - Uncommon breeder in interior coastal plain, rare breeder in outer coastal plain. The earliest observation on the ANWR coastal plain was of a pair of Sadlerochit Springs 22 May 1979 (M. A. Robus unpubl. data). The species was confirmed breeding at Demarcation Point in 1979 (R. M. Burgess unpubl. data). Green-winged teal have usually been recorded as singles, or infrequent small flocks (up to 16 individuals) mostly in June. Sites of observation in addition to those given have been Beaufort Lagoon and Aichilik Delta (Schmidt 1970, Anderson 1973 J. Levison, unpubl. data Schmidt (1970) found one nest near Beaufort Lagoon and estimated 0.8 adults/$km^2$). Okpilak Delta (Spindler 1978a) and Canning Delta. On the ANWR there has been only one July observation a female at the mouth of the Egaksrak River (Schmidt 1970) and only one August observation (Martin and Moitoret 1981). The species breeds in regular but small numbers to the east on the Yukon North Slope (Salter et al. 1980) to the west near Umiat (West and White 1964), and to the south in wetlands along north flowing rivers of the Brooks Range (e.g. Hulahula River, M. A. Spindler, unpubl. data).

AMERICAN WIGEON - Uncommon to fairly common migrant on the ANWR coastal plain. The first observations during spring migration are on 22 May 1979 in the interior coastal plain at Sadlerochit Springs (M. A. Robus unpubl. data) where open water most of the winter provides an attractant for early-arriving waterbirds (M. A. Spindler unpubl. data, D. E. Ross, unpubl. data). On the outer coastal plain, American wigeons arrive in the last few days of May (25 May 1979 at Demarcation Point R.M. Burgess unpubl. data) and May 29 1980 at Canning Delta (Martin and Moitoret 1981). Observations on ANWR in June are frequent: Schmidt (1970) 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, unpubl. data) and two pairs were at Sadlerochit Springs 22 May 1979 (M.A. Robus, unpubl. data). At the Canning Delta in 1979 observations were of singles to groups of 5, 1 June, 25 June, and 16 August. In 1980, American wigeons were more common at the Canning Delta with singles, pairs and groups of up to 23 seen on 29 May, 5,7,8,13,14,16, and 21 June. No birds were seen in July and fall movement was slight, with just two flocks seen flying east on 19 August 1980 (Martin and Moitoret 1981). A Group of 14 was seen on the Aichilik Delta 18 August 1980 (J. Levison, unpubl. data).

Although there are no breeding rcords on the ANWR, Salter et. al. (1980) observed broods at Phillips Bay, Yukon, and Pitelka (1974) lists the species as a regular breeder along the central sector of the Alaskan North Slope.

EUROPEAN WIGEON - Casual visitor to the ANWR coastal plain. A pair was observed in an *Arctophila* marsh within a Drained Basin Wetland Complex near the Okpilak delta (Spindler 1978a).

NORTHERN SHOVELER - Rare summer visitant. The earliest date on the ANWR coastal plain for this species is 7 June 1980, when 2 drakes and a hen were seen flying east at the Canning River Delta (Martin and Moitoret 1981). Schmidt (1970) reported a drake at the Aichilik River Delta 24 June 1970. One to three individuals were seen on four occasions 22 June 1979 at Demarcation Point (R.M. Burgess unpubl. data). A pair was observed 22 May 1979 at Sadlerochit Springs (M.A. Robus unpubl. data). On the Canning Delta the species was not recorded in 1979 but was fairly regular in 1980. Records are for 1 to 4 birds seen 7, 11, 17, 18, 19, 20 June, 5, and 29 July, 3 and 14 August (Martin and Moitoret 1981). A few shovelers probably molted on the Canning Delta in 1980, using dense *Arctophila* beds for cover during the molt (Martin and Moitoret 1981).

GREATER SCAUP - Probably fairly common breeder in interior coastal plain and an uncommon summer visitant in outer coastal plain. In 1978 first arrival on the ANWR outer coastal plain was 6 June at the Okpilak Delta (Spindler 1978a); in 1979 and 1980 first arrival at the Canning Delta was 6 June, and 7 June, respectively (Martin and Moitoret 1981). June records of the greater scaup on ANWR are common: The Okpilak River Delta, a group consisting of two drakes and a hen remained in a small drained basin wetland area from 11-29 June (Spindler 1978a). Three flocks numbering 10, 16, and 23 were seen in the Beaufort Lagoon area 24 June 1970 (Schmidt 1970); at Demarcation Point small groups of unidentified scaup were seen several times in June 1979 (R.M. Burgess, unpubl. data). At the Aichilik River delta at Beaufort Lagoon 50 scaup sp. (probably this species) were seen with scoters during the last week in June 1970 (Anderson 1973). At the Canning Delta 5 drakes were observed in *Arctophila* wetlands 6 June 1979; all other subsequent records 7, 15 June 1979, 21 July 1979, 22 July 1980, 20 August 19179 and 21 August 1980 were of up to 5 birds flying over the study area or in the Beaufort Sea nearshore and coastal lagoon waters (Martin and Moitoret 1981). There are no breeding records for the ANWR coastal plain, however, Sage (1974) stated the greater scaup is probably "the most numerous breeding duck" in the interior coastal plain at the Sagavanirvik drainage, and Salter et. al. 1980 described the species as "second only to the oldsquaw in abundance" with breeding confirmed between the Firth and Blow Rivers. It is because of the above observations that the species is ascribed "probable uncommon breeder" status in the interior coastal plain, but there have been no intensive bird population survey efforts in the interior coastal plain that would yield such data for this and other species.

COMMON GOLDENEYE - Rare summer visitant in lagons and coastal plain wetlands. J. Levison (unpubl. data) observed one bird near Beaufort Lagoon 17 July 1980. Adjacent to ANWR, Salter et. al. (1980) reported a male in breeding plumage on 26 June 1975 at Clarence Lagoon, 10 km east of ANWR border. The species was also observed molting in lower numbers in association with scoters, oldsquaw, and mergansers at Herschel Island 8-15 August 1973 (Salter et. al. 1980). Common goldeneye has also been recorded in wetlands along north-flowing rivers in the Broks Range (e.g. Hulahula River, M.A. Spindler, unpubl. data 1980).

OLDSQUAW - Common breeder on coastal plain tundra near lakes, ponds, and wetlands; abundant summer resident in lagoons and nearshore waters; abundant migrant along coast. Oldsquaw have been called the most numerous breeding duck across the outer coastal plain from NPR-A (Derksen et. al. in press) to the Yukon North Slope (Salter et al. 1980). On the ANWR coastal plain it is probably the single most abundant duck species, and it is the most numerous resident species in coastal lagoons and neashore waters (Spindler 1981b). The abundance of the oldsquaw on Alaska's North Slope has prompted intensive study as a key species at Simpson Lagoon (Johnson and Richardson 1980) and elsewhere (Taylor 1981). Because of its importance in the arctic ecosystem and the comparatively good data base, the oldsquaw will be discussed in some detail here.

Oldsquaw migrate eastward along the Beaufort Sea coast from wintering areas in the Bering Sea and North Pacific to breeding areas on the Alaska and Yukon North Slopes and the Canadian arctic; there is also some evidence for a northerly migration across interior Alaska and the Brooks Range to the North Slope (Johnson et al. 1975). Documented spring arrival dates on the ANWR coastal plain and nearby are 22 May (1979 at Canning River Delta); 24 May (1914 at Demarcation Point and 1980 at Canning River Delta); 25 May (1914 at Humphrey Point); 26 May (1980 at Beaufor Lagoon); 28 May (1975 at Clarence River) and 1 June (1972 at both Firth and Babbage Rivers) (Martin and Moitoret 1981 J. Levison, unpubl. data and Johnson et al. 1975). Peak spring movement occurred on 5 June 1980 at Canning Delta, where about 2000 oldsquaw were estimated to have passed at the average rate of 30 birds/hour during systematic migration watches 2-8 1980 (Martin and Moitoret 1981). Oldsquaw were observed to use open river delta overflow waters as soon as they became available at the Canning Delta: 31 May 1979, 65 birds at Flaxman Lagoon; 1-4 June 1979, 15-30 birds at West Branch Flats; 29 May-5 June 1980, 35-60 birds at West Branch Flats (Martin and Moitoret 1981). Generally the spring movement of oldsquaw past Canning Delta was not as intense as the fall movement in 1980 (Fig. B-2). The spring movement past Oliktok was apparently more intense with 178.3 birds/hour seen in systematic migration watches from 2-10 June 1977 (Johnson and Richardson 1980). An appreciation for the spatial pattern of spring bird migration of which oldsquaw represent a major portion can be gained from examination of Johnson and Richardson's (1980) radar and visual data: the spring migration near and west of Oliktok appeared to be a "broad front" extending from 50-60 km inland on the coastal plain to 50-60 seaward of the coastline, while at Komakuk Beach, on the Yukon North Slope, the route appeared to be concentrated along the coastline. Additionally, within Simpson Lagoon in 1977, the breakdown of migrants was 15 birds/hour along the southern half of lagoon, 6.2 birds/hour long the northern half of the lagoon, and 3.4 birds/hour in the nearshore Beaufort Sea offshore of the barrier islands. The above data included 4,778 observed and 13,026 estimated oldsquaw passing Komakuk Beach in 1975 and 2,059 observed and 7,078 estimated oldsquaw passing Oliktok in 1977

The earliest observation of oldsquaw using tundra wetlands on ANWR is 7 June 1978 at the Okpilak Delta (Spindler 1978a). By 9 June 1979 and 10 June 1980 paired birds wre able to move onto open ponds and wet tundra beginning to melt free on the Canning Delta (Martin and Moitoret 1980). Probable initial food sources for oldsquaw arriving on tundra wetlands may be chironomid larvae which appeared active in shallow tundra ponds at the Canning Delta in early June 1979 and 1980 (Martin and Moitoret 1981). "Along Alaska's arctic coast, oldsquaws nest most frequently near shallow lakes, which characteristically freeze solid during winter" (Johnson et al. 1975). On such lakes, those birds find an abundant source of food in the form of euphyllopods, which appear to be an especially important food source of oldsquaw ducklings (Anderson 1973). Oldsquaw nests on the ANWR found to date have been widely scattered (Spindler 1978a and Martin and Moitoret 1981). However, Alison (1975) reported frequent nesting in small clusters or colonies elsewhere. Of the 16 nests found on ANWR during recent studies (12 at Canning Delta, Martin and Moitoret 1981, and 2 at Okpilak Delta, Spindler 1978a), 7 were in wet tundra with shallow <u>Crex</u> ponds 15-100 m away; 3 were in narrow penninsulas or islands within 2 m of water; 2 were in basin-complex wetlands; 3 were in barren ground near a river distributary; and 1 was on dry tundra near a lake. At Canning Delta minimum estimated nesting density was 0.40 nests/$km^2$ in 1979 and 0.45 nests/$km^2$ in 1980 (Martin and Moitoret 1981).

Egg-laying was estimated to have peaked during the last week of June and the first week of July at the Canning Delta, with the first broods seen on 18 July 1979 and 23 July 1980, however, some nests were still incubated as late as 28 July (Martin and Moitoret 1981). Nesting females lead their young to the nearest water after they hatch and dry (Johnson et al. 1975). The departure of oldsquaw from tundra habitats can be seen by the following temporal pattern in adult density observed at Canning Delta in 1979: 4.9 birds/$km^2$ in June, 4.0 in July, and 1.1 in August (Martin and Moitoret 1981). In 1979 adult oldsquaw densitites at Canning Delta were found to be higher than those at Storkerson Point, Meade River, and Island Lake, but equal to or lower than those at Square Lake, Singiluk and E. Long Lake (all NRP-A or Prudhoe Bay sites observed in 1978, 1979, or 1980) (Derksen et al. <u>in press</u>).

Shortly after mating and copulation occur, male oldsquaw vacate the tundra breeding areas and presumably go to nearby large deep-open lakes and coastal lagoons to molt (Taylor 1981, Martin and Moitoret 1981). The exodus of males occurs about 5 July, at which time an obvious westward migration along the lagoons and Beaufort coast is in progress (Spindler 1978a, Martin and Moitoret 1981). The occurence of a mid-summer molt migration and oldsquaw use of Beaufort Sea coastal waters are well documented (Gollop and Richardson 1974, Johnson and Richardson 1980), however, it is not known what portion of the birds molting in the ANWR lagoons are ones which bred on the ANWR coastal plain. The magnitude of movement from the east to west suggests that birds could be arriving from some distance to the east (M.A. Spindler, unpub. data, J. Levison, unpubl. data, Gollop and Davis 1975). Furthermore, we do not know whether bird use of individual lagoons involves a small or large degree of turnover of individual birds. Some data exist to indicate that large flocks of flightless molting oldsquaw have moved (swam) from one lagoon to another (Johnson and Richardson 1980, and S.R. Johnson, pers. comm.). If that is frequently the case, then lagoon use by oldsquaw should be conceptualized as a dynamic system in which the numbers of birds present and the individual birds present are not static. Moreover, data on the origin and destination of oldsquaw using ANWR lagoons, the extent of their residence time, turnover rates, and comparisons population levels amongst several differing lagoon types on ANWR and elsewhere along the Beaufort coast will be needed to elucidate the relative importance to continued population maintenance (statewide and international) of coastal lagoons on ANWR.

Our current knowledge of lagoon use by oldsquaw on ANWR is composed of periodic population estimates throughout the open water season from which seasonal abundance and spatial abundance patterns may be examined. An ecological process study, at Simpson Lagoon, 250 km to the west, in which oldsquaw and their invertebrate prey base were examined provides much of our knowledge of oldsquaw trophic relationships and molting biology (Johnson and Richardson 1980).

Along the Beaufort Sea coast the period of the male oldsquaw molt occurs about 15 July to 15 August, whereas, the period of the female molt occurs about 7 August through 18 August (Johnson and Richardson 1980). On ANWR coastal lagoons peak oldsquaw abundance was observed on 5 August 1978 (115 birds/km$^2$), 29 July 1979 (229 birds/km$^2$) and 20 August 1980 (191 birds/km$^2$) (Spindler 1981b). The maximum estimated oldsquaw numbers using ANWR lagoons and nearshore waters was estimated at 30-40,000 birds during these 3 years (Spindler 1981b). Examination of seasonal abundance curves for oldsquaw 1978-1981 indicate a gradual buildup of birds through July until a peak is reached in late July or early-mid August followed by a decline into mid-September (Fig. B-6).

In comparison to the ANWR lagoons, Johnson and Richardson (1981) found that the peak and average density of oldsquaw in Simpson Lagoon was 566 and 145 birds/km$^2$, respectively, with an estimated total population of 50,000 birds (in one lagoon) on 28-29 July 1977. The seasonal abundance curves of oldsquaw at Simpson Lagoon are similar to the ANWR coastal lagoon yet the populations there apprear to ephemerally denser.

An examination of aerial transect results at Simpson Lagoon and for transects east and west of Simpson Lagoon indicated great spatial differences in the concentration sites for oldsquaw, but that oldsquaw densities at Simpson averaged 20-30% higher than in areas to the east of Simpson Lagoon (Johnson and Richardson 1980). Indeed, spatial variation in concentration of oldsquaw was found to be the greatest source of sample variability on ANWR lagoon surveys (Spindler 1981b), much of which was probably bird response to varying wind, water surface, oceanographic, and perhaps planktonic conditions combined with greatly varying bird sightability conditions. Johnson and Richardson (1980) determined that 90% of all birds seen in aerial surveys at Simpson Lagoon were in the lee of the barrier island chain. After comparing oldsquaw distribution with prevailing wind patterns and invertebrate prey density patterns, results of Johnson and Richardson's (1980) study suggest "that the presence of protective (from wind, waves, ice) barrier islands and the availability of rich supplies of food in adjacent coastal lagoons at least partially account for the dense concentrations of molting (and feeding) oldsquaws in lagoon habitats".

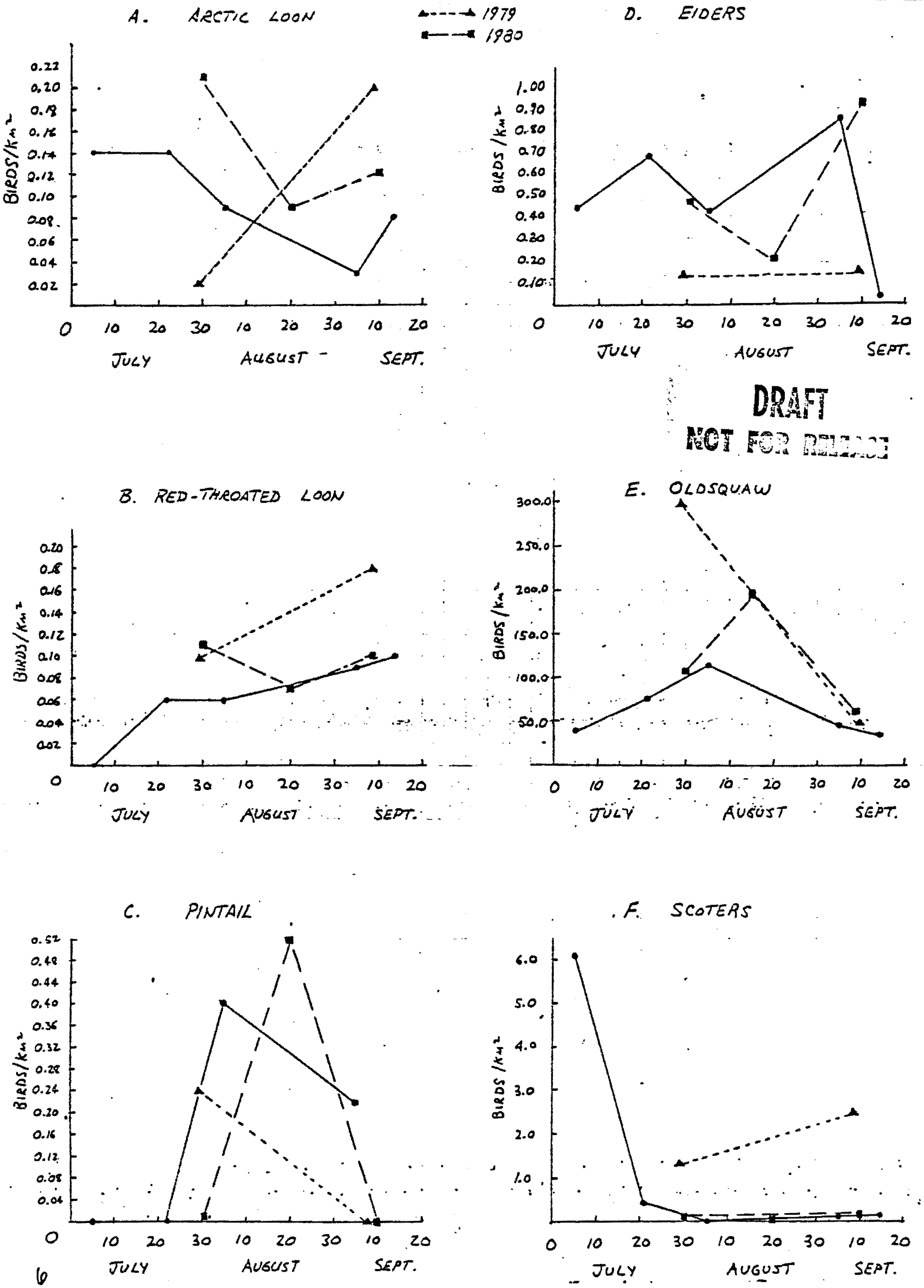

Figure B-~~2~~6.Seasonal abundance fo 6 key species (or species groups) in coastal lagoons of the Arctic National Wildlife Refuge, Alaska 1978-1980.

Johnson and Richardson (1980) determined that the epibenthic invertebrte species <u>Mysis relicta</u>, <u>M. littoralis</u> and <u>Onisimus lacialis</u> were the primary food items in the crop of collected oldsquaw at Simpson Lagoon, and determined that oldsquaw fed in areas where those invertebrates wre denser. Among the 19 lagoons studied 1978-1980, and 12 lagoons studied in 1981 on ANWR, aerial survey results indicated great differences in levels of molting and feeding oldsquaw use (Spindler 1981b) and (see section on lagoon bird use in this report) that could possibly be related to differing physical, oceanographic and planktonic properties. Preliminary studies in 1981 by ANWR staff will attempt to relate oldsquaw use levels in nine lagoons to levels of invertebrate prey abundance. However the data are not yet available for this report.

Oldsquaw also use large deep-open lakes on the tundra for molting (Derkson et al <u>in press,</u> Taylor 1981), and there is limited evidence from the Canning Delta to suggest that these inland lakes are used more frequently by females than by males (Martin and Moitoret 1981), however an opposite pattern was observed at Island Lake near Teshekpuk Lake (E.J. Taylor, pers. comm.). In addition to coastal lagoons and inland lakes, flightless molting oldsquaw have been observed as the most abundant species in nearshore Beaufort Sea aerial surveys from 0-400 m offshore of the barrier islands (Spindler 1981). Densities of oldsquaws seaward of the barrier islands have ranged from a low of 1.4 birds/km$^2$ on 14 September 1978 to a maximum of 42.6 birds/km$^2$ on 9-10 September 1980 (Spindler 1981b). Nearshore use by oldsquaws is generally very low in July and increases during August and September; variability between the extremely low value observed in September 1978 and the unusually high value observed in September 1980 is probably due to oldsquaw avoidance of offshore waters during high winds and rough seas (Spindler 1981b). Martin and Moitoret (1981) noted that in 1980 most oldsquaw sought protection inside the barrier islands while they were in the molt and that before and after the molt, most oldsquaw were seen outside the barrier islands at Brownlow Lagoon.

To summarize mid-summer oldsquaw use of ANWR lagoons and offshore waters extreme seasonality is apparent over which is superimposed a large degree of annual variability (46% coefficient of variation in mean population density over three years, 1978-1980) in terms of population levels and areas of concentrated bird use.

Fall migration along the ANWR coast is westward and quite intensive during the major movement, with a peak of 538 birds/hour determined from systematic migration watches at the Canning Delta in 1980 (Fig. B-2) (Martin and Moitoret 1981). The actual westward movement begins, as noted above, with the male molt migration in late June and early July, however, the levels of movement are many times greater during the fall migration period (Fig. B-2). Between 18 and 31 August 1979, 4,728 oldsquaw were observed flying west past the Canning Delta, with an estimated total of 20,800 birds migrating; for 1980 the migration watch on 18 August-6 September revealed an estimated 32,000 oldsquaw flying past the Canning Delta, but Martin and Moitoret (1980) caution that these figures represent only the earlier half of oldsquaw fall migration. By comparison, Johnson and Richardson (1980) counted 33,000 oldsquaw flying west past Pingok island 21 August-22 September 1988, and estimated that over 100,000 oldsquaw migrated through or past Simpson Lagoon. In 1978, they did not see nearly as many oldsquaw migrating west and warn that "oldsquaws do occur far offshore in the Beaufort Sea during late August and September (Searing et al. 1975, Divoky 1978a). Thus it is probably that a significant fraction of autumn migration is not near the coast" at Simpson Lagoon. Indeed Simpson (1976) estimated that 240,500 oldsquaw passed Barrow, migrating west 3-16 September 1975.

A significant observation on the nature of fall migrating oldsquaw was that "more than other waterfowl, oldsquaw were noticed using the (Canning Delta) study area rather than just flying past. Otfen 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" (Martin and Moitoret 1981). Johnson and Richardson (1980) noted "considerable turnover" of individual oldsquaw in Simpson Lagoon 22-23 September 1977-1979. If turnover is high during the molt and fall migration the consequences of the disruption or loss of productivity in a lagoon system are obvious -- because far more than the daily total of individuals in that particular lagoon may be affected. Oldsquaws have been seen utilizing ANWR lagoon and nearshore Beaufort Sea waters on aerial surveys as late a 20 September 1981 (see data in lagoon section of this report), and elsewhere along the Beaufort Sea Coast as late as 15 October at Prudhoe Bay (1978, Johnson and Richardson 1980), and 19 October (Bailey 1948).

Harlequin Duck - Rare summer visitor and possible breeder along rivers in northern foothills of Brooks Range and interior coastal plain of ANWR; casual visitor to arctic coast. Salter et al. (1980) observed the species in small numbers (less than 3) in coastal plain rivers, lakes, lagoons, and open ocean of the Yukon coast June, July, August 1972, August 1973, June 1975, and August 1976. They did not document breeding on the Yukon Territiories coastal plain, but found a brood 13 km to the south in the Brooks Range foothills. ANWR records include several pairs, or single males and females at Sadlerochit Springs on June 1978, 21 May 1979, 7 June 1979, and 12 June 1979. Only mostlymales were observed on 20 June 1979; females seen again on 18 and 19 July 1979 (M.A. Robus, unpubl. data). One specimen was collected near Barter Island 26 June (no year given, Gabrielson and Lincoln 1959). There are additional records in adjacent areas including one brood to the west at the Ivishak River on 6 August 1971 (Gavin 1971).

Steller's Eider - Rare breeder and summer resident on ANWR coastal barrier islands, lagoons, and shores of lagoons and large coastal lakes and wetlands. The regular breeding range of this species centers on the Siberian arctic coast and extends as far east as Point Barrow (Myres 1958). East of Barow the species decreases in abundance and regularity of breeding (Myres 1958, Watson and Divoky 1974, Gavin 1970 and 1972). The only documented occurrences on ANWR are several birds at Humphrey Point 13 June 1914, reported by Dixon (1943) who believed they nested in the area. Brooks (1915) saw only one Steller's eider (a female) at Demarcation Point in 1914. First arrival of the species is probably in the first to second week of June. At Storkerson Point, Bergman et al. (1977) reported arrival dates of 8 June 1971, 12 June 1972 and 7 June 1973.

Common Eider - Uncommon breeder on barrier islands, along lagoon shores, and in outer coastal plain tundra wetlands of ANWR; fairly common migrant and summer resident in coastal lagoon and nearshore waters of the Beaufort Sea off ANWR. Barry (1974) estimated that over one million eiders summer in the Beaufort Sea area, and that slightly less than half are common eiders.

In spring common eiders arrive from the west. On 11 June 1975 30.8 birds/hour were observed flying east past Komakuk Beach (Salter et al. 1980). The first spring observations at Canning Delta were on 27 May 1979 and on 31 May 1980 (Martin and Moitoret 1981). A flock of 50 were seen flying east past Simpson Cove on May 1, 1980 (M.A. Spindler, unpubl. data). The latter observation is unusually early for the ANWR coast considering that the main spring migration past Barrow is 10-15 May. It is also possible that common eiders occasionally winter in leads and polynias since they have been recorded at Banks Island as early as 10 April (1953). It is believed however, that the great majority winters in the Bering Sea and North Pacific (Johnson et al. 1975). Spring migration along the ANWR coast (and most of the Beaufort Sea coast from Harrison Bay to Mackenzie Bay) is relatively unspectacular, with seldom more than a few hundred eastbound migrants seen, a compared to the hundreds of thousands seen passing Barrow in mid-May (Johnson 1971) and Cape Dalhousie, N.W.T. late-May to mid-June (Barry 1974). Johnson et al. (1975) summarized what little information is available on offshore Beaufort Sea eider migration.

Following spring migration small numbers are seen on the tundra on the Okpilak Delta in mid-June 1978 (Spindler 1978b) and on open water in coastal lagoons and the Beaufort Sea near the Canning Delta in June 1979-80 (Martin and Moitoret 1981).

Nest initiation at the Canning Delta is generally in the last two weeks of June and the first few days of July (Martin and Moitoret 1981). A total of nine nests in 1979 and three nests in 1980 were found in a colony on the spit west of Brownlow Point. Divoky (1978) reported nests at the following locations in 1975 or 1976 (number of nests in parenthesis): Konganevik Point Island (8), Arey Island ("several"), Arey Spit (1), Bernard Spit (1), Jago Spit (4), Egaksrak Island (1), S. of Siku Entrance (6). Schmidt (1970) found 23 active nests on two reefs one mile south of Pingokraluk Point. Tundra nesting density in coastal flooded-Carex and basin-complex wetlands at the Okpilak Delta were estimated to be very low, at 0.04 nests/km$^2$ (Spindler 1978a). At the Canning Delta the first broods were seen 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 at the Canning Delta in 1980, despite intensive weekly shoreline surveys" (Martin and Moitoret 1981).

The earliest westerly migration non-breeding eiders is in mid-June: birds were observed flying both east and west past Komakuk Beach, Y.T. and Clarence Lagoon, Y.T. after mid-June and a generally westerly movement past Nunaluk Spit, Y.T. began on 10 July 1972 (Salter et al. 1980); small flocks seen flying west past Nuvagapak Point in late June (Schmidt 1970 and Anderson 1973). Martin and Moitoret (1981) noted extensive use by eiders, probably mostly male common eiders, in a developing shore lead between Flaxman Island and Brownlow Point: at least 500-800 birds were present 27-30 June 1979. As the shore-lead opened closer to Brownlow Point, 200 eiders were observed on 10 July 1979. Comparable use of the Brownlow Point area by eiders was not seen in 1980 by Martin and Moitoret (1981).

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In both 1979 and 1981 a major westward movement of eiders, of which "at least 90% " were male common eiders was noted past the Canning Delta from the end of July to the tenth of August. Peak movement was on 28 July 1980 when greater than 500 birds/hour were counted; in 1979 peak movement of 150 birds/hour was noted on 21 July (Martin and Moitoret 1981). By contrast Johnson and Richardson (1980) reported about 35 common eiders/hour migrating west past Pingok Island 20-25 July 1977, at which time 157 king eiders/hour were reported flying west. During the molt migration Johnson and Richardson (1980) determined that most of the eiders migrated along shoreleads and over lagoon ice before breakup, and over the lagoons and open sea north of the barrier islands after breakup. They estimated a total of 3,602 eiders (both king and common) passing through Simpson Lagoon during molt migration.

During the molt migration and fall migration eiders stop and rest in the coastal lagoons and neashore waters of ANWR (Spindler 1979, 1981b, Martin and Moitoret 1981). Eiders frequently cannot be identified to species in aerial surveys so estimates of eider density in lagoons must be lumped a "all eiders". In 1978 there were two peaks in eider use of lagoons 0.68 eiders/km$^2$ on 22 July and 0.85 eiders/km$^2$ on 5 August shown in (Fig. B-6,) (Spindler 1981b). Maximum eider density ever observed was 0.90 eiders/km$^2$ on 10 September 1980. The 1981 seasonal abundance pattern for eiders showed (insert data when available). At Simpson Lagoon eider denstities offshore in the Beaufort Sea peaked at 1.5 eiders/km$^2$ 28-29 July 1977 and along the south shore of the barrier islands they peaked at 1.6 eiders/km$^2$ 28-29 July 1979 (Johnson and Richardson 1980). There were no eiders seen in mid-lagoon 1977-1979, and denities along the mainland shore and mainland varied from 0-1.2 and 0-1.8 eiders/km$^2$ (Johnson and Richardson 1980).

Fall migration of common eiders is largely a movement of female and juvenile eiders, the majority of males have already moved out during the molt migration (Thompson and Person 1963). At Brownlow Point small numbers (about 10/hour for 74 hours of observation) migrated west 14-31 August 1979, most of which were females and juveniles (Martin and Moitoret 1981). Fewer total numbers of eiders were seen passing Brownlow Point 19 August to 1 September 1980, but a peak rate 45 eiders/hour was counted on 1 September. By comparison, Johnson and Richardson (1980) counted a peak rate of 47 birds/day 21 August-22 September 1977 and 135 birds/day in 1978 at Simpson Lagoon. The above low numbers, and the observations of Bartels (1973), Watson and Divoky (1974) and Divoky (1978a) seem to indicate a migration 13-16 km offshore in the Beaufort Sea which may not be detected by observers along the shore.

Johnson and Richardson (1980) saw eiders in Harrison Bay as late as 22-23 September 1977-1979, and common eiders were observed on lagoon and nearshore transects along the ANWR coast as late as 9-10 September 1980 (Spindler 1981b) and 20 September 1981 (Spindler unpubl. data).

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King Eider

Uncommon breeder and outer coastal plain wetlands and uncommon migratant along the ANWR Beaufort Sea coast. The center of abundance of King eiders in Alaska is near Point Barrow and eastward (Gabrielson and Lincoln 1959) and in Canada, is along the coasts of the Arctic Archipelago (Godfrey 1966). Barry (1974) estimated that about 700,000 King eiders migrate into and through the Beaufort Sea.

As with the common eider, the bulk of the eastward spring migration probably occurs in the Beaufort Sea offshore of ANWR (Johnson et al. 1975). King eiders first appear along the eastern Beaufort Sea coastal tundra during the first two weeks of June, however, data from Searing and Richardson (1975) suggest that they probably arrive in offshore leads and polynias around the third or fourth week of May. Martin and Moitoret (1981) reasoned that "since king eiders probably arrive in the Canadian arctic during the last two weeks of May the Alaska breeders must either wait in offshore leads for snow on 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, (Johnson and Richardson 1980), supporting the second hypothesis. Arrival dates for king eiders ANWR and nearby areas were 14 May in 1975 at Komakuk Beach, 15 May in 1914 at Humphrey Point, 1 June in 1979 and 4 June in 1980 at Canning Delta, 7 June in 1914 at Demarcation Bay and 7 June in 1978 at the Okpilak Delta (Johnson et al. 1975; Dixon 1943; Martin and Moitoret 1981; Brooks 1915 and Spindler 1978b). On the Canning Delta no eastward migration was detected, rather birds arrived and began using overflow water at the river delta and water in snow melt pools. Pairs became especially numerous 12-22 June on tundra at the Canning Delta, and males began to decrease on the tundra by the last week in June, disappearing entirely by the end of the first week in July (Martin and Moitoret 1981).

Limited data on nest initiation at the Canning Delta indicated that laying began during the second week of June 1979 and 1980 (Martin and Moitoret 1981). A total of 7 nests were found during the 2 years of study at the Canning Delta in sites ranging from wet tundra with pool nearby to mesic tundra with shallow-_Carex_ ponds and deep-_Arctophila_ portions of basin-complex wetlands. By comparison, king eiders were not found nesting east of the Okpilak at Beaufort Lagoon (Schmidt 1970), Demarcation Bay (R.M. Burgess, unpubl. data), or the Yukon North Slope (Salter et al. 1980). At Storkerson Point to the west of ANWR, they are more common nesters, in generally similar shallow-_Carex_ and deep-_Arctophila_ habitats (Bergman et al. 1977).

A molt migration was not evident past Canning Delta in either 1979 or 1980. However, a few males were seen flying west there on 1 August 1980 (Martin and Moitoret 1981). Johnson et al. (1975) reported that:

> It is probable that King eiders migrate offshore past the Mackenzie Delta (Martel in prep.); Brooks ( 1915) has recorded these birds migrating west past Demarcation Bay, during mid-July 1914, and Dixon (1943) saw them migrating past Humphrey Point on 13 July 1914. Schmidt (1970) saw flocks that consisted mostly of King eiders flying west past Beaufort lagoon as early as the last days of June and the first days of July. According to King (1970), Thompson and Person (1963) and Johnson (1971), the molt migration of King eiders past Point Barrow begins in the second week of July; at this time flocks consist primarily of males.

At Simpson Lagoon Johnson and Richardson (1980) noted a medium sized westward movement totalling 1,931 birds 1-31 July 1977 most of which moved through 21-25 July. No comparable movement of king eiders was noted near the shore there in 1978. About equal numbers, of common and king eiders were seen during the 1977 molt migration at Simpson Lagoon (1,910 and 1,931 respectively). At Canning Delta in 1979 and 1980, common eiders were by far in the majority during the molt migration period (Johnson and Richardson 1980; Martin and Moitoret 1981).

Since the fall migration of eiders along the ANWR coast consists mostly of females and juveniles, identification to species is usually impossible at distances greater than 20 meters, and during aerial surveys. Therefore, our knowledge of eider species composition during the fall migration is quite limited. From the definite observations of eiders made at the Canning Delta 1979 and 1980 it appeared as though king eiders were in the minority. Schmidt (1970) reported "a few small flocks" flying past Angun Point during late August and early September 1970. Johnson and Richardson (1980) counted only 5 King eiders during intensive fall migration watches at Simpson Lagoon. Most king eiders have left the coastal lagoons along ANWR by September (Spindler 1981b), however, individuals have been seen in Barrow coastal waters as late as 9 November and 2 December (Johnson et al. 1975).

## Spectacled Eider

Uncommon breeder in basin-complex wetlands on ANWR outer coastal plain. The species was observed arriving at the Canning Delta on 1 June 1979 and 5 June 1980 (Martin and Moitoret 1981), and at Demarcation Bay 12 June and 26 June (Gabrielson and Lincoln 1959). The nceter of abundance of breeding spectacled eiders on the North Slope of Alaska is thought to be near Cape Halkett or Cape Simpson (Johnson et al. 1975). On the ANWR Schmidt (1970) 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. Andersson (1973) reported breeding at Nuvagapuk Point. J. Levison (unpubl. data observed 2 birds off shore the Barrier Island at Beaufort Lagoon 24 July 1980.. Brooks (1915) collected 5 at Humphrey Point 12-26 June 1914. A pair and a group of 2 females and 1 male were seen in mid-June 1979 at Demarcation Point (R.M. Burgess, unpubl. data). Egg-laying is reported to commence on the North Slope during the second week in June (Andersson 1973; Gabrielson and Lincoln 1959). At the Canning Delta 3 broods were located in 1979, the first of which was seen 28 July; only 1 brood was found in 1980. Females with broods used shallow-Carex and deep-Arctophila wetlands (Martin and Moitoret 1981). Johnson et al. (1975) reported that spectacled eiders preferred coastal areas with shallow, muddy water. Departure of males from the Beaufort Sea nesting areas following the onset of incubation was reported by Gabrielson and Lincoln (1959). 3 males and 1 female at Angun Point on 1 September by Schmidt (1970) are the only fall records for the species on ANWR

## White-Winged Scoter

Uncommon migrant along Beaufort Sea coast of ANWR, possible breeder near lakes of interior coastal plain. The species is a common breeder in the upper Yukon and Porcupine Valleys (Johnson et al. 1975), an uncommon breeder near eastern Brooks Range lakes (M.A. Spindler unpubl. data), and is a migrant and summer resident in the coastal lagoons of ANWR.

White-winged scoters may arrive in the ANWR coastal region from the west, since eastward movements were noted past Nunaluk Spit and Clarence Lagoon, Y.T. in early June 1975 (Johnson et al. 1975), and past the Canning Delta in early June 1979-80 (Martin and Moitoret 1981). They also may arrive from the south, following rivers and passes through the Brooks Range and then eastward along the Beaufort Coast (Bent 1925). First arrival dates along the Beaufort coast near ANWR have been 1 June (1972, Firth River, 1979 Canning Delta); 5 June (1975 Babbage River, 1980 Canning Delta); 6 June (1975 Komakuk Beach); 8 June (1980 Beaufort Lagoon) 13 June (1914 Demarcation Point) (Johnson et al. 1975; J. Levison, unpubl. data. Martin and Moitoret 1981; and R.M. Burgess, unpubl. data).

Most late June and July observations of white-winged scoters are of birds resting in lagoons or flying west: In the Beaufort Lagoon area 6 flew northwest 17 June 1970 (Andersson 1973); single birds and a pair were at Angun Point July 1976 (P.D. Martin unpubl. data) and a group of 6 males and a group of 4 males were on Beaufort Lagoon 6 and 7 August, respectively. J. Levison (unpubl. data) observed groups of 2-72 from mid June through late August 1980 at Beaufort Lagoon. Spindler (1978a) saw 4 flying west on 1 July 1978 at the Okpilak River Delta. At the Canning River Delta Martin and Moitoret (1981) reported white-winged scoters resting or milling in the area with no definite migratory direction: "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 see 6-24 July flying along the barrier spits or in the lagoon or Beaufort Sea waters. The maximum number of white-winged scoters seen in coastal aerial surveys was 45 birds in the nearshore transects between Barter Island and Brownlow Point Demarcation Bay 12 July 1980. 4 birds were seen in Nuvagapak lagoon the same date and 3 birds were seen in lagoon transects 22 July 1978. Johnson and Richardson (1980) noted a westward molt migration of white-winged scoters that was not as extensive as that of surf scoters past Simpson Lagoon in July 1978. Johnson et al. (1975) stated that "there is little evidence that white-winged scoters actually molt along the Beaufort Sea coast" and that it is suspected the molt migration seen along the Beaufort occurs prior to their departure to molting areas farther south.

"White-winged scoters apparently leave the Beaufort Sea earlier than Surf Scoters..." possibly as early as mid-to-late August (Johnson et al. 1975). Since more westbound molt-migrants were seen passing Nunaluk Spit in June-July than returning eastward migrants in August, Johnson et al. (1975) and Gabrielson and Lincoln (1959) speculated that they may "fly directly south through the river passes in the Brooks Range and then to the Pacific coast via the Yukon river drainage." ANWR fall observations are inconclusive as regards direction of fall migration: three drakes flew west past Brownlow Point 20 August 1979; five drakes flew east past Brownlow Point 28 August 1979; and one hen flow west 29 August 1979. On 1 September 1980 a drake flow west past Brownlow Point (Martin and Moitoret 1980).

## Surf Scoter

Uncommon migrant and summer resident in ANWR coastal lagoons and nearshore waters. The major breeding areas of the species are in interior Yukon, the upper Yukon valley and the Bering Sea coast (Gabrielson and Lincoln 1959). Occurrence of the species along the ANWR Beaufort Sea coast is primarily post-breeding males and an unusual pre-molt migration that is in a direction opposite to their fall migration route (Johnson et al. 1975; Johnson and Richardson 1980). There is no positive documentation of this species breeding on the Yukon North Slope or eastern Alaskan north slope (Johnson et al. 1975).

Surf scoters usually first appear along ANWR coast mid-to-late June: At the Canning Delta "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" (Martin and Moitoret 1981). "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. P.D. Martin (unpubl. data) saw small numbers of surf scoters on four occasionas 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 (P.D. Martin unpubl. data)" (Martin and Moitoret 1981). A definite westward molt-migration of surf scoters was noted in early July 1980 at Canning Delta (Martin and Moitoret 1981), J. Levison (unpubl. data) counted 562 surf scoters flying west or using the lagoons near or at Nuagapak Lagoon during between 25 June and 4 July 1980. Johnson and Richardson (1980) noted 906 westbound and 22 eastbound surf scoters flying past Simpson Lagoon during July 1978. Heavy westward movement has been noted on the Yukon coast with over 6,200 estimated 10-25 July 1972 going west past Nunaluk Spit; surf scoters were classified as locally abundant in molting flocks in the Canadian Beaufort Sea especially near Herschel Island (Salter et al. 1980). The period of westerly movement at Clarence Lagoon and Komukuk Beach was 17 June-9 July (Salter et al. 1980).

Seasonal abundance of scoters (most of which are surf scoters) is given in Fig. B-2. Mid-summer densities of surf scoters in the ANWR coastal lagoons has been estimated at 0.30 birds/km$^2$ on 1-3 August 1980, 0.07 birds/km$^2$ 9 September 1980, 0.24 birds/km$^2$ 29 July 1979, and 0.31 birds/km$^2$ 22 July 1978, all in the transects just south of the barrier island chain. The only other transect on which the species was recorded at Simpson Lagoon was the mid-lagoon transect with a density of 0.70 birds/km$^2$ 15 and 25 July 1978.

Following the mid-summer molt period surf scoters are not observed returning eastward in the same large numbers which they are seen migrating westward prior to the molt... "These observations suggest that some surf scoters possibly migrated farther offshore and out of view of the observers stationed at Nunaluk Spit, Y.T., or that some birds of this species migrated south through passes in the Brooks Range (the same passes used during spring migration) and then down the Yukon River drainage." (Johnson et al. 1975). There is some evidence for eastward and southward migration, however, since "between 9 September and 10 October 1972, Salter 1974) specifically identified 35 surf scoters flying south up the Mackenzie Valley, N.W.T." (Johnson et al. 1980).

## Black Scoter

Uncommon migrant along Beaufort Sea coastal lagoons and nearshore waters of ANWR. The species nests mainly from the eastern Aleutians and Alaska Penninsula east through Interior Alaska to the Northwest Territories, northern Quebec, and Newfoundland (Johnson et al. 1975). Occurrence of the species on the eastern Alaskan north slope appears to be post-breeding shuffle and perhaps a westward molt migration. On the ANWR the species has been seen flying west past Brwonlow Point as a flock of 50 on 24 June 1980, and four males and a female on 29 August 1979 (Martin and Moitoret 1981). One Black scoter was also observed swimming in the sea among a group of white-winged scoters off Brwonlow Point (Martin and Moitoret 1981). A total of 200 Black scoters on 21 June and 70 on 28 June were seen flying past Demarcation point in 1979 (R.M. Burgess, unpubl. data). Black scoters may also frequent interior coastal plain lakes on ANWR: 3 males on 23 June and 1 female on 14 July were seen at the lake on the upper Hulahula River in 1980 (Spindler, unpubl. data ). Elsewhere along the arctic coastal plain near ANWR, Derksen et al. (in press) reported four flocks totalling 127 birds flying west past Point McIntyre near Prudhoe Bay 30 June 1976. On the Yukon Beaufort Sea coast observations included single males seen at Nunaluk Spit 11, 12 and 28 July 1972, a flock of four at Clarence Lagoon 21 June 1975 and a flock of 30 2 km north of Herschel Island on 26 June 1975 (Salter et al. 1980).

## Red-Breasted Merganser

Uncommon summer resident and breeder along foothills and interior coastal plain rivers; rare breeder and summer resident along outer coastal plain rivers; fairly common migrant along coastal lagoons and nearshore Beaufort Sea waters.

Initial spring migration routes into the Beaufort Sea area are uncertain at this time, however, Salter et al. (1974) suggested a possible migration dowh the Mackenzie Valley, thence westward along the coast. The earliest ANWR observations are 4 birds at Sadlerochit Springs 22 May 1978 (M.A. Robus unpubl data); one bird at Beaufort Lagoon 9 June 1980 (J. Levison, unpubl. data); a pair at the Canning Delta 16 June 1980 (Martin and Moitoret 1981); a single bird at Demarcation Point 22 June 1978 (R.M. Burgess, unpubl. data). Red-breasted mergansers were seen regularly along the Sadlerochit River, from the springs down to a point within 15 km of the coast (M.A. Robus unpubl. data). The species was seen regularly in late-June 1979 and 1980, and in July 1980 at the Canning Delta, including a maximum count of 10 in Brownlow Lagoon 10 July 1980 (Martin and Moitoret 1981).

Evidence of breeding on the coastal plain includes 3 birds accompanying a brood of 9 at Demarcation Point 7 August 1978; a female and a brood at Griffin Point 2 August 1914 (Dixon 1943); a brood on the Canning River interior coastal plain (Valkenburg et al. 1972); and a hen with 3 young on the Staines River at Canning Delta (Martin and Moitoret 1981). The nest sites are usually on the shore of a river or lake, concealed in brush or driftwood (Godfrey 1966).

There is some evidence for a predominantly westbound molt-migration; one such movement was noted past Nunaluk Spit, Y.T. 10 July-13 August 1972 (Gallop and Davis 1974b). Martin and Moitoret (1981) reported a late-August influx of mergansers on the Beaufort Sea and lagoon shores near Canning Delta; most birds appeared to be males; and evidence was obtained to indicate "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". The seasonal abundance curves for red-breasted merganser indicate increasing abundances in coastal lagoons starting in late-July and reaching a peak of 0.70 birds/km$^2$ on 5 September 1978. and a peak of 0.18 birds/km$^2$ on 20 August 1980 (Fig. B-7).

## Goshawk

Rare summer visitor to ANWR foothills and coastal plain. One adult was seen at Sadlerochit Springs 20 May 1979 (M.A. Robus unpubl. data). The species occurred as an uncommon summer resident at Mancha Creek at the northerly limit of tree growth in ANWR, and it is not unlikely that individuals would occasionally venture out onto the North Slope. Irving (1960) reported several goshawks at Anaktuvuk Pass, several km beyond tree-line 1954-1956, and speculated that they may have wandered out onto the tundra because ptarmigan were abundant then.

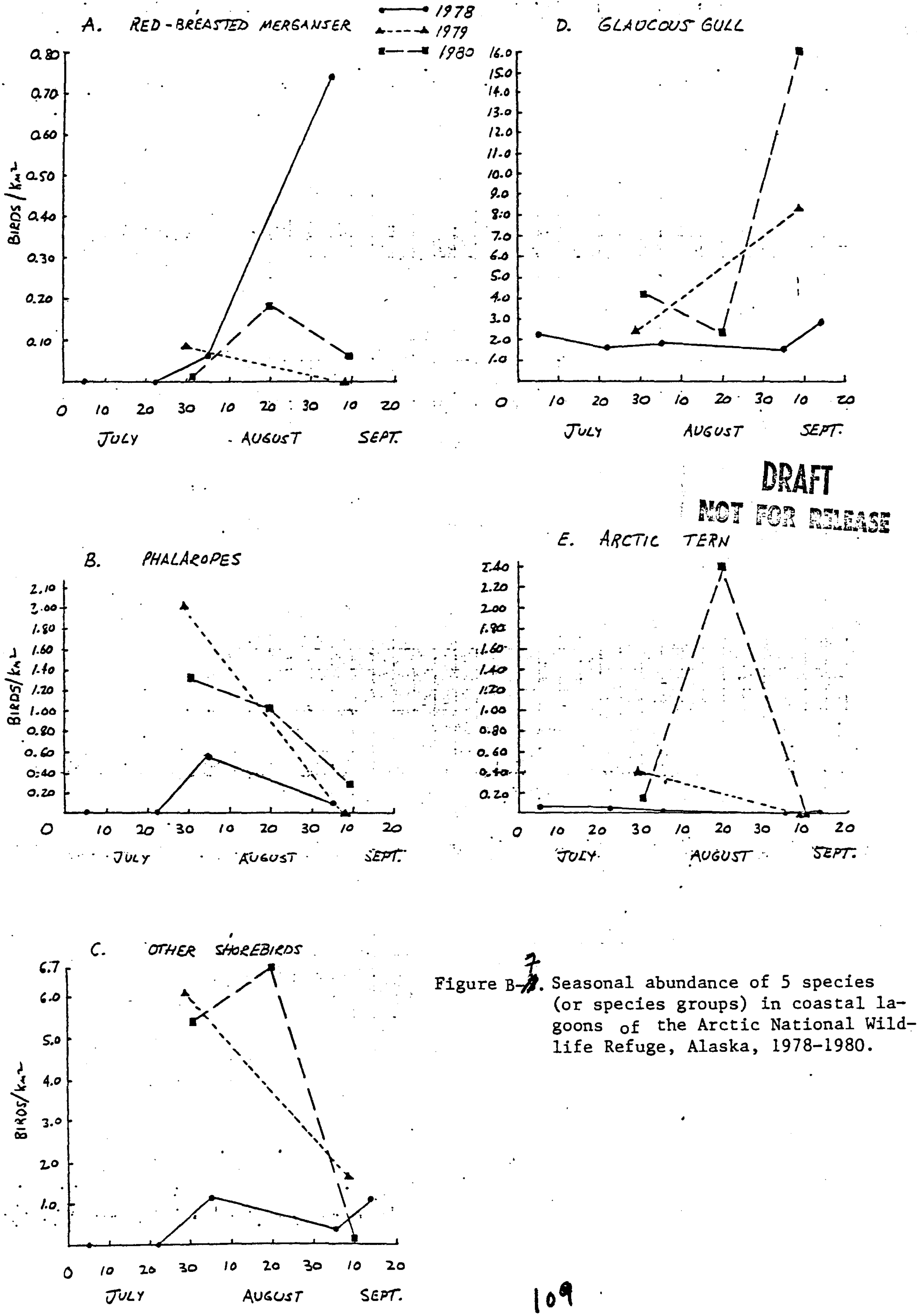

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Figure B-7. Seasonal abundance of 5 species (or species groups) in coastal lagoons of the Arctic National Wildlife Refuge, Alaska, 1978-1980.

## Rough-Legged Hawk

Uncommon summer resident and breeder in ANWR interior coastal plain along river bluffs and near steep foothill slopes; rare visitant to outer coastal plain.

The main breeding range of the species in northern Alaska consists of the Brooks Range north of the continental divide, the foothills, and portions of the interior arctic coastal plain, as well as the Seward Pennınsula (Roseneau 1974). Rough-legged hawks arrive at their breeding grounds west of ANWR in NPRA from 21 April to 7 May (NPR-A Task Force 1978). Migration routes are apparently across the interior and through Brooks Range Passes. Irving (1960) reported northward migration through Anaktuvuk Pass 5-19 May 1949-1952, and Spindler (unpubl. data) has observed rough-legged hawks in migration through the Hulahula River pass in ANWR.

The earliest records on the ANWR coastal plain are one adult seen 14, 18 and 20 May 1979 at Demarcation Point (R.M. Burgess, unpubl. data). Spindler (1978a) observed two adults on the Okpilak Delta on 4 June 1980. One individual was seen at the Canning Delta on 9 June 1980 (Martin and Moitoret 1981). Most ANWR coastal plain records are for early summer, however, Andersson (1973) and Martin (unpubl. data) observed rough-legged hawks at Beaufort Lagoon in July. Presence of rough-legged hawks on the coastal plain can vary considerably between years; P.D. Martin (unpubl. data) noted four sightings in the Beaufort Lagoon vicinity July 1976, but none for the same month in 1974. a difference that he felt was caused by an abundance of lemmings in the area in 1976. Nesting areas on the ANWR coastal plain and foothills were documented by Roseneau (1974, and see Map B-5 "the species has commonly nested in the Canning drainage, the Shublik and Sadlerochit Mountain areas and along the northern edge of the Brooks Range between the Jago River and the Alaskan border. Some nesting has occurred along the high dirt/rock bluffs of the Katakturuk River and Marsh Creek drainages north of the Sadlerochit Mountains and some may occur along the upper Tamayariak and lower Carter Creek drainages. The upper Echooka River, upper Juniper Creek and upper Kavik River drainages also offer relatively good nesting habitat for ths species, as does the Kongakut River valley south of about 69 25'N [where search effort has been restricted by logistical considerations])." M.A. Robus (unpubl. data) found one nest at Sadlerochit Springs and a probable nest about 2.4-3.2 km west-northwest of the springs, where a pair of adults acted defensively 16-18 June 1979. Roseneau 1974) and Roseaneau et al. (1980) reported a rough-legged hawk nest on the bluffs near the 300 m contour line along the Katakturuk River in 1973. 16-18 June 1979 intensive surveys in the ANWR north of the continental divide in 1973 indicated about 20 active nests (Roseneau 1974) 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.) White (cited in Roseneau 1974) reported no nesting rough-legged hawks in the Canning drainage in 1971. Roseneau (1974) reported several pairs nesting there in 1972 and 1973 and Roseneau et al. (1980) found two nests in the Canning near Mt. Coppleston in August 1980. The variation in population could have been caused by changing microtine population levels (White cited in Roseneau 1974). Preferred nesting habitat includes cliffs along river courses, some drier upland outcrops

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away from river (NPR-A Task Force 1978) and occasionally less stable mud-bluffs along rivers (Roseneau 1974). Rough-legged hawks appear to favor the lowest average nesting elevations of the large cliff-nesting species (362 m, Roseneau 1974).

The NPR-A Task Force (1978) reported the range of nesting dates as 15 May-21 July, brood rearing dates as 15 June to 21 August, and fledging dates as 31 July- 30 August (Table B-5). The recommended mangement of rough-legged hawk habitat and other cliff-nesting raptor habitat to consist of eliminating or minimizing disturbances during the critical nesting times given above and in Table B-5 (NPR-A Task Force 1978).

There is apparently a southward fall migration through Anaktuvuk Pass, but Irving (1960) gives no dates, and comments that the southward movement is not as conspicuous as the northward movement.

## Golden Eagle

Uncommon summer resident and probable rare breeder in interior coastal plain; uncommon summer visitant to outer coastal plain.

Golden eagles are one of the more abundant cliff-nesting raptors in the Brooks Range of ANWR (Roseneau 1974; Spindler 1979), however, their occurrence on the coastal plain is largely of hunting individuals and individuals feeding on carrion. M.A. Robus (unpubl data) observed one at Sadlerochit Springs 14 June 1979,and two immatures there on 23 June 1979. Magoun and Robus (1977) observed an immature at Sadlerochit Springs 17 July 1977 and another immature accompanied by an adult on 14 August 1977. Spindler (1978a) observed one immature bird on 15 June 1978 "soaring above the Okpilak River, 14 km inland from the coast. One immature was observed buzzing and swooping over two caribou calves along the Okpilak River 26 km inland on June 16. Another immature bird was observed 10 km inland along the Okpilak on June 17." Golden eagles were also observed at Demarcation Point in 1978 and 1979 (R.M. Burgess unpubl. data). A golden eagle was observed at Beaufort Lagoon 29 June 1980 at Pokok Bay 17 July 1980 (Levison, unpubl. data), and one was observed at Oruktalik Lagoon 5 August 1981 (Spindler, unpubl. data). The preponderance of immatures using the coastal plain can be seen in the above observations, and in those of Roseneau (1974). He reported 33 of 35 birds to be immatures along the Tamayariak and Egaksrak Rivers, and 16 of 22 to be immatures elsewhere on the coastal plain 2-14 July 1973.

On the ANWR coastal plain, nesting sites are known for the bluffs near the 300 m contour line along the Katakturuk River (Roseneau 1974; Roseneau et al. 1980). Adjacent to ANWR, nesting has been reported in suitable river cliff terrain on the Yukon coastal plain (Salter et al. 1980) and in NPR-A (NPR-A Task Force 1978).

Table ~~B-4.~~ B-5 General chronology of raptor nesting on the North Slope of Alaska. Dates given are approximate for each species and in some cases are estimated. Data from NPR-A Task Force (1978).

| Species | Arrival | Nesting | Brood Rearing | Fledging |
|---|---|---|---|---|
| Peregrine | 4/21 to 5/7 | 5/15 to 7/21 | 6/15 to 8/21 | 7/31 to 8/30 |
| Gyrfalcon | Resident | 4/1 to 6/30 | 5/1 to 8/15 | 6/21 to 8/15 |
| Rough-legged hawk | 4/21 to 5/7 | 5/15 to 7/21 | 6/15 to 8/21 | 7/31 to 8/30 |
| Golden Eagle | 4/1 to 4/15 | 5/1 to 6/30 | 6/7 to 8/30 | |
| Snowy owl | | 5/15 to 6/7 | 6/21 to 8/4 | 8/15 on |
| Short-eared owl | | 6/7 to 7/7 | 7/7 to 8/21 | 8/15 on |

## Marsh Hawk (northern Harrier)

Rare summer visitant to the ANWR coastal plain. The species undoubtedly breeds in interior Alaska (Gabrielson and Lincoln 1959), is an uncommon visitor in forested and open habitats in the eastern Brooks Range (Roseneau 1974; Spindler 1979) and is a probable breeder in the Old Crow area (Irving 1960).

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 Alaska arctic coastal plain is slight; a defensive pair was observed at the Sagavanirktok/Lupine River area on 31 July 1975 (Kessel and Gibson 1978). Salter et al. (1980) termed this species an "uncommon visitor" to the Yukon arctic coastal plain and reported no nesting.

On ANWR coastal plain the Marsh hawk appears to be an infrequent spring visitor 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, unpubl. data). J. Levison (unpubl. data) observed one bird at Beaufort Lagoon on 5 June 1980; 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 Sadlerochit Springs 22 May 1979 and on 27 May 1979 two were seen between 16 km Sadlerochit River and Sadlerochit Springs (M.A. Robus unpubl. data). At the Canning River Delta 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 (Martin and Moitoret 1981).

## Gyrfalcon

Uncommon permanent resident breeding in cliff, outcrops and river bluff terrain in interior coastal plain; uncommon visitor to outer coastal plain.

Irving (1960), Roseneau (1972), and Salter et al. (1980) reported that at least the adults winter near their nest site if prey abundance permits; immatures frequently migrate south into the taiga for their first winter, and adults may leave the nesting area for the winter if prey is scarce.

In 1972-1973 Roseneau (1974) reported 12 active eyries in the ANWR north of the continental divide near the following locations: Red Hill near the Canning, Sadlerochit Springs and other areas in the Sadlerochit Mountains, the eastern Shubelik Mountains, the Canning drainage south of Cache Creek, the Jago River eastward to the Alaska-Canada border (and extending into Canada along the northern edge of the British Mountains), and the interior coastal plain and foothill bluffs such as VABM Atte, Hula, Nob, Gwen, and Dar. Favorable nesting habitat for Gyrfalcons is outlined on Fig B-8.

Snow (1974) summarized the characteristics of gyrfalcon nesting habitat as cliffs or bluffs in treeless terrain frequently between 610-1220 m elevation; often the egg is laid on a ledge of platform protected from snow accumulation by an overhanging projection of rock. Cade (1960) found the average height above ground for Alaska gyrfalcon nests to be 29 m (range 8-91 m) the average distance below the brink of the cliff 13 m (0-61 m), and the distance above the base of the vertical face 15 m (range 2-61 m). Roseneau (1974) found that gyrfalcon eyries had the highest average elevation of the large cliff-nesting raptors in northeast Alaska.

Gyrfalcons probably nest earlier than any other species on the ANWR coastal plain; at NPR-A the reported range of nesting dates was 1 April to 30 June, brood rearing dates were 1 May to 15 August, and fledging dates were 21 June to 15 August, (NPR-A Task Force 1978, and Table B-5).

By comparison to the 12 eyries found in ANWR north of the divide in 1973, in NPR-A there were 17 active eyries in 1977 (NPR-A TAsk Force 1978). The Yukon North Slope had 22 total nest sites of which 10 were known active sites in 1973, 4 were active sites in 1974, 2 were active sites in 1975 and 6 were active sites in 1976 (Salter et al. 1980).

On the outer coastal plain most of the observations are apparently hunting or migrating birds. R.M. Burgess (unpubl. data) observed one bird on 15 May 1979 and one on 30 August 1979 at Demarcation Point. Near Pokok Lagoon Andersson (1973) observed one gyrfalcon flying northwest on 2 July 1970.

At the Canning Delta Martin and Moitoret (1981) observed one bird on 8 August 1979. In 1980 they observed single birds on eight dates in the period 2 August - 5 September 1980. It was impossible for them to determine whether they were different birds or not. Their observations suggested that one bird was using the area -- it was seen perched and hunting over the West Branch Flats. On the interior coastal plain along the Sadlerochit River, M.A. Robus (unpubl. data) observed a gyrfalcon on 25 May, 9 June and 19 June. During the period 31 August - 2 September 1979, 3-4 immature gyrfalcons were observed in aerial play about 10 km upstream on the Sadlerochit River (M.A. Robus unpubl. data).

Salter et al. (1980) reported numerous observations along the Yukon coast 22 August - 29 September 1973, and thought the birds may have been following the fall shorebird and waterfowl migration.

## Peregrine Falcon

Rare summer resident and possible breeder in cliff and river bluff terrain of interior coastal plain and foothills; uncommon fall migrant over coastal tundra and lagoons of outer coastal plain.

Because of its endangered species status (Endangered Species Act of 1973, 16 U.S.C. 1531-1543) the populations and productivity of the arctic subspecies of Peregrine Falcon (Falco peregrinus tundrius) nesting on the North Slope of Alaska west of the ANWR are well documented and monitored annually to biannually (Roseneau and Bente 1980, Roseneau et al. 1976; NPR-A Task Force 1978). An estimated 12 nest sites were occupied and 9 nests were found in NPR-A in 1977; occupancy and nesting populations were determined to be increasing, while productivity was found to be extremely low (NPR-A Task Force 1978). Haugh (1976) estimated a total Alaska North Slope population of 100 nesting pairs for recent years, 1950-1970.

Peregrine falcons in NPR-A arrive at the nest sites 21 April to 7 May; nesting occurs 15 May to 21 July; brood-rearing is from 15 June to 21 August, and fledging occurs 31 July to 30 August (NPR-A Task Force 1978 and Table B-5). Fall migration occurs late August through mid-September (Martin and Moitoret 1981 and J. Levinson, unpubl. data). Routes of migration into and out from the nesting areas are thought to occur both through Brooks Range, and along the Beaufort Sea coast. (D.R. Roseneau pers. comm.).

The current status of arctic peregrine falcons on the North Slope of ANWR is more uncertain because 1972-1973 survey efforts identified three active nests with over 20 formerly occupied sites (Roseneau 1974; Roseneau et al. 1976), and 1980 surveys found no nesting activity (Roseneau et al. 1980). The latter study hypothesized that the decline in peregrine nesting activity on the ANWR North Slope may have been due to the generally poor habitat and limited extent of good habitat and/or unfavorable nesting conditions in the region as a whole which also affected the success of other raptor species nesting in the area (Roseneau et al. 1980). Roseneau (1974) identified known historical peregrine nest sites in ANWR up through 1973, and Roseneau et al. (1980) evaluated these sites in terms of previous known use and habitat suitability (Table B-6). Reasons given for recent declines in arctic peregrine falcon numbers in Alaska in general have been largely extrinsic: high pesticide residue levels in migratory prey species summering in Alaska but wintering elsewhere in developing nations ouside of N. America, combined with high pesticide levels in prey species on the wintering ground (NPR-A Task Force 1978).

Characteristics of nesting habitat have been described as "large relatively stable bedrock cliffs" along rivers (e.g. the upper Colville River) as well as "unstable earthern bluffs" along rivers (e.g. the Sagwon Bluffs) (NPR-A Task Force 1978, and P.J. Bente pers. comm.).

Observations of non-nesting peregrine falcons in the ANWR study area are frequent. Most of the observations are in late summer, however, there are a few earlier ones: at Canning Delta on June 2, 1980 1 bird flew east across the spit at Brownlow Point; one adult landed briefly on a lake shore on 17 June 1980; one flew west across the West Branch flats 21 June 1980; and one bird was startled from below a river bluff at the West Branch 22 July 1979 (Martin and Moitoret 1981). At Sadlerochit Springs a pair was observed in early June, and on 10 July an adult female was seen sitting on a grass tussock 2.5 km inland from the west end of Pokok Bay (Roseneau 1974). August and September observations on the coastal plain of ANWR are much more numerous and predictable. In 1979 at Demarcation Point R.M. Burgess (unpubl. data) observed one immature on 20 August, one adult on 21 August and 25 August, and 3 adults on 26 August. On 28 August 1979 M.A. Robus (unpubl. data) observed one pair at Sadlerochit Springs, and on 31 August a pair was observed 10 km inland along the Sadlerochit River. Martin and Moitoret (1981) reported from the Canning Delta: "An adult was seen 1 August 1979 flying along the bluffs on the east side of Flaxman Lagoon. An immature feamle was seen three times near Brownlow Point 19 August 1979 and a similarly plomaged individual (or individuals) was seen 28, 29 and 30 August at or near Brownlow Point; one was flying

Table ~~3-5~~ ~~B-5~~ B-6 An evaluation of Arctic Slope river drainages in northeastern Alaska with regard to potential and known peregrine nesting habitat found in them. (Source: Roseneau et al. 1980).

| River drainage | Habitat classification[1] | Number of confirmed or reported nesting locations | Potential habitat (if present) |
|---|---|---|---|
| Ivishak | 2-3 | -- | -- |
| Echooka | 2-3 | -- | -- |
| Kadleroshilik | 1 | -- | -- |
| Shaviovik | 2-3 | -- | Small portions of mid and upper Juniper Creek. |
| Kavik | 2 | 1 reported[2] | Small portion of headwaters and 69°29' N. Upper drainage, primarily between 69 21' and 69°00' N below 762 m asl. Best locations are generally at tributary valley entrances. |
| Tamayariak | 2 | -- | -- |
| Katakturuk | 2-3 | 1 reported[2] | Upper drainage - primarily the west fork between 244 and 610 m contour lines. |
| Marsh Creek | 2-3 | -- | Upper main drainage between 305 and 610 contour lines. |
| Carter Creek | 2 | -- | Lower 4.8 - 6.4 km. |

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? ~~Table~~ ~~Appendix I~~ (continued)

Table - B-6

| River drainage | Habitat classification[1] | Number of confirmed or reported nesting locations | Potential habitat (if present) |
|---|---|---|---|
| Sadlerochit | 4-5 | 1 confirmed[4] | Between 274 and 762 m contour lines, but centered in upper reaches and Sadlerochit Springs area. |
| Hulahula | 2-3 | 1 reported[5] | Kingak Hill vicinity or Kikiktat Mountain vicinity. |
| Okpilak | 2 | -- | -- |
| Jago | 2-3 | 2 reported[6] | VABM Bitty vicinity<br>Marie Mountain vicinity |
| Aichilik | 3-4 | 2 reported[2] | Primarily between 69°29' and 69°20' N. |
| Egaksrak | 3-4 | -- | Primarily between 69°35' and 69°25' N. |
| Ekaluakat | 2-3 | -- | Headwaters area |
| Siksikpalak | 1 | -- | -- |
| Kongakut | 5-6 | 3 reported[2] | Primarily between 69°34' and 69°00' N. |
| Clarence (Alaskan portion) | 2-3 | -- | Between 69°29' N and U.S.-Canad~~ian~~a Border. |

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7 Table ~~Appendix 7~~ (continued)

1 Habitat was classified on a scale of 1-10: 1-very poor, 5-6=fair, 10=excellent. Classifications were made on the basis of the total drainage. Even though a drainage may have a few potential nesting locaions, its overall rating may be quite low.

2 Peregrines were said to have nested at one location on the Kavik River in 1947; at two locations on the Canning River downstream of about 69°18' N in 1963, and at one location downstream of about 69°18' N in 1947; at one location on the Katakturuk River in 1963 and 1966; at two locations, simultaneously, on the Aichilik River in 1966 and 1969; and at three locatons, simultaneoulsy, on the Kongakut River in 1966 (M.D. Mangus personal communication to C.M. White 1975, memorandum C.M. White to T.J. Cade and D.~~R~~G. Roseneau 1 November 1975).

3 Roseneau (1974)

4 Cade (1960) found a pair with 4 eggs at about the 670 m level in a headwater tributary on 4 June 1959. We have never been able to relocate that nest site. The site was definitely well upstream of the Sadlerochit Springs area (Cade personal communication 1976). We suspect the area may include a series of escarpments between Snow and Gravel Creeks. No raptors were observed there in 1972-1975 (Roseneau 1974; Roseneau et al. 1976).

5 A nesting pair was reported present in 1975 (W. Mills personal communication 1975).

6 T.J. Cade received a report of two nesting pairs from J. Drew in 1957 (Cade personal communication 1976).

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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 August-September 1980 Levison (unpubl. data) reported a fall movement of peregrines past Beaufort Lagoon and Pingokruluk Point; 14 definite peregrine falcons, including 7 immature birds, plus 10 falcon spp. were observed 18 August-3 September (Table B-7) Salter et al. (1980) observed a fall movement of several birds along the Yukon Beaufort Sea coast, the latest of which was a Shingle Point 17 Sept..

In aggregate, these August-September sightings suggest an easterly coastal movement of peregrine falcons. 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. Roseneau (unpublished) hypothesized that such a coastal migration corrigor would be important for peregrines because it may provde a prey base consisting of fall migrating shorebirds and waterfowl.

## Merlin

Very rare spring and summer visitant to the outer coastal plain; possible rare breeder in interior coastal plain and foothills.

Merlins nest along the Kongakut River in the Brooks Range, near and upstream from Mt. Greenough (Spindler unpubl. data; P.D. Martin unpubl. data). They are also reported to be probable nesters on the south slope of the eastern Brooks Range (Roseneau 1974), and the Central Brooks Range (Irving 1960). Reynolds (cited in Roseneau 1974) observed a merlin in the upper Canning drainage. Irving (1960) thought they bred in the Anaktuvuk Pass area.

Occurrence on the ANWR coastal plain has been documented three times. P.D. Martin (unpubl. data) observed one bird near Nuvagapak Point 11 July 1976; M.A. Spindler (unpubl. data) observed an adult perched on DEW line buildings at Beaufort Lagoon 23 May 1978, and one individual was reported by R.M. Burgess (unpubl. data) at Demarcation point in 1978. On the Yukon coastal plain Salter et al. (1980) reported an individual at Phillips Bay 28 May 1972, and four records at Shingle Point 21 August-15 September 1973.

## Kestrel

Casual summer visitor to ANWR coastal plain. The species nests in low numbers south of the continental divide in the Brooks Range (Spindler 1979). It has been documented on the ANWR coastal plain on three occasions: one was seen at Demarcation Point on ___?___ 1978 (R.M. Burgess unpubl. data), one was seen at Beaufort Lagoon in late May 1980 (J. Levinson unpubl data), and a male was seen at Brownlow Point 27 May 1980 using the DEW-line buildings as shelter and feeding on snow buntings (Martin and Moitoret 1981). On the Yukon North Slope a female was seen near the foothills 4 May 1974 (Salter et al. 1980).

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Table ~~B-6~~ B-7 Peregrine falcon and falcon sp. observations made during migration watches at Beaufort Lagoon and Pingokraluk Point, 15 August-4 September 1980, (Source: ~~By~~ J. Levison and D. Blomstrom, unpubl. data).

| Date | Number/identity | activity | location |
|---|---|---|---|
| 18 August | 1 Falcon spp., hunting over tundra, Egaksrak Lagoon | | |
| 20 August | 1 Peregrine Falcon, adult, Flying near Arey Island. | | |
| 23 August | 1 Peregrine Falcon, imm., flying S over Beaufort Lagoon DEW | | |
| 24 August | 3 Falcon spp., flying past Beaufort Lagoon DEW | | |
| | 2 Peregrine Falcon, imm., flying past Beufort Lagoon DEW seemed like hunting in area for few hours then flying S. | | |
| | 2 Falcon spp., flying SE past Beaufort Lagoon DEW | | |
| | 1 Peregrine Falcon, flying E past Beaufort Lagoon DEW. | | |
| 25 August | 1 Peregrine falcon, imm, hunting over tundra near Beaufort Lagoon DEW. | | |
| 26 August | Between noon and 6 p.m. Pingokraluk Pt. | | |
| | 1 Peregrine Falcon, adult, flying (direction unspecified) | | |
| | 1 Peregrine Falcon, imm., flying NW | | |
| 27 August | 1 Peregrine Falcon, imm., Beaufort Lagoon DEW | | |
| | 1 Peregrine Falcon, ad., flying west Beaufort Lagoon DEW | | |
| 28 August | 1 Peregrine Falcon, ad., Hunting snow bunting at Beaufort Lagoon DEW | | |
| | 1 Falcon spp., Flying E along Siku Lagoon | | |
| 29 August | 1 Peregrine Falcon, adult, hunting near Pingokraluk Put. direction unspec. | | |
| 30 August | 1 Falcon spp., migrating by Pingokraluk Pt. direction unspec. | | |
| 31 August | 1 Peregrine Falcon, imm., by Pingokraluk Pt. direction unspec. | | |
| 1 September | 1 Peregrine Falcon, by Pingokraluk Pt. direction unspec. | | |
| | 1 Falcon spp., by Pingokraluk Pt. direction unspec. | | |
| 3 September | 1 Falcon spp. hunting over tundra Pingokraluk Pt. | | |

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## Willow Ptarmigan

A common resident and breeder in tall riparian willow habitats along rivers of interior coastal plain; uncommon resident and breeder in sedge-tussock heath and dwarf shrub tundra of outer coastal plain, decreaseing in abundance northward in proximity to coast where dwarf shrubs become scarce.

Willow ptarmigan winter as far north as the north side of the Brooks Range, however, at this currently known northerly limit of wintering in ANWR they are uncommon (Spindler unpubl. data). In April and mid-May a general northward migraiton of willow ptarmigan has been observed through ANWR, with obvious flocks of several thousand seen predictably each May flying from the Brooks Range north toward the coastal plain (Spindler unpubl. data). Irving (1960), summarizing Eskimo reports and his own observations from Anaktuvuk Pass, found that the northward movement began in February and lasted until late May and that there were two "waves", one before the end of March and the other after the end of March.

Willow ptarmigan were present on the interior coastal plain near the Sadlerochit River on 11 May 1979 (M.A. Robus, unpubl data). There were first seen at Demarcation Point on 19 May 1979, although unidentified ptarmigan were seen there as early as 12 May 1979 (R.M. Burgess unpubl. data). At the Canning Delta Martin and Moitoret (1981) recorded the first male on 30 May 1979, and displaying males on 13 and 22 June 1979. In 1980 single males, pairs or small groups were seen on numerous occasions 27 May through 20 July, with most observations in late May and early June (Martin and Moitoret 1981). Spindler (1978a) found willow ptarmigan present on his arrival to the Okpilak River study area 30 May 1978; the species was observed most frequently inland along the Okpilak River, where several males were seen displaying on 16 June 1978. The observations of Martin and Moitoret (1981) and Brooks 91915) suggest that some willow ptarmigan may appear in the coastal areas earliest because wind-swept bluffs may initially provide easier forage than the low-lying wind-drifted riparian willow thickets of the interior coastal plain. In 1977 Magown and Robus (1977) found willow ptarmigan to be more numerous than rock ptarmigan on Niguanak Ridge 8-9 June, along the Sadlerochit River 19 July, and along the Katakturuk River 26 July. AT the Okpilak Delta, Spindler (1978) found willow ptarmigan most common on an upland sedge tussock census plot with numerous patches of dwarf birch (4.0 birds/km$^2$, 2.0 nests/km$^2$); the species did not occur in quantifiable abundance on other plots there. In an adjacent area, in 1978 Derkson et al. (in press) found willow ptarmigan more common than rock ptarmigan at one interior coastal plain site (Meade River) and two near foothills sites (Singiluk and Square Lake) in NPR-A. Similarly, Salter et al. (1980) found willow ptarmigan the more common ptarmigan species at 3 sites on the Yukon north slope in 1972 and 1973, estimating territory densities of 9.5, 12.7, and 11.8 territories/km$^2$. At some localities with the areas listed above, and some additional ones, willow ptarmigan were less common than rock ptramigan. Such spatial differences in species abundance could be fluctuations in population levels (Weeden 1964).

Salter et al. 1980) noted that for breeding habitat on the north slope willow ptarmigan preferred flat tussock-heath tundra with small patches of dwarf shrub or tall shrub if available; these findings were corroborated by Spindler (1978).

In late August 1979 Martin and Moitoret (1981) noted flocking of this species at the Canning Delta. Such behavior was not noted there in 1980, but could be a prelude to fall migration. Intense flocking (several hundred) was observed in low willow thickets along the Kavik River on the interior coastal plain west of ANWR, 10 August 1981 (Spindler unpubl. data). Irving (1960) observed southward movement of willow ptarmigan through Anaktuvuk Pass beginning about 1 October. The southward movement was not as dramatic or as large as the northward movement. Weeden (1964) provided some data indicating that there is sexual and spatial segregation of willow ptarmigan on the wintering habitat with males more prevalent in alpine habitats and females more prevalent in the forested habitats. Porsild (1943) said that willow ptarmigan flocked in groups of one sex in winter in the Mackenzie River delta, N.W.T. These data indicate the possibility that at least some males may winter on the coastal plain. Wintering status of the species on ANWR remains poorly known.

Rock Ptarmigan

Uncommon resident and common breeder in outer coastal plain, uncommon resident and breeder in interior coastal palin of ANWR.

Little is know of the wintering status of this species on the ANWR coastal plain. Irving (1960) and Weeden (1964) stated that rock ptarmigan do not appear to undergo large scale long distance migrations as the willow ptarmigan, however, it is difficult to imagine that the ANWR coastal plain could support all of the rock ptarmigan in winter that it does in summer. It is probable that at least some of the large numbers of ptarmigan seen migrating northward through the Brooks Range out to the ANWR coastal plain in April and could be rock ptarmigan.

Rock ptarmigan were observed on the interior coastal plain at the Sadlerochit River on 11 May 1979 (M.A. Robus unpubl. data), and on the outer coastal plain at Demarcation Point on 19 May 1979 (R.M. Burgess unpubl. data). The species was seen at the Canning Delta by the third week of May 1979 and 1980, and were most often seen in late May on wind-swept coastal or lake shore bluffs. Displaying peaked during the last week of May and the first week of June (Martin and Moitoret 1981). Egg laying began on the Canning Delta (Martin and Moitoret 1981). On the Okpilak Delta hatching was observed 7 July 1978 (Spindler 1978). Broods were observed on the Canning Delta 13-27 July 1980, with fledged young seen on the latter date; no nests or young were seen there in 1979 (Martin and Moitoret 1981).

Magoun and Robus (1977) reported Rock ptarmigan to be more common than willow ptarmigan at Marsh Creek 23 June 1977. Rock ptarmigan were also found to be the more common ptarmigan at Beaufort Lagoon (Andersson 1973; Martin unpubl. data), Demarcatin Point (R.M. Burgess unpubl. data) and Storkerson Point (Derkson et al. in press). The above authors noted Rock ptarmigan in the drier coastal tundra types, while Salter et al. (1980)

stated that Rock ptarmigan tended to use steep hilsides during the breeding season, indicating a dichotomy in habitat use. Apparently Rock ptarmigan do quite well on windswept dry coastal sites (frost boil tundra), on windswept ridges, and on steep hillsides, hence, the distribution of rick ptarmigan would and does indicate abundance near the coast, and a gain abundance near the foothills if suitable steep or windswept slopes are available (Spindler unpubl. data). Estimates of abundance for rock ptarmigan on ANWR include 2.0 birds/$km^2$, with 4.0 nests/$km^2$ in mosaic wet sedge-dry sedge tundra at the Okpilak Delta in 1978; 7.0 birds/$km^2$ with 3.7 nests/$km^2$ on mosaic wet sedge-dry sedge tundra on the Canning delta in 1980 (Spindler 1980; Martin and Moitoret 1981). By comparison, Salter et al. (1980) estimated 8.5 and 1.3 territories/$km^2$ for two sites on the Yukon North Slope 1972 and 1973.

Martin and Moitoret (1981) observed post-breeding flocking at the Canning Delta the first week of August: "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 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".

We have no data th~~e~~a indicate when or if large numbers of rock ptarmigan leave the coastal palin on the Alaska North Slope. Weeden (1964) noted that the build-up of rock ptarmigan in wintering habitat east of Fairbanks occurred at the lower altitudinal limit of their nesting range in timberline areas and below in late October and November. He remarks that their winter movements were largely nomadic, perhaps affected by food supply, weather, roosting conditions and predation. Spatial and habitat segregation of rock ptarmigan sexes was noted, with females using mostly areas below timberline and males using areas mostly at or above timberline (Weeden 1964).

Rock Ptarmigan populations are apparently most susceptible to hunting mortality (and perhaps other sources) in late spring as pair formation occurs when any reduction in number of breeding pairs at that time reduced the breeding population (Weeden 1972). Conversely, reduction of adult populations in fall did not result in a drop in breeding populations the following spring (Weeden 1972).

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## Bird Use of Tundra Habitats

Since 1970 there have been a handful of studies undertaken on the ANWR coastal plain with a major objective of describing intensity of bird use on various tundra habitat types. In 1970 near Beaufort Lagoon Schmidt (1970) censused birds on randomly-located (402x402m, 0.62 km$^2$) quadrats to determine waterfowl-use days. Also in 1970 Anderson (1973) estimated densities of certain shorebird species using the Nuvagapak Point area. Salter and Davis (1974) performed ground transect surveys to estimate levels of bird use in several Yukon and Alaska North Slope habitat types, including 5 sites and 10 habitat types on the ANWR coastal plain. The most extensive study of total bird populations in most of the habitat types on the ANWR coastal plain was conducted in 1977, by Magoun and Robus (1977). A total of 8 different sites and 14 different habitats were surveyed using 86 km of linear transects (3.4 km$^2$ of area surveyed). In 1978 Spindler (1979) censused nesting and transient bird populations on the 4 different tundra habitat types prevalent near the Okpilak River Delta. A total of 1.75 km$^2$ was sampled by three 0.5 km$^2$ plots and one 0.25 km$^2$ plot each representing a different habitat type. At Demarcation Point in both 1978 and 1979 Burgess (unpubl. data) censused nesting birds on one 0.30 km$^2$ plot in an area of varied tundra habitats consisting mostly of wet sedge meadow, polygonal wet/moist meadow, and upland moist sedge meadow. The most intensive bird census of nesting and transient bird populations in relation to habitat conditions and prey base on ANWR was performed by Martin and Moitoret (1981) in 1979 and 1980.

Adjacent to the ANWR coastal plain several other studies on the Alaska North Slope provide comparative data on nesting populations: on the outer coastal plain near Pt. Thomson (Wright and Fancy 1980), near Prudhoe Bay (Norton et al. 1975 and Hoheburger et al. 1980), and near Barrow (Myers and Pitelka 1980); on the interior coastal plain at Atkasook (Myers and Pitelka 1980). In addition, Derksen et al. (in press) present data on seasonal bird populations (including breeders and transients) at 2 interior coastal plain sites, Singiluk and Square Lake, and 4 outer coastal plain sites, Storkerson Pt., Meade River Delta, East Long Lake, and Island Lake.

The above North Slope studies describe bird populations and species composition for one or more years in one or more habitats. Through an analysis of the population levels we can determine which habitat types consistently harbor more birds, and more species, than others, both for nesting and for transient birds. For some of the more common or widespread species we can describe the variation in population levels by habitat, by season, and by year. However, with the data currently available, we cannot make extrapolations as to the total population of a species, or the total number of individuals of a species breeding, resident, or transient in any given area. To make such extrapolations would require replicate census plots in each habitat type sampled, each year, at each site, requiring considerably more manpower than field research projects have been able to afford (S.J. Harbo, pers. comm.; G. Garner, pers. comm.). One project conducted by L.G.L. in 1981 at Prudhoe Bay to evaluate waterflood impacts has utilized many replicate plots, and should be able to provide some extrapolations of total populations, nesting and transient, in a mixture of major habitat types (D. Troy, pers. comm.).

Bird use of tundra habitats on ANWR falls into several major temporal/functional categories: spring migration (May 1-June 21), breeding (May 1-August 1), brood rearing, transient, non-breeding resident and molting (June 21-August 31), pre-migratory staging (25 June-25 September), and fall migration (1 July-30 September) (Bergman et al. 1977, Spindler 1979, Martin and Moitoret 1981). In each of the above temporal/functional categories one major or several major and several minor species may be involved, and have been identified in the annotated species list. The purpose of this section is to summarize that use on a biological community basis. In most cases species-specific details will have been covered in the annotated species list, and brief mention of the species in the text or tables of this section will suffice. However, a great amount of the available bird community information (e.g., patterns of habitat occupancy, productivity, diversity, etc.) applies to species groups (e.g., waterbirds, waterfowl, shorebirds, etc.) and hence will be discussed in more detail in this section.

## Spring Migration

For most species the coastal plain is the end of the spring migration -- the birds simply arrive on the tundra and begin breeding activities. For a few species the ANWR coastal plain tundra is part of their spring migration corridor and is used to varying degrees for resting and feeding while enroute to the main breeding areas elsewhere (even though the species may breed in small numbers on the ANWR coastal plain).

Brant primarily use the coastal migratory corridor, however, they are dependent on tundra vegetation, specifically wet saline tundra (=coastal vegetated mudflats), for resting and feeding while enroute to the main breeding grounds in Canada (Fig B-3).

Snow geese use wet sedge meadows for grazing while enroute to breeding areas. Red knots migrating to Canadian breeding grounds occasionally stop to rest and feed in wet sedge meadows. Sanderlings in migration frequently stop to forage on coastal bluffs and dunes while enroute to breeding areas (Spindler 1978a, Martin and Moitoret 1981).

Pomarine jaegers, perhaps many thousand, migrate low over the coastal plain feeding on birds and small mammals as they fly toward Canadian breeding grounds. (Spindler 1978a, Martin and Moitoret 1981).

## Breeding

### Small birds

Table T-1 lists the species currently known to utilize the ANWR coastal plain for breeding. Table T-2 presents species nesting densities for 5 habitat types at 3 ANWR sites which have been censused intensively for nesting birds. Of the habitat types censused, a mosaic low-centered/high ridge polygon tundra (class IIIc) on the Canning Delta produced the highest total nesting density, 138 nests/km$^2$. A mixed habitat plot at Demarcation Point (classes IIb, IIIb, Vb) consistently supported nesting densities in excess of 100 nests/km$^2$ (Table T-2). Intermediate levels of nesting density were observed in a mosaic of low-centered/high ridge polygonal tundra (IIIc) on the Okpilak Delta in 1978, in an upland dry sedge tundra (Vb) on the Canning Delta in 1980

Table T-1. Species known to breed (or have bred) on the ANWR arctic coastal plain.

Yellow-billed loon
Arctic loon
Red-throated loon
Whistling swan
Canada goose
Brant
Pintail
Green-winged teal
Greater scaup
Oldsquaw
Harlequin duck
Steller's eider
Common eider
King eider
Spectacled eider
Red-breasted merganser
Rough-legged hawk
Golden eagle
Gyrfalcon
Peregrine falcon
Willow ptarmigan
Rock ptarmigan
Sandhill crane
Golden plover
Black-bellied plover
Ruddy turnstone
Northern phalarope
Red phalarope
Common snipe
Long-billed dowitcher
Semipalmated sandpiper
White-rumped sandpiper
Baird's Sandpiper
Pectoral sandpiper
Dunlin
Stilt sandpiper
Buff-breasted sandpiper
Pomarine jaeger
Parasitic jaeger
Long-tailed jaeger
Glaucous gull
Sabine's gull
Arctic tern
Snowy owl
Short-eared owl
Raven
Dipper
American robin
Yellow wagtail
Redpoll
Savannah sparrow
Tree sparrow
White-crowned sparrow
Lapland longspur
Snow bunting

Table T-2 Nesting densities of bird species on various vegetation types in the Coastal plain of ANWR. Determined from intensive plot census studies 1978-1980. Sources: Okpilak, Spindler (1978), Canning, Martin and Moitoret (1981), Demarcation Point, R.W. Burgess, unpubl. data. Densities are given in nests/km².

| Vegetation Class | IIa,b. Wet Sedge Tundra (wet or very wet complexes) | | | | IIc. Wet Sedge Tundra (moist complex) | | Vb. Moist Sedge/Dryas Tundra Complex | | VIa. Moist Tussock-Dwarf Shrub Tundra | Mixed Type IIb, IIb, Vb | | No. of Plots species noted on | Maximum nesting density |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | IIa. Homogeneous wet sedge tundra | IIb. Flooded sedge tundra | IIb. Lowland very wet sedge tundra | | | | | | | | | | |
| Habitat description | | | | | Mosaic wet/dry – Low center/high ridge polygons | | Upland dry sedge tundra | | Upland sedge/tussock tundra | Demarcation Point | | | |
| Location/date | Okpilak 1978 | Okpilak 1978 | Canning 1979 | Canning 1980 | Okpilak 1978 | Canning 1980 | Canning 1979 | Canning 1980 | Okpilak 1978 | 1978 | 1979 | | |
| SPECIES | | | | | | | | | | | | | |
| Arctic loon | | 2 | | | | | | | | | | 1 | 2 |
| Red-throated loon | | 6 | | | | | | | | 3 | 3 | 2 | 6 |
| Green-winged teal | | | | | | | | | | | 3 | 1 | 3 |
| Oldsquaw | 2 | | | | | 4 | | | 1 | | | 3 | 4 |
| Common eider | | 2 | | | | | | | | | | 1 | 2 |
| King eider | | 2 | | 4 | | | | | | | | 2 | 4 |
| Willow ptarmigan | | | | | | | | | 2 | | | 1 | 2 |
| Rock ptarmigan | | | | | 4 | 4 | | 4 | | | 3 | 4 | 4 |
| Golden plover | | | | | 1 | 4 | 4 | | 4 | | | 4 | 4 |
| Northern phalarope | 4 | 19 | 11 | 4 | 6 | 8 | 4 | | 2 | 13 | 10 | 9 | 18 |
| Red phalarope | 2 | 14 | 36 | 43 | 4 | | 8 | 9 | | 3 | 3 | 6 | 48 |
| Long-billed dowitcher | 2 | | | | | | | | | | | 1 | 2 |
| Semipalmated sandpiper | | 3 | | | 6 | 20 | 8 | 24 | | 37 | 33 | 5 | 37 |
| Baird's sandpiper | | | | | | | | | | | 3 | 1 | 3 |
| Pectoral sandpiper | 6 | 4 | 11 | 15 | 8 | 31 | | 4 | | 33 | 7 | 7 | 33 |
| Dunlin | | | | | | 8 | 4 | 4 | | | | 2 | 8 |
| Buff-breasted sandpiper | | | | | 3 | 8 | 4 | | | 3 | | 4 | 8 |
| Glaucous gull | | 1 | | | | | | | | | | 1 | 1 |
| Lapland longspur | 29 | 10 | 11 | 22 | 56 | 51 | 20 | 25 | 40 | 40 | 70 | 8 | 70 |
| Total nest density | 45 | 61 | 51 | 93 | 87 | 131 | 52 | 79 | 49 | 121 | 135 | | |
| Number of species | 6 | 10 | 4 | 5 | 8 | 9 | 7 | 6 | 5 | 7 | 9 | | |
| Plot size (Km²) | 0.50 | 0.50 | 0.27 | 0.27 | 0.50 | 0.25 | 0.25 | 0.25 | 0.25 | 0.30 | 0.30 | | |

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and in a lowland very wet sedge tundra (IIIb) on the Canning in 1980 (Table T-2). The homogeneous wet sedge tundra (IIIa), flooded sedge tundra (IIIb) and upland sedge-tussock tundra (VIa) on the Okpilak in 1978, along with the lowland very wet sedge tundra (IIIb) and the upland dry sedge tundra on the Canning Delta in 1979 showed lower levels of nesting density. Higher numbers of nesting species were found in the flooded sedge tundra (IIIb) on the Okpilak, mosaic tundra (IIIc) on the Okpilak and Canning, and in the mixed habitat plot on Demarcation Point (Table T-2).

The species nesting in the highest densities on the wet sedge tundra types include red phalarope, northern phalarope, pectoral sandpiper, and Lapland longspur. Species attaining high densities in mosaic tundra types were northern phalarope, semipalmated sandpiper, pectoral sandpiper, dunlin, buff-breasted sandpiper and Lapland longspur. In the upland dry sedge tundra types semipalmated sandpiper and Lapland longspur reached high densities. The only species reaching high nesting density in the upland sedge-tussock tundra was the Lapland longspur.

An examination of annual changes in nesting density in the plots where 2 years of census data are available indicates that substantial changes in nesting density were observed for some species. Northern phalarope dropped considerably on the Canning Delta lowland plot between 1979 and 1980, while red phalarope and Lapland longspur nesting density was approximately doubled in the same period (Table T-2). Semipalmated sandpiper and Lapland longspur nesting density increased greatly on the Canning Delta upland plot between 1979 and 1980. At Demarcation Pt. pectoral sandpiper nesting density dropped over 78% in one year while Lapland longspur increased 75% during the same period (Table T-2). Myers and Pitelka (1980) noted that northern phalarope and pectoral sandpiper were among the more annually variable species at Barrow and Atkasook. They also found similar or greater annual fluctuations in shorebird nesting densities at Barrow and Atkasook as compared to ANWR areas, and pointed out that the magnitude of annual changes are about the same as [illegible] those experienced in temperate North American grasslands and less than the changes observed in desert bird communities. Nevertheless, annual fluctuations of the magnitudes commonly observed on ANWR make comparisons between areas studied in different years, detection of trends in populations, and identification of before and after effects on populations much more difficult.

So far, we have examined patterns of small bird abundance on ANWR plots. Table T-3 summarizes results of breeding bird censuses conducted at other Alaska Arctic Coastal Plain sites. With a few exceptions, breeding densities reported from ANWR are lower than those from other north slope locations, particularly Barrow. Differences in analysis 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 likely to underestimate nest density while the latter may overestimate nest density for some species. For example, Lapland longspurs at Barrow have been found to exhibit polygyny and utilize a nest "helper" male that raised young of a different male (Tryon and MacLean 1980), so that the number of males present may not equal the number of nests present.

Table [illegible]3. Breeding bird densities 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. Adapted from: Martin and Moitoret (1981).

| 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 | 45 |
| Upland Sedge-Tussock | '78 | 8 | 40 | 5 | 49 |
| Canning River Delta | | | | | |
| Upland | '79-80 | 31-39 | 20-35 | 0-4 | 51-78 |
| Lowland | '79-80 | 48-67 | 11-22 | 0-4 | 59-89 |
| 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 | 40-75 | 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.H. Burgess pers. comm.
[2] source, Spindler 1979a.
[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.

The Okpilak River Delta study may show lower densities because of less intensive coverage of very large (three 50ha. and one 25ha.) plots. Recognizing the above mentioned differences in census intensity and analysis methods, the differences between total nesting density on the ANWR plots and the coastal plain sites to the west seem significant, and may be related to habitat composition (more extensive wet tundra to the west), zoogeographic factors (more species nesting to the west), and perhaps other factors such as prey abundance and predator abundance. Nesting density differences will have to be studied in more detail before any definite conclusions can be made.

Studies at Barrow and Atkasook have resulted in several conclusions regarding nesting shorebird abundances and habitat use that may also apply to the ANWR coastal plain (Myers and Pitelka 1980):

> Four gradients reflect most strongly the range of conditions seen in different tundra habitats: polygonization, pondiness, vegetation density, and shrubiness.
>
> Coastal (Barrow) and inland (Atkasook) sites differ in that well-drained upland habitats are much more extensive at the latter, topographic relief is much stronger, and indices of vegetation density and shrubiness are higher. As a result, Atkasook has more varied terrain, especially along the polygonization and vegetation-related gradients.
>
> Breeding shorebirds are almost twice as dense coastally as they are inland....
>
> Shorebird species differ in habitat choice; in general more species and higher densities occur in wetter habitats both coastally and inland.
>
> Inland, breeding shorebirds select low, poorly drained, non-polygonized habitats strongly, meaning that shorebird activity is more strongly localized. Coastally, breeding shorebirds are broadly distributed over all habitats....

Unfortunately, on the ANWR coastal plain there has been no intensive census work at inland coastal plain sites so we therefore cannot confirm these conclusions at the present time.

### Large birds

Breeding densities of large bird species with sparse nesting densities that are not adequately estimated by intensive plot surveys were estimated by periodically traversing a 50km$^2$ area on the Okpilak Delta in 1978 and a 20 km$^2$ area on the Canning Delta in 1979 and 1980. The estimates are by necessity a minimum estimate since the intensity of coverage on such a large area is not adequate to find all nests. Intensity on both the Okpilak and Canning areas amounted to a systematic walk around all lakes and wetlands at about 5-10 day intervals throughout the breeding season.

Both the Canning and the Okpilak Delta areas showed similar levels of total large bird nesting density, between 2.90 and 3.54 nests/km$^2$ (Table T-4). The Canning area, in 1979 and 1980, had 1 and 3 more nesting species, respectively, than the Okpilak in 1978. Nesting densities of most species

Table T-4. Minimum estimated nesting densities (nests/km$^2$) for large bird species on two sites in the Arctic Coastal Plain of ANWR, 1978-1980.

| | Okpilak Delta[a] | Canning Delta[b] | |
|---|---|---|---|
| | 1978 | 1979 | 1980 |
| Arctic loon | 0.40 | 0.55 | 0.75 |
| Red-throated loon | 0.32 | 0.45 | 0.60 |
| Whistling swan | 0.12 | 0.25 | 0.15 |
| Canada goose | 0.04 | 0.25 | 0.30 |
| Pintail | 0.30 | - | 0.10 |
| Oldsquaw | 2.00 | 0.40 | 0.45 |
| Common eider | 0.04 | - | - |
| King eider | 0.04 | 0.45 | 0.30 |
| Spectacled eider | - | 0.10 | 0.05 |
| Parasitic jaeger | - | - | 0.10 |
| Glaucous gull | 0.28 | 0.25 | 0.20 |
| Sabine's gull | - | 0.10 | 0.20 |
| Arctic tern | - | 0.10 | 0.10 |
| Total density | 3.54 | 2.90 | 3.30 |
| No. of species | 9 | 10 | 12 |
| km$^2$ censused | 50 | 20 | 20 |

Sources:
[a] Spindler(1978)
[b] Martin and Moitoret(1981)

were similar between the two areas, but the Okpilak had lower whistling swan and eider densities, and higher oldsquaw densities. In the Canning area, where two years data are available, annual variations in nesting density were surprisingly low for large birds.

The estimated nesting densities for the Okpilak and Canning areas are probably typical for river delta tundra with fairly large amounts of wetlands -- pond complex (IIa) or aquatic tundra (IIb) on ANWR. There are some delta areas on ANWR with higher concentrations of wetlands, such as the Tamayariak and Aichilik-Egaksrak, but most of the ANWR tundra, especially inland, has lower concentrations of wetlands and is therefore likely to have lower nesting densities of large birds. Use of wetland types by large birds varies by specific wetland type and by species (Bergman et al. 1977 and Derksen et al. in press.), but most data on species and wetland use are based on total seasonal use, breeding and non-breeding, hence the use of wetlands by large birds will be discussed under the section on transient and summer residents, below. Individual species nesting habitat preferences have been discussed in the annotated species list.

## Summer Residents and Transients

### Small birds

Following courtship in several shorebird species, one sex of each pair usually departs the nesting habitat and moves to premigratory staging grounds. In phalaropes the female usually leaves the male to incubate the eggs (Palmer 1967) or in some cases mates with a second different male before departing or incubating her own clutch (Schamel and Tracy 1977). In Baird's, pectoral, buff-breasted sandpipers and dunlin the males usually depart after courtship (Pitelka et al. 1974). These movements result in a shift in the center of distribution of summering adult birds, as well as a change in habitat use, which occurs in mid-to-late July (Myers and Pitelka 1980, Martin and Moitoret 1981). Most of these adults soon migrate, perhaps by the first of August, and they are followed by successive "waves" in early to mid-August of failed breeders, females that have completed breeding young, and finally young birds of the year (Myers and Pitelka 1980, Martin and Moitoret 1981). Additionally, large numbers of some species which do not breed commonly on the ANWR, or breed inland, move out to the outer coastal plain to stage and feed in very wet and flooded tundra habitats as well as shoreline habitats (Martin and Moitoret 1981). West of ANWR, Myers and Pitelka (1980) reached similar conclusions regarding shorebird movements and shifts in habitat use:

> ...The striking difference between Barrow and Atkasook is the post-breeding decline in numbers inland, against the post-breeding rise in numbers coastally. Thus during July and August, coastal habitats are used heavily by populations both local and by those moving coastward from inland habitats....
>
> Shorebirds show seasonal shifts in habitat use, the majority moving to lower, wetter sites as the summer progresses, both coastally and inland, but upland sites are never completely deserted. Numerically, this shift is strongest in coastal habitats....

> On the coast, seasonal fluctuations in shorebird numbers are characterized by highs each year in early summer (arriving birds), early July (non-breeding transients), and late August (drifting, departing birds).
>
> Inland, seasonal fluctuation differs through much of the summer. There, shorebirds arrive a week earlier than coastally. But most important, no later peaks in numbers occur; that is, there is a slow drift away from the area beginning after breeding stops, in early July.

The chronology of bird use in four different habitat types on the Canning Delta is presented in Figs. T-1 and T-2. Martin and Moitoret (1981) reported that an upland dry sedge tundra plot on the Canning Delta had the greatest bird use in early June 1980, but throughout June use on the mosaic and lowland sedge tundra plots increased to levels higher than the upland: "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 wet saline tundra habitat showed extremely high use in mid-June and early-July, mostly due to flocks of resident phalaropes and migrating semipalmated sandpipers. Over much of the Alaska north slope, the shift of shorebird numbers from upland and inland areas to wet coastal tundra is coincident with an increase in use of shoreline habitats by shorebirds, the subject of another section in this report (Connors and Risebrough 1981, Martin and Moitoret 1981).

The above-mentioned seasonal variations in bird use of tundra habitats, and immigration of transients and non-breeding summer residents into certain habitats after breeding, dictates that description of tundra bird populations also include the non-breeders.

The transect data of Magoun and Robus (1977) (Table T-5) provide a good indication of how various habitat types ranked according to levels of total breeding and non-breeding use, mostly because of the extensive coverage of many geographic areas with the same intensity. There are some problems with the transect methods on tundra since Richardson and Gollop (1974) noted that transect methods on open habitats of the Y.T. north slope tended to over estimate populations, however, extrapolations from such data seem valid because the lower manpower requirements of transects allow replicate samples in each habitat. Given the above qualifications, the densities given for each habitat type in Table T-5 serve as an adequate comparative index for bird use levels from early-June to early-August 1977.

Wet Sedge Meadow is by far the most important avian habitat type in terms of both numbers of species and abundance of bird life (Table T-5). The most abundant species were northern phalarope, semipalmated sandpiper, pectoral sandpiper, red phalarope, and arctic tern. It should be noted, however, that arctic terns were only abundant in this habitat type if ponds, lakes, or

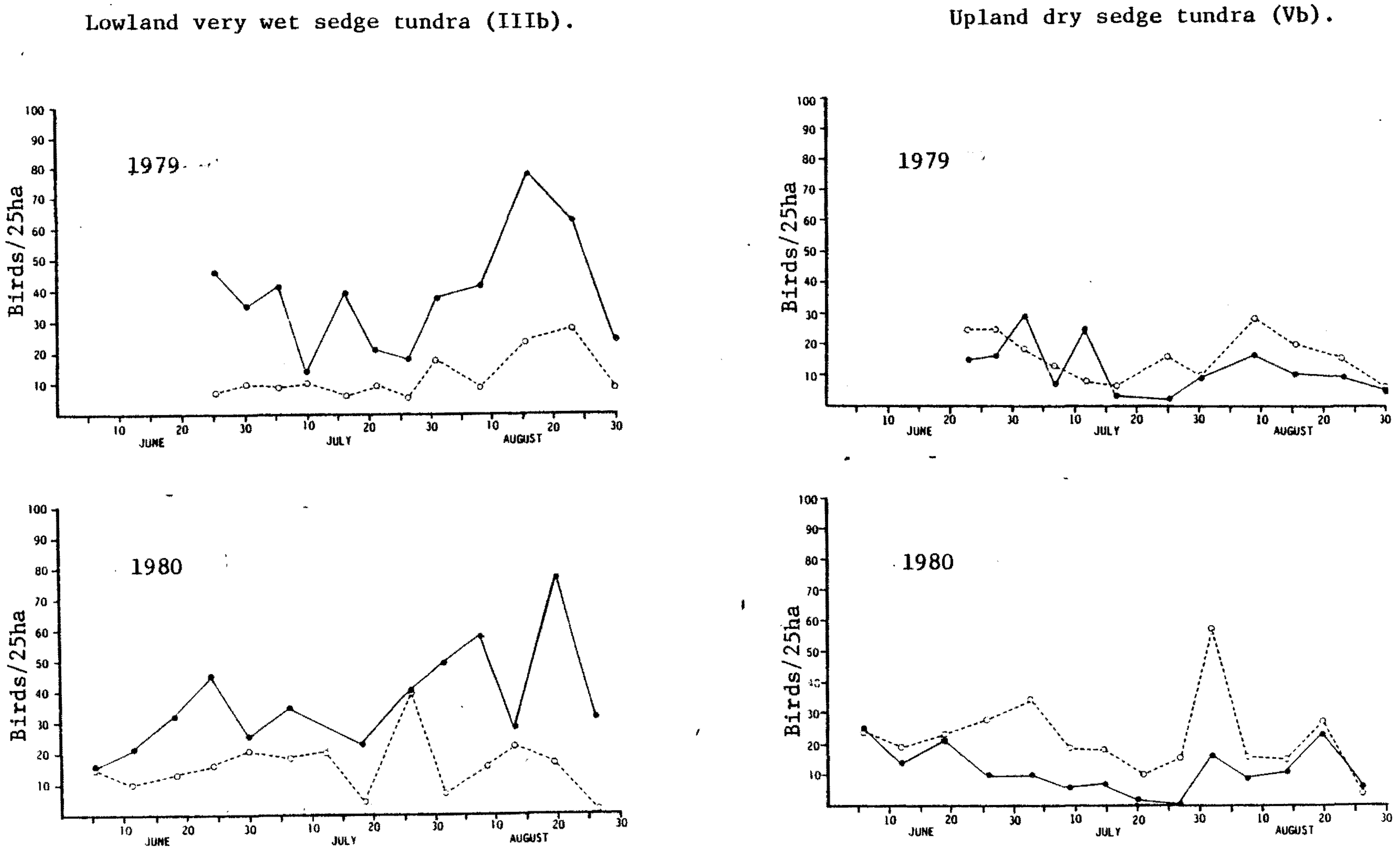
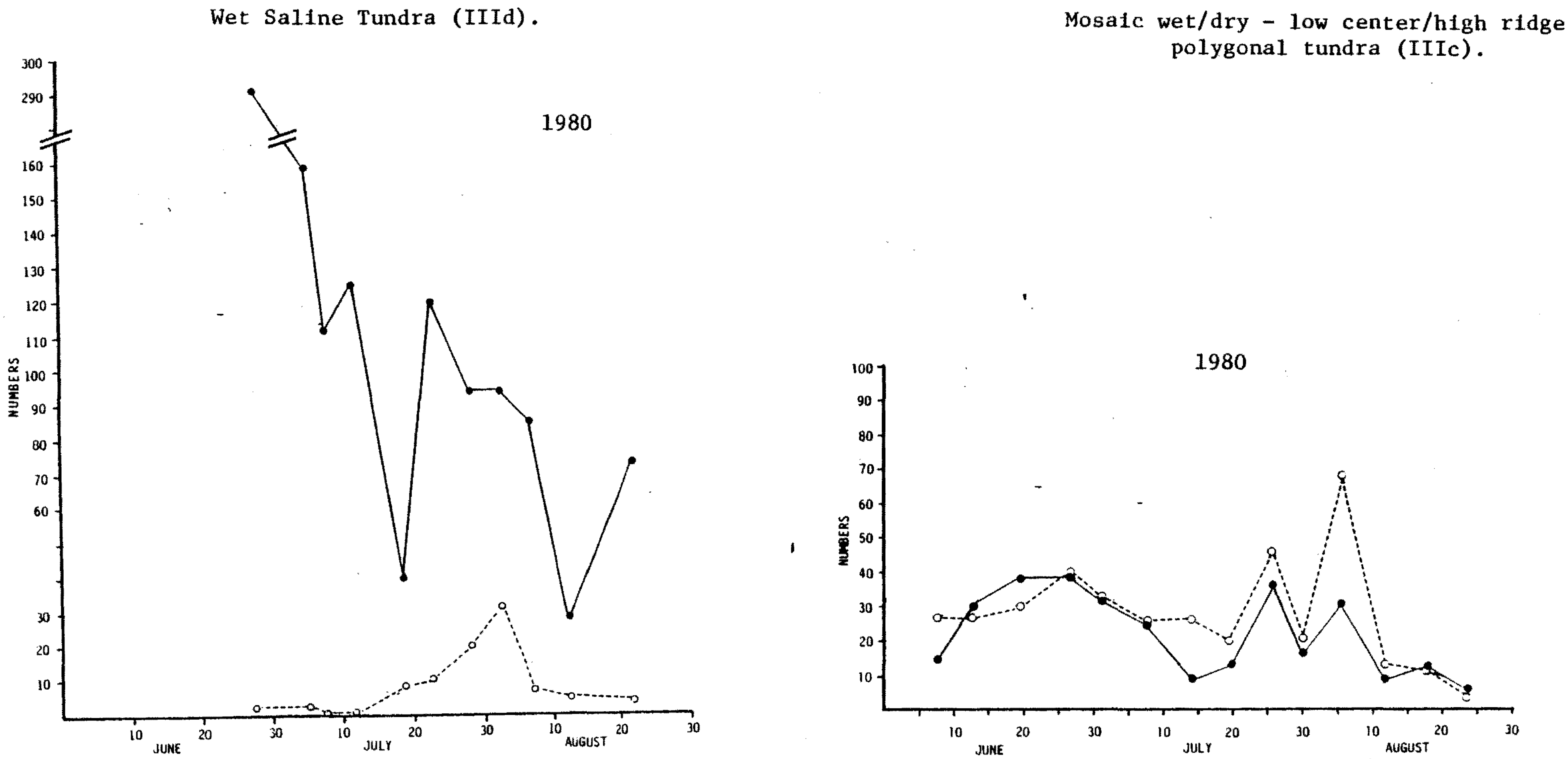


Figure T-1. Numbers of shorebirds (●) and longspurs (○) on upland and lowland study plots, Canning River Delta, 1979 and 1980. Sources: Martin and Moitoret (1981).


Wet Saline Tundra (IIId).

Mosaic wet/dry - low center/high ridge polygonal tundra (IIIc).

Figure T-2. Numbers of shorebirds (●) and longspurs (○) on West Branch Flats and mosaic study plots, Canning River Delta, 1980. Source: Martin and Moitoret (1981).

Very Wet Sedge Meadow were adjacent to the Wet Sedge Meadow. Magoun and Robus (1977) reported that "Very Wet Sedge Meadow and Moist Sedge Meadow habitat types were often integrated with Wet Sedge Meadow areas. The activity of birds in these areas overlap all three habitat types and the importance of these habitats should not be considered independent of each other. For example, the activity observed on the transect run on Barter Island through Wet Sedge Meadow was closely associated with an adjacent large area of Very Wet Sedge Meadow through which no transects were run. The importance of the Wet Sedge areas on Barter Island is undoubtedly dependent on the presence of Very Wet Sedge Meadow nearby. This is probably true for all areas of the Arctic Slope where Wet Sedge Meadow is present; therefore, Wet Sedge Meadow, Very Wet Sedge Meadow, and Moist Sedge Meadow, where they are integrated, should be given equal value in terms of importance to avian species on the Arctic Slope."

In Magoun and Robus' (1977) transect data Riparian Willow stands supported the second highest number of birds (Table T-5). Though the number of species ranked fourth in this habitat type, the riparian willows were particularly important for five passerines: Lapland longspur, redpoll, savannah sparrow, yellow wagtail, and tree sparrow. The latter four species were almost entirely restricted to riparian willow thickets or adjacent habitat types such as riparian dryas terrace or riparian gravel bars which also supported willow growth.

The third most important habitat type was Coastal Vegetated Mudflats. These areas supported 15 species at an average density of 830 birds/km$^2$ (Table T-5). The most abundant species were semipalmated sandpiper, pintail, dunlin, Lapland longspur, and pectoral sandpiper.

A population and density estimate for the entire ANWR coastal plain, based on the prevalence of each habitat type, was made which considered total densities together with habitat surface area within each type. These data were obtained from the LANDSAT habitat type map prepared by Nodler (1977). Utilizing Nodler's (1977) satellite habitat classification data and Magoun and Robus' (1977) bird data, a stratified population estimate of bird density for the entire ANWR arctic coastal plain of 405.3 birds/km$^2$ was made. This density extrapolated to actual area of available habitat (5728 km$^2$ for the coastal plain) yields a crude estimate of over 2,300,000 birds from June to August for the coastal plain of ANWR, which seems realistic. The stratified density and population figures should not be taken as final refined estimates, since the bird transect data and 1977 LANDSAT habitat map are based on only one year of census and ground truth. Further replicative transect censuses and a refined LANDSAT map will be required to make more accurate estimates of total coastal plain bird populations.

A different approach for evaluating populations of summer resident and transient birds in North Slope habitats has been to repeatedly census plots ranging in size from 0.25 km$^2$ (Spindler 1978a, Burgess, unpubl. data, Martin and Moitoret 1981) to clusters of small plots totaling over 1.0 km$^2$ (Derksen et al., in press). The repeated census results are then averaged to produce a mean density value for each species and total birds, reflecting the total seasonal use Table T-6. In the ANWR seasonal density data presented in Table T-6, the Okpilak sites were censused from mid-June to late-July. At the Canning site, the plots were censused early/mid-June to late-August, T-5

Table 8. Estimated total bird population densities (birds/km$^2$) in 12 habitat types on the ANWR coastal plain, June-August 1977.

| Species | HABITATS IIIa Wet Sedge Meadow | Riparian Willow | IIId Coastal Veg. Mudflats | Va, VIb, IXb Upland Dryas Tundra | IIb, IIIb Very Wet Sedge Meadow | IIIc Mosaic wet/dry Sedge Meadow | IVa Moist Sedge Meadow | IVb Riparian Dryas terrace | Vb Dryas Sedge Meadow/Upland Dryas Heath | ~~IXb~~ a Riparian Gravel Bars | Vb Dry Sedge Meadow | VII a,b,c Tussock Meadow |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Arctic Loon | 11 | | | | | | | | | | | |
| Red-throated loon | 29 | | 6 | | | | 2 | | | | | |
| Pintail | 15 | | 234 | | 13 | | 45 | | 2 | | | |
| Oldsquaw | 58 | | 6 | | 15 | | | | | | | |
| King Eider | | | | | | | 11 | | | | | |
| Willow Ptarmigan | | 23 | | | | | | | | | 24 | 12 |
| Rock Ptarmigan | 1 | 22 | | | | | | 34 | 11 | 5 | 12 | 7 |
| Golden plover | 80 | 15 | | | | | 7 | 37 | 110 | | 5 | 26 |
| Black-bellied plover | | | | | | | | 4 | | | | |
| Lesser yellowlegs | | | 8 | | | | 5 | | | | | |
| Ruddy turnstone | | | 15 | | | | 4 | | | 37 | 4 | |
| Northern phalarope | 549 | | 13 | 44 | 164 | 178 | 59 | 6 | | | | 2 |
| Red phalarope | 154 | | | | 126 | | | | | 12 | | |
| Long-billed dowitcher | 1 | | | | | | 21 | | | | | 1 |
| Semipalmated sandpiper | 41~~1~~8 | 13 | 266 | 29 | 21 | 68 | 22 | 5 | 32 | 25 | 57 | 4 |
| Pectoral sandpiper | 268 | 8 | 58 | 265 | 35 | | 102 | 67 | 2 | 12 | | 14 |
| Dunlin | 1 | | 114 | | | | | | | | | |
| Stilt sandpiper | | | 8 | | | | | | | | | |
| Buff-breasted sandpiper | 3 | | | | | | 11 | 2 | 27 | 6 | | |
| Pomarine jaeger | 1 | | 6 | | | | | | | | | |
| Parasitic jaeger | 4 | | | | 3 | | | | | | | 6 |
| Long-tailed jaeger | 14 | 173 | 6 | 12 | 3 | | 6 | 29 | | 10 | 3 | 6 |
| Glaucous gull | 35 | 8 | 12 | | | | 2 | 16 | 2 | 10 | 17 | 4 |
| Arctic tern | 143 | | | | 9 | | | | | 6 | | |
| Snowy Owl | | | | | | | ② | | 2 | | | |
| Yellow wagtail | | 32 | | | | | | | | | | 1 |
| Redpoll sp. | | 165 | | | | | | | | 40 | | |
| Savannah sparrow | 4 | 66 | | | | | 2 | 12 | | 10 | | |
| Tree sparrow | | 28 | | | | | | | | | | |
| Lapland longspur | 96 | 478 | 66 | 17~~1~~8 | 77 | 100 | 129 | 124 | 106 | 126 | 66 | 71 |
| Snow bunting | | | 12 | | | | 5 | | 2 | | | |
| Unidentified shorebirds | 72 | 1 | | 4 | 6 | 30 | | 4 | 24 | 6 | 4 | 2 |
| Unidentified sparrows | 9 | 21 | | | | | | | | 7 | | 2 |
| Total Average Density | 1966 | 1053 | 830 | 532 | 472 | 421 | 388 | 340 | 330 | 312 | 198 | 152 |
| Number of species | 22 | 14 | 15 | 6 | 11 | 4 | 16 | 12 | 11 | 14 | 9 | 14 |
| km of transect censused | 11.4 | 3.7 | 3.2 | 4.3 | 4.6 | 0.04 | 13.6 | 5.8 | 6.7 | 3.5 | 8.8 | 17.2 |

Source:
Magoun and Robus (1977)

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thus including the fall "peak" of staging and migrating shorebirds. Recognizing the differences in duration of study, the wet sedge, flooded sedge, and mosaic plots on the Okpilak would be expected to show lower densities than if their census period extended into August. Mean total density was highest in the coastal vegetated mudflats, mosaic wet/dry polygonal tundra, flooded sedge tundra and very wet sedge tundra (Table T-6). Lower seasonal bird densities were reported for homogeneous wet sedge tundra, upland dry sedge tundra, and upland sedge-tussock tundra (Table T-6).

Mean total seasonal density of the more productive outer coastal plain tundra habitat types on ANWR was equal to or higher than the mean densities observed to the west in NPR-A (Table T-7). Also, densities in the less productive habitats on ANWR were comparable to some of the lower densities observed on NPR-A (Table T-7). These data suggest that although much higher nesting densities have been observed to the west, total seasonal use on ANWR is comparable to that observed at western sites.

Large birds

Table T-8 compares mean seasonal densities of large birds as determined by repeated censuses of 2.5-50 $km^2$ census areas in ANWR and areas to the west. Arctic loon densities on ANWR appear to be comparable to other areas surveyed to the west, whereas red-throated loons appear to be more abundant in ANWR. Canada geese were fairly abundant on the Canning, exceeded only at the Island Lake goose molting area in NPR-A. Pintail numbers appear to be lower on ANWR than in the western areas. King eiders seem to be much more plentiful from Prudhoe Bay eastward. Oldsquaw numbers were higher on the Okpilak and comparable on the Canning as compared to the western areas. Whistling swan densities were very high on the Canning as compared to the other areas.

Seasonal mean density values obscure the fact that there are restricted areas of very good habitat for some species where densities may be much higher than the regional average. Loons and Canada geese, for instance, have extremely patchy distributions. Another species with extremely patchy distribution is the Sabine's Gull, which nests colonially or semi-colonially. Only three nesting areas are known for this species on the ANWR, all of which are on the Canning River Delta.

Most of the large bird use of the ANWR coastal plain is concentrated within a few wetland types (as classified by Bergman et al. 1977). Bergman's types, Basin-Complex, and Coastal Wetlands (= coastal saline tundra, CRREL this report = coastal vegetated mudflats, Nodler 1977) (Spindler 1978a, Martin and Moitoret 1981). Martin and Moitoret (1981) reported that large basin-complexes on the Canning Delta, "which have irregular shorelines with islands and extensive beds of emergent vegetation (Carex aquatilis and Arctophila fulva) were often prime areas for nesting activity. In addition to providing protected nest sites on islands (Canada goose nests, for instance, were always on islands surrounded by deep water) these areas had dense stands of Arctophila which provided cover for waterfowl broods. Pintails used these grass beds during wing molt and migration, as well. The diversity and numbers of birds in these wetland types was markedly higher than the other wetlands in the study area." The other wetland type to receive extensive waterbird use is the coastal wetland, which on the Canning Delta in 1979 and 1980 were used primarily by brant, white-fronted geese, Canada geese, pintails, oldsquaw,

Table T-6 Densities of bird species on various vegetation types in the coastal plain of ANWR. Determined by intensive plot census studies 1978-1980. Sources: Okpilak, Spindler (1978); Canning, Martin and Moitoret (1981). Densities are given as mean numbers of birds/km² observed on the plot for the duration of census effort; at Okpilak mid-June to mid-July 1978, at Canning early or mid-June through August 1979 and 1980.

| Vegetation Class | IIa,b,d. Wet Sedge Tundra (wet, emergent or saline complexes) | | | | | IIc. Wet sedge Tundra (moist complex) | | IVb. Moist sedge Barren Tundra Complex | | IIIa Moist Tussock Dwarf Shrub Tundra | No. of plots species occurred | Maximum density |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Habitat description | IIa Homogeneous wet sedge tundra | IIb Flooded sedge Tundra | IIb Lowland string wet sedge tundra | | IId wet saline tundra (coastal vegetated mudflat) | Mosaic wet low-/low center/high center polygons | | upland dry sedge tundra | | Upland sedge tussock tundra | | |
| Location/date | Okpilak 1978 | Okpilak 1978 | Canning 1979 | Canning 1980 | Canning 1980 | Okpilak 1978 | Canning 1980 | Canning 1979 | Canning 1980 | Okpilak 1978 | | |
| Arctic loon | | 5.2 | | | 1.7 | | | | | | 2 | 5.2 |
| Red-throated loon | | 6.4 | | | 0.8 | 1.0 | | | | | 3 | 6.4 |
| Whistling swan | | 0.8 | | | | | | | | | 1 | 0.8 |
| Canada goose | | | | | 0.8 | | | | | | 1 | 0.8 |
| Pintail | | 1.2 | | | 85.3 | 2.0 | | | | | 3 | 85.3 |
| Northern shoveler | | | | | 1.3 | | | | | | 1 | 1.3 |
| Oldsquaw | 2.0 | 4.0 | | | 39.2 | 1.0 | | | | 4.0 | 5 | 39.2 |
| Common eider | | 0.4 | | | | | | | | | 1 | 0.4 |
| King eider | | 0.4 | | | 10.4 | | | | | | 2 | 10.4 |
| Willow ptarmigan | | | | 0.8 | | | 3.4 | | | 4.0 | 3 | 4.0 |
| Rock ptarmigan | | | | 2.6 | 1.7 | 2.0 | 3.4 | 4.2 | 7.0 | | 4 | 7.0 |
| Sandhill crane | | 0.8 | | | | 1.0 | | | | | 2 | 1.0 |
| Golden plover | | 1.6 | 17.9 | 10.6 | 22.9 | 2.0 | 5.1 | 7.8 | 10.4 | 8.3 | 7 | 22.9 |
| Black-bellied plover | | | 9.6 | 11.7 | 9.3 | | | | | | 3 | 11.7 |
| Whimbrel | | | 1.9 | | | | | 0.3 | | | 2 | 1.9 |
| Ruddy turnstone | | | | 0.5 | 9.8 | | | | | | 2 | 9.8 |
| Northern phalarope | 6.5 | 36.4 | 8.6 | 1.6 | 135.0 | 9.5 | 5.4 | 2.6 | | 4.0 | 9 | 135.0 |
| Red phalarope | 0.5 | 60.0 | 16.7 | 28.5 | 31.3 | 5.0 | 5.9 | 1.6 | 3.3 | | 7 | 60.0 |
| Common snipe | | | | | | | | 0.3 | | | 1 | 0.3 |
| Long-billed dowitcher | 3.0 | 6.0 | 11.1 | 6.9 | 3.7 | 1.0 | 0.8 | | 1.2 | 4.0 | 8 | 19.1 |
| Red Knot | | | | | 0.4 | | | | | | 1 | 0.4 |
| Semipalmated sandpiper | | 9.6 | 5.6 | 1.9 | 125.0 | 14.0 | 16.9 | 7.8 | 9.8 | 2.7 | 7 | 125.0 |
| Western sandpiper | | | | | 5.9 | | | | | | 1 | 5.9 |
| Least sandpiper | 1.0 | | | | | 6.5 | | | | | 2 | 1.0 |
| White-rumped sandpiper | | | | 0.5 | 1.2 | | 6.6 | | | | 3 | 6.2 |
| Baird's sandpiper | | | | | 5.8 | | | 0.3 | 1.1 | | 2 | 5.8 |
| Pectoral sandpiper | 31.4 | 96.4 | 51.2 | 63.7 | 31.3 | 45.0 | 33.3 | 11.1 | 9.2 | 6.7 | 9 | 86.4 |
| Dunlin | | | 16.2 | 6.9 | 31.3 | | 19.6 | 3.6 | 2.1 | | 4 | 31.3 |
| Stilt sandpiper | | | 0.9 | 1.3 | 12.5 | | 1.5 | | | | 3 | 12.5 |
| Buff-breasted sandpiper | | | | 0.3 | 0.4 | 5.0 | 3.1 | 12.1 | 4.5 | | 5 | 12.1 |
| Unidentified shorebird | | | 1.9 | | 15.0 | | | | | | – | 15.0 |
| Pomarine jaeger | | 0.9 | | | | | | | | | 1 | 0.9 |
| Parasitic jaeger | 2.0 | 0.8 | | | 0.8 | 1.5 | | | | | 4 | 2.0 |
| Long-tailed jaeger | 2.0 | 0.9 | | | | 1.5 | | | | 4.0 | 4 | 4.0 |
| Glaucous gull | 6.5 | 2.0 | | | | | | | | | 2 | 2.0 |
| Sabine's gull | | 0.4 | | | 7.6 | | | | | | 2 | 7.5 |
| Arctic tern | | 2.4 | | | 12.5 | | | | | | 2 | 12.5 |
| Snowy owl | | 0.4 | | | | | | | | | 1 | 0.4 |
| Short-eared owl | 0.5 | | | | | | | | | | 1 | 0.5 |
| Horned lark | | | | | | | | | 0.5 | | 1 | 0.5 |
| Yellow wagtail | | | | | | | | | 0.5 | | 1 | 0.5 |
| Lapland longspur | 62.6 | 9.6 | 42.9 | 61.7 | 31.3 | 96.0 | 103.5 | 68.3 | 89.6 | 97.3 | 9 | 97.3 |
| Snow bunting | | | | | | | | | 0.5 | | | |
| Mean Total Density | 112.0 | 244.8 | 114.7 | 192.2 | 626.7 | 191.0 | 213.0 | 113.6 | 138.2 | 141.2 | | 626.7 |
| Number of Species | 11 | 22 | 12 | 15 | 26 | 16 | 13 | 12 | 13 | 10 | | 26 |
| Plot size (km²) | 0.50 | 0.50 | 0.27 | 0.27 | 0.20 | 0.50 | 0.35 | 0.25 | 0.25 | 0.25 | | – |

Singiluk Square Storkerson
Lake Point

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| Okpilak | | Canning | | | |
|---|---|---|---|---|---|
| 1978 | | 1979 | | 1980 | |
| Min | Max | Min | Max | Min | Max |
| 112 | 245 | 114 | 185 | 138 | 213 |

Table ~~7~~ 6. Comparison of mean total bird density in NPRA and ANWR sites 1977-1980.

| | Central and Western North Slope | | | | | ANWR | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Large Lake Regime | Delta | Near Foothills | | Coastal | Outer Coastal Plain River Deltas | | | | | |
| | East Long[a] Lake | Meade[a] River | Singiluk | Square[b] Lake | Storkerson[c] Point | Okpilak[d] | | Canning[e] | | | |
| | | | | | | 1978 | | | | 1979 | 1980 |
| | | | | | | Min[f] | Max[g] | Min[h] | Max[i] | Min[h] | Max[i] |
| Mean Total Density | 206 | 118 | 118 | ? | 154 | 112 | 245 | 114 | 185 | 138 | 213 |

[a] Derksen et al. 1977
[b] Metzner and Martin 1978
[c] McDonald and Kenyon 1978
[d] Spindler 1978
[e] Martin and Moitoret 1981
[f] Homogeneous Wet Sedge Tundra (IIIa.)
[g] Flooded Tundra (IIIb.)
[h] Upland Dry Sedge Tundra (Vb.)
[i] Lowland Very Wet Sedge Tundra (IIIb.)
[j] Mosaic Wet/Dry Sedge Tundra (IIIc.)

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Table [illegible]. Comparison of mean seasonal densities for large birds (birds/km²), ANWR ) 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[2] Lake |
| 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.~~6~~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 | 5.0 | 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).

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king eiders, Sabine's gulls, and arctic terns. Intensive studies of large bird habitat use have been conducted at NPR-A and Prudhoe Bay sites (Bergman et al. 1977, and Derksen et al., in press), hence the reader is referred to those studies and the annotated species list for more detailed habitat information. The similarities between waterbird habitat use in NPR-A and Prudhoe Bay and on the ANWR coastal plain suggest that further studies of large bird habitat use on ANWR are not warranted unless the primary objective is to monitor population levels and determine the effects of disturbance.

Staging, Molting, and Fall Migration

Table T-9 lists the species that have been observed during staging, molting and fall migration; approximately 1 August to 10 September, 1978 to 1980. Major utilization of the coastal plain during this period is by (1) large numbers of shorebirds which move into the wetter tundra types near the coast; (2) staging snow geese on the interior coastal plain and (3) migrating brant using wet saline tundra (= coastal vegetated mudflats).

The coastal shift in shorebird abundance was described above. Martin and Moitoret (1981) reported about twice the density of shorebirds using lowland very wet sedge tundra in August ($320/km^2$) as compared to the June-July breeding periods at the Canning Delta (Figs T-1 and T-2). The LANDSAT classes receiving the greatest use at this time are IIb, IIIa, IIIb, IIId.

Snow goose staging begins in mid-to-late August and extends into mid-or-late September (see Annotated Species List for references). Both upland foothill tundra (classes VIa, VIIa, b, c, and VIIIa) and coastal wet tundra (IIIa, b, c, d, and IVa) are used extensively (see LANDSAT map in Ch. III and Fig. B-4 a, b, c).

Brant migrating westward in fall along the Beaufort Sea coast frequently stop to feed in wet saline tundra (= coastal vegetated mudflats, class IIId).

Pintails molt in Basin-complex, deep Arctophila, shallow Arctophila, shallow-Carex, and beaded stream wetland types (Bergman et al. 1977, Spindler 1978a, Martin and Moitoret 1981). Oldsquaw molt in deep-open lakes on the coastal plain (Taylor 1981, Martin and Moitoret 1981), which fall under classes I and IIa, b on the LANDSAT map.

Winter

Only 6 species of birds are known to winter (or probably winter) on the Arctic Coastal Plain of ANWR: gyrfalcon, rock ptarmigan, willow ptarmigan, snowy owl, raven, and dipper. The extent of wintering habitat use is poorly known for the ptarmigan, snowy owl, and raven. Gyrfalcons most likely remain within 20 km of their eyrie sites if prey availability permits (references in Annotated Species section), and dippers must winter in the only open water available near Sadlerochit and Shubelik springs. Reduction of water flow at the springs, or any other activity that would cause the open water to ice-over, would probably extirpate dippers from the particular spring/stream system. The dippers that winter at Sadlerochit Springs are the farthest north known population in Alaska.

Table T-9. Bird species which have been observed using coastal plain tundra habitats during staging, molting, and fall migration in ANWR, 1978-1980.

Arctic loon
Red-throated loon
Whistling swan
Canada goose
Brant
White-fronted goose
Snow goose
Mallard
Pintail
Green-winged teal
American wigeon
Oldsquaw
Common eider
Spectacled eider
Red-breasted Merganser
Marsh hawk
Gyrfalcon
Peregrine falcon
Willow ptarmigan
Rock ptarmigan
Sandhill crane
Golden plover
Black-bellied plover
Bar-tailed godwit
Ruddy turnstone
Northern phalarope
Red phalarope
Common snipe
Long-billed dowitcher
Sanderling
Semipalmated sandpiper
Western sandpiper
White-rumped sandpiper
Baird's sandpiper
Pectoral sandpiper
Dunlin
Stilt sandpiper
Buff-breasted sandpiper
Pomarine jaeger
Parasitic jaeger
Long-tailed jaeger
Glaucous gull
Herring gull
Sabine's gull
Arctic tern
Snowy owl
Raven
Dipper
Yellow wagtail
Redpoll
Lapland longspur
Snow bunting

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# BIRD USE OF LAGOON AND OFFSHORE HABITATS

The greatest concentrations of summer resident waterfowl on the Arctic National Wildlife Refuge (ANWR) occur in the shallow coastal waters of the Beaufort Sea. This area includes shallow coastal lagoons formed by gravel barrier islands and shoals; river deltas; mudflats; and offshore waters.

Previous surveys conducted on ANWR included Schmidt (1970), Frickie and Schmidt (1974), and Spindler (1979, 1981). Bartels (1973), Gallop and Richardson (1974), Ward and Sharp (1974), Harrison (1977), Divoky (1979), and Johnson and Richardson (1981) conducted studies in nearby coastal waters. All these studies identified Beaufort Sea lagoons as one of the most important habitats for molting waterfowl and staging shorebird populations in the arctic region of Alaska.

Comparable aerial transect surveys over the coastal lagoons and offshore waters of the ANWR were conducted periodically during the open water seasons of 1978, 1980, and 1981. The coastal lagoon transects surveyed the 400 meter band directly adjacent to the barrier islands for 11 selected lagoons. The offshore transect surveyed the 400 Meter area directly seaward of the barrier island or shoreline along the entire north coast of ANWR.

A major characteristic of bird populations in the lagoons was extreme seasonality. In all years, the use of lagoon by birds started with snow melt in early June. During this period, river overflow covered the deltaic portions of the lagoons and provided the first open water of the season. Bird use then remained at low levels until ice-out occured, usually in late June to mid July. Populations gradually increased through July until a peak was reached in August, then populations gradually declined. However, a second peak was often observed in mid September as birds began staging for fall migration. Some Birds were usually present until freeze up in late September or early October.

## LAGOONS

### SEASONAL USE

Eight key avian species groups were chosen to be representatives of coastal lagoon waterbirds. The key species were: Arctic, red-throated, and yellow-billed loons - loons are fairly common breeders, migrants, and transient, and sensitive to disturbance; oldsquaw - most abundant migrant, molter, and major avian consumer in lagoon ecosystem; phalarope sp. - abundant coastal nester and common consumer in lagoons late in open water season (species not separable during aerial surveys); glaucous gull - second most abundant avian consumer in lagoon ecosystem, a scavenger that may increase in abundance due to human activities; eider - common nester, and migrant; scoters - uncommon transient.

Surveys were conducted in 1980 (3) and 1981 (5) on the 11 selected coastal lagoons (Table 1&2). The 11 surveyed lagoons were selected as representing lagoons of various bird use levels (high, medium and low) based on previous years information (Spindler 1981). A record of individual species was kept during these surveys. Two additional surveys were conducted in 1978.

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TABLE 1. Summary of bird population data for each lagoon or coastline segment, Arctic National Wildlife Refuge, Alaska. Based on aerial transects flown on 1 August (1); 20 August (2); 9 September (3), 1980. Sigma ( ) represents cumulative use of the lagoon by birds, a summation of total numbers of each species over the three surveys.

| | Brownlow L. | | | | Tamayariak L. | | | | Simpson Cove | | | | Arey Lagoon | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | | 1 | 2 | 3 | | 1 | 2 | 3 | | 1 | 2 | 3 | |
| Arctic loon | 3 | | 2 | 5 | 1 | | | 1 | | 3 | | 3 | 4 | 1 | | 5 |
| Red-throated loon | 1 | | | 1 | 1 | | | 1 | 1 | | 4 | 5 | | 2 | 2 | 4 |
| Loon, sp. | | 1 | 5 | 6 | | | 1 | 1 | | | 1 | 1 | | | | |
| Brant | | | 21 | 21 | | | 105 | 105 | | | | | | | | |
| White-fronted goose | | | | | | | | | | | | | | | | |
| Duck, sp. | | | | | | | 4 | 4 | | | 2 | 2 | | | | |
| Eider, sp. | 10 | | | 10 | | | | | | | 9 | 9 | 16 | | | 16 |
| Oldsquaw | 86 | 627 | 307 | 1020 | 248 | 3515 | 95 | 3858 | 1596 | 2012 | 39 | 3647 | 1402 | 214 | 166 | 1782 |
| Falcon, sp. | | | | | | | | | | | | | | 1 | | 1 |
| Phalarope, sp. | | 5 | | 5 | | | | | | 3 | | 3 | | 29 | | 29 |
| Small shorebird | | | | | | 500 | | 500 | | | | | 10 | | | 10 |
| Medium shorebird | | | | | | | 5 | 5 | | | | | | | 1 | 1 |
| Glaucous gull | | 9 | | 9 | | 18 | 29 | 47 | 2 | 22 | 19 | 43 | 103 | 14 | 16 | 133 |
| Arctic tern | | 1 | | 1 | | 89 | | 89 | | | | | | | | |
| No. of taxa | 4 | 5 | 4 | 9 | 2 | 5 | 6 | 10 | 3 | 4 | 8 | 8 | 5 | 5 | 4 | 9 |
| Total no. of birds observed | 100 | 643 | 335 | 1078 | 249 | 4123 | 237 | 4609 | 1599 | 2040 | 74 | 3713 | 1535 | 259 | 185 | 1979 |
| Area sampled (km²) | | | 6.18 | | | | 7.32 | | | | 6.71 | | | | 5.37 | |
| Bird density | 16 | 104 | 54 | 174 | 33 | 548 | 32 | 613 | 213 | 271 | 10 | 494 | 286 | 48 | 34 | 369 |

Table 1. (Cont'd)

| | Jago Lagoon | | | | Tapkaurak L | | | | Oruktalik L. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | | 1 | 2 | 3 | | 1 | 2 | 3 | |
| Yellow-billed loon | | | | | | | | | 1 | | | 1 |
| Arctic loon | 1 | | | 1 | | | | | | | | |
| Red-throated loon | | | | | | | | | | | 2 | 2 |
| Loon, sp | 1 | 2 | | 3 | | | 5 | 5 | | | 3 | 3 |
| Diver | 1 | | | 1 | | | | | | | | |
| Duck, sp | | 4 | | 4 | | | | | | | | |
| Eider, sp. | | | | | | | | | | | | |
| Oldsquaw | 489 | 52 | 940 | 1481 | 327 | 286 | 300 | 913 | 425 | 354 | 779 | 1558 |
| Surf scoter | 12 | | | 12 | | | | | | | | |
| Phalarope, sp. | | 40 | | 40 | | | | | | | | |
| Medium shorebird | | | | | | 4 | | 4 | | | | |
| Shorebird, sp | | 15 | | 15 | | | | | | | | |
| Black-bellied plover | | | | | | | | | | 1 | | 1 |
| Jaeger, sp. | | | | | | | 2 | 2 | | | | |
| Glaucous gull | 19 | 1 | 379 | 399 | | 1 | 1 | 2 | 11 | | 3 | 14 |
| Arctic tern | | | | | | 1 | | 1 | 9 | | | 9 |
| Black guillemot | | | | | | 1 | | 1 | | | | |
| No. of taxa | 6 | 5 | 3 | 9 | 1 | 5 | 4 | 7 | 4 | 2 | 4 | 7 |
| Total no. of birds observed | 523 | 112 | 1321 | 1956 | 327 | 293 | 308 | 928 | 446 | 355 | 787 | 1588 |
| Area sampled (km²) | | | 2.69 | | | | 4.30 | | | | 2.15 | |
| Bird density | 194 | 42 | 491 | 727 | 76 | 68 | 72 | 216 | 207 | 165 | 366 | 739 |

Table 1. (Cont'd)

| | Pokok Lagoon | | | | Nuvagapak | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | | 1 | 2 | 3 | |
| Yellow-billed loon | | | | | | 1 | | 1 |
| Arctic loon | | 1 | 1 | 2 | 1 | | 1 | 2 |
| Red-throated loon | | | | | | | | |
| Loon, sp. | | | | | | 1 | 2 | 3 |
| Whistling swan | | | 2 | 2 | | | | |
| Dabbler, sp. | | | | | | | | |
| Duck, sp | | | | | | | 4 | 4 |
| Oldsquaw | | | 12 | 12 | 735 | 762 | 296 | 1793 |
| White-winged scoter | | | | | | | 4 | 4 |
| Scoter, sp | | | | | | | 4 | 4 |
| Red-breasted merganser | | | | | | | | |
| Phalarope, sp. | | | 1 | 1 | | 3 | | 3 |
| Small shorebird | 65 | | | 65 | 7 | 6 | | 13 |
| Medium shorebird | 16 | | | 16 | 201 | | | 201 |
| Plover, sp. | | | | | | 8 | | 8 |
| Parasitic jaeger | | | | | | | | |
| Glaucous gull | 1 | | 1 | 2 | 4 | 11 | 15 | 30 |
| Arctic tern | | | | | | | | |
| No. of taxa | 3 | 1 | 5 | 7 | 5 | 7 | 7 | 12 |
| Total no. of birds observed | 82 | 1 | 17 | 100 | 948 | 792 | 326 | 2066 |
| Area sampled (km²) | | | 2.01 | | | | 5.91 | |
| Bird density | 41 | 1 | 8 | 50 | 160 | 134 | 55 | 350 |

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Table 1. (Cont'd)

| | Egaksrak L. | | | | Demarcation B. | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | | 1 | 2 | 3 | |
| Yellow-billed loon | | | | | | | | |
| Arctic loon | | | | | 1 | | 1 | 2 |
| Red-throated loon | 2 | | | 2 | | | | |
| Loon, sp. | | 2 | 2 | 4 | | 1 | 1 | 2 |
| Whistling swan | | | | | | | 1 | 1 |
| Snow goose | | | | | | | | |
| Pintail | | 22 | | 22 | | | | |
| Duck, sp. | | | | | | | | |
| Common eider | | | | | 3 | | | 3 |
| Eider, sp. | | | | | | 4 | | 4 |
| Oldsquaw | 139 | 261 | 178 | 578 | 198 | 1736 | 227 | 2161 |
| Surf scoter | | | 3 | 3 | | | | |
| Red-breasted merganser | | | | | | | | |
| Phalarope.sp. | 4 | | | 4 | 4 | | | 4 |
| Small shorebird | 16 | | | 16 | 1 | | | 1 |
| Medium shorebird | | | | | | | | |
| Parasitic jaeger | | | | | | | | |
| Jaeger, sp. | | | | | | | | |
| Glaucous gull | 2 | 1 | 70 | 73 | 1 | | 103 | 104 |
| Arctic tern | | | | | | | | |
| No. of taxa | 5 | 4 | 4 | 8 | 6 | 3 | 5 | 9 |
| Total no. of birds observed | 163 | 286 | 253 | 702 | 208 | 1741 | 333 | 2282 |
| Area sampled (km²) | | | 2.69 | | | | 2.01 | |
| Bird density | 61 | 106 | 94 | 261 | 103 | 866 | 166 | 1135 |

Table 2. Summary of 1981 aeriel surveys of 11 selected Coastal Lagoons, Arctic National Wildlife Refuge, Alaska.

| | Brownlow-6.2 km$^2$ | | | | Tamayariak 7.5 km$^2$ | | | |
|---|---|---|---|---|---|---|---|---|
| Species | July 23, 1981 | August 4, 1981 | August 26, 1981 | September 18, 1981 | July 23, 1981 | August 4, 1981 | August 26, 1981 | September 18, 1981 |
| Old Squaw | 50 | 690 | 94 | 264 | 78 | 860 | 31 | 20 |
| Glaucous Gull | 2 | 7 | 5 | 85 | 1 | 22 | 1 | 258 |
| Eider sp. | | | | | 1 | 75 | | 37 |
| Red-throated loon | | | 1 | | | 2 | | |
| Arctic tern | | | | | | 1 | | |
| Phalarope sp. | | | | | | 2 | | |
| Shorebird | | | | | | 2 | | |
| Arctic loon | | 1 | 2 | | | | | |
| Loon Sp. | | | 3 | | | | | |
| Total | 52 | 698 | 105 | 349 | 80 | 964 | 32 | 315 |
| Density(Birds/km$^2$) | 8 | 113 | 17 | 56 | 11 | 129 | 4 | 42 |
| Number of species | 2 | 3 | 5 | 2 | 3 | 7 | 2 | 3 |

| | Simpson Cove 6.7 km$^2$ | | | | Arey Lagoon 5.4 km$^2$ | | | |
|---|---|---|---|---|---|---|---|---|
| | July 23, 1981 | August 4, 1981 | August 26, 1981 | September 18, 1981 | July 23, 1981 | August 4, 1981 | August 26, 1981 | September 18, 1981 |
| Old Squaw | 180 | 1164 | 47 | Not | 267 | 461 | 97 | 1209 |
| Glaucous Gull | | | 3 | | 4 | 3 | 21 | 871 |
| Red-throated loon | | 9 | | Separated | 1 | 2 | | |
| Eider sp. | | | | | | 7 | | |
| Phalarope sp. | | | | | | 85 | | |
| Arctic loon | | 3 | | | | 2 | | |
| Loon sp | | | | | | 2 | | |
| Small Shorebird | | | 30 | | | | | |
| Total | 180 | 1176 | 80 | - | 272 | 562 | 118 | 2080 |
| Density(- Birds/km$^2$) | 27 | 176 | 12 | | 50 | 104 | 22 | 385 |
| Number of species | 1 | 3 | 3 | | 3 | 7 | 2 | 2 |

| | Jago Lagoon 2.7 km$^2$ | | | | Tapkaurak Lagoon 4.3 km$^2$ | | | |
|---|---|---|---|---|---|---|---|---|
| | July 22, 1981 | August 3, 1981 | August 24, 1981 | September 18, 1981 | July 22, 1981 | August 3, 1981 | August 24, 1981 | September 18, 1981 |
| Old Squaw | 615 | 585 | 484 | 21 | 2149 | 1082 | 97 | 17 |
| Glaucous Gull | 2 | 3 | 7 | 43 | 21 | | | 55 |
| Pintail | 1 | | | | | | | |
| Arctic loon | 2 | | | | | | | |
| Loon sp. | 1 | 3 | | | 1 | | | |
| Scoter sp. | | | | | 1 | | | |
| Arctic tern | | | 1 | | | | | |
| Com. Eider | | | | 2 | | | | |
| W.W. Scoter | | | | 1 | | | | |
| Red-breasted merganser | | | | | | | | 2 |
| Total | 621 | 591 | 492 | 67 | 2172 | 1082 | 97 | 74 |
| Density(-Birds/km$^2$) | 230 | 219 | 182 | 25 | 505 | 252 | 23 | 17 |

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Table 2. (Cont'd)

| | Nuvagapak Lagoon 5.9 km$^2$ | | | | Egakerak Lagoon 2.7 km$^2$ | | | |
|---|---|---|---|---|---|---|---|---|
| | July 22, 1981 | August 3, 1981 | August 24, 1981 | September 18, 1981 | July 22, 1981 | August 3, 1981 | August 24, 1981 | Sepetmber 18 1981 |
| Old Squaw | 494 | 435 | 586 | 6 | 101 | 299 | 56 | 6 |
| Duck sp. | 4 | 1 | | | 4 | | | |
| Glaucous Gull | 2 | 4 | 26 | 81 | 8 | 5 | | 8 |
| Arctic tern | 1 | | | | | | | |
| Arctic loon | 2 | | 1 | | | | | |
| Com. Eider | | | | | 10 | | | |
| White Swan | | | | | 16 | | | |
| Medium Shorebird | | | | | 5 | | | |
| Scamp sp. | | | | | | 1 | | |
| Loon sp. | | 2 | | | | 1 | | |
| Pintail | | | 25 | | | | | |
| Total | 503 | 442 | 638 | 87 | 144 | 306 | 56 | 14 |
| Density (-Birds/km$^2$) | 85 | 75 | 108 | 15 | 53 | 113 | 21 | 5 |
| Number of species | 5 | 4 | 4 | 2 | 6 | 4 | 1 | 2 |

| | Oruktalik Lagoon 2.2 km$^2$ | | | | Pokok Lagoon 2.0 km$^2$ | | | |
|---|---|---|---|---|---|---|---|---|
| | July 22, 1981 | August 3, 1981 | August 24, 1981 | September 18, 1981 | July 22, 1981 | August 3, 1981 | August 24, 1981 | September 18, 1981 |
| Old Squaw | 1828 | 517 | 9 | 35 | 7 | 36 | 1 | |
| Glaucous Gull | 21 | 5 | | 3 | | | | 23 |
| Eider sp. | 1 | | | | | | | |
| Scoter sp. | 1 | 2 | | | | | | |
| Yellow-billed loon | 1 | | | | 2 | | | |
| Loon sp. | 1 | | | | | 1 | 1 | |
| Phalarope sp. | | 1 | | | | | | |
| Total | 1853 | 525 | 9 | 38 | 9 | 37 | 2 | 23 |
| Density(-Birds/km$^2$) | 842 | 239 | 4 | 17 | 5 | 19 | 1 | 12 |
| Number of species | 6 | 4 | 1 | 2 | 2 | 2 | 2 | 1 |

| | Demarcation 2.0 km2 | | | |
|---|---|---|---|---|
| | July 22, 1981 | August 3, 1981 | August 24, 1981 | September 18, 1981 |
| Old Squaw | 1272 | 726 | 864 | No Separation |
| Eider sp. | 1 | 11 | | |
| Scaup sp. | 10 | | | |
| Glaucous Gull | 3 | 1 | 2 | |
| Arctic tern | 1 | | | |
| Arctic loon | 1 | 1 | | |
| Loon sp. | | 1 | | |
| Sooter sp. | | 2 | | |
| Total | 1288 | 742 | 866 | -- |
| Density Birds/km$^2$ | 644 | 371 | 433 | |
| Number of species | 6 | 6 | 2 | |

However, only a total of all bird species encountered was recorded. (Table 3)

Fig. 1 portrays 3 years of surveys with density of all bird species combined for the 11 lagoons. The 1978 data shows an increase in bird numbers early in the season. The peak is unknown. Data for 1980 indicate peak bird densities on the lagoons about 2 weeks later than 1981. This is probably a result of earlier ice-out in 1981. A second smaller peak is shown for the last survey of 1981.

Oldsquaw densities, also, peaked about 2 weeks later in 1980 than in 1981 (Fig. 2). Glaucous gulls increased in density in the lagoons in 1980 and 1981 (Fig. 3.). Loons and phalaropes both show peaks of density later in 1980 than in 1981 (Fig. ~~5~~ 4 and 5).

Eiders and scoters show densities with 2 peaks (Fig. ~~4~~ 6 and 7). This probably reflects the migration of males several weeks before females and young.

These data illustrate that bird use in the coastal lagoons is very seasonal from year to year. Peak use by all birds and, particularly, oldsquaw and the other key species can vary by over 2 weeks. The graphs, also, illustrate that the lagoons are important to migratory birds throughout the period when open water is present.

An attempt was made to rank the 11 selected lagoons in order of importance to birds. This ranking scheme considers density, absolute number of birds present, and the number of species present. Obviously, a habitat with a high bird density that is limited in size and/or involves few individuals or species is not as important as a habitat of high bird density, with high population levels and high species richness. Eleven selected coastal lagoons were ranked according to importance for bird use on ANWR. This scheme gives equal weight to total number of individuals present, density levels, and species or taxa present using data from 9 aerial surveys conducted in 1978, 1980 and 1981 (Table 4). The population data were derived from the 400 m wide transect strip adjacent to the barrier island. In most cases, this area represented only a fraction of the total lagoon surface area. Therefore, all of the estimates should be considered a minimum.

Five of the eleven lagoons exhibited bird densities of over 100 birds/$Km^2$. Seven out of eleven lagoons supported an average of over 350 birds per survey. As mentioned earlier, the surveys utilize only a fraction of the lagoon surface area. Therefore, this ranking is tenative as the lagoon survey technique will be refined. However, the data suggest the great importance of the coastal lagoon to migratory birds.

Since the oldsquaw is the most numerous migratory bird utilizing the lagoons, a separate ranking of lagoon use was made for this species. Only surveys from 1980 and 1981 delineated oldsquaw separately from all birds. Therefore, the ranking utilizes only these 2 years and the ranking is made for density per survey and mean number per survey (Table 5).

The ranking within the 11 lagoons changed somewhat for oldsquaw, but 7 of 9 lagoons supported an average of over 300 oldsquaws per survey.

Table 3 Summary of Aerial Survey Data for all bird species on eleven selected Coastal Lagoons, Arctic Wildlife Refuge, Alaska. 1978, 1980, 1981

| | Lagoon | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Brownlow | Tamayariak | Simpson | Arey | Jago | Tapkaurak | Oruktalik | Pokok Lag. | Nuvagapak | Egakerak | Demarcation |
| Density - Birds/km$^2$ (all species): | | | | | | | | | | | |
| July 5, 1978 | 31 | 13 | 42 | 0 | 24 | 61 | 239 | 69 | 47 | 39 | 197 |
| July 22, 1978 | 109 | 115 | 52 | 45 | 55 | 138 | 214 | 7 | 112 | 74 | 476 |
| August 1, 1981 | 16 | 33 | 238 | 286 | 194 | 76 | 207 | 41 | 160 | 61 | 104 |
| August 20, 1980 | 104 | 548 | 304 | 48 | 42 | 68 | 165 | 0.5 | 134 | 106 | 866 |
| September 10, 1980 | 54 | 32 | 11 | 35 | 491 | 72 | 366 | 9 | 55 | 94 | 170 |
| July 22, 1981 | 8 | 80 | 27 | 50 | 230 | 505 | 842 | 5 | 85 | 53 | 644 |
| August 3, 1981 | 113 | 964 | 176 | 104 | 219 | 252 | 239 | 19 | 75 | 113 | 371 |
| August 24, 1981 | 17 | 32 | 12 | 22 | 182 | 23 | 4 | 1 | 108 | 21 | 433 |
| September 18, 1981 | 56 | 315 | Not Done | 385 | 25 | 17 | 17 | 12 | 15 | 5 | Not Done |
| X̄ | 56 | 237 | 108 | 108 | 162 | 135 | 255 | 18 | 88 | 63 | 408 |
| Total Individuals: | | | | | | | | | | | |
| July 5, 1978 | 194 | 101 | 284 | 0 | 65 | 262 | 529 | 138 | 279 | 104 | 395 |
| July 22, 1978 | 671 | 868 | 347 | 240 | 149 | 594 | 461 | 13 | 660 | 200 | 956 |
| August 1, 1980 | 100 | 249 | 1599 | 1535 | 523 | 327 | 446 | 82 | 948 | 163 | 208 |
| August 20, 1980 | 643 | 4123 | 2040 | 259 | 112 | 293 | 355 | 1 | 792 | 286 | 1741 |
| September 10, 1980 | 335 | 237 | 74 | 185 | 1321 | 308 | 787 | 17 | 326 | 253 | 333 |
| July 22, 1981 | 52 | 80 | 180 | 272 | 621 | 2172 | 1853 | 9 | 503 | 144 | 1288 |
| August 3, 1981 | 698 | 964 | 1176 | 562 | 591 | 1082 | 525 | 37 | 442 | 306 | 742 |
| August 24, 1981 | 105 | 32 | 80 | 118 | 492 | 97 | 9 | 2 | 638 | 56 | 866 |
| September 18, 1981 | 349 | 315 | Not Done | 2080 | 67 | 74 | 38 | 23 | 87 | 14 | Not Done |
| Total | 3147 | 6969 | 5780 | 5251 | 3941 | 5209 | 5003 | 322 | 4675 | 1526 | 6529 |
| X̄ | 350 | 774 | 723 | 583 | 438 | 579 | 556 | 36 | 519 | 170 | 816 |
| Number of taxa | | | | | | | | | | | |
| July 5, 1978 | 3 | 2 | 4 | 0 | 3 | 4 | 3 | 5 | 5 | 3 | 4 |
| July 22, 1978 | 6 | 7 | 9 | 4 | 6 | 3 | 1 | 3 | 5 | 6 | 5 |
| August 1, 1978 | 4 | 2 | 3 | 5 | 6 | 1 | 4 | 3 | 5 | 5 | 6 |
| August 20, 1980 | 5 | 5 | 4 | 5 | 5 | 5 | 2 | 1 | 7 | 4 | 3 |
| September 10, 1980 | 4 | 6 | 6 | 4 | 3 | 4 | 4 | 5 | 7 | 4 | 5 |
| July 22, 1981 | 2 | 3 | 1 | 3 | 5 | 4 | 6 | 2 | 5 | 6 | 6 |
| August 3, 1981 | 3 | 7 | 3 | 7 | 3 | 1 | 4 | 2 | 4 | 4 | 6 |
| August 24, 1981 | 5 | 2 | 3 | 2 | 3 | 1 | 1 | 2 | 4 | 1 | 2 |
| September 18, 1981 | 2 | 3 | - | 2 | 4 | 3 | 2 | 1 | 2 | 2 | - |
| X̄ No. taxa | 3.8 | 4.1 | 4.1 | 3.6 | 4.2 | 2.9 | 3 | 2.7 | 4.9 | 3.9 | 4.6 |
| No. different taxa | 7 | 4.5 | 4.5 | 8 | 3 | 10 | 9 | 11 | 1 | 6 | 2 |

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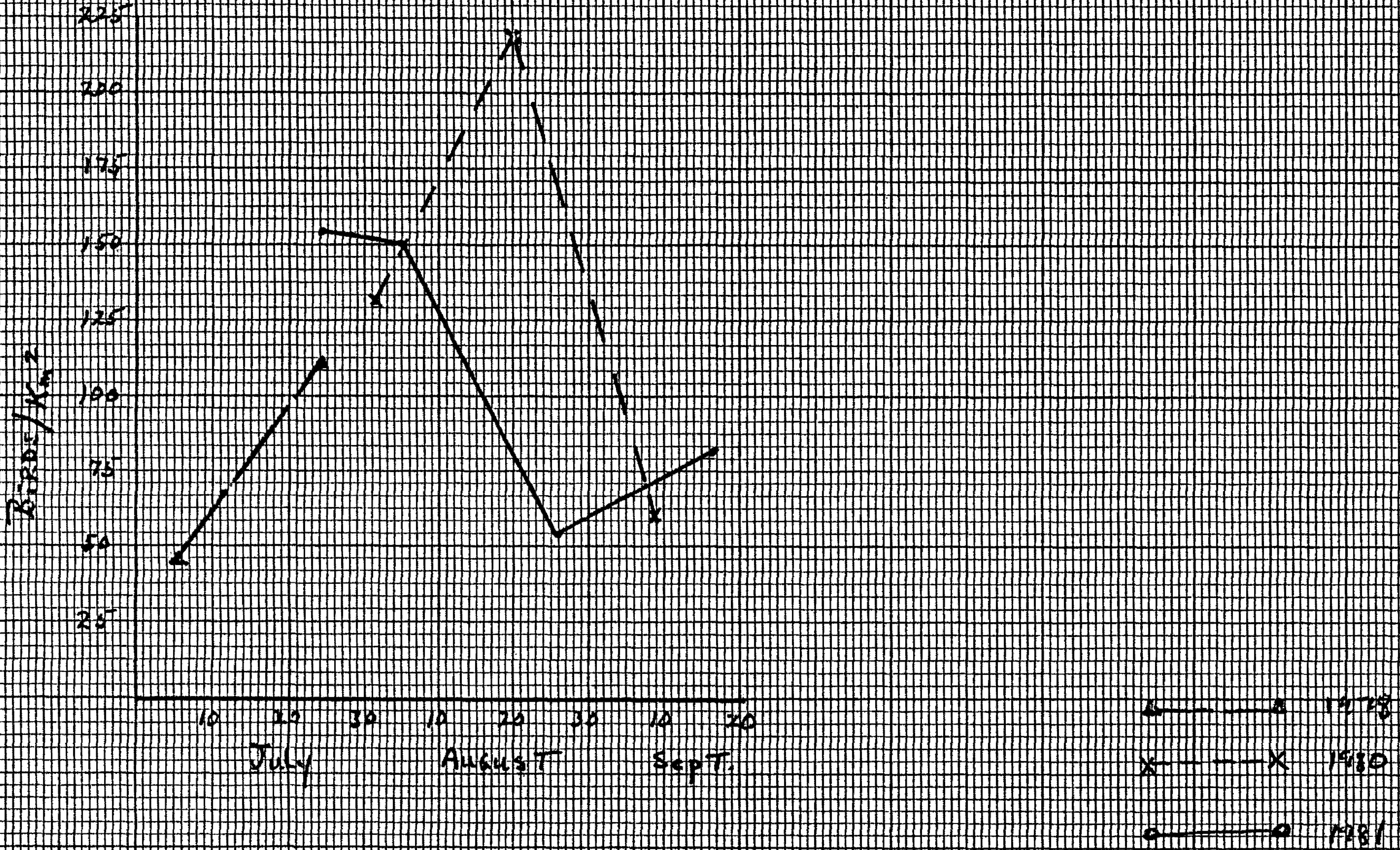

Figure 1. Seasonal abundance of all bird species combined for ~~[illegible]~~ eleven selected lagoons of Arctic National Wildlife Refuge, Alaska ~~[illegible]~~
1978, 1980, 1981

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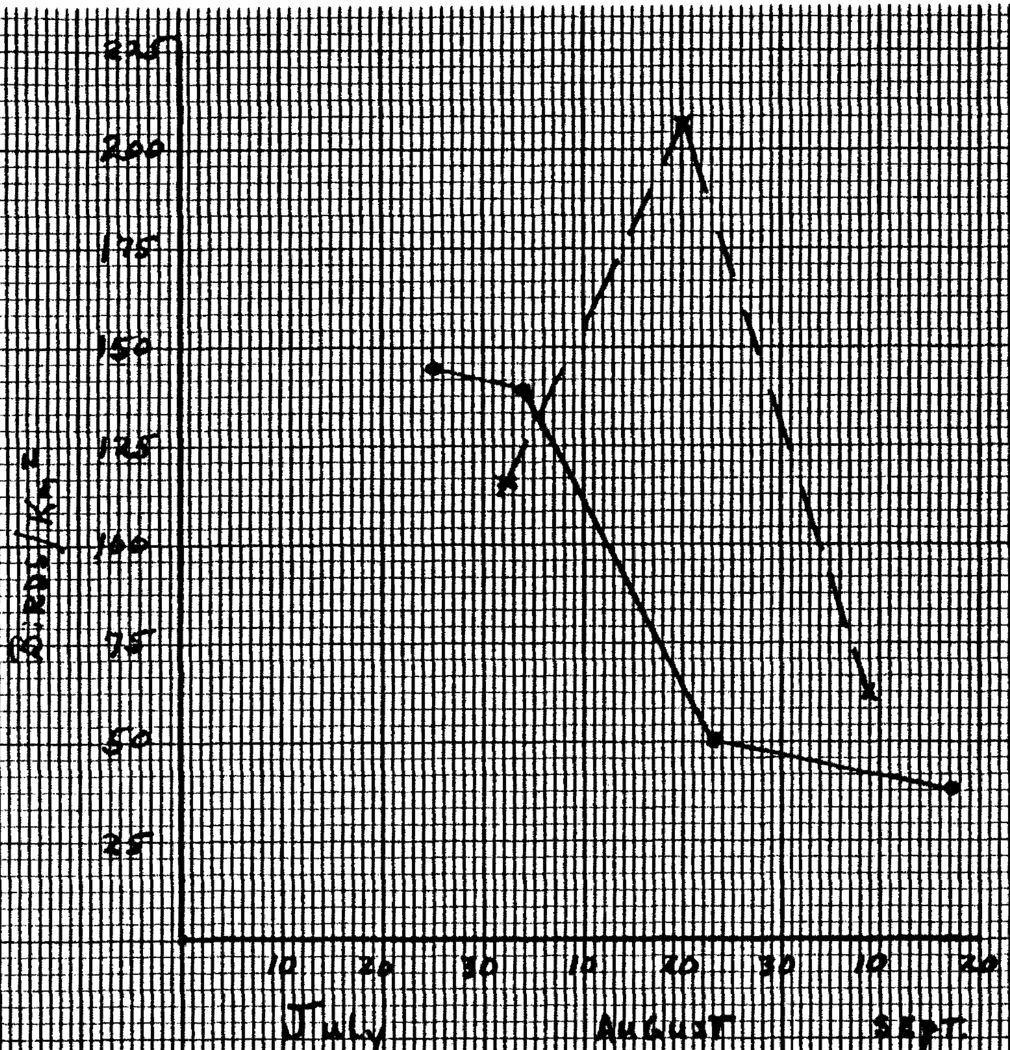

OLDSQUAW USE OF ELEVEN SELECTED COASTAL LAGOONS

FIG. 2.

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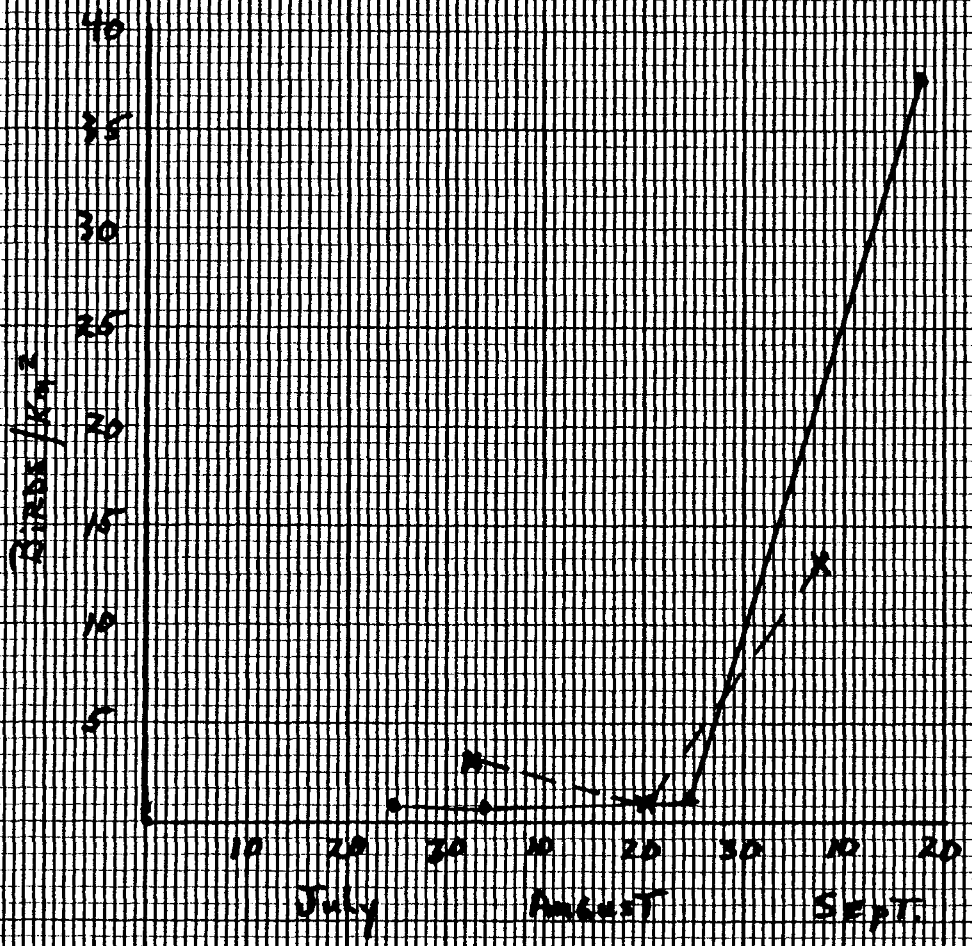
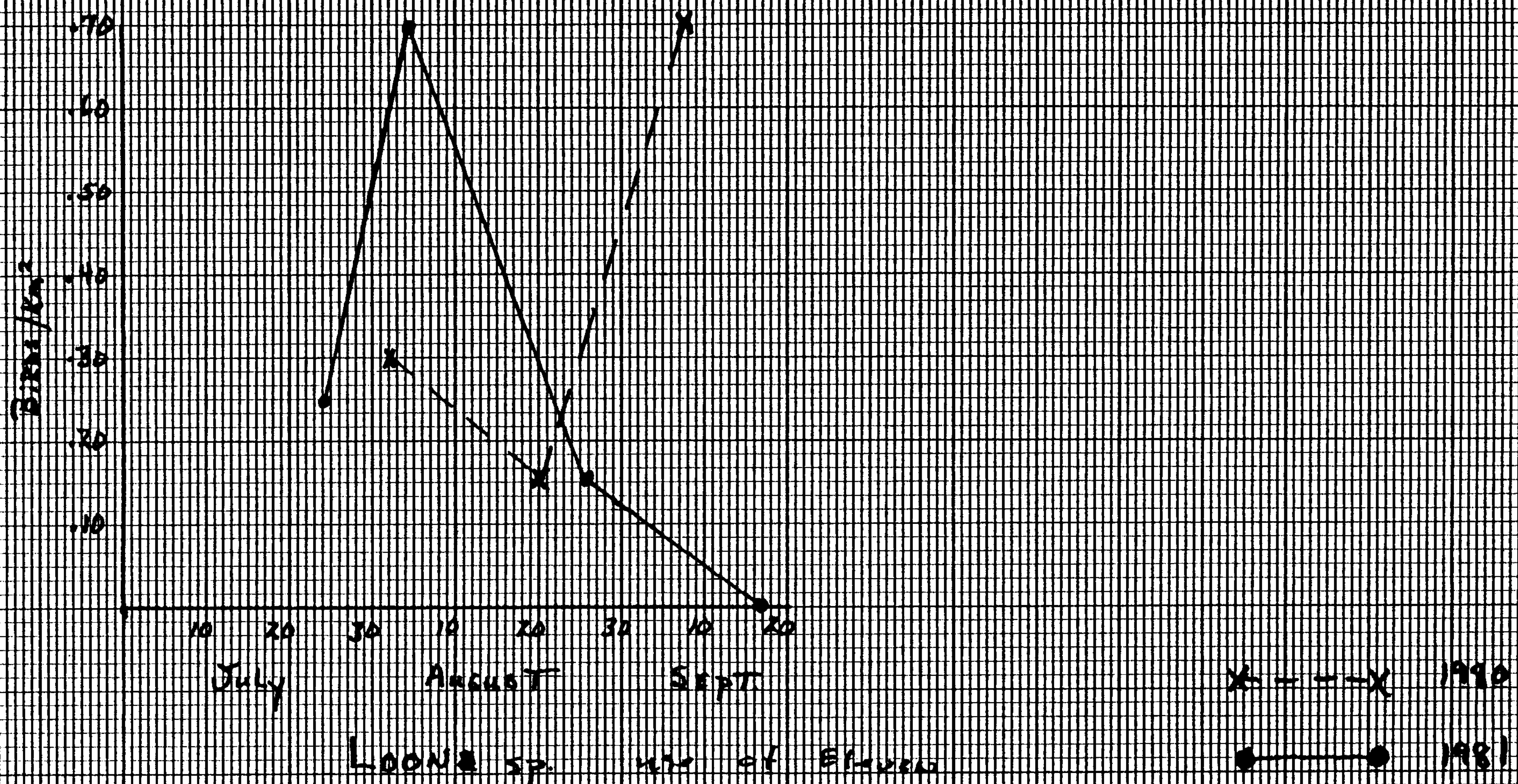


GLAUCOUS GULL USE OF ELEVEN
SELECTED COASTAL LAGOONS

FIG. 3



LOONS SP. USE OF [illegible]
SELECTED COASTAL LAGOONS

FIG. 4

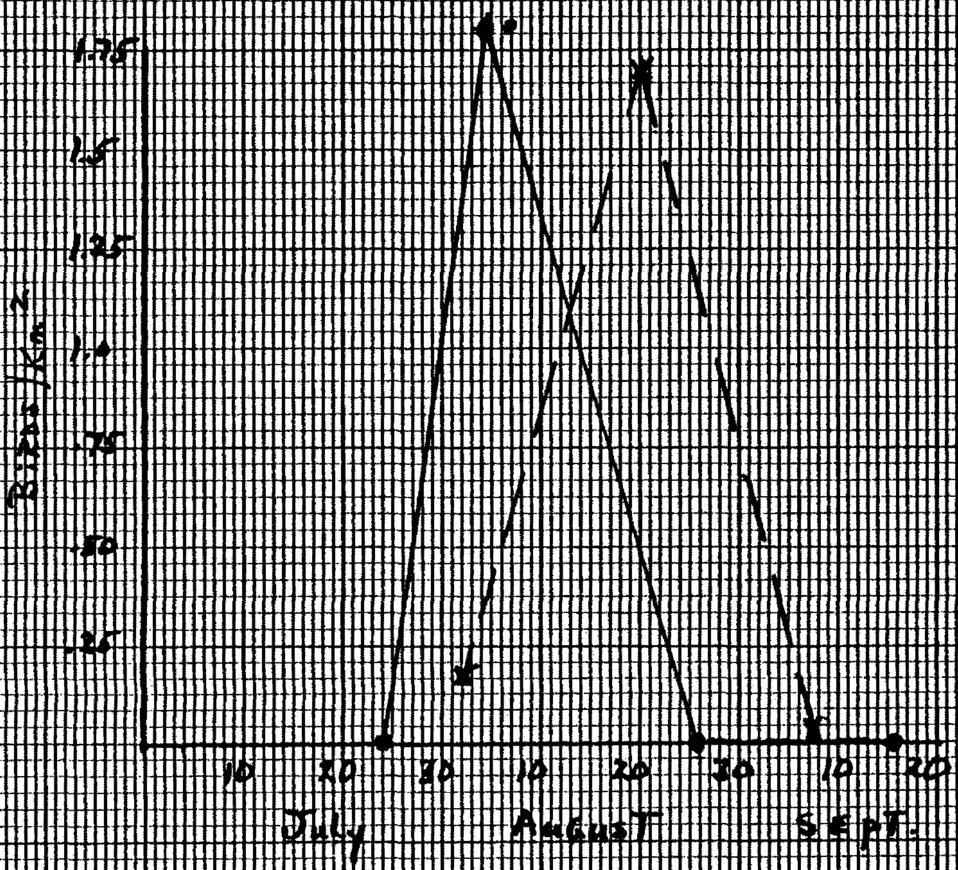


FIG 5. PHALAROPE SP. USE OF ELEVEN SELECTED COASTAL LAGOONS.

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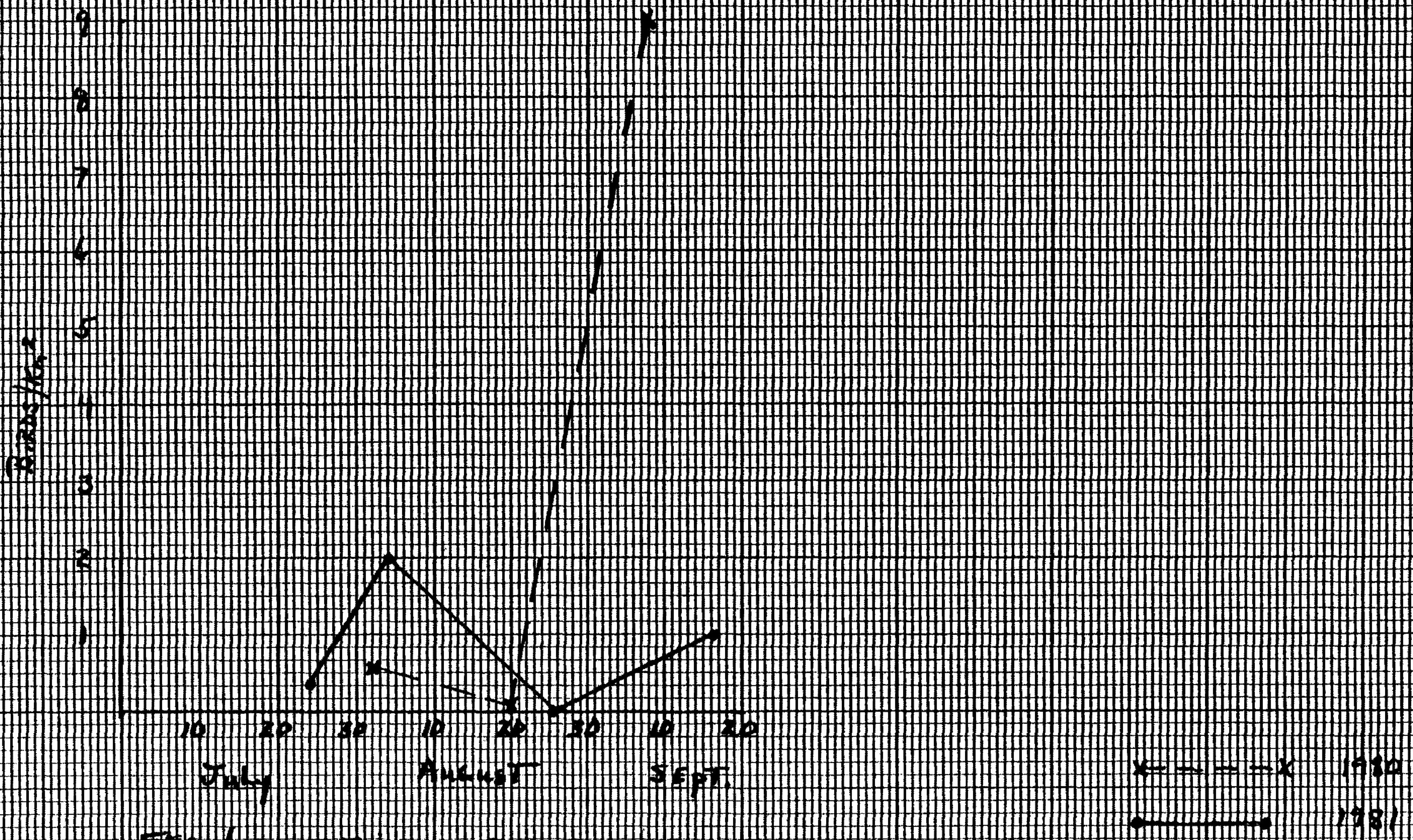

FIG 6 EIDER sp. use of eleven selected coastal lagoons

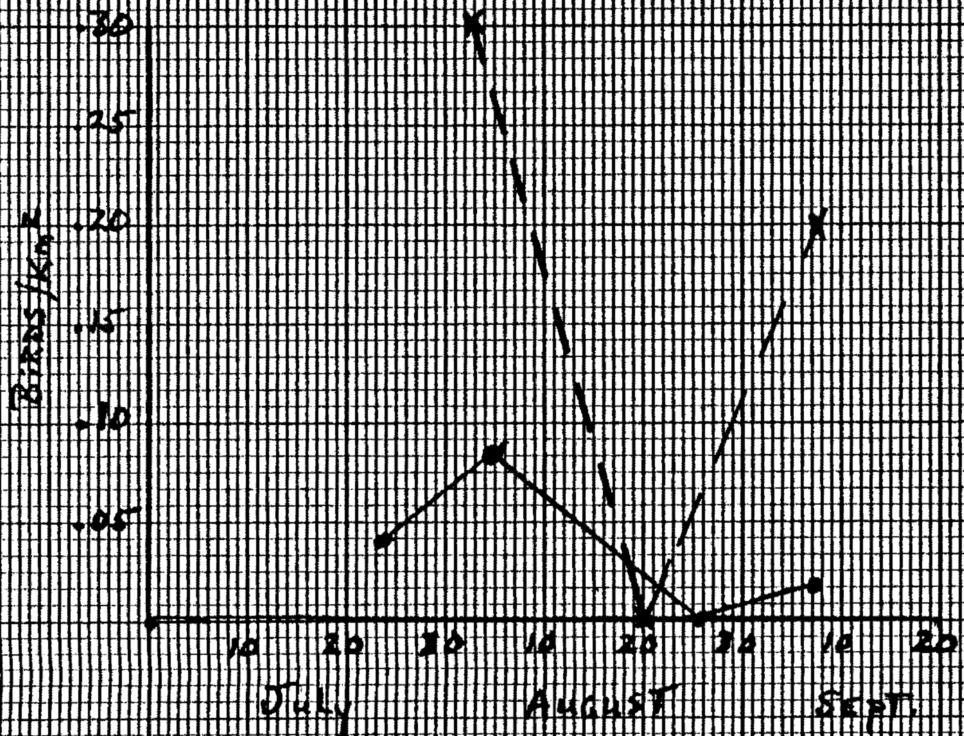

FIG 7 SCOTER sp. USE OF ELEVEN SELECTED COASTAL LAGOONS.

Table 4 Importance ranking of selected coastal lagoon units according to mean rank in bird population, density, and species richness. Arctic National Wildlife Refuge, Alaska, 1978, 1980 & 1981.

| Lagoon | Mean Density /Survey Birds/km$^2$ | Rank | Mean No. Birds/ /Survey | Rank | Mean No. Taxa /Survey | Rank | Overall Mean Rank |
|---|---|---|---|---|---|---|---|
| Demarcation Bay | 408 | 1 | 816 | 1 | 4.6 | 2 | 1.3 |
| Tamayariak | 237 | 3 | 774 | 2 | 4.1 | 4.5 | 3.2 |
| Simpson Cove | 108 | 6.5 | 723 | 3 | 4.1 | 4.5 | 4.7 |
| Jago | 162 | 4 | 438 | 8 | 4.2 | 3 | 5.0 |
| Nuvagapak | 88 | 8 | 519 | 7 | 4.9 | 1 | 5.3 |
| Oruktalik | 255 | 2 | 556 | 6 | 3 | 9 | 5.7 |
| Arey | 108 | 6.5 | 583 | 4 | 3.6 | 8 | 6.2 |
| Tapkaurak | 237 | 3 | 579 | 5 | 2.9 | 10 | 6.7 |
| Egaksrak | 63 | 9 | 170 | 10 | 3.9 | 6 | 8.3 |
| Brownlow | 56 | 10 | 350 | 9 | 3.8 | 7 | 8.7 |
| Pokok Lagoon | 18 | 11 | 36 | 11 | 2.7 | 11 | 11 |

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Table 5 Importance ranking of eleven selected lagoons for oldsquaw use. Arctic National Wildlife Refuge, Alaska, 1980 & 1981.

| Lagoon | Mean Density /Survey Oldsquaw/km$^2$ | Rank | Mean No. Oldsquaw /Survey | Rank | Mean Rank |
|---|---|---|---|---|---|
| Demarcation Bay | 418 | 1 | 837 | 2 | 1.5 |
| Simpson Cove | 125 | 5 | 840 | 1 | 3 |
| Oruktalik | 256 | 2 | 564 | 5 | 3.5 |
| Tapkaurak | 141 | 4 | 608 | 4 | 4 |
| Tamayariak | 92 | 7 | 692 | 3 | 5 |
| Jago | 168 | 3 | 455 | 8 | 5.5 |
| Arey | 101 | 6 | 545 | 6 | 6 |
| Nuvagapak | 80 | 8 | 473 | 7 | 7.5 |
| Brownlow | 49 | 10 | 303 | 9 | 9.5 |
| Egaksrak | 55 | 9 | 149 | 10 | 9.5 |
| Pokok Lagoon | 4 | 11 | 8 | 11 | 1.1 |

Six of eleven lagoons exhibited densities of over 100 birds/$Km^2$.

## OFFSHORE

The species with the highest observed density in the offshore transects (generally 0-400 meters offshore of the barrier islands) was oldsquaw. Second in density was glaucous gull. This held for all 1980 surveys and all but the Sept. 18, 1981 survey (Table 6). Duriong the Sept. 18, 1981 survey glaucous gulls were more numerous than oldsquaw. Total density ranged from 13 birds/$km^2$ on the August 24 & 26, 1981 survey to 48 birds/$km^2$ on September 9-10, 1980 survey.

Offshore bird use was not as consistent as in lagoons. In both 1980 and 1981 there was an increase in bird density during the September survey (Fig. 8). In 1980, oldsquaws were the major reason for this increase. Possibly post-molting male birds move to the offshore areas to feed as observed by Johnson and Richardson (1980) at Simpson lagoon. In 1981, glaucous gulls increases dramatically during the Sept. survey. Oldsquaw use peaked about 30 days earlier in 1981 then in 1980 (Fig. 8). Other lagoon data suggested an early season in 1981.

In summary, the limited offshore data suggest that this area does not exhibit as high a level of bird use as the coastal lagoon system. However, the offshore area does host considerable bird use. As with the lagoons, the use can vary a great deal within a particular season and from year to year.

These limited data suggest that the coastal lagoons of the ANWR are very important to migratory birds. The use of the lagoons is greatest during the open water period, but also use continues from initial river overflow onto lagoon ice until freezing.

In subsequent seasons the surveys of these lagoons should be continued and expanded to cover the entire lagoon surface. Studies investigating physical factors such as lagoon depth, activity, etc. when coupled with samples of epibenthic invertebrates will give a better understanding of why particular lagoons are more heavily utilized.

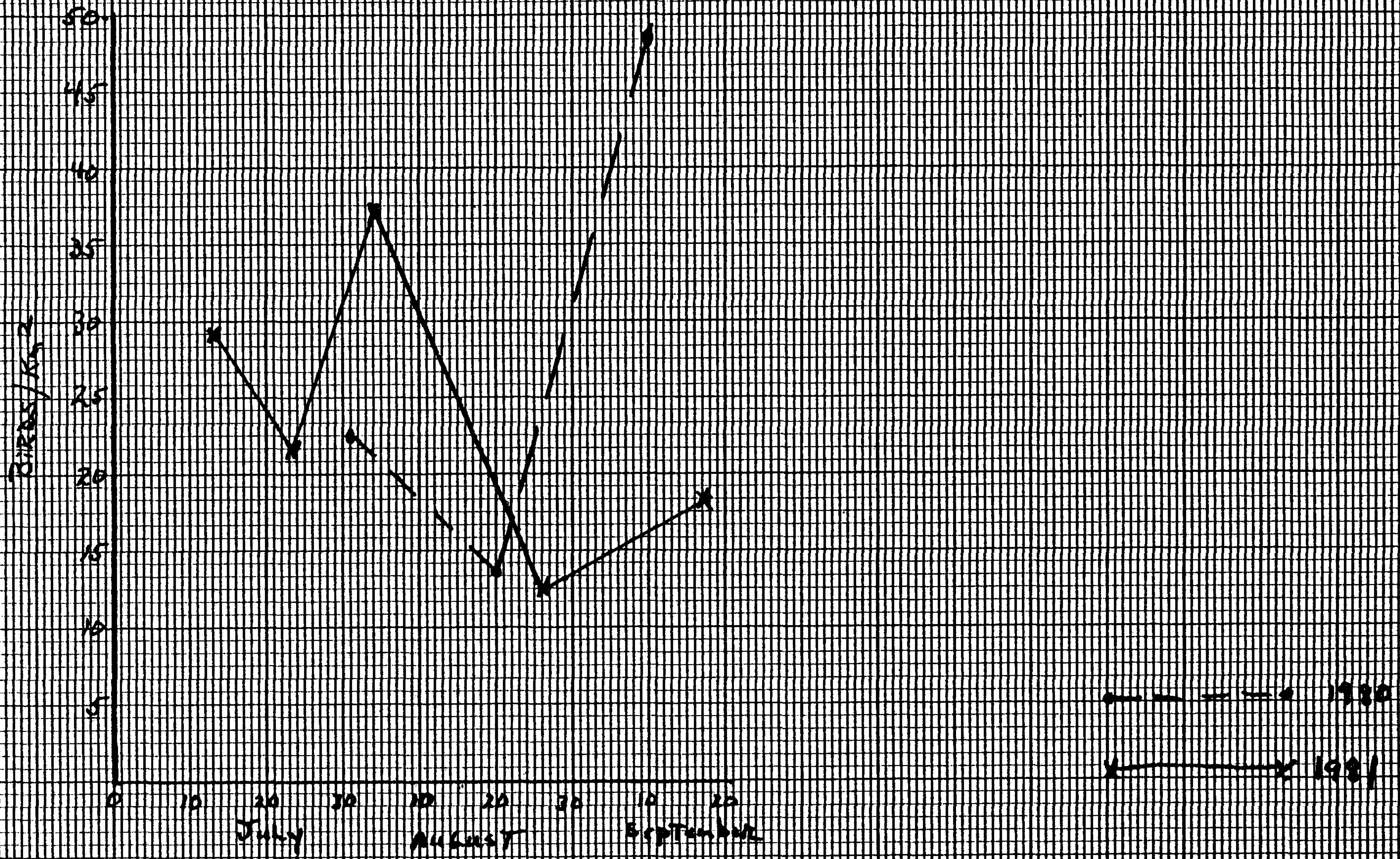

FIG. 8 Seasonal abundance of all bird species combined for offshore waters of Arctic National Wildlife Refuge, Alaska, 1980-1981.

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# Chapter V.

# MAMMALS

## Caribou (*Rangifer tarandus granti*)

### Introduction

Early biological studies of caribou in Alaska were initiated by E.W. Nelson (1887) and Olaus Murie (1935) and in Canada by C.H.D. Clark (1940). For the most part these early efforts were general in nature, and concentrated on basic life history studies. The use of airplanes to survey caribou populations and map distributions began in the late 1930's in Alaska (White and Rhode 1939) and in the 1940's in Canada (Banfield 1954). Aerial survey techniques were further developed and refined during the 1940's and 1950's (Watson and Scott 1956, Banfield et al. 1955; Olson 1957). As a result of these pioneering efforts, information on the distribution, movements and populations of caribou in northeastern Alaska began to increase (Scott et. al. 1950, Munro 1953).

When large oil and gas reserves were found at Prudhoe Bay, Alaska and in the western Canadian Arctic over a decade ago, the welfare of large herds of barren ground caribou became an issue of concern as plans were being made for industrial development in the Arctic. To satisfy concerns for the caribou as well as other species, major investigations were undertaken by government and industry. In 1970 caribou studies were intitiated in northeastern Alaska and northern Yukon by Renewable Resources Consulting Services Ltd. (under contract with Canadian and Alaskan Gas Consortiums) and Interdisciplinary Systems Ltd. (for the Environmental Protection Board of Canada). The Alaska Department of Fish and Game and the Candian Wildlife Service also began caribou studies in the region in 1972. From these studies came the first in-depth documentation of the distribution, chronology of migration, migration routes, habitat use and population dynamics of caribou in northeastern Alaska. Industry sponsored caribou studies continued through 1975-76 while varying levels of govenment efforts have continued to the present time.

Investigations at Prudhoe Bay on the effect of the Trans-Alaska Pipeline, haul road and oilfield complex on the Central Arctic Caribou Herd was started in 1974 by the Alaska Dept. of Fish and Game (Cameron and Whitten 1976). This ongoing effort has yielded significant information on the reactions of caribou to oil and gas development and promises to be of considerable value in the future.

As a result of these previous studies, the body of information dealing with caribou in the region of the study area is fairly large. Of particular significance is the historical analysis provided by Skoog (1968) and further historical examinations by LeResche (1972). A valuable update on distribution and movement of Alaskan caribou was developed by Hemming (1971). Much of the recently collected data on the Porcupine caribou herd has been assembled by Calef (1974), LeBlond (1977), Curatolo and Roseneau (1977), Roseneau and Thompson (1978), Davis (1978, 1979), Kelsall and Klein (1979) and U.S. Dept. of State (1980). Finally, Kelsall and Bisdee (1980), have compiled on impressive annotated bibliography featuring 682 cross-referenced entries on the Porcupine caribou herd and its range.

Barren ground caribou have inhabited northeastern Alaska and northern Yukon for at least 54,000 years (Harington 1977). Evidence of human use of caribou in the region of the ANWR study area has been found dating back some 27,000 years (Irving 1968). Remnants of caribou fences and corral structures used by Kutchin Indians can be found throughout much of the current southern range of the Porcupine caribou herd (Roseneau 1974). Stone fences used for the deflection and ambush of migrating caribou by Eskimos can be found in the northern foothills to the Brooks Range (see Chapter VII, Archaeology and Early History).

The first written reference of caribou in the study area is that of Franklin's exploration of the arctic coast of northeastern Alaska in 1825-27 (Franklin 1828). Later expeditions to the region by Dease and Simpson (1838), and Ibister (1845) confirm that caribou were abundant in the region. Caribou were used heavily by overwintering whalers at Herschel Island during the mid-to-late 1800's (Stone 1900). In an extensive review of historical records of Alaskan caribou herds Skoog (1968) surmized that the northeastern Alaska-northern Yukon caribou population was at a high level prior to 1900. In the early 1900's these caribou shifted their range away from the arctic coast and more to the west (Skoog 1968). Caribou from the McKinley and Fortymile herds moved into the area during the 1920's. Skoog (1968) reported a decrease in caribou numbers in the 1940's with a gradual build up in the 1950's. An interchange of caribou from the Fortymile herd was observed in 1964. However, it could not be determined if it was a permanent emigration (Skoog 1968). Although early accounts from which Skoog made the preceding summaries are sketchy and accurate population estimates were not possible, they indicate that the caribou herd inhabited northeastern Alaska and northern Yukon in a manner similar to current distributions, movements, and annual cycles (LeResche 1972, Calef 1974, Roseneau et.al. 1974). This population of caribou is called the Porcupine herd.

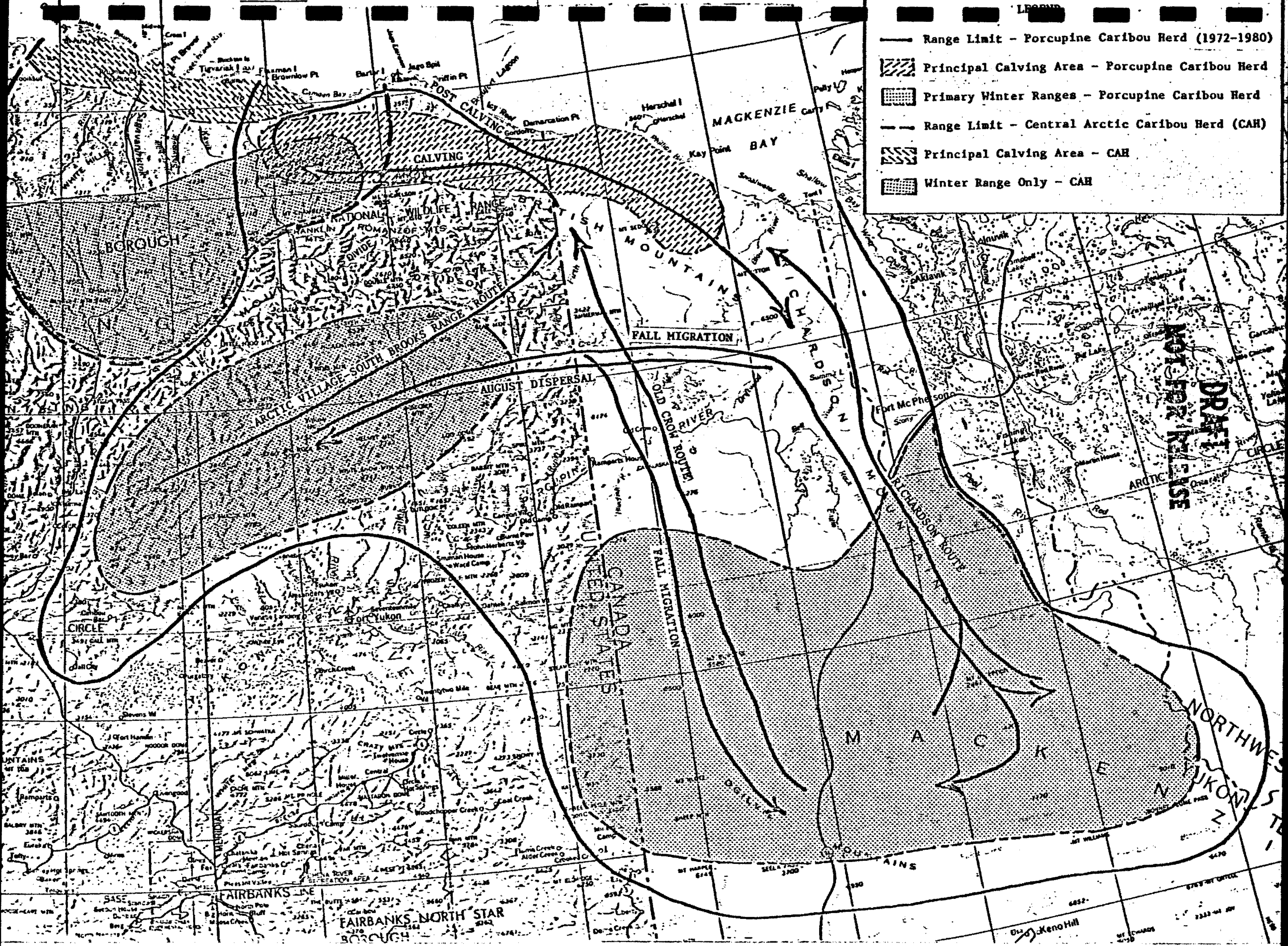
As investigations of caribou intensified in the Prudhoe Bay area as well as northeastern Alaska it became clear that a separate, previously undescribed herd (the Central Arctic Herd) occupies the region from the Colville River to slightly east of the Canning River (Cameron and Whitten 1976, 1979a). Currently these two caribou herds, the Porcupine herd and Central Arctic herd use the study area during various periods of the year (Fig. 1).

## Porcupine Herd

### Size, range and distribution

The Porcupine caribou herd currently numbers about 110,000 individuals (Whitten and Cameron 1980) and ranges over an area of about 250,000 km$^2$ (Mair and I. Cowan 1980). Seven distinct phases based upon behavior and distribution have been identified in the annual life cycle of caribou (Skoog 1968, Bergerud 1974[a]). The following sequence of annual life cycle phases for the Porcupine caribou herd are presented to develop an understanding of the herd's use of the study area within the context of its overall annual activities.

FIGURE 1. RECENT RANGES OF THE PORCUPINE AND CENTRAL ARCTIC CARIBOU HERDS



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## Spring Migration

In early March the spring migration begins with a gradual drift by caribou towards the northern limits of their wintering areas (Calef 1974). It is believed that the timing and selection of routes for spring migrations are most likely due to snow conditions, topography, weather factors and the advancing pregnancy of the adult cows (Pruitt 1959, Henshaw 1968, Thompson 1978).

Three major spring migration routes: the Richardson, Old Crow and Arctic Village - South Brooks Range have been indentified (Figure 1). The extent a spring migration route is used in any given year depends on where wintering takes place (Thompson 1978). The Richardson route runs through the Richardson, Barn and British Mountain ranges and is usually used by caribou that have wintered in the area of the lower Wind, Bonnet Plume, Snake and Arctic Red Rivers of the Yukon and North West Territories. Caribou that have wintered in the Ogilvie Mountains (Hart, Ogilvie, Blackstone, Tatonduk and Kandik drainages) migrate north through the Keele Mountains, cross the Porcupine River in the vicinity of Old Crow and continue north through the Old Crow flats and over the British Mountains to the Firth River valley. When caribou winter in the Arctic Village-Chandalar Lake area of Alaska, the Arctic Village-South Brooks Range route is used which crosses the East Fork of the Chandalar River, Sheenjek and upper Coleen Rivers and follows the Firth River into Canada, joining there with the Old Crow route (Roseneau et. al. 1974). In years of light snow cover, caribou of the Arctic Village wintering area have been observed crossing northern mountain passes and moving directly to the calving grounds (Roseneau et. al. 1974).

Spring migrations usually come in two separate movements, the first being predominately pregnant females, the second consisting mainly of juveniles and bulls (Kelsall 1968). Typically, the first movement of caribou traveling the Richardson route reach the Blow River on the Arctic coast by mid-to-late May whereas the second movement is only beginning to cross the Peel River at this time (Thompson and Roseneau 1978). Similar time-space relationships occur during spring migration on the Old Crow and Arctic Village-South Brooks Range routes. During the spring migration caribou typically move in long, single-file lines, following wind-swept ridges and frozen lakes and rivers where the walking is usually less difficult and attacking predators are more easily detected (Thompson 1978, Kelsall 1968).

## Calving

The calving grounds of the Porcupine caribou herd are international - extending along the Arctic Foothills and Arctic Coastal Plain (up to 1,100 meters elevation) from approximately the Babbage River in Canada to the Canning River in Alaska (Figure 1).

A distinctive feature of the calving grounds of Alaskan caribou herds is that they are relatively snowfree (as compared to surrounding areas) at the time of calving (Lent and Lønø 1962, Skoog 1968). Lent (1980) confirmed earlier observations of this characteristic by analyzing snow melt patterns shown on satellite images. In the case of the Porcupine caribou herd Lent (1980) documented an area of early snow-melt along the arctic foothills from Herschel Island to the Canning River. This area of early snow melt corresponds with the identified area of calving activity for the Porcupine herd. The arctic

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foothills portion of the calving grounds is more wind-swept of snow and has less fog-cover in spring, which allows for an earlier melt-off than the frequently fog-covered coastal plain (Lent 1980; Calef and Lortie 1973). In addition the tussock (Eriophorum Sp.) communities which predominate in the foothills contribute to early melting and evaporation by virtue of their micro-topography (Benson 1969 cited in Lent 1980). Kuropat and Bryant (1980) described vegetative and nutirent phenology associated with calving and post-calving habitats which present distinct advantages for caribou. Traditional calving grounds are additionally advantageous due to the relative low density of wolves found there (Calef and Lortie, 1973).

The date of arrival of cows on the calving grounds varies annually depending on the location of previous wintering areas and snow conditions encountered along the migration routes. Table 1 (from Curatolo and Roseneau, 1977) illustrates variation in arrival dates for the Porcupine herd. In years of difficult snow conditions calving can occur along the migration routes (Lent, 1966). Some calving has occurred in the Old Crow flats, and upper Firth River area when migrations were delayed because of deep snow (Roseneau et al. 1974). When calving occurs along migration routes, the cows will continue to move northward and west toward the traditional calving areas as soon as the calves are able to travel (Hemming 1971).

Snow cover on the traditional calving grounds at the time of arrival also seems to influence the location(s) of major calving activity. Although calving occurs in a variety of habitats from wet tundra to dry ridges, most arriving cows seek out the dry, snow-free upland tussock (Eriophorum sp.) meadows of the foothills to give birth to their calves (Lent 1966, Skoog 1968, Calef 1974). Calving activity expands on to the coastal plain during the later part of the calving season as that area becomes snow free (Roseneau et al. 1974). Figure 2 a,b,c,: d, and ~~and~~ e ~~f~~ illustrate annual variations in the location of calving activity over the past ten years. It should be noted that in years such as 1975 when snow conditions along the migration routes were easy and arriving cows found a relatively snow-free calving grounds, nearly all of the Porcupine herd calved on the extreme western portion of the traditional area (Roseneau and Curatolo 1976, Surrendi and DeBock 1976). In 1972, a year of deep snow on the migration routes and limited snow-free areas on the western calving grounds, most calving activity occurred in the northern Yukon and along the foothills from the international border to the Jago River area (Calef and Lortie 1973).

Major calving concentrations occurred in the study area (1974, 1975) between Camden Bay and the Sadlerochit Mtns. (from the Tamayariak River on the west to Marsh Creek on the east) and (1972, 1975, 1976) along the foothills from the Sadlerochit River to the Aichilik River. Scattered calving activity has occurred throughout much of the coastal plain of the study area from the Canning River to the Aichilik River.

Although there is considerable variation in where calving occurs, there is little difference from year to year as to when it occurs. The first calf of the season is usually observed in the last week of May. The peak of calving occurred between June 5 and 9 during the period of 1971-76 (Curatolo and Roseneau, 1977). Calving is usually complete by June 18.

Caribou cows arrive on the calving grounds travelling in small groups which are constantly changing in size and composition (Kelsall, 1968). The animals

Table 1. Date of first arrival of caribou on the Alaskan portion of the calving grounds of the Porcupine caribou herd.*

| Winter | Arrival Date[1] | Snow Cover (estimated) | Wintering Area[2] |
|---|---|---|---|
| 1970-71 | 30 May | heavy | e |
| 1971-72 | 26 May | heavy | d |
| 1972-73 | 24 May | medium | c |
| 1973-74 | 5 May | light | a |
| 1973-75 | 12 May | light | a |
| 1975-76 | 20 May | medium | c |

*From Curatolo and Roseneau 1977.

[1] rate on which caribou crossed Alaska-Yukon border; used as an estimate of arrival on calving grounds.

[2] Wintering area (area closest to calving grounds where significant numbers of wintering caribou were observed):

a) central-eastern Yukon coastal plain (nearest to Alaskan portion of the calving grounds:
b) northern Richardson Mountains
c) central Richardson Mountains
d) southern Richardson Mountains
e) Ogilvie Mountains (farthest from the calving grounds).

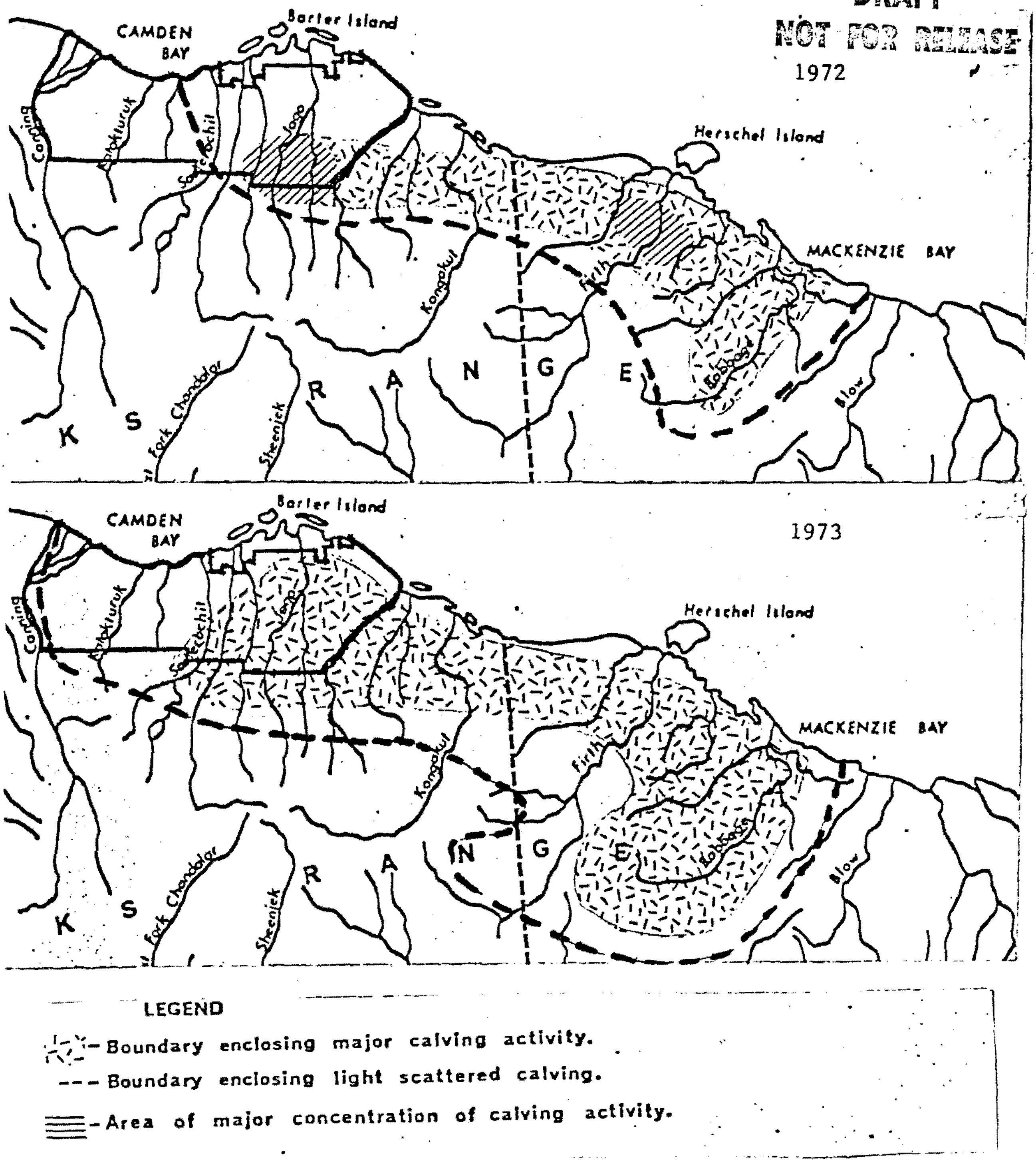


FIGURE 2-a The Porcupine Caribou Herd's Calving Grounds From 1972 to 1973

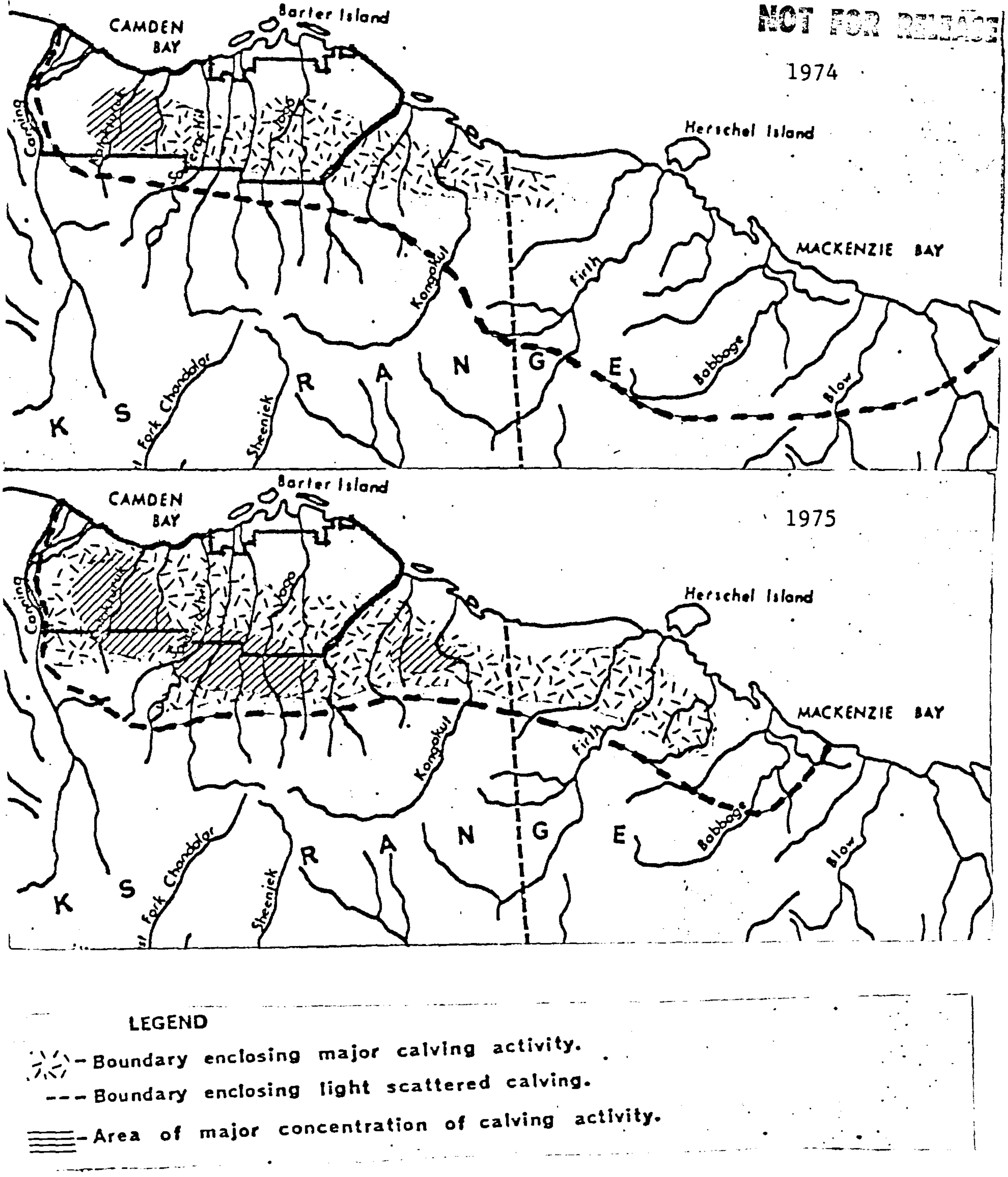
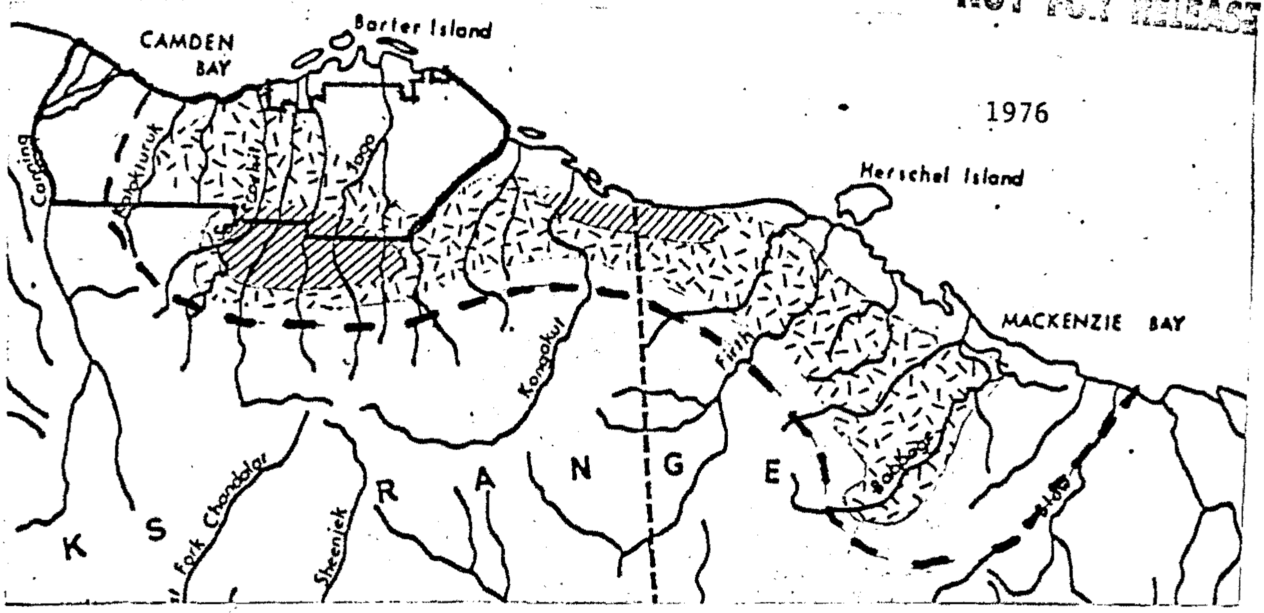


FIGURE 2-b The Porcupine Caribou Herd's Calving Grounds From 1974 to 1975



LEGEND

- Boundary enclosing major calving activity.

--- Boundary enclosing light scattered calving.

≡ - Area of major concentration of calving activity.

FIGURE 2-c The Porcupine Caribou Herd's Calving Grounds From 1976 to 1977

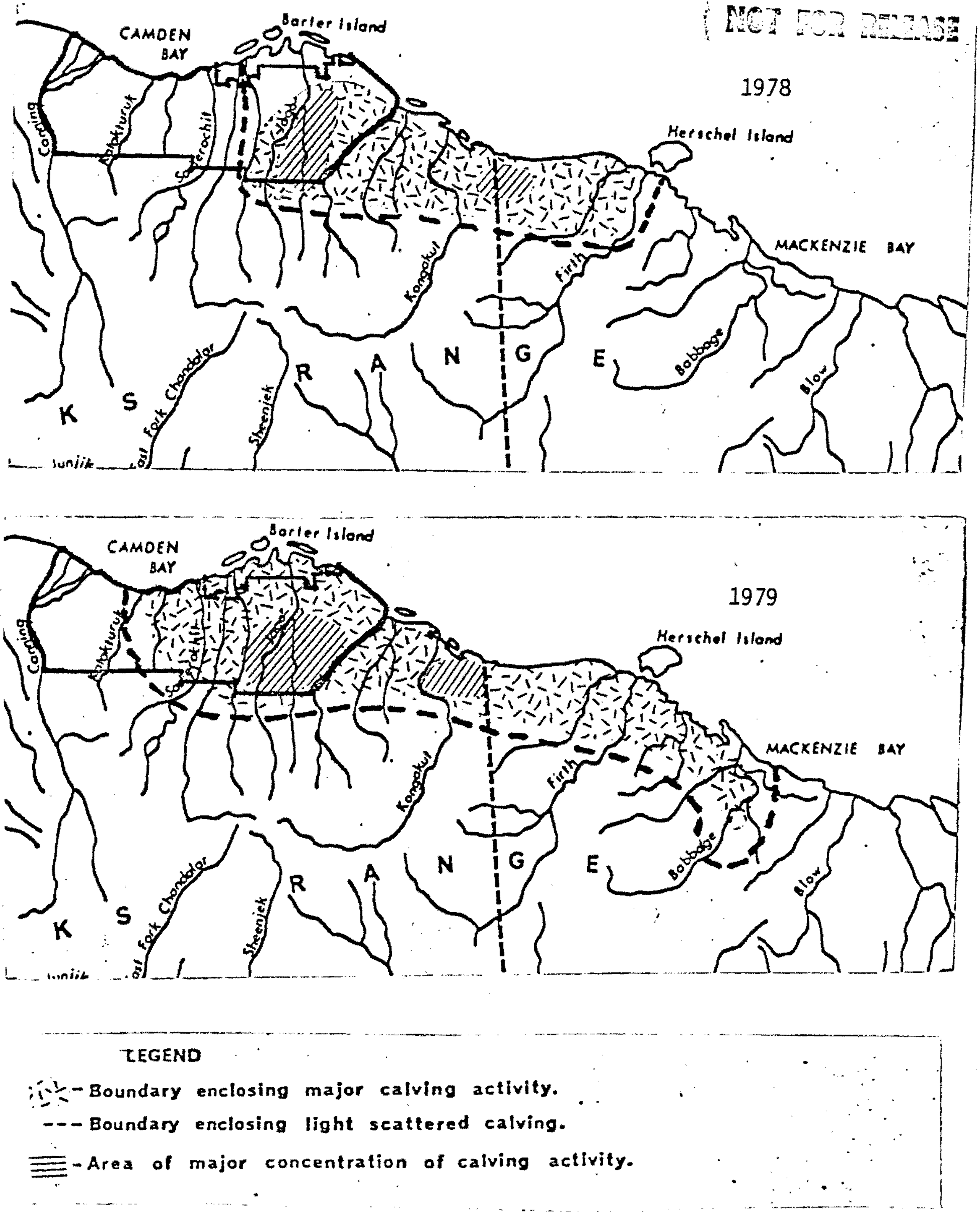


FIGURE 2- The Porcupine Caribou Herd's Calving Grounds From 1978 to 1979

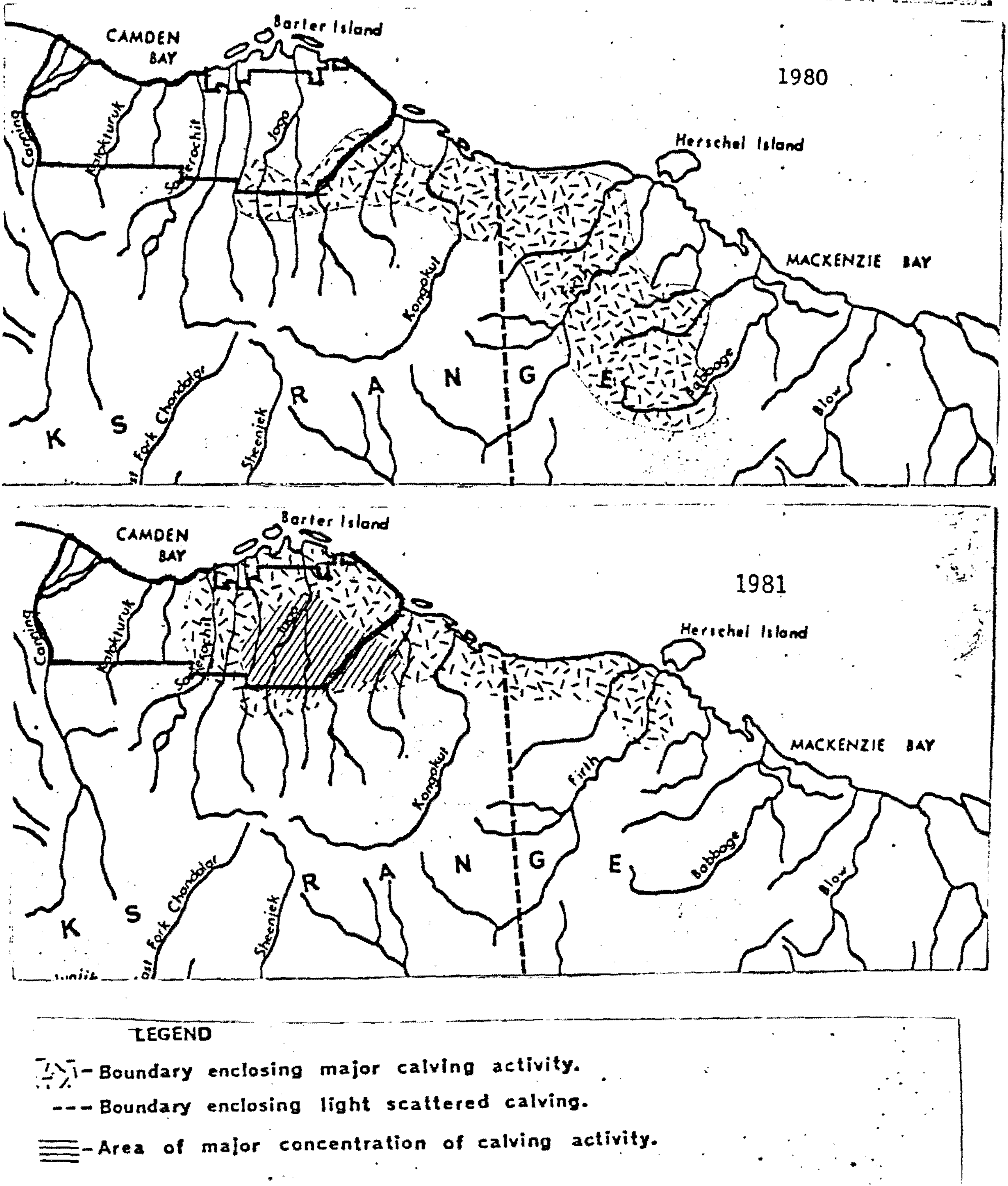


FIGURE 2$^{e}$ The Pourcupine Caribou Herd's Calving Grounds From 1980 to 1981 spread unevenly over the calving areas with higher concentrations occurring in the upland tussock habitats. The cows are usually alone or near small groups at the time of birth. After the calf is born, the cow licks the calf and often eats or mouthes the after-birth (Calef and Lortie 1973). The cow and calf usually remain near the birth place for the first day (Skoog 1968). Caribou calves are very precocious, being able to stand and suckle within an hour or two after birth (Kelsall 1968). After the third day the calf can walk well enough to follow its mother and can even run for considerable distances. By a week the calves can travel with swiftly moving caribou bands (Skoog 1968)

The cow-calf bond in caribou is not as strong as that of other ungulates (Kelsall 1968) and separations are common during the calving and post-calving seasons (Lent 1964, Skoog 1968, Calef and Lortie 1973). It seems that calves are particularly vulnerable during the bond-forming process. Lost calves have been observed to approach humans (Calef and Lortie 1973) and predators (Roseneau and Curatolo 1976) in their search for the maternal cow. After giving birth, cows with calves are frequently found in small "nursery bands", moving at a casual pace through the calving grounds, the cows grazing primarily on new-growth Eriophorum shoots. There is a continued movement to the west and north on to the coastal plain as the zone of snow melt advances towards the north.

Post-calving Perhaps the most spectacular aspect of the annual cycle of the barren ground caribou is the formation of large post-calving aggregations. At no other time are the caribou so concentrated. There is considerable annual variation in the chronology, location, movement and group size of post-calving aggregations. Although this phenomenon is poorly understood, factors such as the location of calving concentrations, snow-melt patterns, vegetation phenology, temperature, wind and other climatic factors as well as insect harassment contribute to the observed variations.

In some years, 1972-74 for example, large numbers of cows and calves gathered in the study area near the coast south of Camden Bay (from the Canning River to the Hulahula River) during late June (LeResche 1972 and 1975, Calef and Lortie 1973, Roseneau et. al. 1974 and 1975, Roseneau and Curatolo 1976). In 1972 over 80,000 caribou were counted from aerial photos of one aggregated group south of Camden Bay (LeResche and Linderman 1975). By early July these large groups of caribou moved eastward in a broad front extending from the coastline to 30 km. inland (LeResche and Linderman 1975). At times large numbers of caribou were observed in the coastal tidelands and even out on the shore-fast sea ice (Roseneau and Stern 1974). After crossing the Jago River near its mouth, the caribou shifted their movement to the southeast. At the Kongakut River caribou pass along the coast and the river delta, or move inland, crossing the river between the foothills and mountains where the river bends to the west. In most years a majority of the Porcupine herd passes into Canada between the first and second weeks of July. It is not uncommon however, for significant numbers of caribou to remain in the refuge throughout the summer. In 1972, for example, about 10-12 thousand caribou spent the summer months ranging in the Katakturuk-Sadlerochit foothills and Peters-Schrader Lake area eastward to the Aichilik River (Roseneau and Stern 1974). It is in the Kongakut-Firth Rivers area that the late migrating bulls and juveniles usually rendezvous with the rest of the herd. In northern Yukon, the post-calving movement consisting of nearly the entire Porcupine herd, continues southeastward along high ridges of the British, Barn and

Richardson Mountains. There is a tendency for the large aggregations to separate into smaller groups and to reform into larger ones several times during the post-calving march. By late July-early August the Porcupine herd reaches a staging area near Bonnett Lake in the Driftwood Hills of northern Yukon. Figure 3 illustrates this "fairly typical" post-calving movement pattern for the Porcupine caribou herd. The traditionality of post-calving movements of the Porcupine herd has been confirmed by studies of caribou trail system (LeResche and Linderman 1975).

Some years such as 1976 and 1981, the Porcupine herd failed to form large aggregations. (Curatolo and Roseneau 1977, Bartels 1981 pers. comm.) Figure 4 shows the post-calving distributions and movements of 1981. In 1976 and 1981 caribou did not move in large numbers to the coast, instead they gathered in loosely-formed groups farther inland (from the Sadlerochit to the Kongakut Rivers). In 1981 fairly large numbers of caribou milled for several days between the Egaksarak and Kongakut Rivers prior to crossing the Kongakut and moving into Canada. By June 30, 1981, most of the herd was in Canada, considerably earlier than most years.

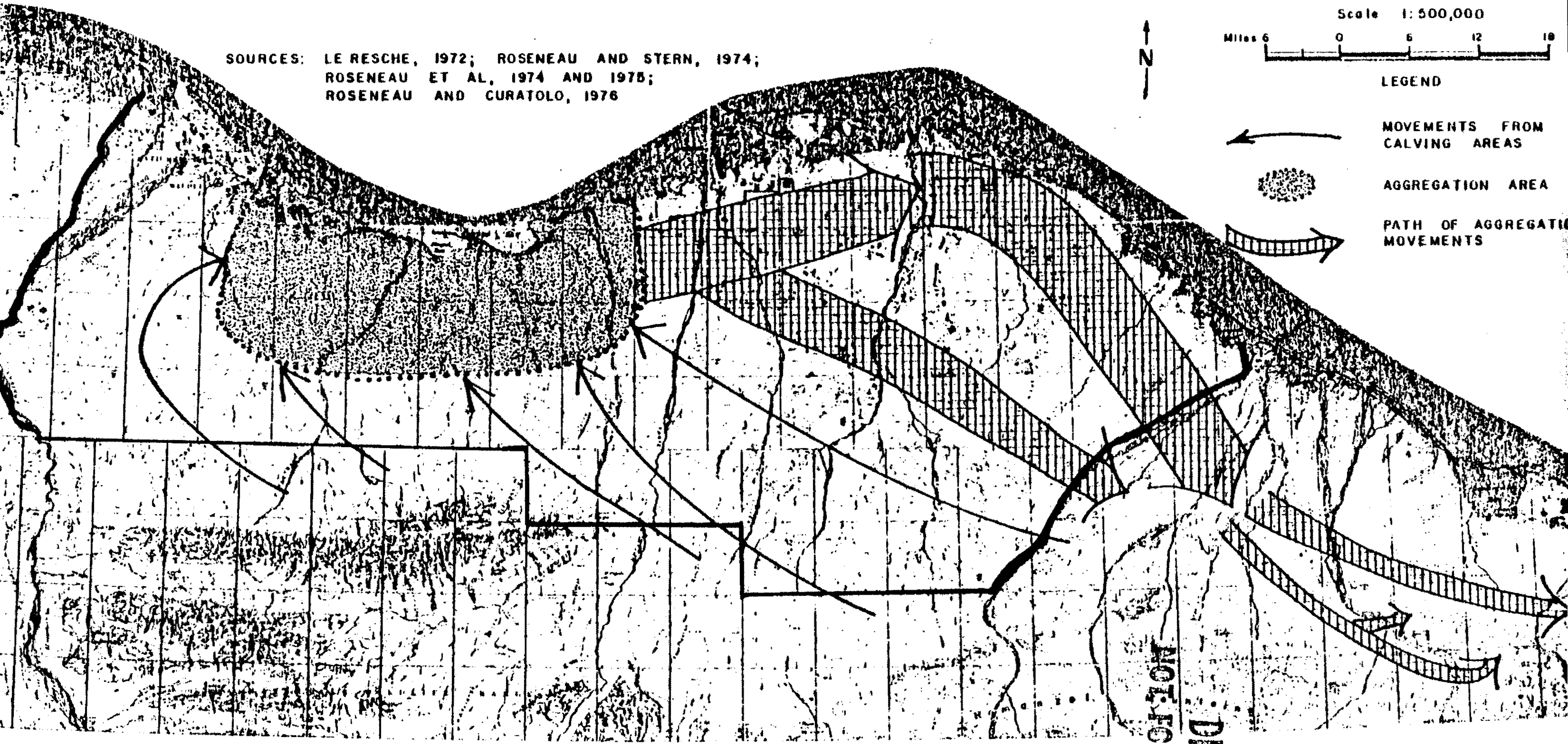
It is believed that the appearance of harassing insects (mosquitoes, warble flys and nasal bot flies) partially contributes to the aggregation behavior of caribou (Kelsall, 1968). When insect harassment is particularly intense, caribou tend to gather into extremely dense, compact groups. Stampedes can be triggered easily during this time and contribute to accidents, crippling and separation of calves from the cows (Calef and Lortie 1973, Roseneau and Curatolo, 1976). During the height of the insect harassment season (July - mid-August), caribou seek out relief on windy ridges, along coastlines, on snow fields and gravel bars. Movement of the herd ~~are~~ is almost constant at this time, and little time is spared for foraging and grazing. It is believed that the insect season is a time of extreme stress on caribou and contributes to a high mortality rate for calves (Calef and Lortie 1973). Additional disturbances during this time period could seriously increase mortality (Calef and Lortie 1973). ✓

### August Dispersal

The Porcupine caribou herd disbands from the Bonnet Lake - Driftwood Hills staging area in early August, moving in widely scattered groups westward through the northern Old Crow flats into Alaska (Surrendi and DeBock, 1976). They continue moving along the southern foothills of the Brooks Range in the Upper Coleen and Sheenjek river drainages. During the period of mid-August to early-September the Porcupine herd is widely dispersed from the broad-rolling hills south of Arctic Village to the Old Crows flats. The level of insect harassment has greatly subsided and a majority of time is spent grazing on willow and sedge vegetation. The month of August and early-September is a time of rapid growth for the calves and fat deposition on the bodies of the adults (Skoog, 1968).

# ARCTIC COASTAL PLAIN BASELINE STUDY

## .3 GENERALIZED MOVEMENTS BY POST-CALVING AGGREGATIONS — PORCUPINE CARIBOU HERD, 1972-



SOURCES: LE RESCHE, 1972; ROSENEAU AND STERN, 1974; ROSENEAU ET AL, 1974 AND 1975; ROSENEAU AND CURATOLO, 1976

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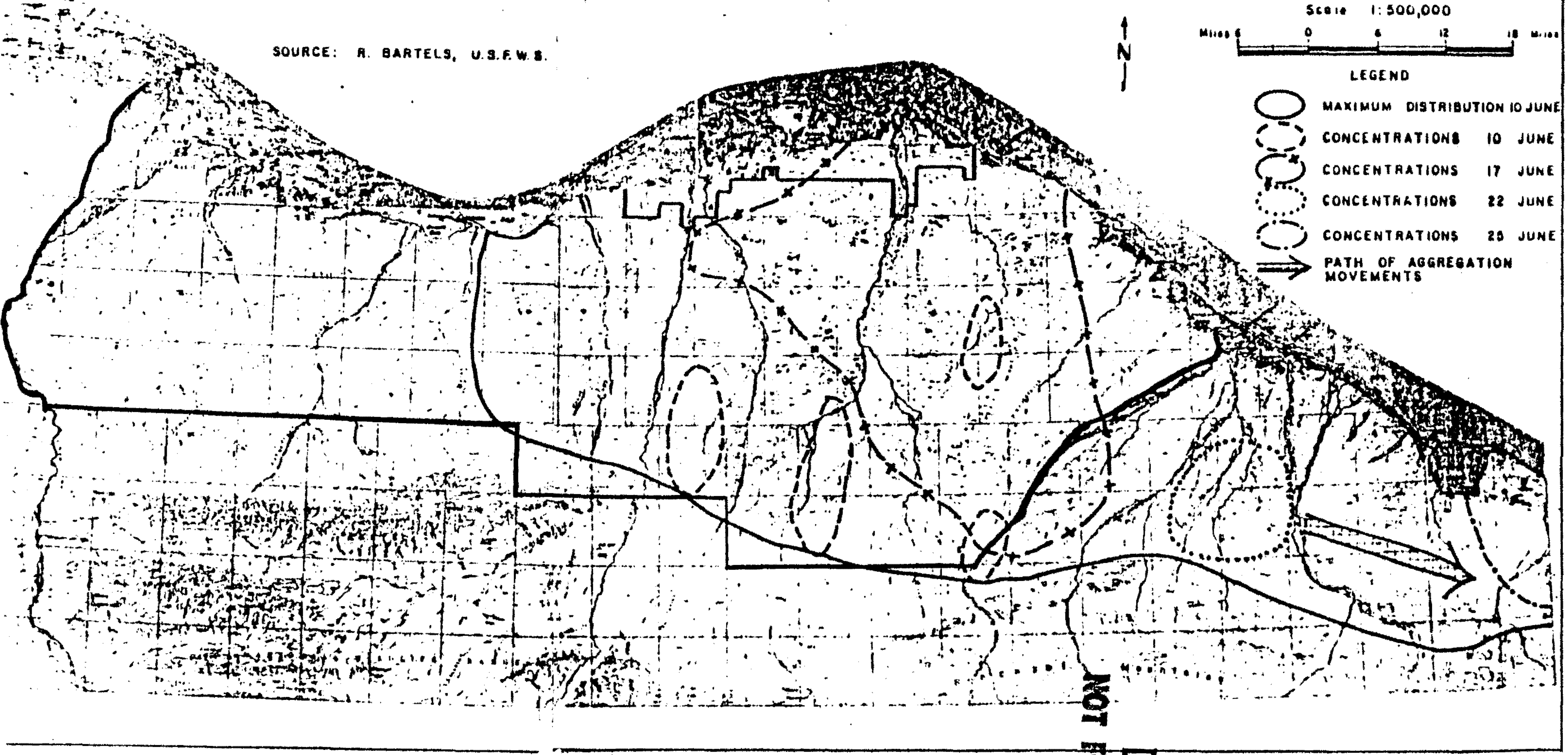
# ARCTIC COASTAL PLAIN BASELINE STUDY

FIG. 4 POST-CALVING DISTRIBUTION AND MOVEMENTS — PORCUPINE CARIBOU HERD 1981



SOURCE: R. BARTELS, U.S.F.W.S.

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## Fall Migration

Usually by the second week of September a gradual eastward shift of caribou into Canada begins. Small groups of caribou begin to coalesce in the Old Crow flats. Autumn snow storms accelerate the southward migrations and seem to influence directional movements towards the primary wintering areas (Bergerud 1974[a], Lent 1966). Major caribou crossing points on the Porcupine River are located near Rampart House on the international border, up and downstream of the village of Old Crow and near the month of the Bell river. The timing of river crossings varies considerably from year to year. In some years large numbers of caribou move to the northeastern slopes of the Richardson Mountains (Kevan 1970 cited in Calef 1974). After crossing the Porcupine River, most of the herd moves into the Keele Mountains and proceeds southwestward as the rut begins.

## Rutting Season

The Porcupine herd breeds during the middle of October while enroute to the winter ranges (Calef 1974). The rut is rather restricted -- lasting about two weeks and accounts in part for the short period in which the calves are born. The cows can have several estrus cycles until conception takes place (Skoog 1968). The bulls usually mate with more than one cow. Most caribou are sexually mature at two years of age.

The bull caribou prepare for the rut in late August when the antler velvet is shed. By the time of rutting, the bulls have developed a thick layer of body fat which helps to sustain them during the breeding season. Throughout September the bulls become increasingly aggressive and begin brief sparring matches with other males. Large bulls are dominant and tend to fight mostly with other bulls of similar size. Usually the sparring matches are not particularily violent and last about five minutes (Skoog 1968). By the end of the rut, the bulls have lost their body fat and begin the winter in lean condition (Skoog, 1968). Several authors have noted an increased sensitivity of caribou to disturbance during the breeding season (Lent 1965, Surrendi and DeBock 1976). Caribou sex and age classes are quite evenly mixed during the rut. Hare~~r~~ms are not formed as is done by some cervids (Lent, 1965). Caribou are commonly in small heterogeneous groups during the breeding season. For the most part, all mature males have opportunity to breed (Skoog, 1968). ✓

## Winter Activity

The two principal winter areas for the Porcupine herd are located in the central portion of Yukon Territory, Canada and in the vicinity of Arctic Village in Alaska (Figure 1). Wintering also takes place in the Richardson Mountains, along the lower Coleen River and on the Arctic Slope of Alaska and northern Yukon (Thompson and Roseneau 1978). Table 2 illustrates annual variations in the use of winter areas during 1970-1978. In recent years the majority of caribou in the Porcupine herd have wintered in Canada. On the average, over 50% of these animals cross to the east side of the Dempster Highway (Thompson and Roseneau, 1978). In the winter of 1972-1973 most of the herd was found in the Arctic Village area. Recently there has been an increasing number of caribou wintering in the vicinity of the international border on the upper Kandik and Tatonduk rivers (U.S. Dept. of State 1980). Here at the southern portions of the winter range inter-change with other caribou herds (Forty-mile herd) has taken place in the past and probably will

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Table Annual variation in numbers of caribou of the Porcupine herd distributed on winter ranges.*

| Winter range areas | Winter | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| In Canada | 70-71 | 71-72 | 1972-73 | 1973-74 | 1974-75 | 1975-76 | 1976-77 | 1977-78 |
| Peel R.-Hungry Lakes, and Ogilvie Mountains | 23-30000<br>15-40000 | 40-62000 | 12,000+ | 60,000 | No est. | Most of Pop. | Most of Pop. | Most of Pop. |
| Richardson Mountains | 2-3000 | 17-30000 | 5,000+ | ------ | 10,000+ | Very Few | | |
| Arctic Coastal Plain | | | Few 100's | 5,000 | 1,000 | 0 | | Few 100's |
| Old Crow Area | | | ------- | 5,000 | ------- | Several 1000's | | |
| Bell R. Drainage | | | ------- | ------- | ------- | 1,000 | | |
| In Alaska | | | | | | | | |
| Chandalar-Sheenjek R. Drainages | 1000 | 1400 - ~~1.4~~-2500~~0~~ | 30-40000 | 10-15,000 | ------- | 100 | 100-1000+ | |
| Coleen R. drainage | | | 1,000+ | 1,000+ | ------- | ------- | 200 | 1000-1500 |
| Arctic Slope | | 2-400 | Few 100's | 1-2,000 | ca.200 | ------- | | |
| Hodzana R. headwaters | | 900 | 2-3,000 | ------ | ------- | ------- | | |
| Est. Total in Alaska | 1000 | 2600-4000 | 50-60,000 | 13-14,000 | 10-15,000 | 3,000 | 300 | 2,400~~0~~ |

*Estimates based on information in Doll et. al. 1974; Roseneau et. al., 1974 Roseneau and Stern, 1974; Roseneau et. al., 1975; Curatolo and Roseneau, 1977; Thompson and Roseneau, 1978.

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continue (Skoog 1968). Most recently, in October of 1981 large numbers of caribou of the Porcupine herd crossed the Yukon River near Eagle -- an event which has not occurred since possibly the 1920's (Whitten per. comm. 1981).

Wintering groups of caribou do not remain on one feeding site for the entire winter (Henshaw 1968). Instead there are frequent short distance movements by wintering groups throughout the season. The condition of snow (depth and hardness) is an important factor in where wintering animals are found (Pruitt 1959, Henshaw 1968). In a recent survey of wintering in the Porcupine caribou herd, Thompson and Roseneau (1978) observed caribou

> "most often in broad rolling valley bottoms or slopes with moderate tree cover and continuous snow cover; or on windswept ridges with no tree cover."

Because varying topography and vegetation alter wind speeds and thus influence snow conditions, the medium density black spruce stands of the taiga seem to provide favorable winter feeding sites for caribou (Bergerud 1974 Thompson and Roseneau 1978). Open windswept ridges are frequented by wintering caribou because of the ease in finding food and the advantage gained in detection of predators afforded by good visibility (Thompson and Roseneau 1978).

Nearly every year several hundred to a thousand caribou winter within portions of the study area (Roseneau and Curatolo, 1976). Information gained through radio-tracking studios indicates that these animals are part of the Central Arctic Herd. Further discussion of wintering caribou in the study area will follow.

## Population Dynamics

A review of basic population parameters indicates that the Porcupine herd has remained relatively stable over the past 10 years. Table 3 summarizes population estimates made for the herd.

Table 3. Porcupine caribou herd population estimates 1961-1979.

| Year | Population Estimate | Method | Source |
|---|---|---|---|
| 1961 | 110-117,000 | calving grounds census | Skoog, 1968 |
| 1964 | 140,000 | calving grounds census | Skoog, 1968 |
| 1972 | 101,000 | "APDCE" [1] | LeResche, 1972 |
| 1977 | 105,000 | "APDCE" | Bente and Roseneau, 1977 ?<br>says 1978 in Lit. Cited |
| 1979 | 110,000 | "modified APDCE" | Cameron and Whitten, 1980 |

[1] Aerial photo - direct count extrapolation.

A population estimate was attempted in June, 1981, but was unsuccessful because the caribou failed to aggregate adequately for aerial censusing (Whitten per. comm.).

Sex and age composition data given in Tables 4 and 5 reflect~~s~~ general health and stability in the Porcupine caribou herd the calf/cow ratio at post-calving has averaged 55% over the past 10 years. A re-examination of the 1979 census in light of 1980 age and sex compositions reveals that perhaps some 10,000 bulls were not counted (Whitten and Cameron, 1980b). A revised 1979 population estimate for the Porcupine caribou herd of 120,000 animals is suggested by Farnell (1981).

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Table 4. A nine year comparison of sex and age composition of the Porcupine caribou herd during July 1-15.

| Year | % Cows | % Calves | % Yearlings | % Bulls | Calf: Cow Ratio |
|---|---|---|---|---|---|
| 1972[1] | 53 | 26 | 9 | 12 | 48:100 |
| 1973[1] | 58 | 27 | 6 | 10 | 47:100 |
| 1974[1] | 55 | 37 | 3 | 5 | 66:100 |
| 1975[1] | 52 | 27 | 9 | 12 | 51:100 |
| 1976[1] | 55 | 32 | 10 | 2 | 59:100 |
| 1977[2] | 61 | 24 | 11 | 4 | 39:100 |
| 1978[3] | 46 | 31 | 8 | 14 | 67:100 |
| 1979[4] | 47 | 26 | 8 | 19 | 55:100 |
| 1980[5] | 39 | 26 | 11 | 23 | 66:100 |

Sources:
[1] Curatolo and Roseneau, 1977
[2] Bente and Roseneau, 1978
[3] Whitten and Cameron, 1980[a]
[4] Whitten and Cameron, 1980[b]
[5] Farnell, 1981

Table 5. Fall sex and age composition of the Porcupine caribou herd 1972-1980.

| Year | % Cows | % Calves | % Yearlings | % Bulls | Calf: Cow Ratio |
|---|---|---|---|---|---|
| 1972 | 48.7 | 14.8 | 8.6 | 27.9 | 30.3:100 |
| 1977 | 39.0 | 18.5 | 12.2 | 30.3 | 47.5:100 |
| 1978 | 48.4 | 30.1 | 6.1 | 15.4 | 62.2:100 |
| 1980 | 42.8 | 23.2 | 8.0 | 25.9 | 54.0:100 |

The problems of poor weather conditions, long distances to cover, sampling errors and incorrect data interpretation continue to plague efforts to obtain more reliable caribou population estimates. The aerial photo-direct count extrapolation (APDCE) method is conducted during the period of optimum aggregation following the calving season. It must be combined with summer and fall composition counts to arrive at an estimate of total population. The APDCE method relies upon the following assumptions:

1) all adult females in the herd are present in the post-calving aggregations.
2) herd composition can be accurately determined in the post-calving aggregations.
3) herd composition can be accurately determined in the fall counts.
4) mortality of adult females from the time of post-calving counts to the time of fall counts is zero.

In an analysis of the APDCE method, Davis et al. (1979) recommend~~s~~ a modified approach which includes a thorough search of a herd's entire range at the time aerial photos are shot. Additional effort made to photograph and enumerate non-aggregated caribou can assist the accuracy of the census. Probably the weakest link in the APDCE method is in obtaining adequate age and sex composition counts. It is extremely difficult to implement adequately rigorous sampling systems during the short breeding season when caribou are most evenly mixed.

## Central Arctic Herd

### Size, range, and distribution

The identity of a separate, discrete caribou herd occupying an area of the arctic slope between the ranges of the Western Arctic and Porcupine herd (Figure 1) was confirmed by Cameron and Whitten (1976 and 1979a). Previous publications (Olson 1959, Skoog 1968, LeResche 1972, Child 1973, Gavin 1971, Roseneau et al. 1974, Roseneau and Stern 1974, Roseneau and Curatolo 1976 and White et al. 1975) mention, describe or acknowledge in some manner, the caribou herd later identified by Cameron and Whitten. Currently the Central Arctic Herd (CAH) is estimated at 6-9,000 individuals (Whitten pers. comm.). Its recent range lies north of the Brooks Range from the Colville River on the west and as far east as the Barter Island vicinity (Whitten, per. comm.). The Prudhoe Bay oil field complex, Trans-Alaska Pipeline and the Dalton Highway bisect the range of the CAH.

The CAH calves on the arctic coastal plain from the Colville River to the Canning River delta. In years of late snow melt and flooding conditions on the coastal plain the herd calves in dryer upland sites such as the Franklin Bluffs area (Whitten et. al. 1981). Calving activity in the Prudhoe Bay area was reported earlier by Gavin (1971), Child (1973) and White (1975) when the oil field was beginning to be developed. Later studies by Cameron and Whitten (1979b, 1980a; Cameron et. al. 1981;) indicate an absence of calving near the coast at Prudhoe Bay possibly due to avoidance of the area by calving caribou. Two centers of concentrated calving activity were located in recent surveys (Whitten et al. 1981). One area, the Kuparuk, lies west of Prudhoe Bay in the vicinity of the newly developing oil field (Cameron and Whitten 1979b, 1980b, Cameron et al. 1981). The other area is east of Prudhoe Bay, primarily in the Canning River delta area within the Arctic National Wildlife

Refuge. Calving activity in the Canning delta has been observed and partially quantified for the years 1978-1981 (Cameron and Whitten 1979b, 1980; Cameron et al. 1981). Surveys conducted in 1981 indicate that the Canning delta area is an important calving grounds for the CAH and may have more calving caribou than the Kuparuk area (Whitten et al. 1981).

Following calving the CAH usually forms into post-calving aggregations and moves eastward along the coast. Animals from the west often cross the Canning River delta and pass into the study area within the Arctic National Wildlife Refuge. (Cameron and Whitten 1979a). These aggregations gradually disperse into smaller groups, some move back along the coast to the west, others remain in the Canning delta area. In mid-July, when insect harassment intensifies, bands of CAH caribou can be found seeking relief on the coastal beaches, sand dunes, shorefast ice and barrier islands of the Canning delta - Camden Bay area. In some years these caribou are hunted by villagers traveling by boat from Kaktovik (Bartels per. comm.). During the summer, groups of caribou believed to belong to the CAH have been observed in the Schrader Lake - Eagle Creek area (Roseneau and Stern 1974).

A gradual southward movement of the CAH occurs in late August and early September. This movement is usually accelerated by the first heavy snowfall. In years of "mild" weather significant numbers of caribou have been found wintering on the coastal plain (Whitten, per. comm.). The foothills are used more extensively in years of harsh weather conditions. Scattered groups of caribou believed to be part of the CAH also winter east of the Canning River. Radio-collared caribou of the CAH have been located during the winter on the North Slope of the Arctic National Wildlife Refuge (Cameron, per. comm.).

In 1975 small numbers (200-300) of caribou were observed in the study area north of the Sadlerochit Mountains from the Canning River to Barter Island (Roseneau and Curatolo, 1976). Eskimo hunters from Kaktovik commonly hunt caribou during the winter in the vicinity of Peters and Schrader Lakes, Hulahula River, Jago River, and Sadlerochit Mountains (Jacobson, 1979). In some years, harvest of caribou from these wintering bands located in or near the study area is a significant part of the subsistence resources for Kaktovik (See Chapter VIII of this report).

The use of portions of the Arctic National Wildlife Refuge (including the study area) by the CAH is not adequately understood at this time. Further delineation of the calving grounds on the Canning delta is needed as well as more precise numeration of calving animals there. Habitat use of the refuge throughout calving, post-calving, insect season, fall and winter needs to be better identified. Interchanges between the CAH and Porcupine herds should be monitored as well.

### Extent, Location, and Carrying Capacity of Caribou Habitats for the Porcupine Caribou Herd

The general range of the Porcupine Caribou herd is depicted in Figure 1. Vegetation maps have been developed for the Arctic Coastal Plain and Foothills using LANDSAT imagery (LaPerriere 1977). A revised vegetation map is presented in this report (Chapter VII). Preliminary calving ground habitat studies have been conducted by personnel of the U.S. Fish and Wildlife Service, Denver Wildlife Research Center. Habitat and range studies currently underway in northern Yukon are being conducted by the Canadian Wildlife

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Service. In spite of these efforts, a comprehensive vegetation map for the entire range of the Porcupine Caribou Herd has not been developed.

It is important to note that the Porcupine herd may spend up to 11 months of the year in mountainous terrain (Calef, 1974). A wide variety of plant communitites, snow conditions and insect densities are encountered as the herd makes altitudinal and latitudinal migrations through its range. Snow has been identified as an important feature throughout much of the caribou's annual cycle (spring migrations, calving, insect relief, fall migrations and wintering areas). Although some general observations have been made regarding the snow environment of the Porcupine herd (Roseneau, et al. 1974; Roseneau and Curatolo 1976; Curatolo and Roseneau, 1977; Thompson and Roseneau 1978), there is a need to obtain more detailed measurements of snow conditions in relation to spring migration routes, calving grounds, and winter areas (Kelsall and Klein 1979).

Several recent studies have correllated plant phenology with calving activities and summer movements of caribou (Kuropat and Bryant, 1980; Klein and White 1978). A high degree of selection has been demonstrated by caribou for certain plant species during early growth stages of the plants. Selection of newly emerging tussock (*Eriophorum sp.*) on the calving grounds has already been discussed. Following calving, there is a general movement toward the lower coastal areas as snow melt progresses and vegetation green-up occurs. Later in summer and early fall, willow (*Salix sp.*) and sedges are the predominant food item (Kuropat and Bryant, 1980).

Lit. cited

Much discussion has taken place regarding caribou winter food requirements. It has been generally felt by some researchers that lichens were required for the winter survival of caribou (Leopold and Darling 1953). Studies in the Canadian High Arctic (Klein 1980a) as well as on isolated caribou ranges in southern Canada (Bergerud 1974b) have determined that *Rangifer sp.* can survive throughout the winter without a lichen-predominant diet.

Lichens on the other hand have been found to be the predominant winter forage for most of the North American caribou populations. Although lichens lack important nutritional elements such as nitrogen and phosphorus, they are relatively high in carbohydrates and apparently are important to caribou for their caloric value during the cold winter season (Kelsall 1968). Comprehensive studies of food habitats and seasonal forage selection patterns have not been conducted for the Porcupine herd. It is believed, however, as a result of general observations, reported by several authors, that similar basic food utilization patterns occur for this herd.

Due to the nomadic nature of migratory barren ground caribou which range over vast areas, the concept of habitat as it is traditionally used for more sedentary species is not applicable with caribou (Skoog 1968). Unlike other migratory species such as birds, which can fly from one important habitat to another, the caribou must move across the earth's surface from one area of advantage to another. Thus, an area of a herd's range may not be visited for a long time period, then as the herd returns, it becomes an area of importance for caribou.

In spite of inherent difficulties, numerous efforts at determining theoretical carrying capacities of caribou ranges have been made. Using basic range inventory techniques such studies have identified much higher capacities than ✓

are exhibited by living populations (Calef 1974). Theoretical carrying capacities calculated for various caribou populations have ranged from 1.2 caribou/km$^2$ (Skoog, 1956) to 3.7 caribou/km$^2$ (Porsild, 1929 as cited in Calef 1974). No theoretical carrying capacity for the Porcupine herd has been calculated. Currently the Porcupine herd occupies its range at a density of .44 caribou/km$^2$. This corresponds closely with the overall average density of caribou populations in Alaska, Canada, and Taimyr (Calef 1974).

It has been demonstrated that as caribou populations increase, there is a corresponding expansion of their range. Likewise as a population declines there is a corresponding shrinkage of range (Simmons et al. 1979). In cases where a caribou population increases rapidly and high densitites are achieved, there is a tendency for erratic movements, often leading to interchange with neighboring herds (Skoog 1968). The Porcupine herd has remained at a relatively high level for the past twenty years (Table 3).

Skoog (1968) and Calef (1974) as well as others have described a close relationship between the Porcupine and Forty-mile caribou ranges and populations. Historically these have reported incidences of interchanges between these herds (Skoog, 1968). The recent movement of Porcupine herd caribou south of the Yukon River may give biologists an opportunity to study the ramifications of herd interchange. The consequences of such exchange between caribou herds are not known. It has been hypothesized that exchange may be essential to reversal of population declines and valuable for the exchange of genetic material crucial for long term viability of stocks (Haber and Walters, 1980).

## Impacts of Existing Processes and Activities

For the purposes of this dicussion, the impact of human activities are defined as those activities of man other than the mandated seismic exploration and future oil and gas exploratory drilling, development and production which are addressed separately.

## Human Activities and Their Effect on the Porcupine Caribou Herd

As mentioned earlier interations between man and caribou in northeastern Alaska dates back at least 27,000 years. Caribou fences, archeological sites and elements of Kutchin Indian and Inupiat Eskimo cultures attest to the early relationship of hunter and caribou in the region. There is no evidence that early man and his structures had significant impacts on the herd (Klein 1980b).

When Western man came to northeastern Alaska, firearms were introduced to indigeneous people and the ease of taking caribou increased. Historical accounts indicate that fairly high harvests were achieved during the late 1800's and early 1900's (Stone 1900; Leffingwell 1919). Considerable numbers of caribou were taken for food by overwintering whalers at Herschel Island at the turn of the century. Discovery of gold in the Klondike region of Yukon Territory brought a wave of miners into the southern range of the Porcupine Herd. Records indicate that caribou was a popular food resource for these miners (Skoog 1968).

The next major influx of human activity in the Porcupine caribou herd came in the 1950's, following World War II when the Distant Early Warning radar sites were constructed. During this time supply trails were used to carry equipment to the Arctic coast from Dawson (Y.T.) and Circle, Alaska. Concerned efforts to locate oil and gas resources within the Porcupine herd's range began in Canada during the early 1960's in the Eagle River - Peel River plateau country. Both seismic exploration and exploratory drilling were conducted at this time. Construction of the Dempster Highway from Dawson to Inuvik was initiated in the 1960's and completed in 1978. The highway transects major winter ranges and migration at the Porcupine caribou herd, (Fig 1)

Other significant human events influencing the Porcupine Caribou herd was the establishment of the Arctic National Wildlife Range (1960), the introduction of snowmobiles as new form of winter transportation (late 1960's), discovery of oil and gas at Prudhoe Bay and the Mackenzie delta (1968), settlement of aboriginal land claims in Alaska (1971) and passage of the Alaska National Interest Lands Conservation Act of 1980 which implements seismic exploration in the study are as well as expands the Arctic National Wildlife Refuge.

Perhaps the most significant influence ? on the Porcupine Herd at the present time is that of hunting. Table 6 presents recent estimated harvest levels for the herd. A detailed discussion of subsistence harvest areas and activities related to the study area is presented in Chapter 8,. Recent annual human harvest of Porcupine Herd caribou has averaged 5% or less of the estimated total population (LeResche 1972, Surrendi and DeBock 1976; Davis 1980). Annual harvest rates of other major caribou herds in northern Canada range from less than 1% to 8.8% (Calef 1980; Davis 1980; Juniper 1980). It is also widely accepted that the annual sustainable harvest probably varies from herd to herd and from year to year depending on many other population dynamics factors.

The annual harvest of the Porcupine has remained reasonably stable over recent years and may be a factor in the overall stability of the herd. Some authors, (Bergerud 1974) attribute drastic declines in caribou populations in North America to hunter harvest and predation. Considerable concern has been raised by caribou biologists over potential harvest increases along the newly-opened Dempster Highway. High harvest levels of the Western Arcitc herd (Davis pers. comm.) and the Kaminuriak herd (Simmons et al. 1979) have led to population declines.

In response to concerns for coordination of harvests as well as other concerns, the U.S. and Canadian Governments began preliminary discussions regarding a possible bilateral treaty to con~~z~~serve the Porcupine Caribou herd (U.S. Dept. of State, 1980). Recently, Native people of the U.S. and Canada depending on caribou of the Porcupine herd have agreed to a system of self-restraint. The sport harvest of Porcupine herd caribou has remained relatively low in Alaska. State law currently allows for an annual bag limit of 5 caribou from the Porcupine herd's range. Two caribou/year may be transported out of the region (Game Mgmt. Units 25A, B and D and 26C).

Other human interactions with the Porcupine Caribou herd include contact by recreationists, air charter operators, trappers, geologists, biologists, other scientists and land administrators. Caution has been raised by a number of caribou biologists familiar with the Porcupine herd with regard to impacts from human disturbance on the calving grounds and post-calving areas (Calef and Lortie, 1973). Specific mention has been made regarding potential conflicts from tourists on the Porcupine caribou herd especially during post-calving migrations at river crossings (Calef and Lortie, 1973). Indiscriminant use of aircraft for transportation and sight-seeing by all human users could result in adverse disturbance especially during the calving, post-calving and rutting seasons.

Data Gaps

In spite of the rather large volume of information that has been collected on caribou, including the Central Arctic (CAH) and Porcupine herds, there remains the need to expand our knowledge of individual herds and interactions between other herds, their environments and man. Because large caribou herds such as the Porcupine range over a vast area of many varying conditons, it is extremely difficult to collect the detailed information which is necessary to understand population ecology of the herd.

Basic ongoing management surveys and studies must be continued and refined. ✓ Improvement in the accurracy of caribou population estimates is needed. Better methods have to be developed that will yield more representative herd composition data. Collection of reliable harvest data is always difficult, especially for the Porcupine herd which is harvested by Eskimos, Indians, non-Natives and sport hunters in both the U.S. and Canada. The status, distribution and movements of both the Porcupine and CAH should be continu~~ed~~ally ~~to be~~ monitored. Special emphasis is needed to determine use patterns of the CAH east of the Canning River as well as interactions that may occur between the two herds. Additional indices of population characteristics may need to be developed to monitor less obvious changes that may be occurring.

Considerable increased study of specific aspects of caribou biology ~~are~~ is needed ✓ to anticipate and document the effects of possible oil and gas developments in the study area. At the present time there is insufficient information on mortality factors, herd productivity, behavioral patterns, habitat requirements and the overall adaptive capability of caribou populations such as the Central Arctic and Porcupine. Specifically there is need for calf mortality studies on the calving grounds and throughout the first year of life. Predator interactions with caribou must be determined throughout the ranges of both herds. Factors such as diseases, weather, and parasites need to be monitored. More detailed information is needed on snow conditions (accumulation patterns, density, hardness and ablation patterns) on the winter grounds, spring migration routes and calving areas. Comprehensive vegetative maps for the entire range of both herds should be developed and assessments should be made regarding seasonal forage selection patterns and habitat use by caribou. Long term studies of the effects of natural wildfire on caribou ranges are also needed. The physiological effects of disturbance-induced stress in caribou should be identified and studied. Related information on normal bioenergetic requirements would be valuable for evaluating the effects of disturbance, and obstructions on caribou populations. Baseline behavioral studies are needed to develop a statistically valid behavior profile for the Porcupine herd. Particular focus of this effort should be on spring migration, calving, post-calving, insect season, fall migration, rutting and wintering activities. With this behavioral picture, in conjunction with improved information on population dynamics, environmental, physiological, nutritional factors as well as human influences, better predictions and recommendations can be made regarding the long term consequences of oil and gas development on the survival of the Porcupine and Central Arctic Caribou Herd.

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# Muskoxen (Ovibus moschatus)

## Introduction

During March and April 1969, 51 Nunivak Island muskoxen (Ovibos moschutus) were released at Barter Island. In June 1970, 13 others were released at Kavik Camp about 80 air miles southwest of Barter Island. About 10 muskoxen died during or shortly after the transplant operation at Barter Island (Pegau pers. com. cited by Roseneau and Stern 1974). Initial mortality among the muskoxen released at Kavik Camp is unknown.

Despite some initial mortality, enough muskoxen survived to form the nucleus of a successful breeding population within the Refuge. The first census of the transplanted muskoxen was by Roseneau and Stern in 1972 as part of the Arctic Gas Pipeline studies. Seven newborn calves were observed. This was the first documentation of reproduction among the transplanted muskoxen. They estimated the population to be a minimum of 29 and a maximum of 34 muskoxen. The population grew slowly from the time of the transplant up to about 1978. Since 1978, the pre-calving population of muskox on the refuge has been annually censused by U.S. Fish and Wildlife Service (USFWS) biologists. Between 1978 and 1981 the population approximately doubled in size. Muskoxen west of the Canning River, outside the refuge, have not been systematically censused. Scattered reports of muskox sightings between Prudhoe Bay and Canning River indicate that the muskoxen transplant at Kavik Camp was also successful.

## Range and Distribution

There are three small herds of muskoxen within the Refuge. These herds have been designated the Canning, Sadlerochit Springs and Jago/Okerokovik herds, named for their affinity to a particular geographic region within the Refuge. Movements to date by these groups have tended to be north/south oriented along major drainages rather than east/west. Jingfors (1980) noted that feeding movements of the Sadlerochit herd were generally linear in riparian habitat as muskoxen moved along the river drainage.

Jingfors (1980) reported that the lowest daily movements for the Sadlerochit herd occurred during calving (average less than 0.5 km $d^{-1}$), reached a peak in mid-summer and declined again during the rut and early winter. In mid-summer the high movement rates may have resulted from the search for relief areas from mosquitoes. Feeding areas used during early and late winter overlapped between feeding areas used during parts of the summer. The seasonal distribution of the herd is related to snow conditions and forage availability and quality. Jingfors' (1980) study of the Sadlerochit herd supports the concensus from the literature that muskoxen are non-migratory and relatively sedentary. Wilkinson and Shank's (1974, cited by Miller and Gunn 1979) study of muskoxen on Banks Island shows that they will remain in one area for days at a time but would also move several kilometers to new foraging areas. Miller and Gunn (1979) reported general impressions that muskoxen on Prince of Wales and Russell Islands are mainly sedentary in summer with a relatively fixed size of range within which they move according to phenology of vegetation, drainage conditions and possibly the size of the herd. Movement patterns of the other two muskox herds during different phases of their annual life cycle have not been studied.

Figure 5 shows the approximate range limits for the three principal populations of muskox within the Refuge. Calving area for the Sadlerochit herd was observed and reported by Jingfors (1980) and used from 1978 through 1980. Calving areas for the other three herds have not been identified. A calving area for the Canning herd may exist just north of VABM TAM based on locations of the herd during pre-calving censuses by USFWS biologists from 1978 through 1981.

Within the Refuge scattered groups of from 1 to 6 muskoxen, usually adult bulls, that have left the larger herds have been seen as far east as VABM Gordon near Demarcation Bay and as far west as the Canning River. In the summer of 1981 Smith (pers comm.) reported the sighting of two muskoxen on the Hulahula River in the Brooks Range mountains by a hunting guide. Roseneau and Stern (1974) reported a muskox was killed by a local Indian hunter near Arctic Village, south of the Brooks Range. Spindler (pers. comm.) reported the sighting of 3 muskoxen at Kay Point, 70 miles east of the Refuge by a pilot flying along the Arctic coast of the Yukon. These muskoxen presumably dispersed from herds within the Refuge. The appearance of lone bulls in an area has been suggested as a precursor to colonization (Pederson 1931 in Hone 1934, and Tener 1965, in Jingfors 1980).

## Population Size and Productivity

In April 1981, 186 muskoxen were counted during a pre-calving population census conducted by USFWS biologists. This census figure was the result of a direct count of muskox both from the air and on the ground.

A population of 186 muskox should be considered a minimum number due to the high probability that some muskoxen were missed during the census. The pre-calving population is probably not significantly larger, because muskoxen are highly visible against a snow covered background and are relatively sedentary within certain regions on the Arctic coastal plain of the Refuge.

No direct census of the post-calving population of muskoxen on the Refuge was made in 1981. Calf production and overwinter survival of calves to yearling age has been good during previous years. Yearlings have made up roughly 20 percent of the population based on four years of FWS pre-calving census data (Table 7). Based on this figure the post-calving population of muskoxen in 1981 may number slightly over 220 animals.

The average annual population increase since 1978 has been about 23 percent. This has resulted in approximately a doubling of the population between 1978 and 1981. Highest productivity among the three principal muskox herds on the Refuge has been in the Sadlerochit herd. Jingfors (1980) reported observing one two-year-old cow nursing a calf during studies of this herd.

# ARCTIC COASTAL PLAIN BASELINE STUDY

Fig. 5. MUSK-OX DISTRIBUTION IN THE ARCTIC NATIONAL WILDLIFE REFUGE 1974 TO 1981

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Table 7. Numbers of Muskox in the Arctic National Wildlife Refuge, 1972 to 1981

| | 1972[3] | 1973 | 1974 | 1975 | 1976 | 1977 | 1978[4] | 1979 | 1980 | 1981 |
|---|---|---|---|---|---|---|---|---|---|---|
| Canning River | 10(2) | 11(1) | 14(5) | -- | 24(4) | 31(7) | 32(7) | 40(8) | 48(9) | 66(8) |
| Sadlerochit Springs | 14(3) | 12(3) | 12(3) | -- | 27(8) | 35(8) | 33(7) | 42(12) | 54(17) | 74(12) |
| Jago/Okerokovik | 11(2) | 13(4) | 10(3) | 10(1) | 15(3) | 18(3) | 14(3) | 24(5) | 27(6) | 33(9) |
| Sadlerochit River | 5 | -- | -- | 5 | -- | 5 | 3 | -- | 4 | 4 |
| Others | 1 | 8[1] | 2 | -- | 1 | 1 | 4 | 6 | 19 | 13 |
| Total | 36-41(7) | 44(8) | 38(11) | 10-15(1) | 67(15) | 90(18) | 86(18) | 112(25) | 148(32) | 186(29) |

() Number of calves/yearlings included in number of muskox

[1] Includes a group of 7 in Yukon Territory that was not located again.
[2] Number of calves/yearlings probably low due to greater percentage of unclassified muskox in the census count
[3] 1972 to 1977 unpublished data from Roseneau and Bente 1977.
[4] 1978 to 1981 unpublished data from ANWR files

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## Habitat Location, Extent and Carrying Capacity

Muskoxen were formerly widespread across the Arctic coastal plain of Alaska. The last surviving herds of muskoxen were reportedly killed on the south side of the Brooks Range around the turn of the century (Reed 1946). With the reintroduction and growth in the population following their extinction more than a century ago, muskoxen are beginning to repopulate areas of, presumably, their former habitat.

Robus' (1981) study of forage use and Jingfors' (1980) study of habitat use are the only habitat studies of muskoxen on the Refuge. Both studies dealt primarily, with the Sadlerochit herd. Robus (1981) found that riparian willows were a major food source for the Sadlerochit muskox herd partictularly in middle and late summer. Food habits of muskoxen from other areas in northern Alaska, mainland Canada and Scandinavia show similar high use of willows (Robus 1981). Robus (1981) suggests that differences in forage preferences of muskoxen in different geographic areas is apparently explained by the availability of forage. A fecal analysis by Robus (1981) from muskoxen in the Tamayariak and Jago drainages had a lower percentage of willow and higher percentage of sedges. Willow is less abundant in these drainages and muskoxen are depending more on sedges and forbes where willow is not abundant (Robus 1981). Productivity in these groups has also been lower than the Sadlerochit herd. Robus (1981) concludes that muskoxen in the Sadlerochit herd are feeding on nutritious and abundant forage species which may explain the herd's high productivity.

Peak production of Salix alaxensis, a preferred muskoxen forage species peaked in early August at 82.4 $gm^{-2}$ (Robus 1981). In contrast, Jingfors (1980), reported a peak biomass value for Salis arctica of 18.6 $gm^{-2}$ on Bathurst Island in the Canadian high Arctic. Productivity of muskoxen (numbers of calves/cows) on Bathurst Island was lower compared to Sadlerochit muskoxen (Jingfors 1980).

The carrying capacity of the refuge for muskoxen is not known. We do know that riparian willows, which appear to be optimal habitat for muskoxen, is limited to major stream drainages such as the Canning, Tamayariak, Katakturuk, Sadlerochit, Hulahula, Aichilik, and Kongakut Rivers. Robus (1981) believes that muskoxen would likely centralize in the few drainages that provide optimal habitat. Moderate to low numbers of muskoxen may use riparian areas and narrow creek drainages where willows grow in small thickets (Robus 1981). Large expanses of tundra isolated from riparian drainages will probably see little or no use by muskoxen (Robus 1981). Locations of muskoxen observed by USFWS biologists during spring pre-calving censuses tend to support these conclusions. During these censuses muskoxen were located either in or quite near a riverine environment presumably where optimal habitat and/or habitat conditions prevail (Fig. 5).

Rather than dispersing into upland tundra of low productivity, muskoxen are more likely to emigrate south into the Brooks Range, east into Canada or west across the Canning River (Robus 1981). Dispersal of muskoxen usually adult bulls from the three principal herds within the Refuge has been observed. Whether this is due to habitat conditions or competitive social pressures within the herds is uncertain.

## Impacts of Existing Processes and Activities

Wolves and brown bears, potentially the most significant predators on muskox, are uncommon on the Arctic Coastal Plain. There have been no reported instances of direct mortality of muskox on the refuge due to wolf and bear predation.

There is no sport or subsistence hunting season for muskox on the Refuge and the season will remain closed for the foreseeable future.

There are no data on natural mortality rates. Dead muskox have occasionally been found on the Refuge by residents of Kaktovik and others.

Jingfors (1980) observed less pronounced reactions to insect harassment than those reported for caribou. Muskoxen decreased the proportion of time spent feeding while increasing movement rates during severe insect harassment (Jingfors 1980).

Caribou, moose, and brown bears, to a limited degree, compete with muskox on the Refuge for available forage. Robus (1981) observed that bears grazing on above ground plants often leave root material which allows for regrowth. Brown bears are not numerous on the Arctic coastal plain and are absent in winter. Brown bears are not important competitors for food with muskoxen (Robus 1981).

Robus (1981) observed both caribou and muskox feeding on the same plant species. During early summer when the food resource is abundant the effects of potential competition, which assumes the active demand for a limited resource are reduced (Miller 1967 cited in Jingfors 1980). Caribou in large numbers are present for only a short period of the year on the Arctic Coastal Plain further limiting competition (Jingfors 1980). Jingfors (1980) observations of caribou/muskox interactions suggest a limited tolerance by muskoxen to approaching caribou.

In winter moose are concentrated where there is suitable riparian willow habitat. Largest numbers of overwintering moose are found on the Cache/Eagle Creek tributaries of the Canning River. The three large herds of muskox on the Refuge have remained further north on the Arctic coastal plain. However, competition for riparian willow has been observed at Sadlerochit Springs by Robus (1981) where the ranges of moose and muskoxen overlap. Heavy browsing of willow by moose was observed but it was concluded that it did not limit forage availability for muskoxen (Robus 1981). As the population of muskoxen expands and disperses competition for willow may increase if areas of prime moose wintering habitat become occupied.

## Data Gaps

Habitat and use patterns have been studied by Robus (1981), and habitat relationships and activity patterns have been studied by Jingfors (1980). Both of these studies focused on the Sadlerochit Springs muskox herd. Little is known about the range characterisitics, traditional use areas for calving, post-calving, rutting and movement patterns for the other herds of muskoxen within the Refuge. There are no data on calf production and natural mortality from the other herds. Interspecific competition between moose and muskoxen for forage may need further study if muskoxen move into traditional moose overwintering areas.

Miller and Gunn (1979) characterized knowledge gaps on the effects of man induced harassment as falling into the short and long term catagories. We do not know the energy budget cost of an individual's response to harassment nor are the long-term effects of harassment known. Baseline studies of muskox physiology are required to be able to interpret data regarding the physiological cost of harassment (Miller and Gunn 1979). The affinity of muskox to traditional ranges is not understood nor the level of harassment that might force range abandonment or the total consequences of such abandonments (Miller and Gunn 1979).

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## Moose (Alces alces gigas)

The occurence of moose in Alaska and other northern environments has been considered a recent range extension into previously unoccupied areas (Anderson 1924, Leopold and Darling 1953, Peterson 1955, Barry 1961, Kelsall 1972). This view was disputed by Lutz (1960). He presented a historical record indicating that moose have long been present in these regions, and are subject to major movements and shifts in the use of available ranges. Causes for these shifts are poorly understood at the present time. However, habitat changes induced by fire have been proposed (Leopold and Darling 1953; Kelsall 1972) and changing habitat conditions caused by a gradual holarctic warming trend have been proposed (Leopold and Darling 1953). Recent archaelogic evidence support Lutz's theory and indicate that moose have long been present in northern Alaska (Hall 1973).

Moose occur throughout Alaska and are considered the most widespread big game animal in the state (Chatelain 1952). Bee and Hall (1956) considered moose common in the riparian communities along major rivers on the North Slope of the Brooks Range. Distributional patterns of moose north of the Brooks Range vary seasonally, with animals being concentrated in the major river valleys in the mountains during the winter and occurring throughout the foothills, mountains, and coastal plain during the summer months (LeResche et al. 1974, Coady 1979). Densities of moose on the coastal plain of the North Slope are low and their occurrence there is considered infrequent (Chesemore 1968, Mould 1977), with speculation that use of tundra habitats may be an effort by moose to seek relief from insect harassment (Mould 1977).

Several major populations of moose occur on the North Slope of Alaska, with the largest populations associated with the Colville River (Mould 1977, NPRA Task Force 1978, NPR-A Work Group 3 1979), although Roseneau and Stern (1974) observed more moose along the Chandalar River than the Colville River in 1972. In northeastern Alaska, concentrations of moose occur along the Canning and Kongakut River drainages (Lenarz et al. 1974, Roseneau and Stern 1974), with sporadic occurrences along other river drainages between the 2 rivers.

In the ANWR, moose range onto the coastal plain during the summer months and would be subject to potential impacts from a summer seismic exploration program in the study area and any subsequent petroleum development that might occur. For the purposes of discussion, the yearly range of moose using the ANWR coastal plain will be presented to enable the reader to comprehend the dynamics of seasonal population shifts and the relative importance of the coastal plain as a component of the habitat requirements of moose. A discussion of the general biology of the species will not be presented; however, the reader is referred to Peterson (1955) and Franzman (1978) for further information on this topic

### Populations

There are 2 major moose populations north of the continental divide on the Arctic National Wildlife Refuge (Fig. 6). The most stable population is associated with the Canning River on the northwestern portion of the refuge. Surveys have been conducted along the Canning River in 1972, 1973, 1974, 1975, 1977, 1978, and 1980. The second moose concentration area is the upper Kongakut River drainage in the northeastern part of the Refuge where surveys have been conducted in 1972, 1973, 1977, 1978, 1980. Timing of these aerial

FIGURE #6. GENERAL AREAS OF LOW, MEDIUM, & HIGH MOOSE DENSITY 1972–1973

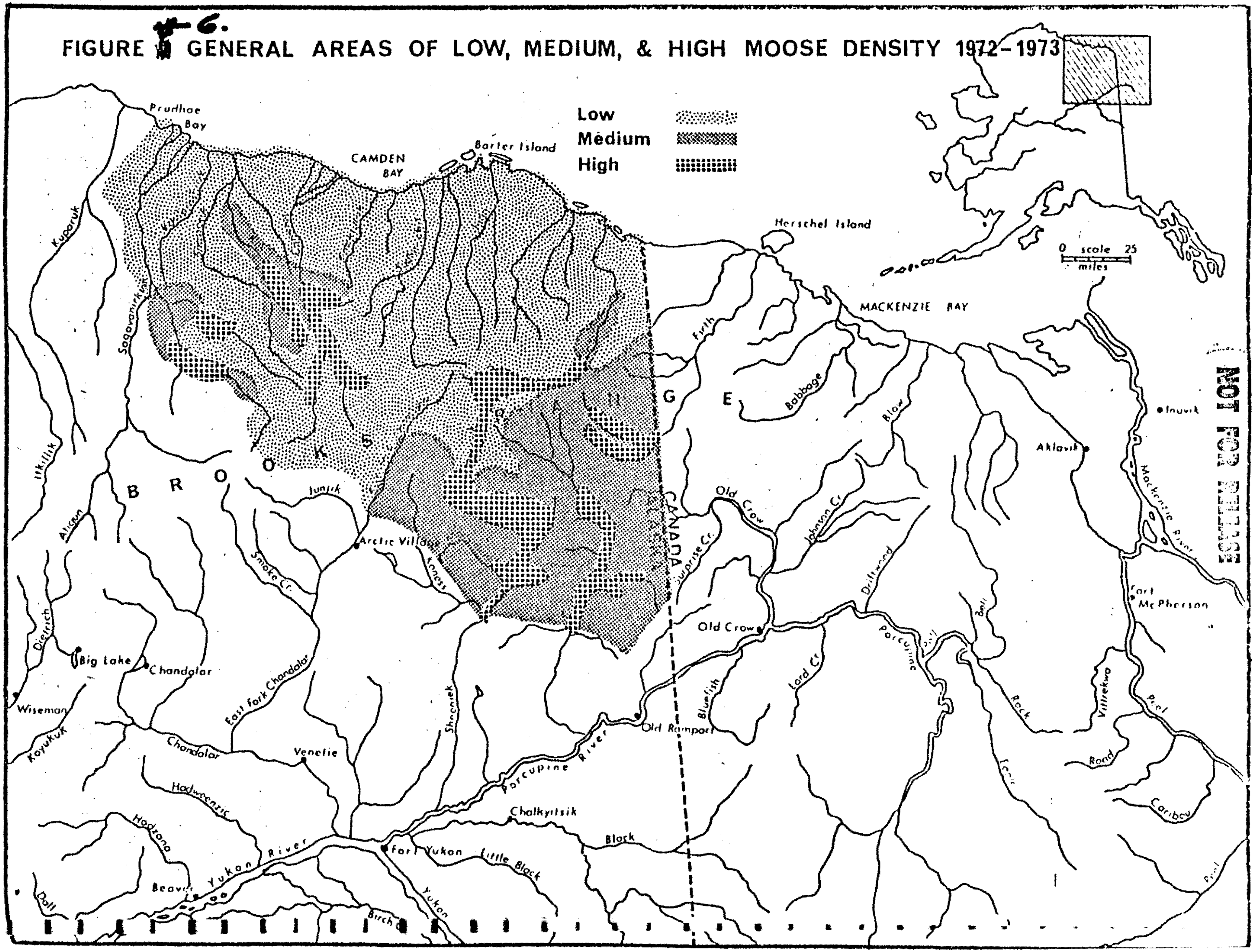

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Fig. 1 - Moose

surveys (March-April or September-October) and survey intensity have varied between years; therefore, direct comparison of the resultant data sets is difficult.

Canning River Population

The Canning River flows from the continental divide north to the Arctic Ocean and has 2 main branches in the Brooks Range. The Marsh Fork flows north from the Phillip Smith Mountains while the main branch of the Canning River flows north from the Franklin mountains. The wildlife studies conducted by Renewable Resources Consulting Services Ltd. for Canadian Arctic Gas Study Limited (CAGSL) included surveys of the wildlife along the Canning River (Jakimchuk 1974a and 1974b). Moose occurring along the Kavik River were considered part of the Canning River moose population because of observed interchanges. A range map (Fig. 7) for this population was presented by Roseneau and Stern (1974).

The Canning River population was surveyed several times in 1972 (Roseneau and Stern 1974) and a maximum of 48 moose were recorded in March-April (Table 8). The Cache/Eagle Creek area was noted as an area important to concentrations of moose, especially in the extension willow (Salix sp.) stands at the mouths of these 2 creeks. The river was surveyed again in 1973 and 1974, and a maximum total of 69 moose was noted in October 1973, with 64 of these animals in the Cache/Eagle Creek area (Lenarz et al. 1974). Subsequent surveys of the Canning River by Arctic National Wildlife Refuge staff recorded decreased numbers of moose in April of 1977 and 1978, while the late April survey in 1980 detected a large increase in the number of moose in the Canning River drainage.

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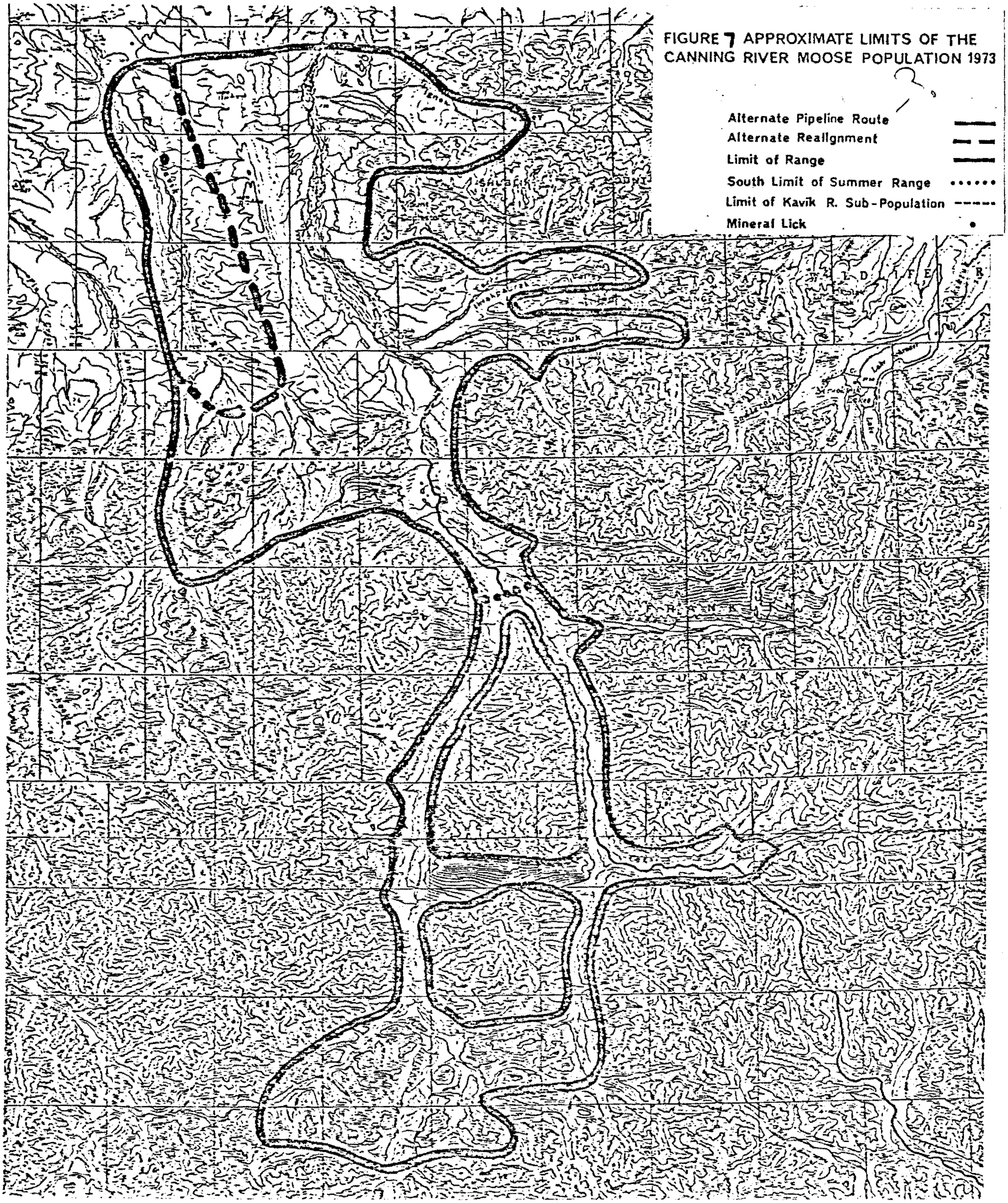

FIGURE 7 APPROXIMATE LIMITS OF THE CANNING RIVER MOOSE POPULATION 1973

Table 8. Total moose observed during aerial surveys of the Canning and Kongakut Rivers on the Arctic National Wildlife Refuge, 1972-1980.

| | Drainage | | |
|---|---|---|---|
| Month - year | Canning River (including Cache/Eagle Creeks) | Cache/Eagle Creeks | Kongakut River |
| March-April 1972[1] | 48 | -- | 21 |
| September-October 1972[1] | 7 | 16 | 8 |
| March-April 1973[2] | 64 | -- | -- |
| May 1973[2] | 45 | -- | -- |
| October 1973[3] | 69 | 65 | 68 |
| March 1974[3] | 42 | -- | -- |
| September 1976[3] | -- | 42 | -- |
| April 1977[3] | 48 | -- | 54 |
| April 1978[3] | 43 | -- | 58 |
| April 1980[3] | 147 | 111 | 123 |

[1] Roseneau and Stern 1974
[2] Lenarz et al. 1974
[3] Arctic National Wildlife Refuge files

Data on age/sex composition of the Canning River populations are limited, with the more detailed information available for the September-October surveys when moose are aggregated during the rut (Table 9). Sex ratios were relatively high in 1973 and 1974 ranging from 33 bulls/100 cows to 67 bulls/100 cows. On 13 October 1973, calves comprised 32.4% of the population, while only accounting for 9.5% of the population in March 1974. These data indicate that some over-winter calf mortality occurred; however, seasonal changes in distributional patterns of moose along the Canning River complicate interpretation of these data. Calf survival in 1976 and 1980 are comparable to the 1974 figures (9,5% of the population); however, calf survival in 1977 was considerably higher (27.1% of the population). Reasons for these observed differences are unknown, but may be an artifact of survey intensity or timing of the surveys in relation to the phenology of season shifts by moose populations along the Canning River.

## Kongakut River Population

The Kongakut River flows north from the continental divide to the Arctic Ocean in the northwest portion of the Arctic National Wildlife Refuge. Moose normally occur in the upper reaches of the river south of Whale Mountain. This population is much more variable than the Canning River population (Table 8) and is subject to emigrations and immigrations of moose in the Sheenjek River drainage and the Firth River/Mancha Creek drainages (Roseneau and Stern 1974). Surveys were conducted in the Kongakut River in 1972 and 1973 by Renewable Resources Consulting Service (Jakimchuk 1974a and 1974b). Additional surveys were conducted by Arctic National Wildlife Refuge staff in 1977, 1978 and 1980.

Table 9. Composition of moose observed during surveys along the Canning and Kongakut Rivers, 1973-1980.

| Date | Location | Bulls | Cows | Yealings | Calves | Unclassified Adults | Total |
|---|---|---|---|---|---|---|---|
| 26 May 1973[1] | Canning River | 7 | 21 | 14 | 3 | -- | 45 |
| 6 October 1973[1] | Canning River | 15 | 23 | 2 | 7 | -- | 47 |
| 16 October 1973[1] | Canning River | 20 | 37 | -- | 12 | -- | 69 |
| 17 October 1973[1] | Canning River | 14 | 21 | -- | 7 | -- | 47 |
| 1 March 1974[1] | Canning River | -- | -- | -- | 4 | 38 | 42 |
| 21September 1976[2] | Cache/Eagle Creeks | 14 | 24 | -- | 4 | -- | 42 |
| 11 April 1977[2] | Canning River | -- | -- | -- | 13 | 35 | 48 |
| 25 April 1980[2] | Canning River | -- | -- | -- | 14 | 133 | 147 |
| 25 April 1980[2] | Cache/Eagle Creeks | -- | -- | -- | 8 | 103 | 111 |
| 11 October 1973[1] | Kongakut River | 25 | 28 | -- | 15 | -- | 68 |
| 13 April 1977[2] | Kongakut River | -- | -- | -- | 9 | 45 | 54 |
| 26-27 April 1980[2] | Kongakut River | -- | -- | -- | 25 | 98 | 123 |

[1] Data from Lenarz et al. (1974)
[2] Data from Arctic National Wildlife Refuge files

Populations varied from a low of 8 moose in 1973 to 123 moose in 1980 (Table 8). Composition data for 1973 indicated 89 bulls/100 cows, with a calf survival rate of 22.1% of the population. Calf survival rates in 1977 and 1980 were 16.7% and 20.3%, respectively (Table 9). These data indicate that calf survival rates in the Kongakut River are higher than those recorded for the Canning River.

### Other Drainages

Moose populations in other drainages north of the Brooks Range within the ANWR were surveyed in 1972, 1973 and 1977. In March and April, 1972 Roseneau and Stern (1974) recorded 2 moose along the Hulahula River, 1 along the Jago River, 1 along the Aichilik River, and 2 along the Egaksrak River . Lenarz et al. (1974) recorded 2 moose along the Sadlerochit River, 6 along the Aichilik River, and 3 along the Egakarak River in April 1973. An extensive moose of moose survey in April 1977 by refuge staff detected 10 moose along the Aichilik River, 7 along the Egaksrak River, and 1 along the Ekaluakat River. Moose were not sighted along the lower Kongakut River (north of Whale Mountain), Okpilak River, Hulahula River, Sadlerochit River, Itkilyariak River, Ignek Creek, or the Peters/Schrader Lake area. These data indicate that moose distribution is sparse within the large area lying between the Canning River on the west and the Kongakut River on the east.

### Mortality

Natural mortality factors affecting these moose populations are poorly documented. Brown bears (*Ursus arctos*) have been observed killing moose along the Canning River (Quimby and Snarski 1974). Wolves (*Canis lupus*) are known predators of moose and can affect moose populations when adverse snow conditions occur (Franzman 1978). Wolves have been observed feeding on moose carcasses in the area (ANWR files); however, it is unknown if the moose were prey items or were scavenged. The extent and effects of such predations on these moose populations is unknown. The role of other natural mortality factors (disease, parasites, etc.) in the dynamics of moose populations in these north slope river drainages is also unknown. Moose disease (Anderson 1964, 1972) does not occur in this area and the majority of diseases and parasites afflicting moose do not normally cause excessive mortality (Anderson and Lankester 1974, as cited in Franzman 1978).

Mortality due to hunting is considered to be minimal along the Canning River, with very little sport harvest. Natives from Kaktovik occasionally use moose for subsistence purposes, although it is not a preferred food (see Subsistence Section, Chapter VII). The 80 km distance between the village and Cache/Eagle Creek may also contribute to the low subsistence use (Lenarz et al. 1974). Sport harvest along the Kongakut is more common than on the Canning; however, the numbers taken each year are quite variable and dependent upon local moose population fluctuations (ANWR file data).

## Habitat

### Willow Communities

Willows (*Salix* spp.) comprise a major portion of the forage consumed by moose in Alaska (Milke 1969; Peek 1974, as cited by Franzman 1978). Use of individual willow species is evidently selective, with *S. alexensis* and *S.*

planifolia being preferred species in interior Alaska (Milke 1969, Machida 1979). S. alexensis was also preferred by moose along the Colville River, with mountain alder (Alnus crispa) being an important winter food item (Mould 1977). In arctic regions, moose are restricted to the riparian communities along the major rivers during winter (LeResche et al. 1974, as cited by Lenarz et al. 1974), however they do disperse into tundra areas during the summer months (Kistchinski 1974, as cited by Mould 1977). The long distances between the major rivers in this region may limit emigration or immigration (Lenarz et al. 1974), although the Kongakut River population seems to be subject to occasional shifts in range use patterns by moose (Roseneau and Stern 1974).

Willow stands along the Canning River drainage were mapped in 1973 [redacted] and these stands were examined qualitatively for evidence of browsing (Lenarz et al. 1974). Practically all willow stands showed evidence of moderate browsing, with heavy browsing occuring in the willow stands along Cache/Eagle Creeks and along the south fork of the Canning River. Again, S. alexensis was considered the major browse species in these willow stands. Balsam popular (Popular balsamifera) occurs in relatively discrete stands at several locations along the Canning River; however, little browsing was noted for this species, except in the large stand along Cache Creek. The Cache Creek/Eagle Creek Area is a major concentration area for moose and heavy utilization of willows and balsam popular was evident throughout the 2 drainages.

Riparian willow densities on the north side of the Brooks Range were estimated and mapped by refuge personnel in April 1977 to assess these areas as critical moose range (Hutson 1977). All rivers and streams between the Canadian border and the Canning River were surveyed and numbers of moose observed were recorded. Willows were most abundant along the Canning, Hulahula, Aichilik and Kongakut Rivers, with the highest proportion of dense willow stands occuring along the Kongakut and Canning Rivers. Most of the moose occurred in the willow stands along the Kongakut and Canning Rivers (54 and 48 of 120 moose, respectively). Ten moose were observed along the Aichilik River and 8 were observed along the Egaksrak and Ekaluakat Rivers. Ground truth data for willow densities were not available for this study, therefore no conclusions were made about willow density as the single criterion for evaluating habitat quality for moose.

Species composition data for the riparian willow communities are limited; however, species occurring along Cache Creek and the Marsh Fork of the Canning River were recorded by Hettinger and Janz (1974). Principal willow species were S. alexensis and S. planifolia pulchra. Species occurring along the Sadlerochit River included the above 2 species and S. phlebophylla, S. arctica, S. glanca, and S. Brachyearpa (Jingfors 1980, Robus 1981).

### Seasonal Habitat Use Patterns

Moose that occur in the northern Brooks Range, foothills, and tundra use the various habitat types in distinct seasonal patterns, dependent upon the particular environmental variables affecting each moose population. The following materials summarize the available knowledge about this seasonal use for the Canning River and the Kongakut River populations.

Canning River Moose. The large willow and balsam poplar stands near the mouths of Cache and Eagle Creeks are the major concentration areas for the

Canning River moose population in late May of each year (Valkenburg et al. 1972, Lenarz et al. 1974). Moose move north into this area in mid-May, and are aggregated into small widely dispersed groups along the lengths of Cache and Eagle Creeks. Calving occurs in late May and early June, therefore this aggregation can be considered a calving aggregation. Following calving, moose gradually disperse north along the Canning River and east along Cache and Eagle Creeks. Very few moose are present in the willow flats along the Canning River during late June and July (Valkenburg et al. 1972). The extent of this summer dispersal was believed limited to the drainages in the mountains (Lenarz et al. 1974), although a few moose were observed on the coastal plain as far north as the Arctic Ocean in 1972 (Roseneau and Stern 1974a, 1974b). Recent observations of moose (cows with calves, single bulls, etc.) along the Sadlerochit River on the coastal plain (Magoun and Robus 1977, Magoun 1979 personal communication) and on to Okpilak delta (Spindler 1979) indicate that this dispersal may be more widespread with unknown numbers of moose dispersing onto the coastal plain for the summer.

Summer dispersal is relatively short-lived, and moose again begin to aggregate in the willow/poplar stands at the Cache/Eagle Creek confluence with the Canning River in late August (Lenarz et al. 1974). This aggregation is associated with the rut and tends to peak in October, when a majority of the Canning River population is located in the Cache/Eagle Creek area (see October 1973, Table 8). In years of relatively light snowfall, a majority of the Canning River moose winter in the Cache/Eagle Creek area (Lenarz et al. 1974). In normal or deep snowfall years, moose move south along the Canning River and winter in the valleys of the Marsh Fork, Main Fork, South Fork and East Fork of the Canning Rvier. The Cache/Eagle Creek area is always used as a wintering area by at least a portion of the moose population occuring along the Canning River (Lenarz et al. 1974), regardless of the snow conditions. A similar pattern of wintering along streams in mountainous terrain and moving north during the summer was noted for moose in northern Yukon Territory (Ruttan 1974). One characteristic of moose wintering north of the continental divide in the Brooks Range is a very high degree of local movements from one willow stand to the next (Roseneau and Stern 1974). Moose were often sighted in one willow stand along a drainage, and a few days later this stand would be devoid of moose. Reasons for these movements was undetermined, although they would tend to distribute browsing pressure across the available willow stands.

In April and early May, moose again move north along the Canning River and aggregate in the Cache/Eagle Creek area. Such seasonal movements can be considered a migration (Edwards and Ritchey 1956), although seasonal shifts in range use appears to be more appropriate terminology for these movements.

Kongakut River Moose. Seasonal distribution of moose using the upper Kongakut River has not been well documented by repeated surveys at various times of the year, although limited survey data do give some evidence on the subject. This population is apparently subject to the influence of mass emigration and immigration of moose to and from adjacent drainages.

Roseneau and Stern (1974) documented an emigration is April 1972 of practically the entire moose population in the upper Kongakut River into the headwaters of the Firth River. These animals had moved approximately 25 km south over a pass and were located in the first 2 willow stands along the Firth River. This movement was in single file as evidenced by a narrow trail in the snow between the 2 locations. Other long distance movements (65-80 km) of moose have been detected by following tracks in snow (A. Thayer 1981, personal communication).

The Kongakut population in 1972 and 1973 ranged from a low of 8 moose in September-October 1972 to a high of 68 moose in October 1973 (Table 9). The decline was attributed to the aforementioned emigration into the Firth River, while the increase to 68 moose was attributed partially to moose moving north from the Sheenjek River across the continental divide into the Kongakut River drainage (Lenarz et al. 1974). The high numbers of moose observed along the upper Kongakut River in April 1980 (Table 9), may have been the result of a similar influx of wintering mooose from the upper Sheenjek River, but no evidence exists to support this contention.

*Use of the Coastal Plain by Moose*. Moose do occur on the coastal plain during the summer months, however the extent of this use and its importance to overall moose populations inhabiting the adjacent river drainages in the Brooks Range is undetermined. Moose have been considered occasional or accidental occupants of the coastal plain (Doll et al. 1974, Lenarz et al. 1974, Roseneau and Stern 1974, Ruttan and Worley 1974, Coady 1979). Recent data suggest that this use may be more extensive than previously suspected (Magoun and Robus 1977). Moose are most often observed along the river drainages and wetland complexes on the coastal plain (Magoun and Robus 1977; Spindler 1979). Carrying capacity of the coastal plain for moose cannot be determined from the available data.

## Data Gaps

The ecology of moose north of the Brooks Range is poorly understood and quantitative data to assess the role and importance of the coastal plain as summer habitat for moose are not available. Baseline information needs include the numbers and distribution of moose using the coastal plain habitats, and an identification of those coastal plain habitat types used by moose. To comprehend the role of the coastal plain in ecology of moose north of the Brooks Range, extensive studies of population dynamics (productivity, mortality, age/sex ratios, etc.), movements, and seasonal food habits would be required for the entire moose population using the area.

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# Marine Mammals

## Introduction

Marine mammals which are found in the study area are ringed seals, bearded seals, polar bears (which may or may not be marine mammals), bowhead and belukha whales, and occasionally spotted seals, walrus, and gray whales.

The presence and location of marine mammals are tied to the condition and location of the pack ice. The ice is used for resting, bearing young, molting and as a feeding platform (Fay 1974). Ringed seals, bearded seals, and polar bears are year 'round residents in the Beaufort Sea (Lowry et al. 1979). Ringed seals are associated mainly with the land fast ice (that which is attached to the shore, also called shorefast) of the winter pack, while bearded seals can be found in the moving pack ice.

Between the landfast ice and the moving pack a flaw or lead zone occurs which contains some open water. Lead zones are important ringed seal (especially non-breeders) and bearded seal habitat, and in turn the polar bears which prey upon them.

When the pack ice begins to break up in the Bering Sea in late March, bowheads and belukhas begin their northward migration. In summer when the ice has retreated from the shore, animals may become pelagic in open sea, move inshore, or concentrate along the edge of the ice (Burns et al. 1980).

Bowheads and belukhas migrate south and west out of the Beaufort Sea before new ice begins to form along the shore in September or October.

## Polar Bears (*Ursus maritimus*)

### Population Distribution, Range and Size

Polar bears are circumpolar in the northern hemisphere. They range from as far as 88°north on the polar ice pack and have been seen as far south as St. Matthew in the Pribilof Islands (DeMaster and Stirling 1981).

Except for denning females, polar bears remain associated with the ice, traveling north and then eastward as the pack begins to melt in spring and spending summers at the edge of the ice, although they may occasionally range further into the pack. They are most abundant in the drifting pack ice zone where ringed seals, their primary food source, occur (Lentfer 1971).

At least 6 distinct populations are believed to exist and are centered in the following areas: Wrangel Island and Western Alaska, Northern Alaska, the Canadian Arctic Archipelago, Greenland, Svalbard-Franz Josef Land, and Central Siberia (DeMaster and Stirling 1981).

Lentfer (1974a) advanced the idea of two discrete populations of Alaskan polar bears based on tag recoveries, differences in body and skull sizes, and levels of mercury in the tissues. Additional cranial measurements taken by Wilson (1976) also support this conclusion. Researchers for the U.S. Fish and Wildlife Service in Alaska are presently collecting polar bear blood serum to conduct electrophoretic examination of blood proteins to further demonstrate this discreteness. Tegelstrom and Larsen (in press, cited by Amstrup 1981) have shown that electrophoretic activities of certain blood proteins in polar bear blood differ according to geographic location and should identify different populations .

A line northwest from Point Lay arbitrarily divides the western and northern populations of Alaskan polar bears, therefore bears found within the study area belong to the northern Alaska population. There is limited movement between these two Alaskan populations and also between Alaskan and Canadian bears (Lentfer 1974a; Stirling 1974).

Estimates of the world population of polar bears vary from 10,000 to 20,000 animals (DeMaster and Stirling 1981). Recent estimates of the total Alaskan population were 6,000 to 9,000 (D.G. Chapman pers. comm., cited in DeMaster and Stirling 1981), and 5,000 to 7,000 bears (Lentfer pers. comm. cited in Seaman et al. 1981). Brooks (1978) estimated that there were 2500 to 3000 polar bears in the northern Alaska population. Mark and recapture studies are currently underway to define population limits more precisely, but at this time, mark and recapture estimates are unreliable because there are not enough data to estimate the statewide population with any confidence (Amstrup 1981).

## General Biology

In Alaska, pairing of males and females was observed between 21 March and 10 May and estrus in females was evident throughout this period (Lentfer et al. 1980). Mating probably continues beyond 10 May but limited field work after May 10 yielded few observations. Lønø (1970) reported that breeding continues until about mid-July in Spitsbergen. Implantation is delayed until about September (Stirling et al. 1975a) and gestation takes from 195 to 265 days (DeMaster and Stirling 1981).

The average breeding age for females is 5.4 years, but reproductively active females between the ages of 3 and 21 have been harvested or captured. Males are capable of breeding from a minimum age of 3 years to a maximum of at least 19 years (Lentfer et al. 1980).

Female polar bears return to land to den in October and November (Lentfer 1976a). The timing is dependent upon ice movement and the arrival of the ice to land in the fall (Lentfer and Hensel 1980). Dens are dug in snowdrifts on land or on the ice.

One, two or occasionally three helpless cubs, about 25.4 cm long (Harington 1968) and .6 kg (DeMaster and Stirling 1981) are born in December or January. Litter size in maternity dens is not known for Alaskan bears but the mean litter size for cubs captured in family groups was 1.58 (Lentfer et al. 1980). By the time cubs leave the den they weigh about 10 to 15 kg (DeMaster an Stirling 1981).

Dens are opened in late March or in April (Lentfer 1976a): Uspenski and Belikov (1976) believe that the emergence date is determined by weather conditions outside the den, especially air temperature and abatement of strong winds. Belikov (1976) reports that a female was observed to enter a den on 14 October and emerge on 14 April, for a total denning period of 183 days.

The mother and cubs remain near the den and take short trips for one to two weeks while the cubs gain strength and become acclimated to the air temperatures outside the den (Lønø 1970; Lentfer 1976a). They then return to the ice to feed on seals.

In Alaska, cubs remain with their mother for up to 28 months (Lentfer 1976a). Males will reach full size at 8-10 years of age and females are about 5 years old when they reach maximum size and weight.

## Habitat

Polar bears utilize a combination of sea ice and terrestrial habitats.

The Beaufort Sea is completely ice covered for almost 10 months of the year. The open water begins to freeze in September or October and the nearshore ice does not melt until May or early June. With the exception of some denning females, polar bears inhabit the ice throughout the winter.

The three basic types of sea ice present in winter are landfast ice, which is anchored to the shore, drifting pack ice, which is in motion between landfast ice and permanent polar pack ice, and the permanent polar pack ice (Lentfer 1972). The distribution of polar bears over the sea ice is influenced by the abundance and accessibility of their major prey species, ringed (Phoca hispida) and bearded (Erignathus barbatus) seals. In winter, ringed and bearded seals may be concentrated in areas of drifting seasonal pack ice where open patches of water form and then refreeze into areas of thin ice in which the seals can maintain breathing holes when open water is not available (Lentfer 1971; Stirling et al. 1975a).

The landfast, or shorefast ice is used mainly as a substrate across which to travel, although some feeding and denning also occurs there. Adult parturient females travel across this landfast ice in September or October to denning sites on land. Other members of the population use the landfast ice to reach areas on land or on barrier islands to which they are attracted by carrion of whales, seals, or walrus. Within the Coastal Plain study area, polar bears are drawn to the carcasses of bowhead whales killed during the fall by Inupiat people in the village of Kaktovik on Barter Island.

Female polar bears must again traverse the shorefast ice in March or April when they lead their young cubs from their dens on land to the drifting pack ice to feed. In transit, they hunt ringed seals and their young which are found in subnivean lairs on the fast ice.

When the nearshore ice breaks up in spring, polar bears move with it and become most abundant at the southern edge of the pack ice, the position of which varies seasonally, but which usually occurs between 71° and 72° north latitude in Alaska.

Sea ice provides polar bears with a hunting platform, shelter from weather, transportation to feeding areas, and occasionally denning sites. Polar bear denning has been documented on shorefast ice and drifting sea ice (Lentfer 1975; Lentfer and Hensel 1980) but the extent to which the latter occurs is not known.

Tagging studies in both Alaska and Canada have shown that in successive winters bears often return to the same general area where they were captured (Stirling 1974). They seem to have the ability to navigate to feeding areas, denning sites, mates, and solid ice during spring break-up even though winds, currents and tides bear them elsewhere (Harington 1968; Lentfer 1972).

Terrestrial habitats are used only by denning females or by bears that have been attracted to carrion on land.

Denning Distribution and Habitat

Lentfer (1972; 1976a) and Lentfer and Hensel (1980) have summarized the results of studies of polar bear denning in Alaska. Only pregnant females go into winter dens for extended periods. They do not concentrate for denning along the coast of Alaska as they do in "core" denning areas in other parts of their range. The Alaskan coastal zone is fairly flat, and snow of a suitable depth for denning occurs only along drainages, cut banks, and rough ice.

Dens have been found on land, offshore islands, shorefast ice, and drifting ice from 169 km offshore from the coast to 48 km inland. The area along the coast from the edge of the shorefast ice to about 40 km inland from the Colville delta to the Canadian border is a significant maternal denning area for the Beaufort Sea population of polar bears.

Of 35 maternity dens previously found in Alaska, 7 were found on land within the ANWR study area and 3 confirmed dens and 2 possible dens were found just north of it on the shorefast ice (Fig. 9, Table 10). A polar bear, digging what appeared to be a den was observed on the coastline midway between Pokok Bay and Pokok Lagoon by U.S. Fish and Wildlife Service personnel conducting mark and recapture studies of polar bears in October 1981. And on 14 November 1981 a radio-collared female was tracked to a den about 12.9 km south of Demarcation Bay. On the adjacent National Petroleum Reserve, Alaska, just west of the study area, 13 of the aforementioned 35 dens were found.

On 13 April 1980, Wilson Soplu of Kaktovik observed a sow and small cub near Itkilyariak Creek where it flows out of the north side of the Sadlerochit ~~Lagoon.~~

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Table 10. Polar Bear dens in or near the Arctic National Wildlife Refuge

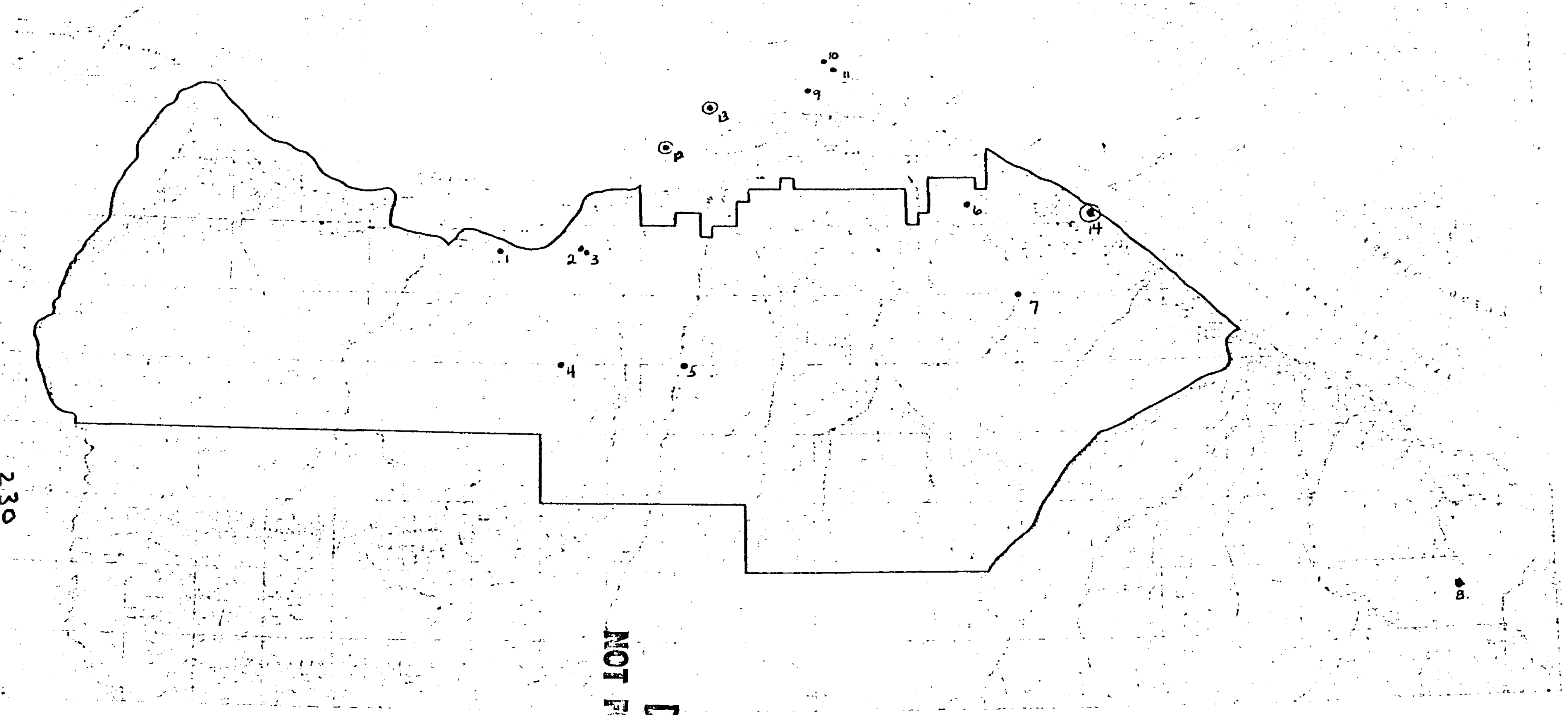
| LOCATION | DATE | SOURCE |
|---|---|---|
| 1. 69 58'N 144 47'W<br>Marsh Creek - .4 km.<br>S VABM Maybell | 1 April 1977 | ANWR files |
| 2. 69 56'N 144 28.2'W<br>3. Between Carter Creek and Sadlerochit R. - 2 dens were 68.6 m apart | 3 April 1974<br>4 April 1974 | ANWR files |
| 4. 69 49.5'N 144 35.0'W<br>16.1 km. S. of Camden Bay-Upper Carter Creek drainage. | 4 April 1974 | ANWR files |
| 5. 69 50'N 144 08'W<br>24.2 km up Hulahula River. | Late Nov. 1968 | USFWS Den Log |
| 6. No co-ordinates<br>2.4 km NW BM Penta | 13 April 1976 | ANWR files |
| 7. No co-ordinates<br>Niguanak R.<br>19.3 km inland SE of Barter Island. | 26 March 1972 | USFWS Den Log |
| 8. 69 32'N 141 25'W<br>12.9 km S of Demarcation Bay on fork of Turner River | 14 November 1981 | USFWS |
| 9. 70 10'N 143 40'W | March 1951 | USFWS Den Log |
| 10. 7.2 km north of Barter Island airstrip. | 19 March 1975 | Moore |
| 11. 6.4 km north of Barter Island airstrip. | 19 March 1975 | Moore, 1975 |
| <u>Possible dens</u> | | |
| 12. 16 km west of Kaktovik and 6.5 km north of VABM Barbara. | 21 March 1975 | Moore, 1975 |
| 13. 14.5 km west of Kaktovik and 6.5 km north of the west end of Arey Island. | 22 March 1975 | Moore, 1975 |
| 14. On shoreline between Pokok Bay and Pokok Lagoon | October 1981 | USFWS |

Figure 9. Polar Bear Maternity Dens

● Confirmed Dens

⊙ Possible Dens.

Numbers correspond to Table 10.



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Mountains, 32 km straight-line distance from the coast. He said that the cub tired easily and had to stop often to rest (Letter from Mike Jacobson to Ancel Johnson). On the ice north of the study area, Lentfer and Hensel (1980) have documented 3 sightings of cubs recently out of dens. Ave Thayer (pers. comm.), former refuge manager of the ANWR, has observed many tracks of adult bears with cubs near Demarcation Bay in the wilderness area of the ANWR. This is an area where the mountains are relatively close to the coast, as is the area north of the Sadlerochit Mountains (within the study area) where the land near the coast has enough relief to allow a greater degree of snow accumulation than other areas within the study area.

Polar bear dens are excavated in snow. Some factors which influence the choice of den location are distance inland from the coast, snow depth, snow density, and other topographic features which help to provide the best drifts, the least windchill, and the best insolation (Harington 1968).

Harington (1968), Lønø (1970), Uspenski and Kistchinski (1972), Moore and Quimby (1975), Larsen (1976) and Lentfer and Hensel (1980) provide detailed descriptions of polar bear dens.

Food Habits

As mentioned before, ringed and bearded seals comprise the main diet of polar bears, therefore bears must feed in areas where seals are either concentrated or accessible. Of 71 pinniped carcasses killed by polar bears and examined by Burns and Eley (1978), 92% were ringed seals, 7% were bearded seals and 1% (one animal) was a walrus (Odobenus rosmarus). Eighty percent of the kills were on flaw zone ice or moving pack ice and 20% were on shorefast ice.

Polar bears are not very successful in obtaining seals by excavating lairs (Stirling et al. 1975a). They usually capture seals by waiting for them at breathing holes. Polar bears are unable to capture seals in open water, and ringed and bearded seals rarely haul out on land, so when there are large areas of open water and seals have more places to breathe than just breathing holes, polar bear hunting success is lower (Stirling et al. 1975a). They feed predominately on the blubber and hide of the seal unless they are very hungry or are sharing the carcass with another bear.

Polar bears must consume about 1 ringed seal every 6.5 days to meet their energy requirements (Burns and Eley 1978). Assuming a northern Alaska population of 2500 bears, 140,000-143,000 seals would be eaten per year.

Small amounts of other foods are occasionally eaten, such as sea birds, which bears capture by diving under the water and coming up beneath them (Stirling et al. 1975a), ptarmigan which they take from fox traps (Lønø 1970), and small amounts of seaweed. Females eat plants dug from under the snow both while constructing their dens (Belikov 1976) and when taking their cubs across the tundra to the sea ice (Uspenski and Kistchinski 1972). Since females do not feed for about 5 months during denning, it is important that a good food source is available during both the pre-denning and post-denning periods.

Impacts of existing processes and activities

Under the provisions of the Marine Mammal Protection Act of 1972, only Alaskan Natives are allowed to hunt polar bears in the state. There are no restrictions on number, sex, age, or method ot taking except that waste shall not occur. An international agreement signed by Canada, Denmark, Norway, USSR, and the USA provides a High Seas sanctuary for polar bears which "...prohibits the taking of polar bears from aircraft of large motor vessels or in areas where they have not been taken by traditional means in the past," (Lentfer 1974b). For information on harvest and use of polar bears within the study area, see Chapter VII.

Climate and sea ice conditions affect polar bear populations and their habitat. Warming and cooling trends of 50 to 100 year durations have been recorded in the Arctic (Vibe 1967 cited in Lentfer 1971). Cooling trends could extend denning habitat further south while warming trends could result in fewer bears reaching favorable denning areas.

In years when the landfast ice arrives late to the coast, there are fewer bears on the coast, and denning may be delayed or reduced so that cub production is lowered (Harington 1968; Lønø 1970; Lentfer 1971; Uspenski and Belikov 1976). Den distribution is also different in different years depending on the ice condition of the previous autumn (Uspenski and Kistchinski 1972).

Mortality to polar bears results from injuries and infections, starvation, cannibalism of young by older bears, and mechanical damage that can occur in the moving ice (Harington 1968).

Lentfer (1976b) reported the results of baseline studies of environmental contaminants and parasites in polar bears. Effects of environmental contaminants on marine mammals are not well understood, but apparently lethal levels were not found in polar bears. About 60% of Alaskan polar bears are infected with *Trinchinella spiralis* but whether or not this is life-threatening is not well documented.

Polar bears compete with man for their main prey item, the ringed seal. Any natural or man-induced reduction in ringed seals will affect the bears.

### Data Gaps

The USFWS is continuing studies which will provide a better understanding of population size, movements of polar bears, and denning locations.

## Ringed Seal (*Phoca hispida*)

### Population, Distribution, Range, and Size

Ringed Seals are circumpolar in distribution and the most abundant and widely distributed of the arctic seals. They inhabit the Beaufort Sea year around. In winter and spring, they are associated with the shorefast ice and the flaw zone, but move out to the pack ice edge during summer and fall. Brooks (1978) estimated that 250,000 to 1,500,000 ringed seals inhabit the seas bordering Alaska.

At lease six aerial censuses of ringed seals have been conducted within the Arctic Coastal Plain Study Area. In 1970, ringed seals were censused along the north coast of Alaska in order to establish a baseline of density and distribution (Burns and Harbo 1972). One of the census areas, Flaxman Island to Barter Island, was censused again in 1975, 1976, and 1977 by Outer Continental Shelf Energy Assessment Program (OCSEAP) personnel. In addition, Gregory Moore (funded by Arctic Gas) used two methods to estimate ringed seal density in the Beaufort Sea from Camden Bay in the American Beaufort, to Shingle Point in the Canadian Beaufort Sea. All censuses were conducted during the second or third week of June when a maximum number of resident ringed seals would be hauled out on the fast ice to molt (Burns and Harbo 1972).

U.S. Fish and Wildlife Service personnel conducted aerial surveys along the coast of the ANWR on 22 June and 16 July, 1974. Twenty-eight survey lines, perpendicular to the coast and approximately 16km apart were flown. Ten were 19.3km long and 18 were 8.0km long. Observations were made out to .2km on each side of the aircraft. The timing of the 22 June survey coincided with the peak of the molt, while the 16 July survey occurred after the peak of the molt and under conditions of poor visibility.

Results of the aerial censuses are summarized in Table 11. The average of the means of 0.44 seals/km$^2$ (Table II A) for the Flaxman Island to Barter Island sector is comparable to the overall observed density of ringed seals in the Beaufort Sea (including the Yukon coast) of 0.40 seals/km$^2$ as derived by Frost and Lowry (1981), and to the density of 0.46 seals/km$^2$ for the Beaufort Sea from Camden Bay to Shingle Point as calculated by Moore for his non-parallel flight lines in 1975.

Moore's parallel flight line surveys found that the highest density of seals within the Arctic National Wildlife Refuge occurred near Beaufort Lagoon. Ringed seal densities were higher to the east in Yukon Territory. With Moore's 1975 parallel flight line method, density was 1.56 seals/km$^2$ at Komakuk Beach (Y.T.), and with the non-parallel method, density was 1.19 seals/km$^2$ in the Herschel Island area (Y.T.) between the Firth and Babbage Rivers.

Table 12 compares ringed seal densities from west to east along the Beaufort Sea coast from 1970 to 1977. West of the ANWR, the average mean densities were higher between Barrow and Lonely but lower in other areas compared with densities in the ANWR.

Table 11. A comparison of ringed seal densities obtained during surveys from 1970-1975 using different techniques.

Table 11 A. Flaxman Island to Barter Island

| Year | Density Seals/km$^2$ | Source |
|---|---|---|
| 1970 | 0.73 | Burns and Harbo 1972 |
| 1975 | 0.54 | Burns and Eley 1978 |
| 1976 | 0.12 | Burns and Eley 1978 |
| 1977 | 0.36 | Burns and Eley 1978 |
| Average of means | 0.44 | Burns and Eley 1978 |

Table 11 B. Non-parallel flight line method - Camden Bay to Beaufort Lagoon

| Year | Density Seals/km$^2$ | Source |
|---|---|---|
| 1975 | 0.26* | Moore 1976 |

*Density extrapolated for segments 1 through 5 of the non-parallel flight line method.

Table 11 C. Parallel flight line method.

| Year | Density Seals/km$^2$ | Area | Source |
|---|---|---|---|
| 1975 | 0.78 | Camden Bay | Moore 1976 |
| | 0.83 | Barter Island | |
| | 0.91 | Beaufort Lagoon | |

Table 11 D. USFWS perpendicular transects

| Date | Density Seals/km$^2$* | Source |
|---|---|---|
| 22 June '74 | 0.82 | Unpublished data, ANWR file |
| 16 July '74 | 0.12 | |

* some bearded seals may have been included in the count.

Table 12. Ringed seal density estimates (number seals sighted/km$^2$) along various sectors of the Beaufort Sea coast. (from Frost and Lowry 1981).

| Year | Barrow to Lonely[1] | Lonely to Oliktok[1] | Oliktok to Flaxman I.[1] | Flaxman I. to Barter I.[1] | Yukon Coast[2] |
|---|---|---|---|---|---|
| 1970 | 0.68 | 0.32 | 0.41 | 0.73 | -- |
| 1974 | -- | -- | -- | -- | 0.52 |
| 1975 | 0.84 | 0.42 | 0.30 | 0.54 | 0.21 |
| 1976 | 0.42 | 0.33 | 0.42 | 0.12 | -- |
| 1977 | 0.30 | 0.15 | 0.21 | 0.36 | -- |

[1] Burns and Harbo 1972; Burns and Eley 1978

[2] Stirling et al. 1977

The density figures presented may be used as an index of abundance but do not represent the actual numbers of seals in the population. In order to estimate the population, one must know what proportion of the population is hauled-out and therefore counted during surveys. The number of seals hauled-out varies with weather conditions (Finley 1979), and at any time may represent from 50 to 70 percent of the population (Finley 1979; Frost and Lowry 1981). In addition, censuses were conducted over the fast ice in spring, and when the ice breaks up there is a summer influx of ringed seals from the Bering and Chukchi Seas, and the ringed seal population increases (Burns and Harbo 1972; Lowry et al. 1979 and Frost and Lowry 1981).

Life History

The age at which female ringed seals reach productive maturity ranges from six to ten years, but most do so between seven and nine years of age. Males reach sexual maturity at age seven and eight (Burns and Eley 1977). Females are impregnated subsequent to pupping (between mid-and-late April) and implantation is delayed 3 1/2 months until mid-July or mid-August (Burns and Eley 1977).

Single white-coated pups are born from mid-March through April in snow dens (subnivean lairs) excavated in packed snow on the lee or windward side of pressure ridges or ice hummocks. Pups are suckled in and dependent upon the dens for approximately two months.

Longevity or ringed seals may approach 36-40 years, but few seals taken in subsistence harvests ~~ae~~ are more than 10-15 years old (Burns and Eley 1978).

Food Habits

Trophic studies or ringed seals in the Beaufort Sea have been funded by the OCSEAP since 1975.

Diets vary seasonally, presumably with the concentrations of prey species (Lowry et al. 1979), and may also vary somewhat with locality (Frost and Lowry 1981). Initially, food samples were collected primarily near Point Barrow and Prudhoe Bay, but during the summer of 1980 additional stomach contents were obtained from Pingok Island (west of Prudhoe Bay) and Beaufort Lagoon which is in the Arctic Coastal Plain Study Area.

In general, ringed seals eat benthic crustaceans such as gammarid amphipods, mysids, shrimps, and isopods, in late winter and early spring (April-June), nektonic crustaceans, such as hyperiid amphipods and euphausiids in summer, (August-September), and arctic cod in winter (November-March) (Frost and Lowry 1981). The recent work at Pingok Island and Beaufort Lagoon, however, has shown that arctic cod may be a major summer prey item in areas where euphausiids or hyperiid amphipods may not be abundant. Arctic cod are present in summer, but more dispersed; concentrations or aggregations of prey species, which occur in localized areas, enable seals to obtain large quantities of food more efficiently (Lowry et al. 1979). The use of actic cod in the winter diet may coincide with an onshore spawning by arctic cod in the fall; this phenomenon has not been reported in Alaska but is documented for other areas of the world (Lowry et al. 1979).

No data are available on foods used by ringed seals in the Alaskan Beaufort Sea during July or October (Frost and Lowry 1981).

### Habitat

Ringed seals occur in both moving and landfast ice and are capable of maintaining breathing holes in ice as thick as two meters by abrading the sea ice with the claws of their foreflippers; an adaption which allows them to inhabit areas of extensive, thick, stable ice (Smith and Stirling 1975; Burns et al. 1980; Cowles 1981). Highest densities of seals along the northern Alaska coast occur in areas of very stable shorefast ice in late winter and early spring.

Preferred breeding habitat is landfast ice, and that is where breeding seals occur in the greatest density; but ringed seals are known to use far offshore areas of shifting but relatively stable ice (Smith and Stirling 1975). Moving ice may be marginal breeding habitat used by younger, more inexperienced seals, and may subject them more to polar bear predation (Burns and Eley 1977).

The lairs, which function to protect ringed seal pups from predators (mainly polar bears (*Ursus maritimus*) and arctic foxes (*Alopex lagopus*) and from the cold, are located above breathing holes in the ice and may be complex structures (Smith and Stirling 1975).

### Lagoons

Most of the lagoons within the Coastal Plain Study Area are so shallow that ice is usually anchored to the bottom in winter, therefore they are not available to ringed seals as pupping habitat or winter feeding areas. Lagoons would have to be deeper than eight to ten feet and have an open connection to the ocean to provide suitable pupping habitat (L. Lowry, pers. comm.). Nuvagapak, Angun, and Jago lagoons are from 10 to 12 feet deep in spots, while Kaktovik lagoon reaches a depth of 13 feet but does not connect directly to the ocean.

Ringed seals are occasionally seen in lagoons in very low numbers in summer and fall. Lowry (pers. comm.) reported seeing one or two seals on several occasions in Beaufort Lagoon while working there in early September 1980. Between 9 June and 3 July 1980, Jim Levison saw one to three seals daily on the ice in the Nuvagapak portion of Beaufort Lagoon. The lagoon was 95% ice covered in June and only 25% ice covered by 3 July (ANWR files, unpubl. data). USFWS biologists have seen seals in the lagoons within the refuge: Bob Bartels (pers. comm.) has observed seals (sp.) in Jago, Kaktovik, and Oruktalik lagoons in summer and fall, and Mike Spindler (unpubl. data) saw one seal (sp.) in Tamayariak Lagoon on 3 August, 1981 while conducting an aerial survey of wildlife.

Seals are occasionally seen in Simpson Cove during the summer (ANWR files unpubl. data.). Although not a lagoon, it does lie within the study area. Spindler noted two seals (sp.) in Simpson Cove on 10 September, 1981 and "Randy" Meyers (pers. comm.) saw two seals (sp.) on 11 August 1981 and one on 23 August 1981 in shallow water near shore.

### Impacts

The smallest of the arctic seals, ringed seals, are the major prey of polar bears. Other predators are arctic and red foxes, dogs, wolves, and ravens.

They are also an important resource for the Inupiat village of Kaktovik on Barter Island. (See Chapter VII).

According to McLaren (1958) "The habit of pupping on the fast ice makes ice quantity and quality of primary importance in the reproductive ecology of this species." Heavily compacted ice in 1974, and limited snow cover in which seals could construct their lairs in 1974 and 1975 are believed to be the causes of a decline in the ringed seal population in the Eastern Beaufort Sea (Stirling, et al. 1975b) and may have affected Alaskan populations of seals as well; this is supported by the census data for Alaska (Table 1A) providing that census effort was consistent for all years.

Data Gaps

Ringed seal use of lagoon is not addressed in the literature. There is fragmentary evidence that some use does occur, and although the extent of such use is not well documented, it seems to be quite limited.

## Bearded Seals (<u>Erignathus</u> <u>barbatus</u>)

### Population Distribution, Size, and Range

Bearded seals are circumpolar in distribution in areas where seasonal ice covers water that is less than or equal to about 200m deep. The Bering-Chukchi population of the north Pacific extends into the Beaufort Sea where the seals are present year round in relatively low numbers (Burns and Frost 1979).

The range of the bearded seal varies seasonally with ice conditions; most of the animals move south through the Bering Strait in the late fall-early winter, and spend winters in the Bering Sea. They move north as the ice breaks up in spring (mid-Apri~~ng~~l to June).

Very little informtion is available regarding the numbers of bearded seals using the Beaufort Sea. Burns and Frost (1979) state that "...the region approaches being marginal habitat for these seals". Burns and Harbo (1972) noted that bearded seals occurred on moving pack ice in some of their survey areas in early June, but none were found in the Flaxman to Barter Island segment of the survey where extensive landfast ice was still present. In 7.9 boat hours of surveys at 2 locations north of the study area in August and September, 1977, no bearded seals were seen (Burns and Frost 1979).

Population studies were conducted in the Canadian Beaufort Sea in 1974 and 1975; the 1974 estimate of bearded seals was 2,759±729, and there were 1,197±235 in 1975 (Stirling et al. 1975b). Jim Levison (unpubl. data ANWR files) noted from 2 to 6 bearded seals daily on the ice near Beaufort Lagoon during the first week of July 1980. Individuals were sighted on 31 July 1980 near Egaksrak Island and on 5 August 1980 on a floe between Beaufort Lagoon and Siku Entrance. Twenty four were seen in leads near Icy Reef on 6 September 1980.

### Habitat extent, location, carrying capacity

The preferred habitat of bearded seals is shallow water zones in areas of moving ice. They move seasonally with the drifting, disturbed sea ice as it advances and retreats north in spring and south each fall (Burns 1967). According to Burns et al. (1980) these seals can be associated with 4 types of winter pack ice: persistent flaw, polynyas, divergence zones, and the ice front. They are capable of maintaining breathing holes in thin ice (Burns and Frost 1979). Bearded seals are not found in areas of landfast ice until it begins to break up in June (Burns and Eley 1977).

Bearded seals are benthic feeders with a diving limit of about 100m, therefore floating or moving ice over shallow water provides optimum feeding habitat. The Beaufort Sea has a very narrow continental shelf, much of which is overlain by landfast ice during winter; therefore, feeding habitat for bearded seals is limited. In summer and autumn, the southern edge of the ice pack is generally over water which is too deep for feeding bearded seals, so in those seasons they are often associated with nearshore ice remnants. The Bering and Chukchi Seas, with their wide continental shelves, provide much more suitable habitat than the Beaufort Sea (Burns and Frost 1979).

Based on data from 20 bearded seals collected in the Beaufort Sea (16 near Barrow) the most important food items were spider crabs (*Hyas coarctatus*), shrimp (*Sabinea septemcarinata*), and arctic cod (*Boreogadus saida*). Clams were important in August and fish were more important from November through February than at other times of the year. Other items consumed were hermit crabs, octopus, gammarid amphipods, and isopods (Burns and Frost 1979).

### Life History

Most bearded seal pups are born on the ice at the end of April (although pupping dates range from March through May) and are able to enter the water shortly after birth (Burns and Eley 1978; Stirling et al. 1975b). Pups nurse for only 12 to 18 days and gain about 45.4 kg (Burns 1967).

Breeding occurs mainly in May, with implantation approximately 2 months later. Males reach sexual maturity at 6 to 7 years and females at 4 to 7 years, although the mean for females is 6 years based on first pregnancy rather than first ovulation (Burns and Frost 1979).

### Impacts of Existing Processes and Activities

Predators of bearded seals include polar bears (*Ursus maritimus*) and man. For information on Eskimo harvest and use of bearded seals see Chapter VIII. In general, causes of natural mortality are unknown. These seals do harbor helminth parasites and have high heavy metal loads. Because of the high concentrations of cadmium in the liver and kidneys these organs should not be consumed by humans (Burns and Frost 1979).

### Data Gaps

Numbers of bearded seals in the American Beaufort Sea are not well documented, especially in the central Beaufort north of the study area.

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## Bowhead Whales (Balaena mysticetus)

### Population distribution, size, and range

Bowhead whales are distributed in four principal areas of arctic and subarctic waters: Spitzbergen west to East Greenland; Davis Strait, Baffin Bay and Hudson Bay; the Bering, Chukchi, Beaufort, and East Siberian Seas; and the Okhotsk Sea. Bowheads that occupy the Bering, Chukchi, and Beaufort Seas are sometimes referred to as the western Arctic population (Tillman 1980).

Recent estimates of the western Arctic population have been derived from counts of whales migrating past Point Barrow, Alaska, in spring. Marquette et al. (1981) felt that the 1978 estimate of 2,264 whales was the most reliable estimate obtained from 5 years of data. The International Whaling Commission, (IWC), however, quotes 1300 animals as the best estimate of the bowhead population (Tillman 1980).

The wintering area for the western Arctic bowheads is along the ice edge of the central and southwestern Bering Sea (Fraker et al. 1978; Naval Arctic Research Laboratory 1980). They undergo a spring migration which is correlated to ice movements (Brooks 1978; Marquette 1977). Leads, or areas of open water, begin to form in landfast ice in March, and the whales migrate from the Bering to the Chukchi and Beaufort Seas from March through June (Braham and Krogman 1977).

Bowheads arrive in the Canadian Arctic (eastern Beaufort Sea) in mid-May, June, and July, and remain in Amundsen Gulf during the late spring and summer. About mid-September they begin their westward migration back to the Bering Sea (Fraker et al. 1978; Fraker 1979).

### Life History

The life history of the bowhead whale is poorly understood. Marquette (1977) provides a summary and discussion of available data on growth and reproduction.

Mating behavior has been observed during spring migration and probably occurs in summer as well. Calving is thought to occur between late winter and early summer; often during spring migration. The gestation period is about 12 months.

Calves are weaned at approximately 5 to 6 months of age, but it is not known how long they remain with their mothers.

Males reach sexual maturity at a length of 1158 cm and physical maturity at 1402 to 1468 cm. Females reach sexual maturity at 1220 cm and physical maturity at a length slightly greater than males.

### Migration and Habitat

The winter habitat of bowhead whales varies with the seasonal distribution of the ice front. According to Frost and Lowry (1981) "All available information indicates a close association with the ice front from at least January through early April. Characteristics of the front provide an area where whales can reside among the ice while maintaining regular access to air between generally dispersed and mobile floes".

In late March or early April, a major flaw zone, or lead, forms between the pack ice and shorefast ice creating a corridor of open water roughly parellel to shore through which the whales can migrate. The lead, which passes through the Bering Strait, is oriented in a southwest to northeast direction (Fay 1974) and passes close to Wales, Point Hope, and Barrow (Braham et al. 1980; Carroll and Smithhisler 1980).

National Marine Fisheries Service (NMFS) personnel have conducted aerial surveys across the nearshore leads to determine the distribution of bowheads across them and found that most whales migrate within the first third of the lead closest to the shorefast ice (Marquette et al. 1981).

From Pt. Barrow eastward, bowheads are believed to cross the Beaufort Sea using far offshore leads in the pack ice which develop in a northeasterly direction towards Banks Island. (Satellite images have shown that these leads may extend as far north as 77° or 78° north latitude.) The whales then follow the Banks Island lead, or the Tuktoyaktuk Penninsula lead south to Amundsen Gulf. As the ice becomes more fractured later in the season, bowheads probably use a more southerly route (Fraker 1979; Braham et al. 1980) (Figure 10).

Bowhead whales summer in the eastern Beaufort Sea and Amundsen Gulf. Fraker and Bockstoce (1980) hypothesize that early in the open water season they are distributed primarily in Amundsen Gulf and the adjacent waters near Cape Bathurst. As the season progresses there is a gradual westward shift in distribution which may be related to the availability of food.

Since, there is open water along the coast of Alaska in fall, bowheads are not dependent upon ice leads as corridors for travel, so they are able to remain closer to the coastline. Recent studies by the Naval Ocean Systems Center (NOSC) for the Bureau of Land Management (BLM) have added to the limited knowledge of the fall migration. Aerial surveys were conducted in August, September, and October, 1979, to study the behavior and movements of whales migrating through the Beaufort Sea. Whales were sighted primarily along the 10 fathom/20 meter line.

The locations of whales sighted near the study area are shown in Figure 11a. On 24 September, 1979, 10 sightings of bowhead whales were made in a small area near Demarcation Bay. From 1 to 10 animals were moted per sighting, for a total of 35 individuals. And, on 26 September, 14 sightings were made totaling 40 individuals (Fig. 11 b). These groups seemed to be moving in a fairly non-directional manner, suggesting that the whales may have been feeding in that area (Ljungblad et al. 1980). The presence of food in the stomachs of whales harvested in Kaktovik, just west of Demarcation Bay supports this hypothesis. Bowheads migrate more slowly in the fall than in the spring, feeding as they go.

Food Habits

Bowhead whales feed by straining marine organisms through baleen plates that are suspended from their upper jaw (Marquette 1977; Fraker et al. 1978). It is not known whether whales feed during the winter. Those migrating in spring feed little or not at all, evidenced by the lack of food in the stomachs of whales harvested at Barrow. They do feed intensively in the Beaufort Sea

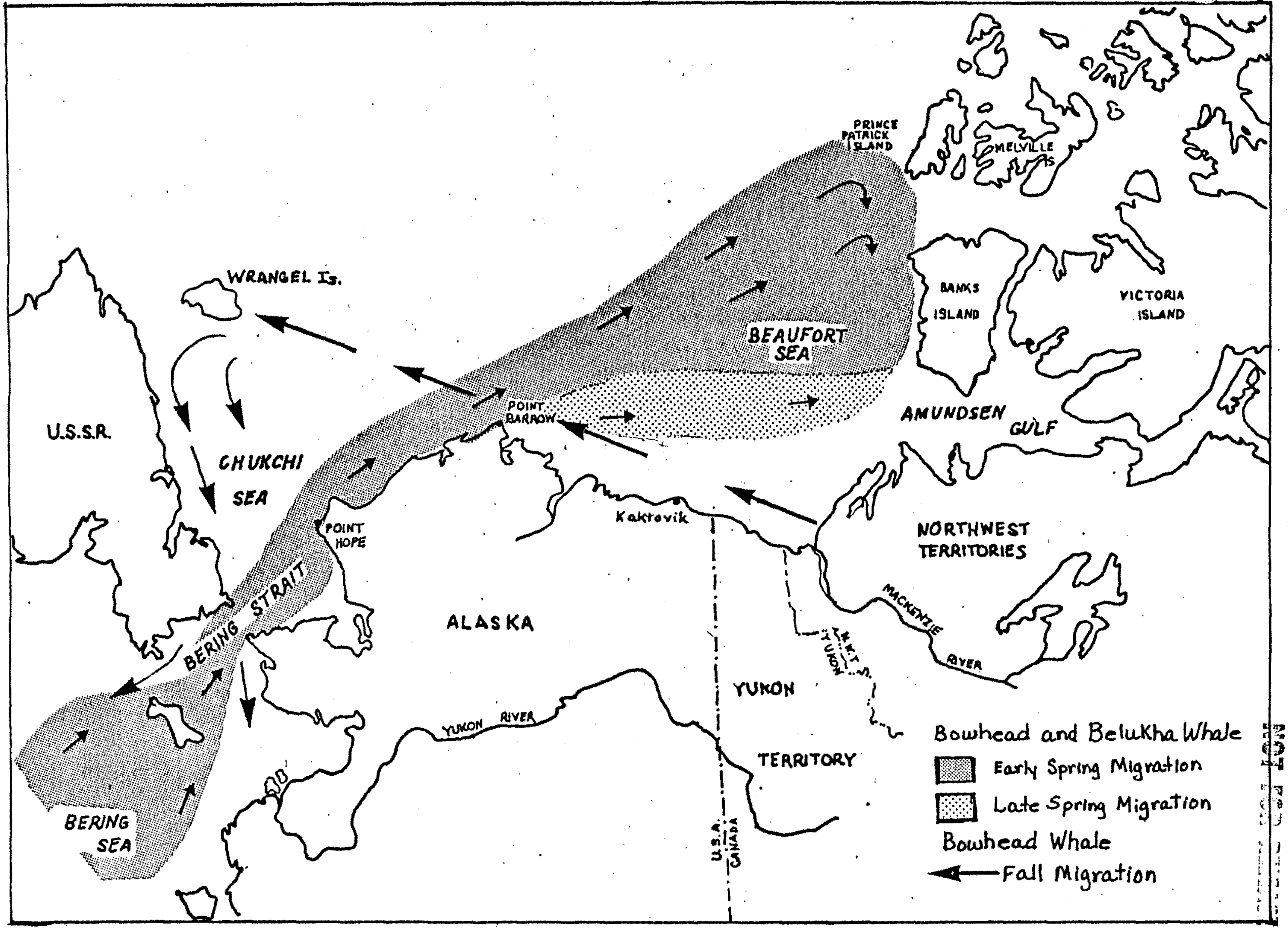

Figure 10. Generalized spring migration pattern of bowhead and belukha whales and fall migration route of bowhead whales. (After Richardson and Fraker 1981).

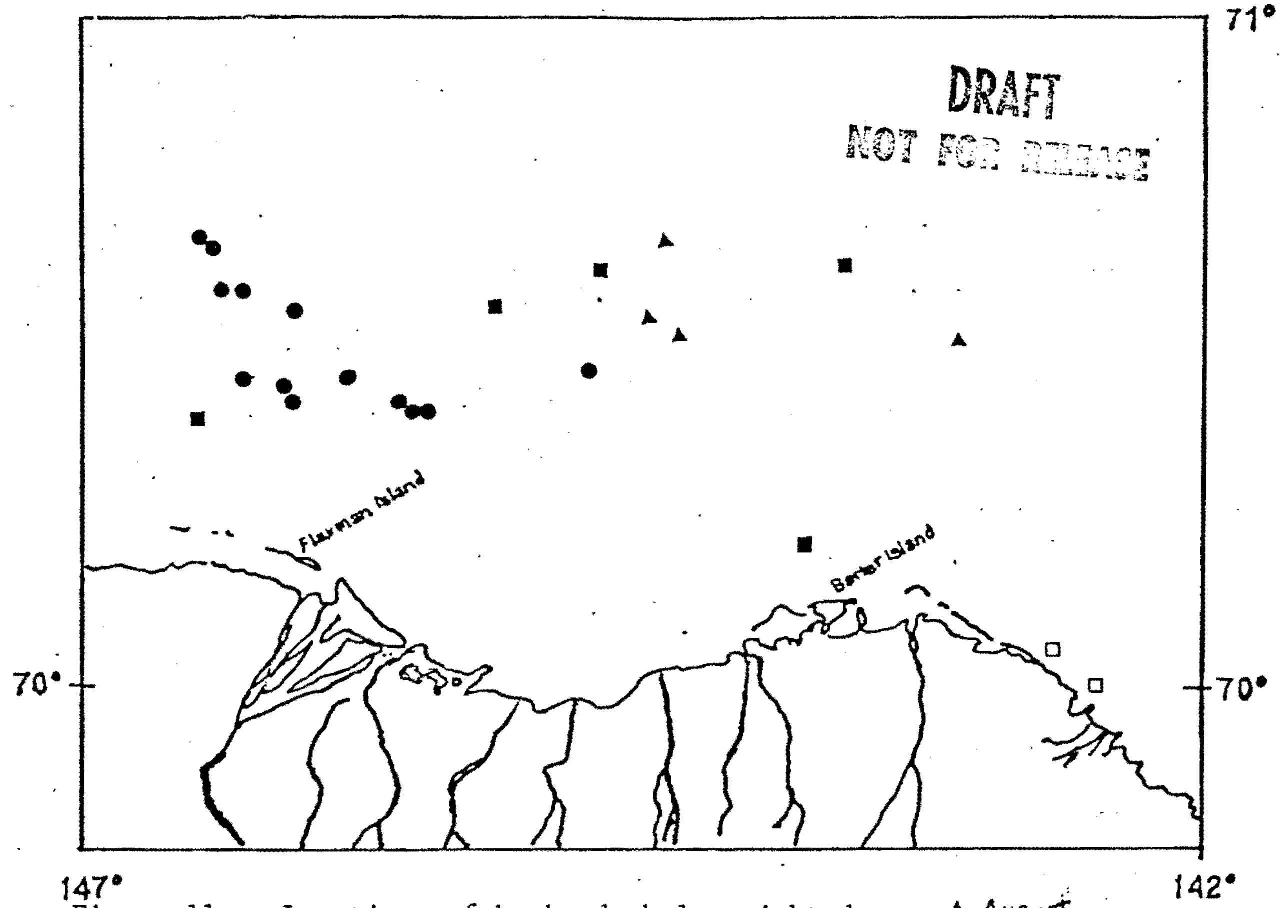

Figure 11a. Locations of bowhead whales sighted during aerial surveys conducted by NOSC, 1979. (Adapted from NOSC TD 314).

▲ August
■ September
○ October
□ September_See below

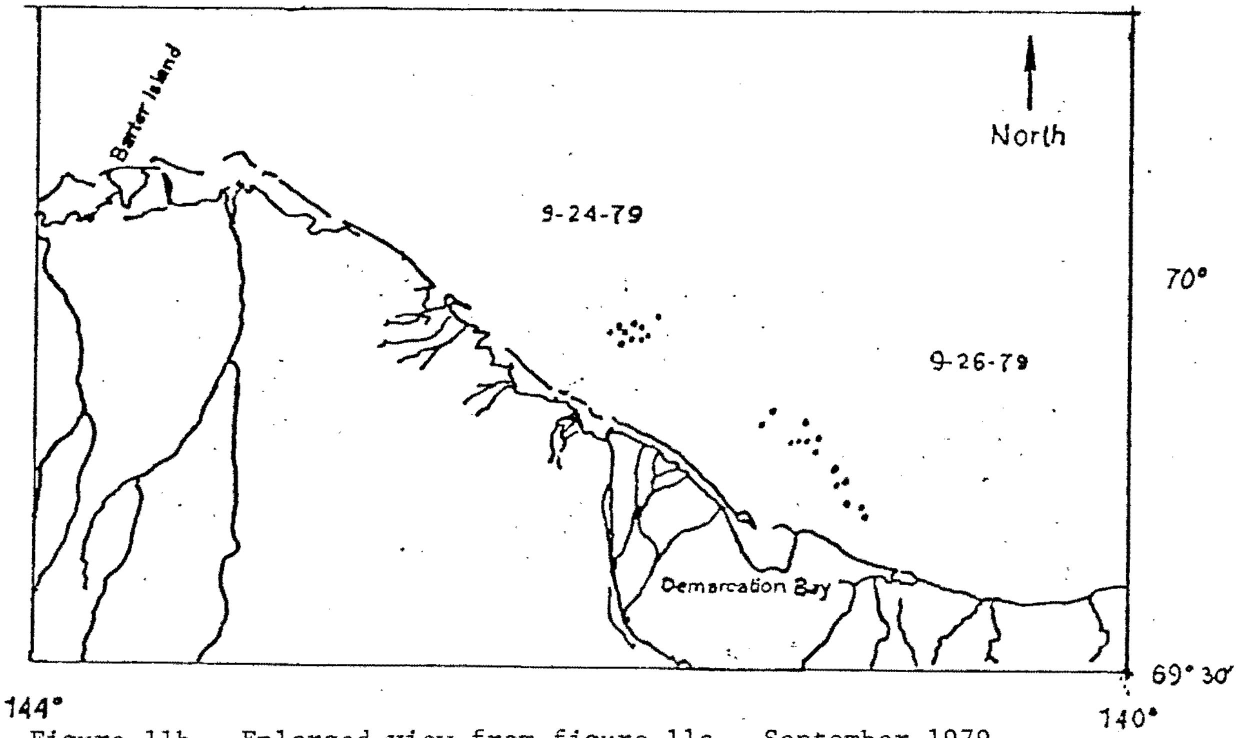

Figure 11b. Enlarged view from figure 11a. September 1979 sightings of bowhead whales near Demarcation Bay. From aerial surveys conducted by NOSC 1979.

during summer and fall, and whales harvested in autumn have contained substantial quantities of food (Lowry et al. 1978; Lowry and Burns 1980; Marquette et al. 1981). There is little information available on food habits of bowhead whales in Alaskan Beaufort Sea, but Lowry and Burns (1980) collected data from 5 stomachs of whales taken 20 September and 11 October, 1979 near Barter Island.

They found that copepods, principally <u>Calanus hyperboreus</u>, and euphausiids, mainly <u>Thysanoessa raschii</u> comprised about 97% of the food eaten. Copepods were dominant in 3 of 5 samples, and euphausiids in 2 samples. Small amounts of mysids, hyperiid and gammarid amphipods and small fishes were also eaten. Whales taken at Barrow in September, 1976, and May, 1977, had eaten mainly euphausiids and copepods respectively (Lowry et al. 1978 cited in Lowry and Burns 1980; Marquette 1979.).

Lowry and Burns (1980) state that "ringed seals and Arctic cod are probably the most significant trophic competitors of bowhead whales in the Beaufort Sea". Marquette et al. (1981) add that they do not know whether competition for food is affecting the recovery of this stock of bowheads.

Impacts of Existing Processes and Activities.

Bowhead whales have been harvested by Alaskan Eskimos for at least 2,000 years (Bockstoce 1978 cited in Tillman 1980). In addition, Yankee whalers were active in the Arctic Ocean from 1848 to 1915 and killed approximately 8,852 whales (Bockstoce 1978 cited in Tillman 1980). The International Whaling Commission (IWC) banned commercial whaling in 1947 and since then only hunting by aborigines has been allowed.

The bowhead whale is considered an endangered species. Mitchell (1977) estimated that the western Arctic population has been reduced to 7 to 11% of its original size. Under conditions of the Endangered Species Act~~s~~ of 1973 and the Marine Mammal Protection Act of 1972, continued harvest by Alaskan Eskimos for subsistence purposes was allowed providing that waste did not occur.

In 1972, the Scientific Committee of the IWC became concerned that the effect of Native hunting on the population was not known, so NMFS began a study in 1973 to determine the extent of the harvest and to gather data on population size, distribution, and abundance of whales. The results of the harvest study alarmed IWC members: In 1976 48 bowhead whales were struck and landed and an additional 43 were struck and lost, for a total of 91 whales struck. They recommended that the whaling cease completely. One-hundred-eleven bowhead whales were struck (29 landed) in 1977 before action on the issue was taken by the U.S. Government. In December, 1977, a compromise between the U.S. Government (with the assistance of the Alaska Eskimo Whaling Commission [AEWC]) and the IWC was affected, and a quota system on number of whales struck and number landed was instituted (Tillman 1980).

In March, 1981, the AEWC signed a cooperative agreement with the National Oceanic and Atmosphereic Administration (NOAA) to aid NOAA in monitoring the bowhead whale hunt for the next two years (Tundra Times 1 April 1981). The quotas are set annually based on the most recent findings on population status by the scientific community and the needs of the Alaskan Eskimos. The quota for 1981 was 17 whales landed and 32 struck. The only whaling community near the study area is Kaktovik, whose residents hunt whales during their fall migration. Kaktovik hunters filled their quota of 3 whales in 1981. For more information on Eskimo whaling see Chapter VII.

Natural impacts to whales may include suffocation from entrapment under the ice or starvation from lack of access to feeding areas (Ljungblad et al. 1981; Eberhardt and Breiwick 1980). Bowhead whales have few parasites and strandings are infrequent (Marquette 1977). The killer whale is the only suspected natural predator.

Data Gaps

Every aspect of the bowhead whale's biology, habitat, and distribution, and population size need further study and clarification.

Belukha whales (Delphinaplerus leucas) and Incidental Species of Marine Mammals

Belukha whales utilize the waters of the Beaufort Sea north of the ANWR study area during their spring migration to feeding and calving grounds in the Amundsen Gulf and Mackenzie River delta, and the subsequent fall migration back to wintering grounds in the Bering and Chukchi Seas. The route and timing of the spring migraion is similar to that of the bowhead whales (Sergeant and ~~Hock~~ Hoek 1974; Fraker 1979). (For more information see the discussion of spring migration in the bowhead whale section of this report).

The westward migration to the wintering grounds occurs in late August and September (Fraker et al. 1978). Although some belukha whales are present in the nearshore waters of the Beaufort Sea during their fall migration, most follow the edge of the ice pack (Seaman et al. 1981).

Belukha whales are not actively hunted by Natives in Kaktovik, but are taken if they are encountered during the bowhead whale hunt. (See Chapter VII).

Gray whales (Eschrichtius robustus), spotted seals, (Phoca largha), and walrus (Odobenus rosmarus) are occasionally found in the portion of the Beaufort Sea north of the coastal plain study area. Walrus are uncommon in spring, summer, and fall, and spotted seals are uncommon in summer (Burns et al. 1980). For informtaion regarding the occurence of gray whales along the Alaskan coast, see Rugh and Fraker (1981), Maher (1960), and Marquette and Braham (1980). Since the central Beaufort Sea is on the fringe of the ranges for these species, they will not be discussed in detail here.

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Chapter VI

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# FISH

## Introduction

Twenty-nine species of fish are known to inhabit arctic estuarine and fresh-water environments (Table I). There is a great amount of variation in habitat preference and life history requirements between these species and within particular species. Some species such as the Arctic and Starry flounders occupy strictly marine-estuarine habitats. Other species occupy only freshwater habitats. Anadromous species, such as some of the Arctic char, may occupy all three types of habitat. Arctic char are the most widely distributed species in the Arctic. Several distinct populations have been identified by Craig and McCart (1975) and Craig (1977a) and include lake resident, stream resident and anadromous populations. As a result, the various life history requirements (spawning, over-wintering, rearing, feeding, etc.) are distributed throughout a wide range of habitat areas. Isolated populations have discrete boundaries and lend themselves much more readily, to impact assessment. Impacts upon anadromous and mobile stream dwelling populations may occur anywhere within a stream system. Current knowledge on arctic fishes is limited to primarily char, grayling and whitefish species. Wilson et.al. (1977) presents an extensive literature review of arctic fisheries information. Lists of marine and freshwater species that occur in the region are provided in Tables 1 and 2.

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Table 1.

Species of fish which inhabit arctic estuarine or fresh waters (Adapted from Wilson et al. 1977 and Craig and Haldorson 1980)

| | |
|---|---|
| Arctic char | Salvelinus alpinus |
| Arctic grayling | Thymallus arcticus |
| Arctic cisco | Coregonus autumnalis |
| Least cisco | Coregonus sardinella |
| Bering cisco | Coregonus laurettae |
| Broad whitefish | Coregonus nasus |
| Humpback (lake) whitefish | Coregonus pidschian |
| Round whitefish | Prosopium cylindraceum |
| Lake trout | Salvelinus namaycush |
| Pink salmon | Onchorynchus gorbuscha |
| Chum salmon | Onchorynchus keta |
| Arctic lamprey | Lampetra japonica |
| Burbot | Lota lota |
| Alaska blackfish | Dallia pectoralis |
| Boreal smelt | Osmerus eperlaus |
| Northern pike | Esoc lucius |
| Longnose sucker | Catostomus catostomus |
| Ninespine stickleback | Pungitius pungitius |
| Slimy sculpin | Cotus cognatus |
| Fourhorn (deepwater) sculpin | Myoxocephalus quadricornis |
| Arctic flounder | Liopsetta glacialis |
| Starry flounder | Platichthys stellatus |
| Three spine stickleback | Gasterosteus aculeatus |
| Arctic cod | Boreogadus saida |
| Saffron cod | Eleginus gracilis |
| Capelin | Mallotus villosus |
| Pacific herring | Clupa harengus |
| Snailfish | Liparus sp. |
| Pacific sand lance | Ammodytes hexapterus |

Table 2. List of fishes reported from lakes and drainages on the North Slope of the Arctic National Wildlife Refuge.

| COMMON NAME | SCIENTIFIC NAME |
|---|---|
| Grayling | |
| Thymallus arcticus | |
| Round whitefish | Prosopium cylindraceum |
| Lake trout | Salvelinus namaycush |
| Burbot | |
| Lota lota | |
| Arctic char | Salvelinus alpinus |
| Ninespine stickleback | Pungitius pungitius |
| Broad whitefish | Coregonus nasus |
| Arctic cisco | Coregonus autumnalis |
| Least cisco | Coregonus sardinella |
| Chum salmon | Oncorhynchus keta |
| Fourhorn scupin* | Myoxocephalus quadricornis |
| Arctic Flounder* | Liopsetta glacialis |

* Reported from lake on the Canning River delta.

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## Habitat Description

Critical habitat areas of arctic fishes have been documented by several authors. Overwintering areas are perhaps the greatest limiting factor for arctic anadromous and freshwater fish populations. Severe winter conditions in the Arctic drastically reduce available water supplies. Winter flow is generally immeasurable (Arnborg et. al. 1972, McCart et.al. 1972, Murphy and Greenwood 1971). Many sections of river channels and coastal lakes (less than 3 meters in depth) freeze solid. During this period water sources are limited to spring areas, deep isolated pools, deeper lakes and brackish river delta areas (Wilson et. al. 1977).

Springs provide the major source of water to downstream overwintering areas (Childers et.al. 1973, Craig and Poulin 1974). The importance of springs for overwintering and spawning for arctic fish populations has been well documented (Alt and Furniss 1976, Craig 1977b, Craig and McCart 1974, Furniss 1974, 1975, McCart and Craig 1973, Yoshihara 1972, 1973). All stages of char life history are present in spring areas (Craig 1977c, Glova and McCart 1974). McCart et. al. (1972) found that the abundance and diversity of macroinvertebrates in springs and spring fed sections of the channel was much greater than in other arctic lotic habitats.

Several springs have been identified on the North Slope of the ANWR (Fig. 1 and Table 3). The cumulative discharge of springs on the Canning River drainage is one of the largest on the North Slope (Childers et al. 1977) The largest on the Canning River is Shublik Springs located on the southwest end of Coplestone Mountain. The discharge from this spring

# ARCTIC COASTAL PLAIN BASELINE STUDY

FIG. 1 LOCATION OF SPRINGS AND ICINGS

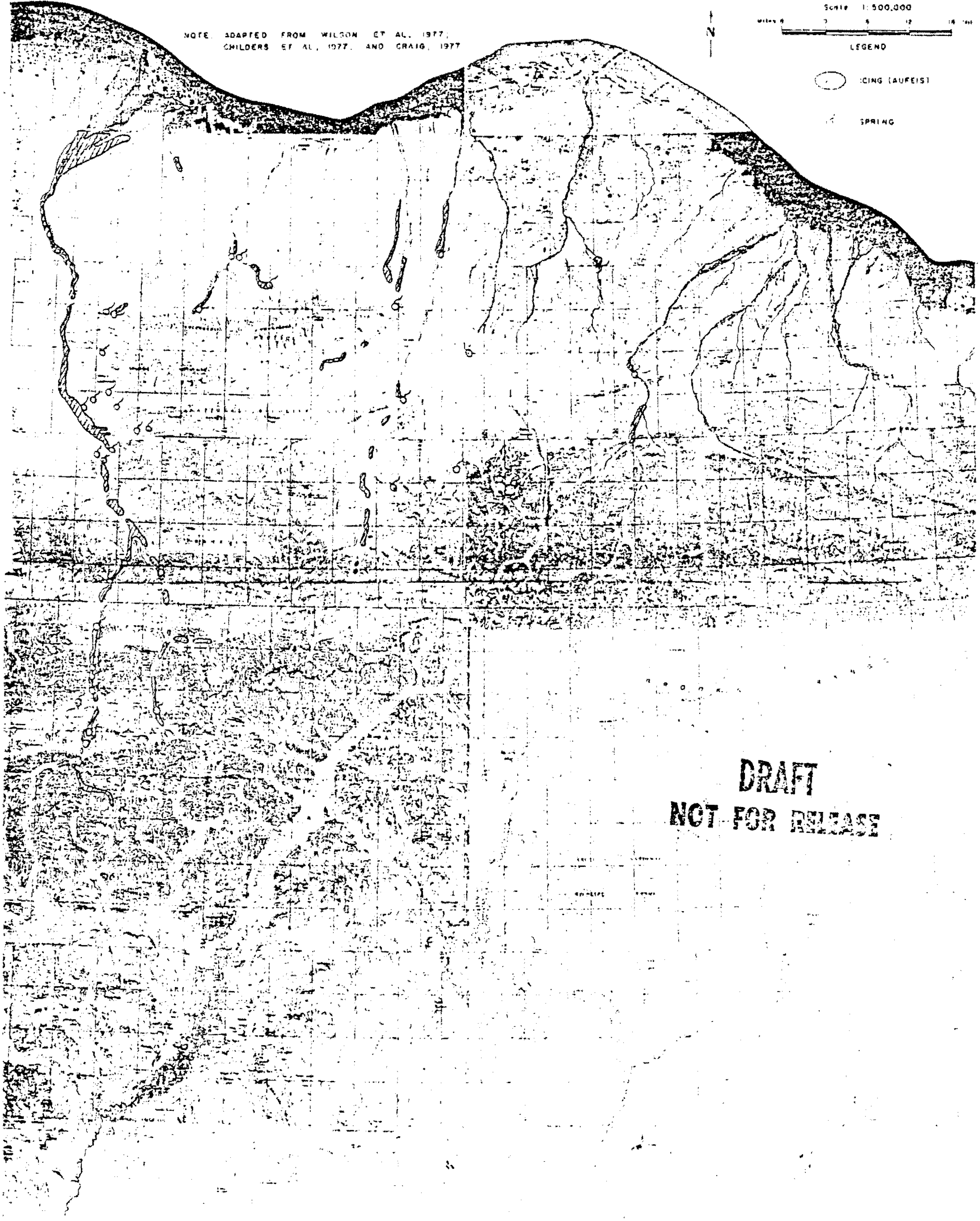

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Table 3. Selected chemical and physical data for springs on the North Slope, ANWR (Adapted from Childers et al. 1977).

| Station name | Shublik Spring | | Red Hill Spring | | Katakuruk R Trib spring | Sadlerochit Spring | | |
|---|---|---|---|---|---|---|---|---|
| Latitude | 69 28'20" | | 69 37'37" | | 69 41'42" | | 69 39'23" | |
| Longitude | 146 11'50" | | 146 01'38" | | 145 06'33" | | 144 23'37" | |
| Date | 05-10-73 | 04-28-75 | 04-28-75 | 08-12-75 | 04-28-75 | 04-27-75 | 08-07-75 | 11-16-75 |
| Discharge($ft^3/s$) | 24 | 24 | 0.85 | -- | 4.28 | 35 | 37.4 | 38.7 |
| Specific conductance (micromhos/cm at 25 C) | 275 | 270 | 1,000 | 950 | 245 | 410 | 400 | 360 |
| pH (units) | 8.0 | 7.9 | 7.0 | 8.2 | 8.2 | 7.9 | 7.9 | 7.3 |
| Water temperature ( C) | 5.5 | 5.5 | 33.0 | 29.0 | 1.0 | 13.0 | 13.0 | 4.0** |
| Color (platinum-cobalt units) | 1 | 0 | 0 | 2 | 0 | 0 | 4 | -- |
| Turbidity (Jackson Turbidity units) | -- | 1 | 2.0 | -- | 1 | 1 | -- | -- |
| Dissolved oxygen | -- | 9.8 | 0.4 | -- | 11.4 | 7.0 | 6.2 | -- |
| Total organic carbon | -- | 0.8 | -- | -- | 2.1 | 0.7 | 0.7 | -- |

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Table 3. Continued

| Station name | Hulahula R.<br>icing spring | | Okerokovik R.<br>spring | Aichilik R.<br>spring |
|---|---|---|---|---|
| Latitude | 69 45'39" | | 69 43'06" | 69 31'06" |
| Longitude | 144 09'15" | | 143 14'25" | 143 02'00" |
| Date | 04-28-75 | 11-26-75 | 11-24-75 | 04-27-75 |
| Discharge (ft$^3$/s) | 7.3 | 4.6 | 26 | 1.5 |
| Specific conductance (micromhos/cm at 25 C) | 240 | 225 | 300 | 338 |
| pH (units) | 8.0 | 7.2 | 7.3 | 8.0 |
| Water temperature ( C) | 1.0 | 1.0 | 1.0 | 3.6 |
| Color (platinum-cobalt units) | 0 | -- | -- | 0 |
| Turbidity (Jackson Turbidity units) | 1 | -- | -- | 2 |
| Dissolved oxygen | 13.6 | -- | -- | 12.4 |
| Total organic carbon | 1.7 | -- | -- | 1.2 |

remains fairly constant throughout the year at about 24 ft$^3$/s.

Sadlerochit Spring, the largest known spring on the north slope that issues from a single bedrock source, is within the study area. This spring is located on the east end of the Sadlerochit Mountains and has a fairly constant discharge of about 37 ft$^3$/s (Childers et al. 1977).

Red Hill Spring, one of the few known hot springs on the Arctic slope, is located on the west end of the Sadlerochit Mountains. Childers et al. (1977) reported water temperature at Red Hill Spring in April, 1975, to be 32.8 C with discharge at .85 ft$^3$/s. Red Hill Spring drains into the Tamayariak River.

Large sheets of ice, or aufeis, that may measure several kilometers in width and several meters thick are formed below springs during winter. These icings have been reported up to 50 m$^2$ on the lower Kongakut River (Childers et al. 1977). The area, thickness and location of these icings are primarily dependent on the volume of water supplied by the spring and to a less extent on the water temperature, air temperature and topography of the ice accumulation area. Icings are slower to melt than snow cover and some persist throughout the year. One icing on the Echooka River was 4.9 meters thick in July (Childers et al. 1977). These icings can have a major effect on stream channel configuration and on riparian vegetation in the area in which they are formed.

On the Canning River, icings are extensive and are almost continuous by late winter from the upper Marsh Fork throughout the entire length of the main channel. One of the largest icings in the study area occurs in the Canning River delta. Icings are common on many of the drainages on the North Slope of the ANWR (Fig. [illegible]).

Deep river pools may also provide overwintering habitat for arctic fishes. Alt and Furniss (1976) found pools in the Sagavanirktok River with depths less than 2 meters, harboring overwintering populations of fish. Depth of these pools plays an important role in their ability to overwinter fish. Furniss (1975) stated that arctic rivers generally range from 1.8 to 3.6 meters in depth, but freezing can reduce available habitat to 0.3 to 0.4 meters. Mann (1975) stated that fish may not be able to overwinter in water less than 0.5 meters in depth. Some surveys indicate that arctic fishes inhabit pools generally deeper than two meters (Furniss 1974, 1975, Yoshihara 1972). Deeper pool on some drainages of the ANWR appear to be relatively scarce. On the Canning River during August, pools were measured by Smith (unpublished) utilizing a recording fathometer. No pools were recorded over 9 feet deep from the confluence of Eagle Creek to the Staines. Similar conditions were observed on the Sadlerochit and lower Hulahula Rivers. Spring and groundwater areas are probably utilized extensively for overwintering on these and other streams in the study area. Flow data for these and other drainages is in Tables 4 and 5. Several other parameters are intimately involved with the suitability of river pools for overwintering. These ultimately effect dissolved oxygen concentration and include: density of organisms in the pool area, species physiological tolerances, volume of the pool, temperature, organic matter, and spring influence. Reports of dissolved oxygen concentrations in river pools have ranged from 1.2 to 15 mg/l (Alt and Furniss 1976, Bendock 1976, Shallock and Lotspeich 1974, and Yoshihara 1972).

Table 4. Flood characteristerics on selected rivers in the ANWR. (Adapted from Childers et al. 1977)

| | | BANKFULL CHANNEL | | | | | MAXIMUM EVIDENT FLOOD | | | FLOOD CHARACTERISTICS | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Stream site | material | Streambed (ft/ft) | (ft) | Slope (ft) | Mean Width (ft) | Max depth (ft$^3$/s) | depth (ft) | Discharge (ft$^3$/s) | Width (ft$^3$/s)/mi$^2$ | Unit Discharge $Q_2$(ft$^3$/s) | runoff $Q_{50}$(ft$^3$/s) |
| Canning River<br>69 50'38"<br>146 27'10" | large<br>cobble | 0.0012 | 960 | 6.9 | 14 | 31,000 | 1,150 | 53,000 | 28.3 | 4,400 | 13,500 |
| Katakturuk River<br>69 52'25"<br>145 27'10" | coarse<br>gravel | 0.0064 | 680 | 3.7 | 7 | 17,000 | 670 | 10,000 | 33.9 | 660 | 2,800 |
| Marsh Creek<br>69 47'32"<br>144 49'00" | coarse<br>gravel | 0.0148 | 560 | 3.4 | 6 | 14,000 | 280 | 500 | 1.9 | 750 | 3,100 |
| Sadlerochit River<br>69 39'13"<br>144 12'10" | boulders | 0.0062 | 280 | 4.5 | 7 | 11,000 | 280 | 11,000 | 20.8 | 1,400 | 5,200 |
| Hulahula River<br>69 41'47"<br>144 12'10" | coarse<br>gravel | 0.0050 | 250 | 7.2 | 9 | 23,000 | 240 | 10,000 | 14.7 | 1,800 | 6,300 |
| Jago River<br>69 37'02"<br>143 41'06" | boulders | 0.0132 | 180 | 5.9 | 7 | 14,000 | 180 | 14,000 | 43.6 | 1,000 | 3,600 |
| Okerokovik River<br>69 42'07"<br>143 14'23" | coarse<br>gravel | 0.0033 | 590 | 3.4 | 7 | 10,000 | 360 | 2,300 | 13.6 | 650 | 2,600 |
| Aichilik River | coarse | 0.0054<br>gravel | 820 | 5.5 | 8 | 33,000 | 817 | 27,000 | 48.0 | 1,900 | 6,300 |

Table 5. Selected chemical and physical data for streams on the North Slope of the ANWR (Adapted from Childers et al. 1977)

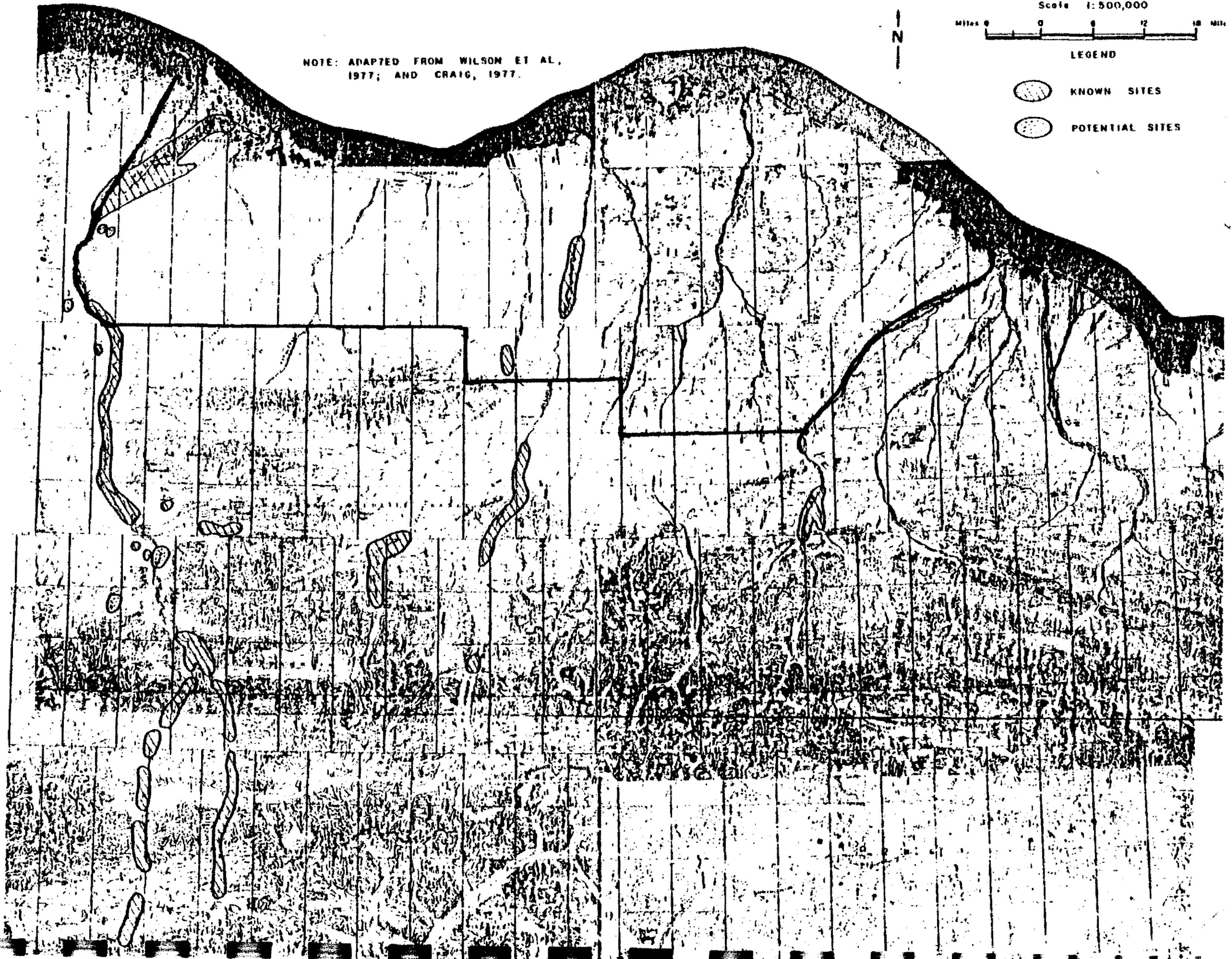
| Station name | Canning R | Canning R | Canning R delta E Chnl | Katakturuk R | Marsh Cr |
|---|---|---|---|---|---|
| Latitude | 69 48'29" | 69 50'38" | 70 04'38" | 69 52'25" | 69 47'33" |
| Longitude | 146 23'25" | 146 42'10" | 145 42'35" | 145 12'00" | 144 49'00" |
| Date | 11-08-75 | 08-12-75 | 11-30-75 | 08-10-75 | 08-10-75 |
| Discharge (ft$^3$/s) | 228 | E2500 | 0 | E400 | E15 |
| Specific conductance (microomhos/cm at 25 C) |  | 240 |  | 250 | 425 |
| pH (units) | 7.7 | 7.7 | 6.7 | 7.8 | 7.5 |
| Water temperature ( C) | 0.0 | 9.0 | 0.0 | 3.0 | 3.5 |
| Color (platinum-cobalt units) | -- | 5 | -- | 5 | 5 |
| Turbidity (Jackson Turbidity units) | -- | 1.3 | -- | 20 | 2 |
| Dissolved Oxygen (mg/L) | -- | 11.8 | -- | 13.2 | 12.2 |
| Total organic carbon (mg/L) | -- | 27 | 8.9 | 3.7 | 6.0 |

Table 5 Continued

| Station name | Sadlerochit R | Hulahula R | Jago R | Okerokovik R | Aichilik R | Aichilik R site 2 | Aichilik R nr mouth |
|---|---|---|---|---|---|---|---|
| Latitude | 69 39'13" | 69 41'47" | 69 50'38" | 69 42'07" | 69 35'23" | 69 40'30" | 69 48'50" |
| Longitude | 144 22'56" | 144 12'10" | 146 27'10" | 143 14'23" | 142 58'03" | 142 46'52" | 142 10'00" |
| Date | 08-07-75 | 08-07-75 | 08-08-75 | 08-08-75 | 08-11-75 | 11-25-75 | 11-23-75 |
| Discharge | -- | 739 | 267 | 85.2 | E800 | 0 | 0 |
| Specific conductance (micromhos/cm at 25 C) | 155 | 210 | 193 | 275 | 235 | 370 | 700 |
| pH (units) | 7.1 | 7.5 | 7.7 | 7.5 | 7.5 | 7.2 | 7.2 |
| Water temperature ( C) | 7.0 | 4.0 | 4.5 | 8.0 | 3.5 | 0.0 | 0.0 |
| Color (platinum-cobalt units) | -- | 5 | 5 | 5.0 | 5 | -- | -- |
| Turbidity (Jackson Turbidity units) | 0.25 | 2 | 1 | 0.0 | 1 | -- | -- |
| Dissolved oxygen (mg/L) | 11.6 | 12.9 | 12.9 | 11.6 | 12.9 | -- | -- |
| Total organic carbon (mg/L) | 3.8 | 5.7 | 6.6 | 14 | 1.8 | -- | -- |

# ARCTIC COASTAL PLAIN BASELINE STUDY

## FIG.__ FISH OVERWINTERING AREAS



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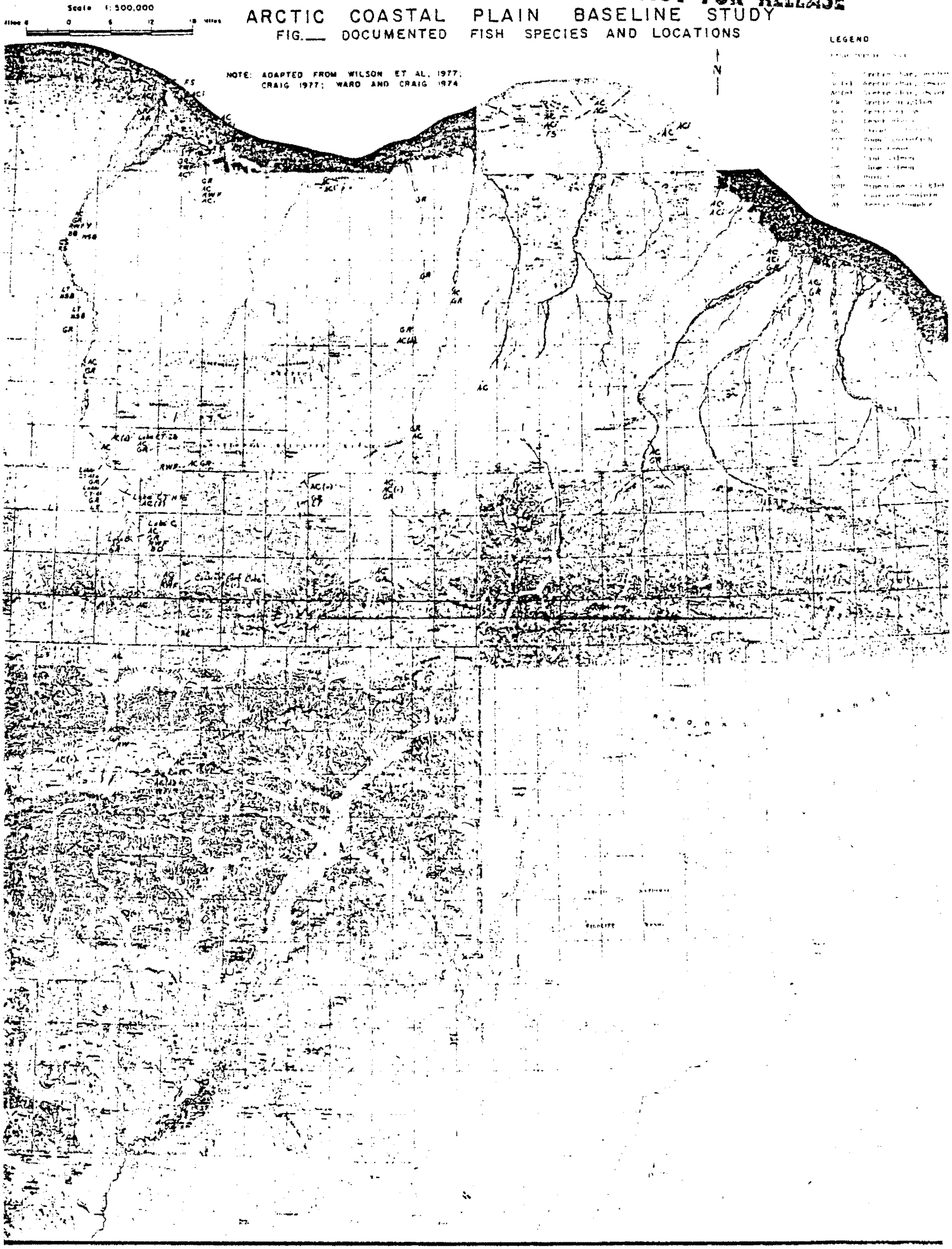
# ARCTIC COASTAL PLAIN BASELINE STUDY

FIG.___ DOCUMENTED FISH SPECIES AND LOCATIONS



Overwintering of fishes in river delta areas and coastal waters influenced by freshwater dilution has not been sufficiently documented. Marine nearshore waters have been shown to be important spawning and overwintering areas for many marine fishes such as arctic cod, fourhorn sculpin, saffron cod and snailfish (Craig and Haldorson 1980). The importance of river deltas as overwintering areas for freshwater and marine fishes had been examined by Kogl and Schnell (1975). Percy (1975) documented fish overwintering in the Mackenzie River delta. Arctic and least cisco have shown a preference for habitats with brackish water during the ice free period and this trend continues during winter when they move into brackish waters of the Colville Delta (Craig 1980). Suitability of delta overwintering areas depends on the salinity and tolerances of species using the area. Arctic char might overwinter in delta areas that are not hypersaline (Alaskan Arctic Gas Study Company 1974).

Arctic lakes have been classified by three geographic areas: coastal plain, foothill and mountain. Coastal plain lakes are generally less than five meters in depth (Carson and Hussey 1962, Kaliff 1968, McCart et.al. 1972, and Prescott 1963). Glacial foothill lakes and mountain lakes generally exceed five meters in depth (Kaliff 1968). The numerous, shallow coastal plain lakes generally offer unsuitable habitat in winter. Many, with maximum depths less than three meters, freeze solid; others, exhibit high ionic concentrations and low dissolved oxygen (Wilson et.al. 1972). Lake overwintering suitability generally increases going from the coastal to the mountainous regions. Walker (1960) noted that arctic lakes that drain into streams often have open water near the outlet with concentrations of fish being found in these areas.

Although overwintering habitat is of primary importance to arctic fishes, those areas that are unsuitable may play an important role as feeding, rearing, spawning and migration passages during ice free periods. Ward and Craig (1974) stated that some coastal lakes may serve only as feeding areas. DeBruyn and McCart (1974) found that grayling spawn primarily in tundra and foothill streams that freeze solid in winter.

## Species Description

### Arctic char *Salvelinus alpinus*

Arctic char have a circumpolar distribution. It is a common species along the Beaufort Sea coastline and occurs in many North Slope rivers and lakes. Both anadromous and freshwater forms are known to occur in the ANWR study area. Drainages within the ANWR study area that have been reported to contain arctic char include: Canning, Sadlerochit, Hulahula, Okpilak and the Aichilik Rivers. Lake resident char have also been reported from Peters/Schrader Lakes (Wilson et.al. 1977) and from lakes in the Canning River drainage (Craig 1977a).

Proper taxonomic classification of the north slope Arctic char has been complicated recently by Morrow (1980) who classifies the stream dwelling char in this region as Dolly Varden (*Salvelinus malma*). This classification has not been widely accepted and most authors still consider this fish an Arctic char.

There have also been four life history patterns reported for Arctic char in the Canning River (Craig 1977a). These include stream-dwelling anadromous, stream dwelling non-anadromous males, spring resident (non-andromous, self perpetuating) and lake resident. Some or all of these life history patterns presumably occur in other locations on the coastal plain of the ANWR.

Arctic char size vary considerably depending on location and life history pattern. Anadromous char from the Canning River are generally smaller than some other North Slope drainages. Craig (1977a) found sea-run char length to range between 183-620 mm. The largest char caught by Smith (unpubl. data) in 1981 from the Canning was 655 mm fork length and weighed 2700 gm. The Sagavanirktok drainage to the west has produced char up to 773 mm while the largest from the Kongakut has been reported at 740 mm and weighed 3200 gm (Furniss 1975).

The most common age classes in the Canning River sea-run char population appear to be 7 through 9 with the range from 2 to 11 (Craig 1977a).

Typically freshwater resident char are substantially smaller than sea-run although some overlap in size distributions occurs. Resident char (including pre-smolts) from the Canning River ranged from 55 to 331 mm (Craig 1977a). Maximum size char caught in Peters/Schrader Lakes by Fischer (unpublished) was 408 mm in total length and weighed 690 gm. Char in three headwater lakes in the Canning River drainage showed large variability in growth rate and maximum age (Craig 1977a). In Big Lake, char attained an older age (13) but were considerably smaller (190 mm) than char of the same age from the two other lakes. In the other two lakes char were measured up to 430 and 482 mm at ages 10 and 12 respectively. The slow growth rate of char in Big Lake is among the slowest recorded in literature (Craig 1977a).

Mature sea-run char begin moving into the Canning River in the last part of July. The peak movement into the river system occurred in the first 10 days of August during 1981 (Smith unpublished). The annual migration appears to be temporally separated by reproductive condition. Mature spawners enter first, followed by mature non-spawners, then immatures although considerable overlap does occur. On August 29, 1981 sea run immature and non-spawners were still entering the Canning River system (Smith unpublished).

Progress upstream is not well documented. On the Canning River, 2000-3000 spawners were counted on September 1972 in the vicinity of a spring in the upper region. Approximately half of these fish had completed spawning and moved downstream by November 5. Upstream progress of two radio tagged char during August 1981 were from 0 to 5 miles per 24 hour period (Smith unpublished). When these fish were located twice daily, all movements were between the period 7:00 p.m. and 9:00 a.m. indicating a nocturnal pattern to their movements. Much more verification is necessary to substantiate this indication.

Several locations on the Canning River have been identified by Craig (1977a) as spawning sites for Arctic char. All known spawning sites for anadromous char on the North Slope are associated with springs or ground water seeps that insure an adequate winter water supply for egg and fry survival. Some anadromous populations may utilize lakes for spawning but none have been documented. Length of time for incubation of char eggs has been estimated at seven to nine months in the Sagavanirktok River (McCart et.al. 1972). Craig

(1977a) estimated the same incubation time requirements for Canning River char although he speculated that fry in perennial springs might emerge sooner. In studies on a Canning River spring by Craig (1977a) peak emergence occurred during the last few days of May and the first part of June.

The age at which North Slope char make their first seaward migration is variable. Craig (1977a) found most char smolting around ages 4 or 5 but occurring as early as age 2. Smolting generally occurs during or shortly after river breakup in the spring.

Char overwintering locations in the ANWR are not well documented. Craig (1977a) lists possible overwintering locations on the Canning River however these areas represent distribution of char at freeze up. It is not known whether these fish remain in these locations through the winter. It is likely that the majority of anadromous char in the ANWR overwinter near springs or seeps. The amount of overwintering in intermittent pools in rivers is unknown but may be minimal because of the scarcity of deep pools. Most common food items of resident char include dipteran larvae, plecopteran nymphs, and trichopteran larvae. Anadromous char greatly decrease or cease feeding upon entering freshwater. In coastal waters char feed mainly on crustaceans (amphipods and mysids) and fish (primarily Arctic cod) (Craig and Haldorson 1980).

### Arctic Cisco Coregonus autumnalis

The Arctic cisco is one of the most abundant and widely distributed fish along the Beaufort Sea coast. They are found in northern coastal waters and lower rivers in Europe, Asia and western North America. In Alaska it ranges from Demarcation Point to Point Barrow. It has been reported from along the ANWR in lagoons and river mouths by Roguski and Komarek (1972) and from the lower Canning River (Craig 1977). Craig and Mann (1974) found Arctic cisco distribution restricted to marine or brackish water in the Beaufort Sea. It has been proposed by several researches that the Colville and Mackenzie Rivers are the source of most of the Arctic cisco stocks found off the ANWR coast. Mature Arctic cisco in spawning condition, however, have seldom been documented from the Colville River.

Spawning movements and timing is not well known for the Beaufort Sea Arctic cisco. The Siberian population is anadromous and makes an upstream spawning migration beginning in July (Scott and Crossman 1973). Craig and Haldorson (1980) reported that most Arctic cisco had moved out of Simpson Lagoon in 1978 by mid-September. It was speculated that most spawners return to the Colville by early July followed by sea-run immatures and non-spawners after mid-September.

No spawning locations have been documented in the Colville River and no Alaskan stream to the east of the Colville has been found to support anadromous runs of Arctic cisco. Mature Arctic cisco which would spawn in the year of capture have been reported off the ANWR coast. Craig and Mann (1974) reported 2 fish (6 percent) from a sample of 33 near the Canning River were mature spawners. Another study with a larger sample size of 169 fish from along the entire coast of the ANWR found 74 fish (44 percent) to be spawners of the year (Roguski and Komarek 1971).

Spawning generally takes place over gravel beds in fast flowing water (Scott and Crossman 1973). Eggs are broadcast and abandoned. Eggs presumably hatch in the spring. Smolting can occur as early as the first year and age 1 fish were the most abundant age class caught by Craig and Haldorson (1980) in the fyke nets in Simpson Lagoon. Age 1 fish were also observed in Prudhoe Bay by Bendock (1977). Roguski and Komareck (1972) captured only one age 1 Arctic cisco in nearshore waters of the ANWR even though the area was widely sampled with small mesh gill nets from June until September 1970. There investigators stated that it was unlikely any significant number of small Arctic cisco were present in their sampling area which extended from the Canadian border to the Canning River.

Overwintering locations of Arctic cisco are not well documented. Craig and Haldorson (1980) found a large non-spawning segment of the Arctic cisco population overwintering in brackish (18-32 ppt) water of the Colville River delta and speculated that more overwintering was probably occurring in brackish river deltas and nearshore than previously thought.

The most common prey of Arctic cisco in Simpson Lagoon especially in summer had been reported as mysids, Mysis litoralis and M relicta (Craig and Haldorson 1980). Amphipods were also important and became the major food eaten in winter. Griffiths et. al. (1975) found the feeding habits to vary seasonably in Arctic cisco near Herschel Island. Predominant food items in the spring included chironomids (18.6%), amphipods (17.5%) and small epibenthic isopods (17.8%). Mysids were the most common food (24.5%) in the summer while copepods (50.8%) and amphipods (15.7%) were abundant in the fall diet.

### Least Cisco Coregonus sardinella

The least cisco are found along coastal waters and in certain inland lakes and streams in northern Europe, Asia and North America. In the Beaufort Sea, least cisco have been reported to be abundant from Barrow to Prudhoe and near the Mackenzie River but relatively scarce in between (Craig and Haldorson 1980). Least cisco have been documented in the Canning River delta (Craig 1977a) and Ward and Craig (1974) found them offshore near the Canning River. Roguski and Komarek (1972) sampled all along the entire coast of the refuge during the summer of 1970 and did not catch any least cisco. It is doubtful that this species ever occurs in large numbers in nearshore waters of the ANWR. Where they do occur in larger numbers they are much more common inland of the barrier islands (Bendock 1977).

Least cisco in the Beaufort Sea have been reported up to 414 mm (Craig and Haldorson 1980) and Bendock (1977) found the mean length of least cisco in Prudhoe Bay to be 272 mm with maximum length 364. Age range of these fish was 1 to 12 with the majority between age 7 and 10. Age at maturity for Simpson Lagoon cisco was found to be 6 to 7 for males and 7 to 10 for females (Craig and Haldorson 1980).

The spawning behavior of least cisco is complicated by the existence of freshwater and anadromous life history patterns. Spawning generally takes place in the fall over sand or gravel in shallows of rivers or along lake shores (Scott and Crossman 1973). Kogl (1972) reported mature least cisco in the Colville delta in July that were potential spawners.

Ripe and spawned out least cisco have been caught in the commercial fishery on the Colville River . Mature potential spawners were also found in the main Colville River and in nearby coastal lakes (Craig and Haldorson 1980). It is likely that some spawning occurs in both lakes and stream drainages along the Beaufort Sea coast, however, the amount in the area of the ANWR is probably minimal.

Overwintering locations are unknown along the ANWR coast. Least cisco are thought to overwinter in both freshwater and brackish water of the Colville River delta in similar habitat utilized by Arctic cisco (Craig and Haldorson 1980). Mann (1975) has found overwintering least cisco in the lower Mackenzie River delta.

Food habits are similar to Arctic cisco. Craig and Haldorson (1980) reported mysids support 66-60% of the summer diet while amphipods were the major prey in the Colville River overwintering population.

Broad whitefish Coregonus nasus

The broad whitefish in Alaska is widely distributed throughout the interior, western and northern regions of the state from the Alaska Range north. It is frequently caught in nearshore waters of the Beaufort Sea and anadromous runs occur in the Colville and Sagavanirktok Rivers. Broad whitefish have been reported in the lower Canning River and they could utilize other drainages to the east although none have been reported. Roguski and Komarek (1972) were unable to catch broad whitefish in 1970 off the coast of the ANWR although a wide scale sampling program was conducted.

Sizes of broad whitefish from Simpson Lagoon to the west of the ANWR ranged from 66-548 mm however, this range was bimodal with no fish in the 200-260 mm range (Craig and Haldorson 1980). Bendock (1977) found ages of Prudhoe Bay fish to range from young-of-the-year to 15 but ages 4 to 7 were not represented. The maximum age reported by Craig and Haldorson (1980) for fish from Simpson Lagoon was 22 years. He thought sexual maturity was reached between the ages 9-14 but only a small percentage (13) of fish caught in coastal waters were mature spawners.

No broad whitefish have been documented spawning in ANWR coastal rivers however, spawning generally takes place in the fall in the lower reaches of other North Slope rivers. Bendock (1977) stated that adult broad whitefish entered the Sagavanirktok River in late August and spawned in deep pools throughout the lower delta. Ripe broad whitefish were captured in the Sagavanirktok River during the last week of September, 1976. Spawning time in the Colville River was reported as mid-September through mid-October (Hablett 1979) and in the Mackenzie River in October (Jessop et.al. 1974, referenced in Craig and Haldorson 1980).

Egg and fry developement is largely unknown but young-of-the-year fish have been documented in coastal waters (Bendock 1977, Craig and Haldorson 1980) indicating early movement away from spawning areas.

Overwintering locations have been reported in pools from the lower Sagavirktok River (Bendock 1977) and from the Colville River in the vicinity of Umiat (Bendock 1980). It is likely that most intermittent pools that do not freeze to the bottom in the mid to lower reaches of the larger rivers that support spawning broad whitefish are utilized for overwintering.

Stomach contents from Colville River whitefish included diptera larva, sand and organic debris (Hablett 1979). In Prudhoe Bay 41 percent of the broad whitefish stomachs contained food which included primarily chironomid larva and amphipods (Bendock 1977). All spawning broad whitefish captured in this study had empty stomachs.

### Arctic Grayling Thymallu arcticus

Grayling are one of the widest distributed fishes in Alaska occurring in most freshwater drainages throughout the state with the exception of the southeast. On the Arctic coast most of the freshwater drainages that have been surveyed have contained grayling. Within the study area grayling have been reported from the following drainages: Canning, Tamayariak, Sadlerochit, Hulahula and the Aichilik Rivers (Ward and Craig 1974). Grayling were caught by Roguski and Komarek (1972) in coastal areas on the ANWR in June in locations where salinities did not exceed 1 ppt. No grayling were captured in these same locations after July 8.

The length ranges for grayling caught in coastal waters by Roguski and Komarek (1972) were 225 to 410 mm. Age classes in this study ranged for 4 to 11 years. The largest grayling caught on the Canning River during July and August 1981 was 475 mm and weighed 925 gm. This individual fish was unusually large and most grayling were less than 400 mm in length (Smith unpublished). Grayling taken from the Colville River near Umiat ranged in length from 34-389 mm and in age from young-of-year to 10 (Kogl 1972). Sexual maturity was reached at ages 7 and 8 for these grayling.

Grayling are typically spring and early summer spawners. On Weir Creek, a tributary to the Kavik River, grayling spawned from June 11 to 18 (Craig and Poulin 1974). Similar timing for spawning would be expected for coastal streams across the coastal plain of the ANWR. Grayling movements to spawning locations are associated with spring thawing and higher flows in late May and early June. Preferred spawning habitat consists of small gravel or rock bottom tributaries to the larger rivers but spawning can occur in gravelly areas on the main rivers (Scott and Crossman 1973).

There appears to be some variation on length of time the adults spend in the spawning stream depending on the size of the stream. Data obtained by Craig and Poulin (1974) indicated that adults depart the smaller tributaries immediately after spawning and return to the main river. In other locations some have been reported to stay until midsummer or autumn (Reed 1964; Tripp and McCart 1974 as referenced in Craig and Poulin 1974).

Generally juvenile grayling and fry remain in smaller streams longer than adults. Warmer water temperatures, more abundant food, and reduced competition for food in smaller streams provide favorable conditions for growth of these smaller fish. Most fry and juveniles move out of the smaller streams by October and presumably move to deeper pools on the main rivers for overwintering. Craig and Poulin (1974) report that most fry downstream movement in northern streams occurs during September.

Grayling overwintering locations are not well known in the ANWR study area. Deeper lakes with outlets such as Peters/Schrader provide some overwintering habitat. Intermittent pools have been shown to contain wintering grayling in the middle reaches of the Colville River (Bendock 1980). Pools in the Canning and Sadlerochit Rivers coastal plain are relatively scarce and most overwintering probably occurs in the vicinity of springs or seeps.

Food habits of grayling have received much study in Alaska. On the Colville River grayling were found to utilize the following in descending order of abundance (during the summer): caddis fly larvae, chironomid larvae, terrestrial and aqautic bettles, aerial insects, snails, bivalves, amphipods, and ninespine sticklebacks (Hablett 1979). Scott and Crossman (1973) report the food of young grayling to be composed mostly of zooplankton with a gradual shift to immature insects as size of the fish increases.

### Round Whitefish  Prosopium cylindraceum

Round whitefish are distributed widely throughout northern North America and into northeastern Asia. They are found throughout northern Alaska in inland lakes and streams and may be found in lakes and streams on the coastal plain of the ANWR. But this species has been documented only from the Canning River drainage.

Round whitefish from the Colville River have been reported up to 422 mm and weighing 800 gm. (Hablett 1979). They averaged 266 mm in length from several locations on the Colville. The largest round whitefish reported from the Canning River has been one measuring 449 mm and 710 gms (Smith unpublished). Furniss (1975) found round whitefish in the Ivishak River up to 14 years old. Over 81 percent of his sample were in the age classes 9 to 11 and were between 323-410 mm in length.

Spawning generally takes place in the fall in shallow water of lakes or streams over gravel substrate (Scott and Crossman 1973). Preliminary information in Colville River round whitefish indicated an instream migration to spawning areas from mid-August to mid-September with spawning occurring from mid-September through the first week of October (Hablett 1979). Characteristic of whitefish, the eggs are broadcast and receive no parental care. Time of egg development is not well known for Alaska round whitefish, but has been reported as 140 days at 2.2 C for New Hampshire fish (Morrow 1980).

Overwintering locations on the ANWR have not been documented. Round whitefish have been reported in late winter in deeper pools on the Colville River (Bendock 1980) and in pools on the lower Kuparuk and Sagavanirktok Rivers (Bendock 1977).

Food of Colville River round whitefish has been reported by Hablett (1979) to include snails, bivalves, aerial insects, chironomid larvae, caddis fly larvae and phytoplankton.

### Burbot  Lota lota

Burbot are widely distributed throughout the Northern Hemisphere from about 40 N to the Arctic Ocean. They are found throughout Alaska in freshwater lakes and streams. Within the study area on the ANWR they have been documented only from the Canning River (Craig 1977a, Smith unpublished).

Burbot age and length data is not available for ANWR coastal plain fish. Hablett (1979) reports Colville River burbot up to 915 mm in length and weighing 4,000 gm. Average length and weight in this report were 658 mm and 1724 gm. Burbot seldom live longer than 15 years according to Morrow (1980).

Spawning generally takes place in winter probably in January and February. Burbot caught in March in the Colville had completed spawning (Bendock 1980). Burbot spawning habitat is described by Scott and Crossman (1973) as 1-4 feet of water over sand, in streams or in gravel shoals 5-10 feet deep in lakes. Eggs take around 30 days to hatch at 43 F (Scott and Crossman 1973) and should take longer on the North Slope where temperatures are near 0 C during egg development.

Burbot utilize some of the same overwintering locations as other freshwater species. Bendock (1980; 1977) documented burbot in intermittent pools from the Colville River and the lower Sagavanirktok and Kuparuk Rivers.

Adult burbot are considered piscivorous. The summer diet of burbot on the Colville River contained, in descending order of abundance: slimy sculpin, ninespine stickleback, round whitefish, grayling, caddis fly larvae and snails (Hablett 1979).

### Salmon *Oncorhyncus sp.*

Small runs of pink (*Oncorhyncus gorbuscha*) and chum salmon (*O.keta*) occur in the Colville and Mackenzie Rivers. These salmon also occasionally enter other North Slope drainages such as the Sagavanirktok River. Three chum salmon were caught in the Canning River during August of 1981 (Smith unpublished). A small run of pink salmon passed through Simpson Lagoon during the first part of August 1978 heading eastward (Craig and Haldorson 1980). One of these fish was caught in September, 250 km to the east off the shore of the ANWR in a subsistence net. Craig and Haldorson (1980) also reported chinook salmon and one sockeye salmon from Simpson Lagoon. Sockeye salmon are extremely rare in the Beaufort Sea but stragglers have been reported from Bathurst Inlet (Scott and Crossman 1973). One sockeye salmon in spawning condition was documented in the Canning River in August 1981 (Smith unpublished).

Pink salmon caught in Simpson Lagoon ranged in size from 388 to 540 mm in length and the two chum salmon caught measured 600 and 622 mm. Pink salmon from the Colville River averaged 503 mm in length and 1,975 gm. in weight (Hablett 1979).

Spawning locatons of salmon are unknown from the ANWR study area. The three chum and one sockeye caught on the Canning River in August were in spawning condition (Smith unpublished). Pink and chum salmon taken on the Colville River between the Itkillik River and Umiat during August 1978, were also in spawning conditon (Hablett 1979). If spawning does occur in drainages of the ANWR it would probably be in the vicinity of springs or seepages that would insure adequate water flow for egg development during winter.

Adult spawning salmon do not normally feed during their upstream migrations. Information regarding fry development and length of time spent in fresh water prior to smolting is unknown for North Slope salmon populations.

Lake Trout Salvelinus namaycush

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Lake trout are widely distributed across the north slope where suitable habitat exists. They are found in rivers such as the Colville and deeper coastal lakes such as Teshekpuk. Within the north slope of the ANWR they are known from coastal plain lakes near the Canning River drainage (Craig 1977a) and from Peters and Schrader Lakes. Suitable habitat such as deep lakes are limited on the coastal plain of the ANWR and lake trout are not expected to be very abundant in the study area.

Lake trout up to 890 mm and weighing 6400 gms have been reported from Peters/Schrader Lakes (Fisher unpublished). Lake trout from Teshekpuk and other nearby lakes ranged in length from 419 to 850 mm and weights ranged from 548 to 6,980 gm (Hablett 1979). These fish ranged in age from 3 to 10 years old.

Spawning generally occurs in the fall over a large boulder or rubble bottom in inland lakes at depths less than 40 feet (Scott and Crossman 1973). Incubation and hatching vary depending on habitat conditions but usually requires 4 to 5 months.

Lake trout overwintering on the North Slope occur in deep lakes and in rivers. Bendock (1980) found a lake trout in the Colville River in a pool 96 inches deep with dissolved oxygen of 2.4 ppm. Overwintering locations on the North Slope of the ANWR other than Peters/Schrader Lakes are unknown.

Hablett (1979) reports that of the lake trout captured during summer in the western arctic only 49% had food in their stomachs and consisted of the following in descending order of frequency: least cisco, snails, aerial insects, round whitefish, slimy sculpin and voles.

n

Impacts of Existing Human Activities

Other Species

Shiny sculpin, Cottus cognatus, are common in drainages in the western Arctic but have been reported from the ANWR. Humpback whitefish, Coregonus pidschian, are also common to the west but apparently absent from the ANWR.

Ninespine stickleback, Pungitius pungitius are common in many lakes and drainages in the ANWR study area. Little information is available on the life history of this species. It apparently spawns in the summer in streams and lakes and can grow up to 2.5 inches or more. It is an important prey for many other species of fish (Scott and Crossman 1973).

Boreal smelt, Osmerus eperlanus, have been reported in subsistence catches in coastal waters of the ANWR. Another common name of this species is rainbow smelt. This fish is typically anadromous moving to freshwater in the spring to spawn. Smelt average 18-20mm in length (Scott and Crossman 1973) and have been reported up to 15 years old (Craig and Holdorson 1980).

Boreal smelt were found to be a minor component of the nearshore fish community during summer in Simpson Lagoon, but one of the most abundant in winter (Craig and Haldorson 1980). Smelt apparently concentrated near some river mouths such as the Colville during winter presumably to migrate up the river to spawn in the spring.

Marine species that are expected to be commonly found along the ANWR coast include fourhorn sculpin, Myoxocephalus quadricornis and arctic cod Boreogachis saida.

Fourhorn sculpins are among the most widespread and numerous of all the marine fishes found along the Beaufort Sea coast. They ranged in length from 18-265 mm in Simpson Lagoon (Craig and Haldorsen 1980). These fish apparently spawn during winter between November and February in coastal waters. Overwintering sculpin have been observed in brackish river deltas and in coastal areas indicating a wide salinity tolerance for this species. Fourhorn sculpins have very limited commercial or subsistence value.

Arctic cod are widely distributed along the Beaufort Sea coast and have been described as a key species in the arctic ocean ecosystem because of their abundance and importance in the diets of marine mammals, birds and other fish (Craig and Holdorsen 1980; Bendock 1977). Craig and Haldorson (1980) found Arctic cod around Simpson Lagoon to range in size from 6 to 257 mm and in age from young-of-year to 6.

Arctic cod primarily spawn near shore under the ice during January and February (Bendock 1977). Specific information on Arctic cod distribution and life history along the ANWR coast is scarce, but they are an important food item for Kaktovik residents and their dogs especially during early winter.

### Impacts of Existing Processes and Activities

One source of mortality to fishes of the coastal plain and nearshore waters of the ANWR is human fishing pressure. No commercial fishery exists in this region at present. The only continuing commercial fishery on the North Slope is located on the Colville River delta. This fishery which operates from October to December has reported an average annual harvest from 1964 to 1976 of 65,230 fish. Sixty five percent of this catch has been arctic cisco and 29% least cisco. Broad and humpback whitefish compose the remaining 6 percent (Craig and Haldorson 1980).

A subsistence fishery exists in nearshore waters and river deltas in summer and traditional fishing locations on rivers and lakes during winter. The main species constituting this fishery are Arctic cisco and Arctic char during summer and char and grayling during winter (see Chapter VII). Very little is known of the numbers of fish taken annually by this fishery. Furniss (1975) reports that on one traditional hole on the Hulahula River, four persons caught 18 char ranging in size from 122 to 331 mm and two grayling during four days of fishing in April 1974.

Some limited sport fishing also occurs by summer recreationists visiting the area. It is doubtful that the current amount of fishing pressure is having a significant effect on the fishery resources of the area.

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# Subsistence

## Kaktovik

### Environmental Setting

Kaktovik is the easternmost village in the North Slope Borough and the only village within the Arctic National Wildlife Refuge. Most of its 175 residents are Inupiat Eskimos who are part of the broader cultural group of Inuit peoples stretching from Siberia to Greenland. Their language is North Slope Inupiaq.

Kaktovik is located on Barter Island which is one of the largest in a series of barrier islands created all along the Beaufort sea-caost by the erosional and depositional forces of moving water and ice. In contrast to the Chukchi Sea, where offshore leads are likely to remain opin all winter, the Beaufort Sea coast may be locked in by tight shorefast ice for 10 months or more each year.

Because of these conditions, winter populations of marine mammals are much smaller in the Beaufort than in the Chukchi Sea [Arctic Environmental Information and Data Center (AEIDC), 1975]. Some species common in the Chukchi Sea, such as walrus, are rarely found far west of Barrow even in summer. In view of the different resource levels, it is not surprising that the Chukchi Sea coast has always supported a larger Native population than has the coast of the Beaufort Sea (AEIDC 1975).

Although marine mammals are relatively less abundant in the area, bowhead whales do migrate by here to and from the Mackenzie Delta and the village today has a fall whale hunt; commercial whaling flourished in the Beaufort Sea around the turn of the century. Ugruk and hair seals are also hunted in the summer, and arctic cisco and large arctic char are caught in coastal lagoons. Kaktovik does not have access to a major navigable river, and summertime activities are mainly confined to the coast. However, Kaktovik is much closer than other coastal villages to the foothills of the Brooks Range, and it is the only coastal village which derives a fair share of its livelihood from sheep hunting. Today, with snowmachines, snow season hunting trips to the mountains are commonplace, and fishing takes place at camps on the Hulahula River. Caribou are another major resource on which the people depend, both in summer and winter.

Most of Kaktovik's present subsistence land use is within the Arctic National Wildlife Refuge, as far south as the headwaters of the Hulahula River. The coastal area west of the Refuge may also be used during summer, often to Bullen Point and occasionally as far as Foggy Island. Some present day Kaktovik people grew up in this mid-Beaufort sea coastal area between the Canning and Colville Rivers, so strong associations with this area remain even though it is no longer the main subsistence area (Wentworth 1979b). Some Kaktovik people also once lived and hunted extensively east of the Arctic National Wildlife Refuge, in Canada.

Because subsistence and trapping activities determined where people lived, historic sites used by Kaktovik people are found within their former and present subsistence land use area.

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The sites span an area from Oliktuk Point (Uuliktuq) at the Colville River mouth, to the Canadian border and beyond.Most of the historic sites that people use now are within the ANWR and associated with their present subsistence land use. (See historic site descriptions, pp.___). The North Slope Borough includes all sites in its ongoing Traditional Land Use Inventory (TLUI).

Historic (TLUI) sites are referred to throughout this narrative. If a place name is underlined in the text, it is a TLUI site. Often Inupiaq place name spellings in use today are different from those appearing on USGS maps. When referring to a specific historic site, the place name is underlined and the correct Inupiaq spelling given. If referring to a USGS map location, however, spelling is used as it appears on the maps. For example, Kanigniivik historic site is in the same general location as Konganevik Point on the USGS map.

## HISTORY

Barter Island, as its name implies, has been an important trading center for centuries. Canadian Inuit people met here to trade with Barrow area residents, sometimes while travelling to another trading center at Niglik at the mouth of the Colville. Inland people also came down from the mountains to trade, and even Indians from south of the Brooks Range visited here occasionally (Nielson, 1977b, as cited in Wentworth, 1979a).

A large prehistoric village once existed on the island. The Canadian explorer Diamond Jenness counted between 30 to 40 old house sites there in 1914 (Leffingwell 1919). Before the present airport was built on top of this site, many whalebones could be found among the sod house ruins, suggesting that the people were whalers (Kaveolook 1977). Cora Ungarook's father Nasunguluk of Barrow wintered there in 1916 and used some of these whalebones for fishnet weights. One legend says these prehistoric people, the Qanmaliurat, were driven east to the Canadian side by other Inupiat through fighting. The Qanmaliurat killed one couple's only son, which is why after that there were no more people living at Barter Island. The couple fished their son's body out of the water with a seining net... hence the name Qaktugvik (Kaktovik) which means "seining place" (Kaveolook 1977; Okakok 1981). Another legend states that the body fished out of the water was that of Pipsuk, who drowned in the lagoon while fishing from a kayak. (See Pipsuk Point site)

Although Barter Island was not a permanent village, it remained a seasonal home for some of the nomadic ancestors of present-day Kaktovik residents, who travelled around in pursuit of caribou, sheep, sea mammals, fish and birds. Two men who had houses on the island and trapped in the area during the early part of this century were Tigutaaq and Panninguna.

Barter Island was also an important stop for commercial whalers during the 1890's and early 1900's (Nielson 1977b as cited in Wentworth, 1979a). In 1917, the whaler and trader Charles Brower sent his associate Tom Gordon from Barrow to Demarcation Point to establish a fur trading outpost for the H.B. Liebes Company of San Francisco. Tom moved to Demarcation with his wife Agiak and family and some of her relatives and friends and their families. After spending about a year at Demarcation, Agiak's younger brother AndrewAkootchook and family moved to the Barter Island area and spent the winter trapping. Finding it to have a good harbor and convenient and accessible location for hunting on land and sea, Akootchook helped Gordon establish a trading post at Barter Island in 1923 (Kaveolook 1977).

Akootchook's wife Susie's parents Adam Alasuuraq and Eve Kignak, and their son Ologak and his wife Annie Taiyugaaq, had also moved over from Barrow to be near Susie and because it was a good hunting area (Okakok 1981). The trading post provided a market for local furs, and was the beginning of Kaktovik as the permanent settlement of today (Nielson 1977b, as cited in Wentworth, 1979a)).

Although Barter Island area people congregated at the fur trading post on holidays and other occasions, most of the time they lived spread out along the coast. They were semi-nomadic, following the animals on which their hunting, fishing and trapping economy depended. The arctic fox was a good source of cash income, and they made a good living by supplementing it with game (Kaveolook 1977). Some of the families also herded reindeer, keeping them at places such as *Nuvugaq* and *Aanallaq* in Camden Bay, Barter Island and Demarcation, and taking them to the foothills of the Brooks Range during winter months.

The Scottish botanist Isobel Hutchinson desciribes life with the Gordon family at Barter Island in 1933, in her book *North to the Rime-Ringed Sun* (See site description for *Igluk paluk*). In his published diary of a trip taken in April 1937, Fred Klerekoper (a Presbyterian minister) writes of his stay with the Ologak family near the mouth of the Sadlerochit River (*Aanallaq*) and with the Akootchook family just east of Barter Island at Bernard Spit (*Tapkak*). Almost all of Kaktovik's present Inupiat population of 175 is closely related by blood or marriage to these three interrelated families.

The fall of the fox fur price in the late 1930's caused most of the Alaskan trading posts to close by the early 1940's. Tom Gordon died of a stroke in 1938 and no one took over the Barter Island post. The trader at *Imaignaurak* died in 1942, and the trader at *Agilguagruk* left in 1943. Reindeer herding also ended in the late 1930's. People had to go to Aklavik, Canada to trade. Several Kaktovik families moved to Herschel Island, Canada. Others built houses at Barter Island.

The early 1940's was a hard time for most Kaktovik people. The small amount of "tannik" or white man's food that they received each summer on the yearly supply ship was not enough to last through the winter,and then they were exclusively reliant on the area's fish and game for survival. Some people went through very lean times one year when game was scarce and they were close to starvation. One man, who was about ten years old at the time, remembers his family going entire days without food. Other days, his mother would fish all day and come home with only one small fish (10-12" long) which she divided among several children.

In 1945 the U.S. Coast and Geodetic Survey began mapping the Beaufort seacoast. Over the next few years at least three Kaktovik people were hired to help with this project.

World War II had little effect on Kaktovik residents, but the postwar military build-up caused major changes. Barter Island was chosen as a radar site for the Distant Early Warning (Dewline) system, which extended across the Alaskan and Canadian Arctic. This development provided jobs for area residents, and caused several physical alterations to the community including three village relocations. In 1947 the Air Force began building an airport runway and hangar facility on the prehistoric village site, where several houses were located. These houses had to be moved.

In 1951, the entire area around Kaktovik (4500 acres or 1,823 ha) was made a military reserve, and some people had to move again. In 1964, the village had to move a third time, and received title to their present site, though not to the old cemetery (see descriptions for Kaktovik historic sites). (Nielson, 1977b., as cited in Wentworth, 1979a).

The availability of jobs resulting from U.S. Coast and Geodetic Survey work and DEW Line construction, and the consequent establishment of a school, caused the Barter Island population to increase rather rapidly. People moved in from the surrounding area and five of the six families living at Herschel Island returned to Barter Island. The U.S. Census had counted 46 people in 1950, but by August 1951 when Harold Kaveolook opened a BIA school at Kaktovik, there were eight families with 86 adults and children. By the spring of 1953, after the Herschel Island families had returned, the population was 140-145 (Kaveolook 1977). The population remained relatively stable until the late 1970's when more employment opportunities and better housing caused some former Barter Island area residents living in Barrow to move back with their families.

## LAND USE PATTERNS OVER TIME

Present day land use patterns in Kaktovik are very much a function of tradition and history. Families have a tendency to return to those places where parents lived or camped in their youth.

As already pointed out in the section on history, Barter Island people used to be more nomadic and scattered than they are at present. Much of the population that congregated at Barter Island in the 1940's and 1950's had formerly lived at other locations, mostly along the coast within 75 mi (121 km) east or west of the island. Today, people often return to these former dwelling places to hunt, fish and trap. They travel as far as the Canadian border on the east, Foggy Island to the west, and the source of the Hulahula River in the Brooks Range to the south.

The congregation of people at Barter Island as a permanent village was initially a result of wage employment opportunities. The establishment of a school in the early 1950's further increased the Barter Island population. Now, the requirement that children attend school, the introduction of other government services, and the continued availability of employment opportunities have helped to perpetuate the permanent village. However, the people's desire and need to pursue their former lifestyle as time permits continues in spite of these material changes.

The changes in living patterns of Kaktovik residents are largely a result of changes in the type of cash economy which has supported them.Although they have lived in a part-subsistence, part-cash economy since the late 1800's, only since the late 1940's has it been the type of cash economy which required them to stay in one place. Before that time, Barter Island area residents earned cash through the land-based activities of fur trapping and reindeer herding. Their pursuits, as well as the traditional hunting and fishing activities, required that they live spread out from each other and be somewhat nomadic.

The establishment of a permanent village and the arrival of modern technology and its amenities, including hunting and fishing technology, has increased people's need or desire for cash. This has, in turn, made it more necessary that they stay in the village to earn it. Those who have permanent jobs arrange their subsistence activities around their jobs by hunting on weekends and during leavetime. Those who have seasonal or intermittent jobs are free to be full-time subsistence hunters the rest of the time. It is rare, however, for people to leave the village for more than a few weeks at a time. The advent of snow machines means they can travel much faster. For example, it used to take two days by dog team to get to the second fishing hole on the Hulahula River, but now it takes only four hours. Therefore, it is now possible to go to the Hulahula River for the weekend, although almost everyone who goes stays a week or two. The expense of gas and the work involved in hauling all the supplies make people want to stay more than two or three days. (Wentworth, 1979a).

Several different individual illustrations of Kaktovik people's land use patterns over time have been compiled (North Slope Borough 1980; Jacobson and Wentworth 1981). These document historic use of the Traditional Land Use Inventory (TLUI) sites as well as subsistence activities. Summaries of three of these will be presented here.

Tommy Uinniq Gordon was born at Siku (Icy Reef) on April 25, 1921. His birthplace means "ice", and his Inupiaq name Uinniq means "flooding, unsafe ice", which describes the ice conditions at the time he was born. He grew up mostly at Pattaktuq in Demarcation Bay, where his grandfather Tom Gordon had established a trading post in 1917. He also lived at Pinuqsraluk just west of the Bay. This was where he learned to handle a shotgun, and in the spring of 1930 he put 50 brant in the ice cellar. Uinniq used to hunt fish with the Norwegian trader John Olsen, who had a trading post first at Uqsruqtalik (Griffin Pt.) and then at Imaignaurak. Uinniq sold Olsen seal oil, and polar bear hides and other furs. The bounty on wolves at that time was $20. Each spring Olsen would go up the Okpilak River valley to look for gold, and Uinniq would sometimes help him haul supplies. Olsen kept his exact prospecting locations a secret, however. The old boiler that he used is still in the Okpilak Valley.

The winter of 1935-36 was a very poor one for subsistence. Uinniq's family lost its fish nets, hunting gear, and boats in a bad wind, and there were no caribou. Uinniq and his sister walked from Demarcation to Barter Island three different times to buy food. One area resident, Joe Arey, starved to death in the mountains when all he had to eat was ptarmigan.

Usually in winter, Uinniq and his family would spend time hunting and fishing in the Kongakut River valley. He often got Dall sheep, especially during the late 1930's and early 1940's, but he never took more than ten per year. Before this, few sheep were found in the Kongakut as they were too heavily hunted for the commerical whalers living at Herschel Island.

One year the family spent the entire winter (September 1942 to March 1943) in the Kongakut Valley. Uinniq remembers what he got in the way of game that winter: 8 wolverine, 1 white fox, 1 cross fox, 2 red foxes 9 sheep (all in one day) and 1 brown bear. He and his father would bring supplies from

Aklavik, N.W.T. to the rest of the family every month, walking while 8 dogs pulled the sled.

After the Alaskan trading posts closed down, Uinniq moved to Herschel Island and Demarcation Bay from 1943 to 1953. In the fall of 1943 he got two bearded seals and nearly 70 caribou, and stored them in ice cellars at Demarcation and Herschel Island. This proved to be a wise decision, for the next spring his brother's family at *Uqsruqtalik* was struck by the flu epidemic and needed meat badly.

Uinniq and his wife move back to Alaska in 1953, and settled at Barter Island. Most of his brothers and sisters stayed in Canada, and now live in Inuvik and Tuktoyaktuk, N.W.T. (Jacobson and Wentworth, 1981).

George Agiak was born at Barrow in 1909 and lived at Wainwright until he was 12 years old. In 1921, his family went to Banks Island, Canada to trap, travelling on the two masted schooner *Lydia*. However, the Canadian government would not allow them to trap, so they subsisted solely on hunting and fishing until they returned to Alaska in the summer of 1922.

The family lived much of the time at *Sigaktitaq* (Mid-Beaufort Site 31) on the west side of Prudhoe Bay. George often travelled to the Colville River to fish, and one time caught 2000 fish there. In the late 1920's he helped catch a whale at Cross Island.

George married Nora Gordon in 1931, at Barter Island. She was born in Barrow in 1911, but in 1917 moved to *Pattaktuq* in Demarcation Bay when her father, Tom Gordon, established a trading post there. The family moved again in 1923 when Tom Gordon established a trading post at Barter Island.

Until 1943, Nora and George lived much of the time at *Siklaktitaq*, taking frequent trips in the wintertime up the Kuparuk, Sagavanirktok, and Shaviovik Rivers to hunt and fish. One of their sons was born in November 1943, at a small house they built far inland on the Kavik (Shavioveak) River. They also lived for a while at *Nuvugaq* in Camden Bay. They often travelled to Barter Island and to Beechey Point for visiting and trading.

In the late 1930's, Agiaks made their first trip to *Qani*, at the headwaters of the Hulahula River, and spent two months there. They have continued to go to *Qani* over the years during the winter, sometimes staying for several months at a time.

When the Alaskan trading posts closed down in the early 1940's, the Agiaks could no longer trade their fox skins for necessary store items. After spending some time on the Aichilik River and at *Uqsruqtalik*, they moved to Herschel Island, N.W.T. Three of their children were born there, and have dual U.S.-Canadian citizenship. Agiaks moved back to Barter Island in the spring of 1952, and George got a job working for the U.S. Coast and Geodetic Survey.

Mary Sirak Akootchook was born at Flaxman Island in September 1921, right after her family moved back there from Barrow. She was named Sirak because this is one of the Inupiaq names for Flaxman Island. It means "place where polar bears go to get covered up with snow to have their cubs".

Mary's family, the Panningonas, usually spent winters at the house they built near the Leffingwell house site on Flaxman Island. From here they trapped, hunted ptarmigan and netted seal.

However, they also lived a semi-nomadic lifestyle, moving seasonally to where the fish and game were. In March or April, they would travel up the Staines River by dogteam, hunting caribou and ptarmigan along the way. When they got inland on the Canning as far as Ignek Creek, they would stop to fish through the ice for awhile. From here they travelled northwest for about 20 miles, using two dogteams to cross over the mountains. They fished at the warm springs on the Kavik (Shavioveak) River. Then they travelled down the Kavik to its confluence with the Shaviovik River, and down the Shaviovik to the coast. Here they would visit people living at Savviugik River (MB Site 40), then return to Flaxman Island while there was still ice for dog sled travelling.

In springtime, Panningonas hunted waterfowl, mainly eider ducks, on Flaxman Island and other barrier islands. In summer and early fall, they often moved to their summer fish camp at Agliguagruk (Brownlow Pt.) where they caught many char and arctic cisco and shot black brant in the fall. Mary and her sisters hunted caribou along the coast as far as three or four miles inland, and did a lot of backpacking to bring the meat out. They hunted seal on the outer side of the barrier islands, throughout the year when there was open water.

Mary learned to trap while still a young girl. The family's arctic fox traplines extended from Flaxman Island to Pt. Gordon (Mid-Beaufort Site 43) and all the Maguire Islands. Mary also trapped red and cross fox as well as arctic fox along the entire length of the Staines River.

Mary hunted ptarmigan on the ice between Flaxman Island and Brownlow Pt. during winter and early spring. She can remember having ptarmigan for breakfast, lunch, and dinner day after day during lean times. The family also trapped snowy owls for food.

The Panningonas stored waterfowl, fish and other game in their ice cellar on Flaxman Island. Many times in fall or winter they had visitors that were really hungry, so they would feed them from the birds in the ice cellar. Food was scarce during the winter of 1939-40, when several present-day Kaktovik residents were living on the Shaviovik River. Two of them came to Panningonas' on Flaxman Island to get birds, seal oil and fish to take back to another person who otherwise would have died of starvation. (North Slope Borough, 1980; Jacobson and Wentworth, 1981).

## Historic (Traditional Land Use Inventory) Sites

In May of 1977, the North Slope Borough, under the direction of Flossie Hopson, prepared a "Traditional Land Use Inventory" (TLUI) of historic and cultural sites in the Beaufort Sea coastal area. This inventory was published as part of the Beaufort Sea Study (Nielson 1977a). This information has been used as a baseline for compiling additional documentation on those sites that are used by and have special significance to the people of Kaktovik. Tables and information goes back to about 1910, which is considered the beginning of the historic period in this area. The sites discussed are also significant to people residing in places such as Barrow, Nuiqsut and Anaktuvak Pass in Alaska; and Inuvik, Aklavik, and Tuktoyaktuk in Canada. Furthermore, Kaktovik people undoubtedly have more information about these and other sites that has not yet been documented. Therefore, the following narrative is by no means a comprehensive compilation of use for these sites; however, it does show how

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extensively people now residing in Kaktovik have used the land, and what their ties are to these sites.

Information for their use of the sites west of the Canning River (between the Canning and the Colville) is not repeated here, since it is included in <u>Qiniqtuagaksrat Utuqqanaat Inuuniagninisiqun</u>: <u>The Traditional Land Use Inventory for the Mid-Beaufort Sea</u> (North Slope Borough, 1980).

Table 2 LIST OF MID BEAUFORT SEA TRADITIONAL LAND

USE INVENTORY SITES

| Inupiat Name | English Name | Site Number |
|---|---|---|
| Sanniuruk | Spy Islands | MB-1 |
| | Leavitt Island | MB-2 |
| Pinu | Pingok Island | MB-3 |
| | Bertoncini Island | MB-4 |
| Nukatpiat | Bodfish Island | MB-5 |
| | Cottle Island | MB-6 |
| Tapqaqturuaq | Long Island | MB-7 |
| Napaqsraligauraq | Reindeer Island | MB-8 |
| | Argo Island | MB-9 |
| Niaquq Island | Niaquq Island | MB-10 |
| Napaqsralik | Cross Island | MB-11 |
| | Foggy Island | MB-12 |
| | Narwhal Island | MB-13 |
| | Jennette Island | MB-14 |
| | Karluk Island | MB-15 |
| | Point Lookout on Tigvagiaq Island | MB-16 |
| Tigvagiaq Island | Tigvariak Island | MB-17 |
| | Pole Island-Stockton Islands | MB-18 |
| | Belvedere Island-Stockton Islands | MB-19 |

Table 2. (continued)

| | | |
|---|---|---|
| | Flaxman Island | MB-20 |
| Uuliktuq | Oliktuk Point | MB-21 |
| Ugrugnavik | | MB-22 |
| Ugrugnavik River | | MB-23 |

Table 2 (continued)

## LIST OF MID BEAUFORT SEA
## TRADITIONAL LAND USE INVENTORY SITES

| Inpiaq Name | English Name | Site Number |
|---|---|---|
| Naqaayuq | Milne Point | MB-24 |
| Takpaam Inaat | MB-25 | |
| Qaviarat | MB-26 | |
| | Beechey Point | MB-27 |
| Aquvlak | Back Point | MB-28 |
| Sakunavgak | MB-29 | |
| Kuukpaągruk | MB-30 | |
| Siklaqtitaq | Point McIntyre | MB-31 |
| Kaniqlug | MB-32 | |
| Tikigaagruk | MB-33 | |
| Agliqvurak | Point Brower | MB-34 |
| Koganak Inaat | Koganak's camp | MB-35 |
| Ekolook Inaat | Ekolook's camp | MB-36 |
| Kisium Inaat | Kisik's camp | MB-37 |
| Kakianaam Inaat | Kakianak's camp | MB-38 |
| Sikiagruum Inaat | Sikiagruk's camp | MB-39 |
| Savviugvik River | Shaviovik River | MB-40 |
| Savagvik | Bullen Point | MB-41 |
| Ikpigauraq | MB-42 | |
| | Point Gordon | MB-43 |

Table 2. (continued)

| | | |
|---|---|---|
| | Point Hopson | MB-44 |
| | Point Thompson | MB-45 |
| Agliguagruk | Brownlow Point | MB-46 |

Table 3

## LIST OF MID BEAUFORT SEA TRADITIONAL LAND USE INVENTORY SITES

| Inpiaq Name | English Name | Site Number |
|---|---|---|
| Tigutaaq | | |
| Kayutak | | |
| Kanigniivik | Konganevik Point | |
| Katakturak | Katakturuk | |
| Nuvugaq | Point Collinson ("POW D") | |
| Kunagrak | | |
| Aanallaq | Anderson Point | |
| | Sadlerochit Springs | |
| Sanniqsaaluk | | |
| Patkotak | | |
| Sivugaq | | |
| | First Fish Hole | |
| | Second Fish Hole | |
| Katak | Third Fish Hole | |
| Kayich | | |
| Uqpillam Paaya | | |
| Naalagiagvik | Arey Island | |
| Iglukpaluk | | |
| | Tikluk-Akootchook housesite | |
| Qaaktugvik | Kaktovik (first location) | |
| Qaaktugvik | Kaktovik (second location) | |
| Qaaktugvik | Kaktovik (presint location) | |
| Pipsuk | Pipsuk Point | |

Table 2. (continued)

| | |
|---|---|
| Qikiktaq | Manning Point ("Drum Island") |
| Tapkak | Bernard Spit |
| Tapqauraq (continued) | Martin Point and Tapkaurak Spit |
| Uqsruqtalik | Griffin Point |
| Pukak | |
| Imaignaurak | Humphrey Point |
| Iglugruatchiat | |
| Anyun | |
| Nuvagapak | Nuvagapak Point |
| Atchilik | |
| Siku | Icy Reef |
| Piyuqsraluk | |
| | Demarcation Bay - west side |
| Kuvluuraq | |
| | Old Man Store |
| Kanigluaqpiat | |
| Pattaktuq | Gordon |

Descriptions for the Canning River delta sites at Flaxman Island and Brownlow Pt. are also included in the above volume, and are part of the North Slope Borough's Mid-Beaufort Sea designation. Brownlow Pt. is also within the boundaries of the Arctic National Wildlife Refuge, and Flaxman Island is in very close proximity. In addition to the Borough's Traditional Land Use Inventory for these sites, the Borough has done a special study of the cultural resources at these two places, which together form the focus of a Borough designated cultural resource subsistence zone. This consolidated discussion of the sites at the two places not only includes much of the previously documented information (Wentworth, 1979; North Slope Borough, 1980) but is based on actual site visits which took place during summer 1980. The documentation team visiting the sites included former residents of the sites as well as a Borough archeologist and ethnohistorian, other Borough officials, and a representative of the Alaska Department of Fish and Game's Subsistence Section.

Credit is given to the North Slope Borough for permission to reprint this Flaxman Island-Brownlow Pt. on-site cultural resource study. Although other archeological studies have been done on the ANWR (see Archeology section), this is the only on the ground study of historic (TLUI) sites that has been

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completed. It is also the only study which combines historical and archeological expertise.

This is a major data gap in this part of the baseline study: the rest of the historic (TLUI) sites within the refuge also need these on-site studies. This is true whether or not the sites have physical remains. Studies are needed to determine exact locations and other relevant archeological and historical documentation information. In order to yield the necessary information, documentation teams should be patterned after the Flaxman Island-Brownlow Pt. study and include former site residents or local resource people as well as an archeologist-ethnohistorian and a biologist. This need for on the ground identification and documentation of historic sites is the most important data gap existing in this subsistence-cultural resource portion of the baseline study.

The following pages contain a reprint of the North Slope Borough's Flaxman Island on site cultural resource study, written by Borough archeologist and ethnohistorian David Libbey, and a site by site description of the other historic (TLUI) sites within the Arctic National Refuge. ← ✱ Insert I

QAAKTUGVIK -KATOVIK (Present location)

TLUI Site

| | |
|---|---|
| Note: | The North Slope Borough's publication, Kaktovik, Alaska: An Overview of Relocations (Nielson, 1977) includes a map of Kaktovik's various locations. It also contains more detailed information concerning acquisition of this present townsite. |
| Location: | Northeast part of Barter Island, inside the small lagoon across from the airport. |
| Meaning: | Kaktovik means seining place. |

Kaktovik has been at this location since 1964, when it was moved for health reasons and so that the Air Force could expand its facility onto the earlier site. As the result of at least four years of negotiations instigated by Kaktovik Village Council President Herman Rexford, Kaktovik teacher Harold Kaveolook, and Utkeagvik Presbyterian Church missionary John R. Chambers, the village was able this time to get title to their village townsite. The village townsite plan was approved July 14, 1964. The village townsite was completed in August 1964, and officially filed in the Fairbanks District Land Office on November 14, 1966. However, the Air Force did not deed over the cemetery, which is still on Air Force land (see Kaktovik second location) (Kaveolook 1977; Nielson and NSB Planning Dept. 1977b).

Kaktovik, Alaska: An Overview of Relocations, states on page 7:

> The new village site was located on the East shore of the island facing Kaktovik Lagoon on 280.29 acres. The official name of "Kaktovik" was adopted and placed on the U.S. Post Office trailer. Again, the Air Force lent its equipment and, under the supervision of the BIA, the village was uprooted for the third time in less than twenty years and moved to its new site overlooking the lagoon, the airport and the Beaufort Sea beyond (Nielson, 1977).

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# Flaxman Island - Brownlow Point

Flaxman Island and Brownlow Point are consolidated in this description, because together they form the focus of the cultural resource subsistence zone adjacent to the mouth of the Staines and Canning Rivers.

## Introduction

Flaxman Island lies about three miles offshore from the Staines River delta between Point Thompson and Brownlow Point. This tundra covered island, which is approximately three-and-a-half miles long and varies from several hundred feet to a mile in width, was named by British explorer John Franklin for John Flaxman, an English sculptor and artist. Consisting of sand and gravel, like most other barrier islands, it differs by having a large number of boulders strewn on its surface. Brownlow Point, which projects from the mainland into the Beaufort Sea, has this same characteristic. Elevation ranges from several feet on the long sand spit at the western end of the island to 20 feet at the eastern end.

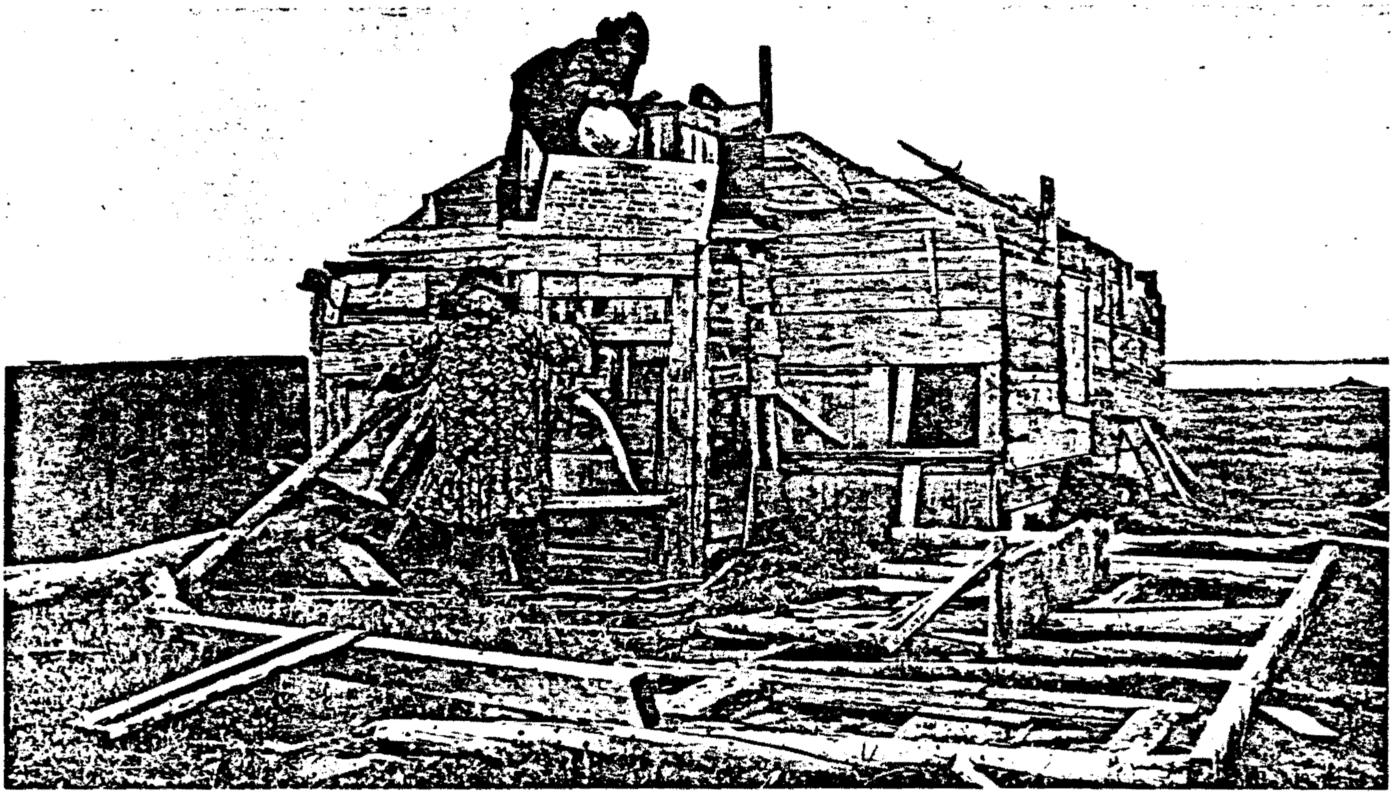
Nearly the entire island is covered with thick, luxurious tundra grass. The rolling terrain is disrupted by large eroded gullies, some up to 15 feet deep and 20 feet across. High mud cliffs on the island's seaward edge and along the eastern shore continuously erode, sloughing off parts of the island and probably cultural remains as well. Ponds spot the island's surface, providing habitat for nesting migratory birds. The water separating it from the mainland, as well as the water on the seaward side, is relatively shallow.

The remains of a cabin at the former campsite of explorer/geologist Ernest Leffingwell are located on the southwest shore of Flaxman Island. This site was placed on the National Register in 1971 and became a National Landmark in 1978. On the south side of the eastern end of the island are the remains of several structures which have not yet been identified. A gravel landing strip in the center of the island is all that remains to attest to the presence of an exploratory oil rig which was removed in June of 1979.

Historic remains on Brownlow Point include several structures along the northeast side. Near the tip of the point is a Teledyne tower and an abandoned DEW Line building which is protected by a breakwater of 55-gallon oil drums. On the west side of the point are the graves of 11 former residents, some enclosed by a picket fence.

## Statement of Significance

Designation of Leffingwell's camp as a National Landmark has already demonstrated Flaxman Island's historical significance. Just as important, however, is the Inupiat's continuous usage of both Flaxman Island and Brownlow Point in their seasonal round of subsistence activities. For centuries they have been drawn to the area for hunting, fishing, and trading. Ejnar Mikkelson, who lived on the island with



**Mary Akootchook, daughter of the original builder, Samuel Panningona, hands dried meat down from the cache above the door — continued use of a historic building in a traditional manner.**

Leffingwell, reported in 1906 that "on the extreme west end of Flaxman Island there were some houses in ruins, while some tombs showed the last inhabitants had died, caught, as we learned later, in a blizzard and froze to death" (Mikkelson 1909; 98). This demonstrates the island's long occupation prior to the arrival of non-Natives.

John Miertsching, aboard the *Investigator* in August 1850, was one of the first to mention habitation on the island when he noted tents and men. He probably witnessed a situation which recurred annually as people came from widely divergent areas to trade. Repeated references to annual trading fairs and human activity at both Flaxman Island and Brownlow Point add to the certainty of prolonged use and importance to the Inupiat people.

The explorer Stefansson noted in August of 1908 that "it was now time for the Eskimo of Point Barrow to be coming along from the west on their annual trading voyage to Flaxman Island." A few days later he wrote that "we stopped for three days at the Flaxman Island trading village, and then continued eastward in company with several Eskimo boats that had come up from Herschel Island for trading purposes" (Stefansson 1913; 116-117). Upon Leffingwell's return to Flaxman Island in 1913, he stated, "When the party landed (August 19) the Natives, who always gather in the neighborhood for trading about the first of August, were now dispersed" (Leffingwell 1919; 17).

During the fur trading era of the 1920's, a white trader named Henry Chamberlain established a trading post at Brownlow Point, indicating the significance of this area as a trade center. Recollections and references to traditional trade fairs are nonexistent after this time, indicating that Chamberlain's post affected traditional trade. Much remains to be learned of the impact non-Native trading posts asserted on traditional Native trade patterns.

### Recommendations

As Flaxman Island and Brownlow Point have both been identified as areas of traditional trading activity and continued subsistence use, they must be protected. Developers of the area must consider their importance to the Inupiat. The history of these sites should be further documented through additional on-site interviews with Inupiat elders.

Little is known of the historic site near the east end of Flaxman Island. Three sod houses, two cellars, and a rack or cache have been identified, but documentation is necessary to determine their ownership and significance. Local elders familiar with them should be interviewed, and archeological testing may be warranted. The sand spit off the western end of the island was not accessible at the time of the team's visit and may contain archeological remains not documented in this survey. An archeological site identified on Brownlow Point also requires further investigation and perhaps deserves protection.

**Part of the house Leffingwell built when he mapped the Arctic coast from this site.**

### Historic Site Team

The historic site documentation team which visited Flaxman Island and Brownlow Point between August 14 and 19, 1980, included Samuel Panningona's daughters, Josephine Itta of Barrow and Mary Akootchook of Kaktovik. The Panningona family lived in the area during the early part of this century, and the sisters have excellent recall of the structures built as early as 1920. Also participating were Sarah Kunaknana and Joe Koganaluk of Nuiqsut and formerly of the mid-Beaufort Sea area; Frank Long, Jr., Nuiqsut Land Chief; Emily Wilson, Co-director of the NSB Planning Department; Sverre Pedersen of the ADF&G Subsistence Division; and David Libbey, archeologist and ethnohistorian for the NSB.

### Historical Information

- Flaxman Island

In 1906, Leffingwell and Mikkelson wintered at Flaxman Island in their ship the *Duchess of Bedford*. Mikkelson left in 1907; and Leffingwell built a cabin from the ship's boards. In September of 1909, a new house was built next door. Leffingwell, Samuel McIntyre, and Storkerson all stayed here at times during the next couple of years. Hudson Stuck and his guide, George Leavitt, Jr., reached Flaxman Island on March 28, 1918, where they were weathered in for four days. Elijah Kakinya and his family were living at Flaxman Island at this time. Elijah made Flaxman Island his home until he was 20 years old (TLUI 1980).

In the summer of 1921, ten-year-old Josephine Panningona Itta moved from Barrow to Flaxman Island with her parents, Samuel Panningona and Iva Evikana. Her sister, Mary Akootchook, was born in September just after the family reached Flaxman Island. At first they lived in Leffingwell's house which, as indicated by the remains of the sod foundation, had two relatively large rooms. According to Josephine, her immediate family and her father's parents were the only ones living in the house at this time. Henry

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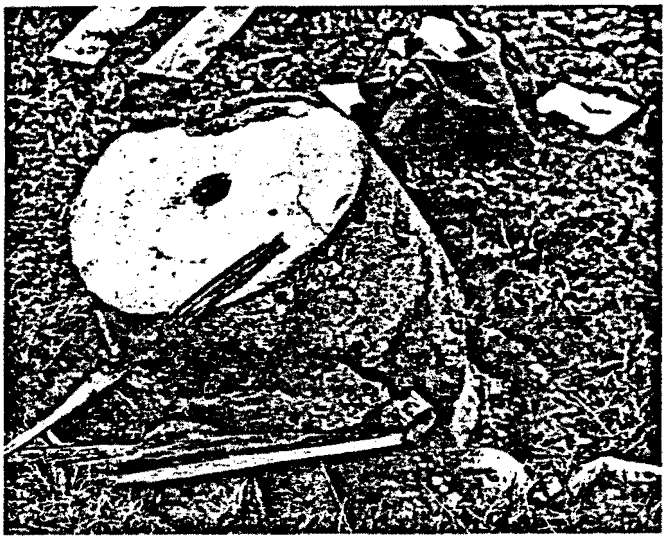
Chamberlain, Costello, and other non-Natives occasionally visited, staying with them at Leffingwell's. Mary Akootchook remembers that Harland Okamailuk and his family were their neighbors, staying there three years before moving on.

Josephine Itta remembers that Leffingwell had a sundial by which her father set his watch. While its concrete block base is still in place, the metal dial is missing. In the 1930's trader Henry Chamberlain disassembled Leffingwell's house and moved it to Brownlow Point where it served as a warehouse for his trading post.

In 1924 Samuel Panningona built a house near Leffingwell's house and his family moved in. Around 1934 Samuel moved the house to where it now stands. Samuel's daughter Mary and her husband, Isaac ~~Roy~~ Akootchook, continue to use the house which is still in relatively good condition. A historic site sign placed over the entry often causes confusion; many think that it is Leffingwell's house. Recently the Akootchooks removed the house's floorboards and stacked them outside to air, as they had buckled due to frost and dampness.



**Concrete base for Leffingwell's sun dial. Day pack and clipboard for scale.**

Nearby are a few posts which are all that remain of Samuel Panningona's cache. It also served as a meat drying rack and a place to hang seal skins to bleach. North of Panningona's house is a small tongue-and-groove wood structure which was part of Leffingwell's house. Panningona later used it as a storehouse. Panningona laid a floor for an 8' x 12' tent used by his family in the summer, and he also built a wood rack.

The Panningonas netted seal, hunted ptarmigan, ducks, snowy owls, caught fish and trapped white and blue fox. They had a trapline running over the island and used their home as a base for inland caribou hunting. The family traveled back and forth between Flaxman Island and Brownlow Point harvesting the bounty offered by each season.

According to Levi Griest, in 1923 Captain C.K. Larson of Nome stayed at Flaxman Island. He had borrowed a two-masted sailboat from Liebes, a San Francisco fur trading company (TLUI 1980). Nannie Woods and her husband George went to Flaxman Island in 1924 and customarily spent Christmas with the Anapkana and Panningona families. Jennie Ahkivgak was born at Flaxman Island on April 3, 1926, to William and Etta Ekolook.

**Remains of a sod house. The large white object at the far left is a piece of whale bone.**

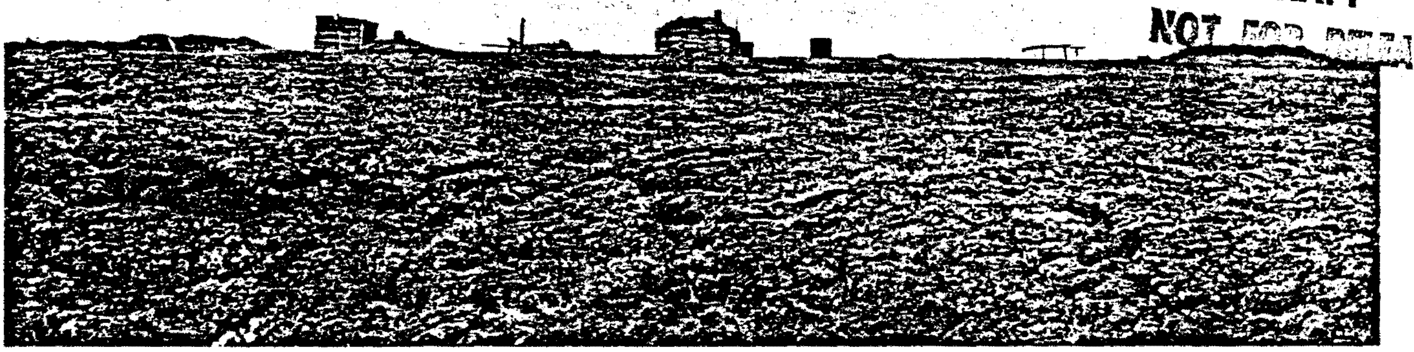
In 1933, botanist Isobel Hutchinson was traveling on Gus Masik's trading boat, the *Hazel*, from Martin Point to Barrow. Tigutaaq and his son were on board, and Tigutaaq got off when the boat arrived at Flaxman Island. Samuel Panningona and his family were also aboard with their canvas covered umiak, and as Hutchinson stated, "the boat was piled high with trading goods for Flaxman Island" (TLUI 1980; 78).

In 1937 Rev. Klerekoper made a dogsled trip from Barrow to Demarcation Point and back. En route he stopped at Brownlow Point, passing "many deserted igloos" near Flaxman Island. In the early 1940's Samuel Panningona's brother, Harland Okomailak, built a house, and the sod foundation still remains. Although he and Qisiilaq supposedly had another house on the north shore of the island, it could not be located.

The following excerpt from the TLUI (1980) provides further information on Flaxman Island.

> "During the winter of 1939, several Kaktovik residents were living on the Shaviovik River. It was a very lean year for hunting. Two of these people came to Panningona's cellar on Flaxman Island to get birds, seal oil and fish to take back to the others, who otherwise would have died of starvation. In the flu epidemic of 1945, quite a few people died at Flaxman Island. A few years after that, somewhere between 1947-1949, Samuel Panningona brought his family back to Utqiagvik (Barrow). During the earlier years Anton Edwardsen with Charlie Brower's daughter

Dora, went to Flaxman Island where they had a trading post. Other people who stayed at Flaxman Island during the 1920's to the 1950's are: Dan Okomailak, Saviatchiak (who moved to Nuvuk), Virat, Sagmaliurak, Nashanik, Oenga, Kunvatchiak, Alfred Linn, Sr., Otuayuk, T. Akootchook, F. Rulland, J. Rulland, and Wilson Soplu" (Page 78).



**Left to right: concrete sun dial base, foundation ___ ruin, Structure #1 Panningona's house, oil drums, Structure #8 Panningona's wood rack, Structure #6 Okomailak's house foundation. for structure #4 Leffingwell's house a remaining part of it, mound with concrete block for part of sun dial, Structure #2 Panningona's work shop**

At the 1978 Point Thompson public hearing in Nuiqsut, Dan Okomailak testified that when he flew over Flaxman Island, he saw an oil rig very close to his grandmother's grave. As previously stated, this oil rig has since been dismantled and removed. Thomas Napageak also testified at Nuiqsut and stated that in 1973 he killed a whale on the east fork of the Canning River and butchered it on Flaxman Island.

Flaxman Island and Brownlow Point continue as significant sites for the subsistence activities. In the *Arctic Coastal Zone Management Newsletter* of September, 1978, Cynthia Wentworth wrote an article based on extensive interviews with subsistence hunters in the Beaufort Sea area. Kaktovik residents stated that the Canning River delta and Flaxman Island are among their most important caribou hunting areas, and that caribou are present in the Canning River delta at various times throughout the entire year.

Three of the families interviewed by Wentworth reported they and other families used Brownlow Point as a summer fish camp. Fishing is also important off Flaxman Island, especially the coastal area northwest of the Leffingwell cabin and the extreme west end of the island's spit. The water and ice around Flaxman Island and Brownlow Point were noted as productive for seal hunting. One of the men said he shot a whale at Flaxman Island before 1930, and remembered the bone was 11 feet long. The island's long western spit was cited as especially important for both waterfowl hunting and egg gathering. Other residents mentioned hunting polar bear on Flaxman Island and using the island for fox trapping. The Kaktovik residents stated that Henry Silameootchiak and Clifford Savak's wife, Tooglak, are buried on the eastern end of Flaxman Island; both died during the flu epidemic of 1945. Kinuak's children are also buried here.

Otis Ahkivgak was brought to Brownlow Point by his parents sometime between 1891 and 1902. Later his family moved to Flaxman Island, but they returned to the point to fish in the summer. Between 1921 and 1925 the Panningonas often moved their summer camp to Brownlow Point to hunt caribou and waterfowl and to fish along the coast. Mary Akootchook recalls the following people stayed at the point year-round: the Clifford Saavġaq family, Lora Oyagak's parents, Tegutaaq and Julia, and the Agñiiñ family (TLUI 1980).

In 1923 Henry Chamberlain came to Brownlow Point, setting up a trading post which he operated until 1943. Here, Inupiat traded their furs for merchandise such as flour, sugar, tea, coffee and ammunition. Sometime in the early 1930's, Chamberlain disassembled Leffingwell's house on Flaxman Island and moved it to Brownlow Point where he used it as a warehouse for food, clothing, and textiles. The house he built does not resemble the original. Chamberlain's house had three rooms, each representing a different type of construction. The Panningonas pitched their tents in the middle room when they came to visit. In front of the house is a collapsed wood frame, the ruins of a rack used for drying polar bear skins. Towards the beach lies Panningona's sled which was sometimes used with a sail.

Herman Rexford, Abraham Woods, and Ruby Linn recall trading at Chamberlains, and Herman remembers that the Woodrow Saavġaq family was living there. During the spring and summer of 1932 Peter Wood, an Inupiaq reindeer herder on the Lomen Brothers' drive from Nome to Canada, recalled trading at the store. He sold Chamberlain four white fox furs for $100 worth of "grub." Also, Captain C.T.

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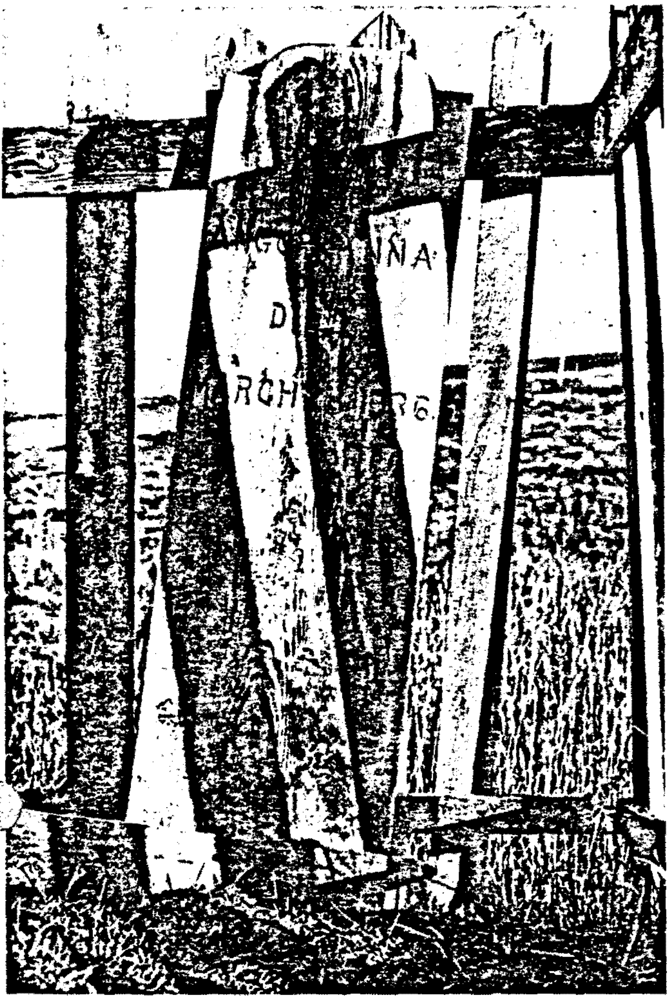
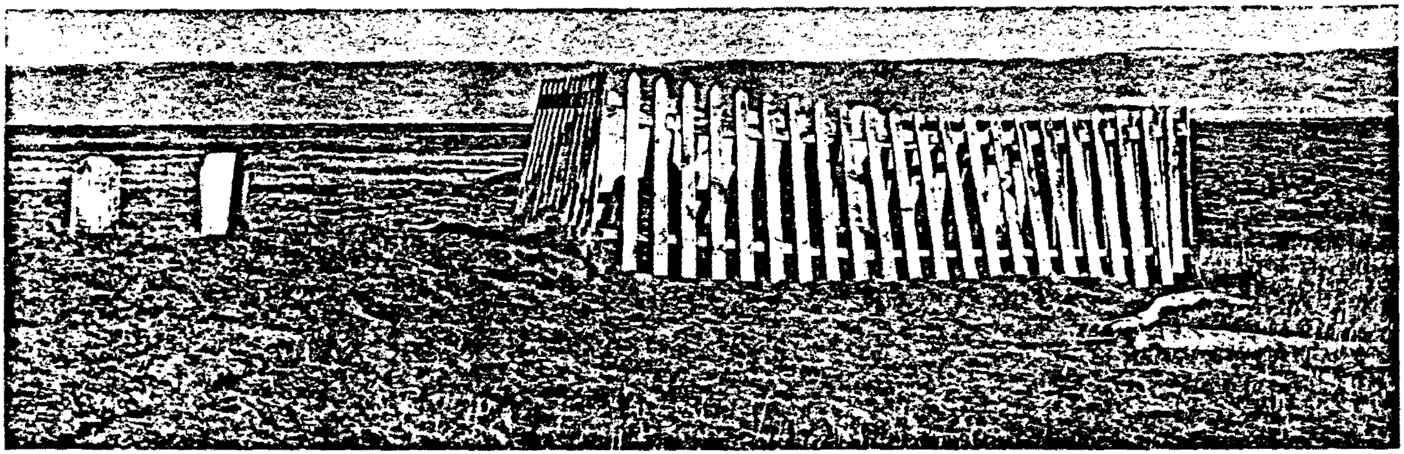
Pederson of the *Patterson* stopped at Brownlow Point with supplies for these herders in July. During the same year, 1932, Ira Rank of Nome arrived here in his boat, the *Trader* (TLUI 1980).



**Grave marker inside picket fence enclosure.**



**The enclosed area has four graves with wood markers in the shape of tombstones like those to the left.**

Southeast of the point, near the head of a lagoon, [illegible] the ruins of a boat with a keel sheathed with bone plates. Panningona built this boat in Barrow sometime before 1920 to transport his family east. It apparently has not been used since the 1940's.

Thomas Napageak was born at Brownlow Point on August 3, 1933, and his family lived here until 1939. Scottish botanist Isobel Hutchinson stopped at Brownlow Point on September 15, 1933, enroute to Martin Point from Barrow on Gus Masik's boat, the *Hazel*. According to Isobel, Brownlow Point was the site of a small Native village and a store owned by Chamberlain, who was working as an engineer on Masik's boat. Chamberlain traveled to Martin Point and then brought the *Hazel* back to Flaxman Island, where he beached it for the winter. Hutchinson went ashore and watched as the men and women of Brownlow Point unloaded the post's winter supplies, including flour, gasoline, and wooden planks. She noted that the "houses were mostly built of turf and stone like those of the Greenland Eskimo" (TLUI 1980; 85).

During April, 1937, Rev. Fred Klerekoper and Roy Ahmaogak traveled by dog sled from Barrow to Demarcation Point and back. Each way they stopped at Brownlow Point and stayed with Chamberlain, where they held prayer meetings and communion for the local residents. According to Klerekoper, Chamberlain received a shipment from Barrow once a year.

In 1943, Henry Chamberlain closed his trading post at Brownlow Point, leaving all his remaining merchandise to the Panningona family. The Panningonas had taken care of him when he first arrived in the area and provided him with suitable fur and skin clothing. Chamberlain's trading post was one of the last Alaskan Beaufort Sea posts to shut down after fox fur prices declined in the 1930's. According to the TLUI (1980), this caused Kaktovik residents to either move or start trading at Herschel Island or Aklavik, Canada.

**Historic Structures**

- Flaxman Island

Leffingwell's Camp

1. House. Built by Samuel Panningona in 1923,

this wood-frame house originally stood on sod foundation No. 2. The house has an exterior measurement of 14' x 20' and a projecting entryway. A large iron tank from a ship, probably used for storage, is found near the entrance. Samuel's daughter, Mary, and her husband, Roy Akootchook, presently use the house.

2. House foundation. This was the original site of structure 1. A partially standing framework at one end served as Samuel Panningona's workshop. Two iron tanks from a ship, used for storage, are beside the house. The two rooms were each approximately 20' x 14'.

3. Cache and drying rack. Four broken posts mark the site of a cache and seal skin drying rack built by Panningona.

4. House foundation. The sod foundation of Leffingwell's house, built sometime between 1907 and 1914, indicates a dwelling with two rooms, 24' x 24'. A small building, in good condition, of tongue-and-groove lumber stands at the end of the house. It was used by Panningona as a storehouse. Twelve posts off the end of the house probably represent another structure. These buildings were built from the wood of a shipwreck.

5. Sundial. The concrete supports for Leffingwell's sundial have been moved. The block holding the metal dial has been broken and tipped over, and the dial is missing.

6. Sod foundation. This house was built around 1940 by Harland Okomailak, Samuel Panningona's brother. The corner posts indicate this house had an interior measurement of 13' x 12' with an entryway to the west.

7. Plank floor. This was made by Samuel Panningona for an 8' x 12' wall tent and is in good condition.

8. Wood rack. Samuel Panningona built this to store and dry driftwood.

East Point

1. Sod house ruin. The corner posts indicate an interior measurement of 8' x 8' with an 8' passage leading to an outside, south facing entryway.

2. Sod house ruin. The room measured 8' x 14' with a 6' south facing passage leading outside. A piece of saw-cut whale bone lies beside one corner of the house, and sod quarries are visible at the back and on the east side.

3. Sod house ruin. The inside was probably about 8' x 12' with a short, south facing passage leading to either another 6' x 8' room or an outside entry.

4. Broken posts. Five posts outline a structure which was probably a cache and drying rack. A bed of decaying wood chips covers part of the area.

5. Sod ruin. This is either the entrance to an ice cellar or the remains of a small house with an interior measurement of 4' x 5'.

6. Sod ruin. This is similar to structure 5.

- Brownlow Point

1. Sod house ruin. Possibly built by Enoch Tegutaaq, this house has an interior measurement of 16' x 12' and an entryway clearly visible to the west.

2. Wood-frame house with metal roof. Originally Leffingwell's house on Flaxman Island, this structure was disassembled and moved to Brownlow Point by Henry Chamberlain sometime in the 1930's. Josephine Itta believes the house is smaller than it was originally. The house measures 16' x 16' and was used as a warehouse until Chamberlain left the area in 1943. He gave all his buildings to the Samuel Panningonas, which today fall inside the allotment of Mary and ~~Roy~~ Isaac Akootchook, Samuel's daughter and son-in-law.

3. Wood and sod house. Built by Henry Chamberlain in the 1920's, this house has three rooms. The main living room has an interior measurement of 8' x 14' and has an inside wall of upright timbers. A layer of sod blocks and an outside wall of planks, propped up by poles, holds the layer of sod blocks in place. Next to this room was Chamberlain's storeroom with 272 sq. ft. of floor space. The floor is wood, and the walls consist of rectangular boards made from gas can boxes. The third room was used to house the dogs and had milled lumber walls which have collapsed. It measured 12' x 14'.

4. Sod house. With walls of upright split driftwood timbers, this house has an interior measurement 8.5' x 9'. The lack of sod insulation clearly reveals the internal structure, making this one of the best examples of historic house interiors on this part of the coast. This house may have belonged to the Agniin or Oyagak families.

5. Sod foundation. Clearly outlined, the interior of this structure was 16' x 16'.

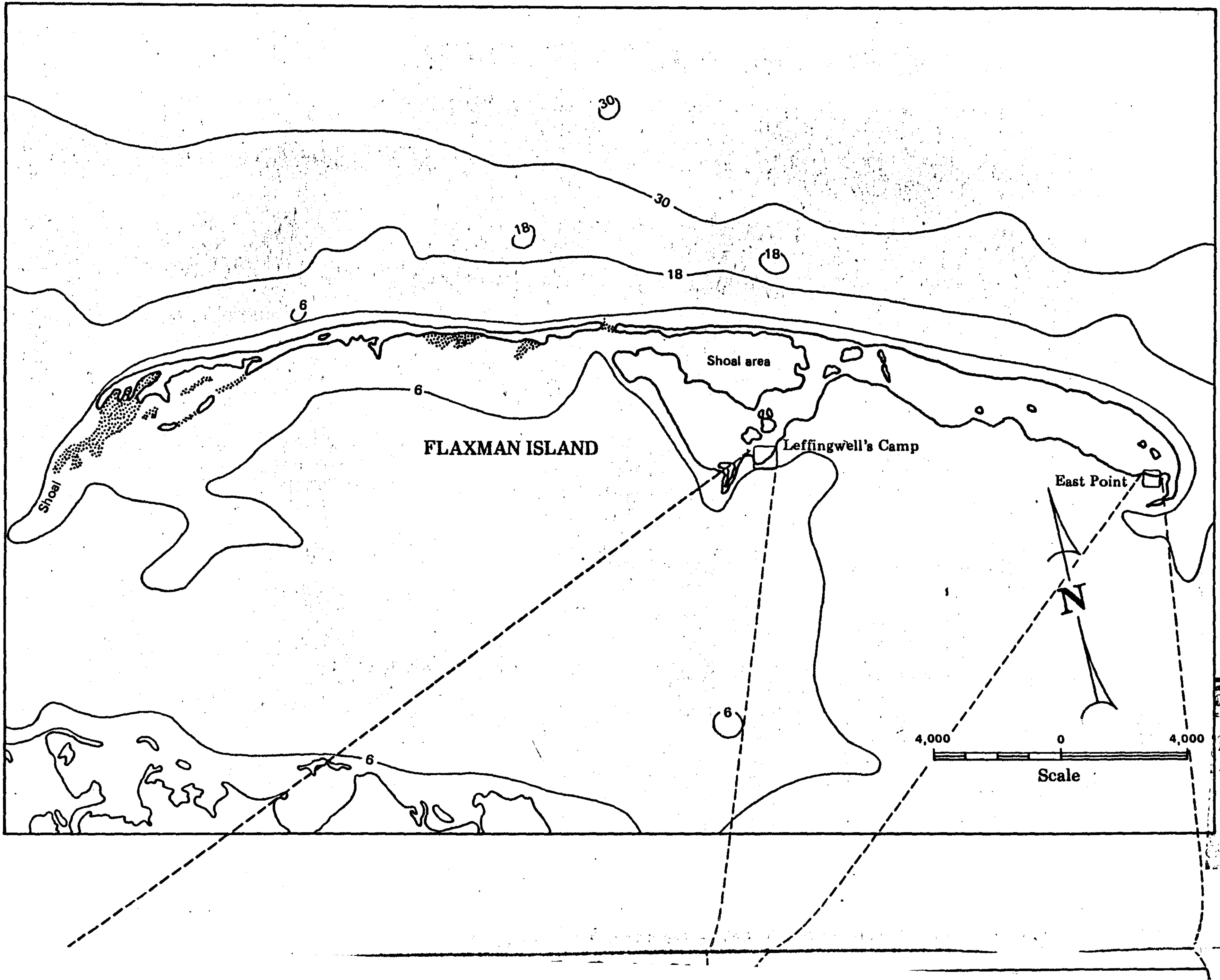
6. Sod foundation. The location of upright post remains makes it difficult to interpret the shape and size of this structure.

7. Sod foundation. The remaining posts indicate the room was about 12' x 14'. Two ice cellar ruins lie nearby.

The graveyard on the west side of the point has several wooden grave markers cut in the shape of tombstones and enclosed by a picket fence. Two graves outside of the fence also have similar markers. One is identified by carving on a fallen post; four graves have not yet been identified. One grave is eroding out of the tundra.

## Artifacts

The historic artifacts at Flaxman Island and Brownlow Point are too numerous to describe, but those found at Brownlow Point include: A bilaterally barbed bone harpoon point, a skin scraper, trade beads, and a clay pipe stem.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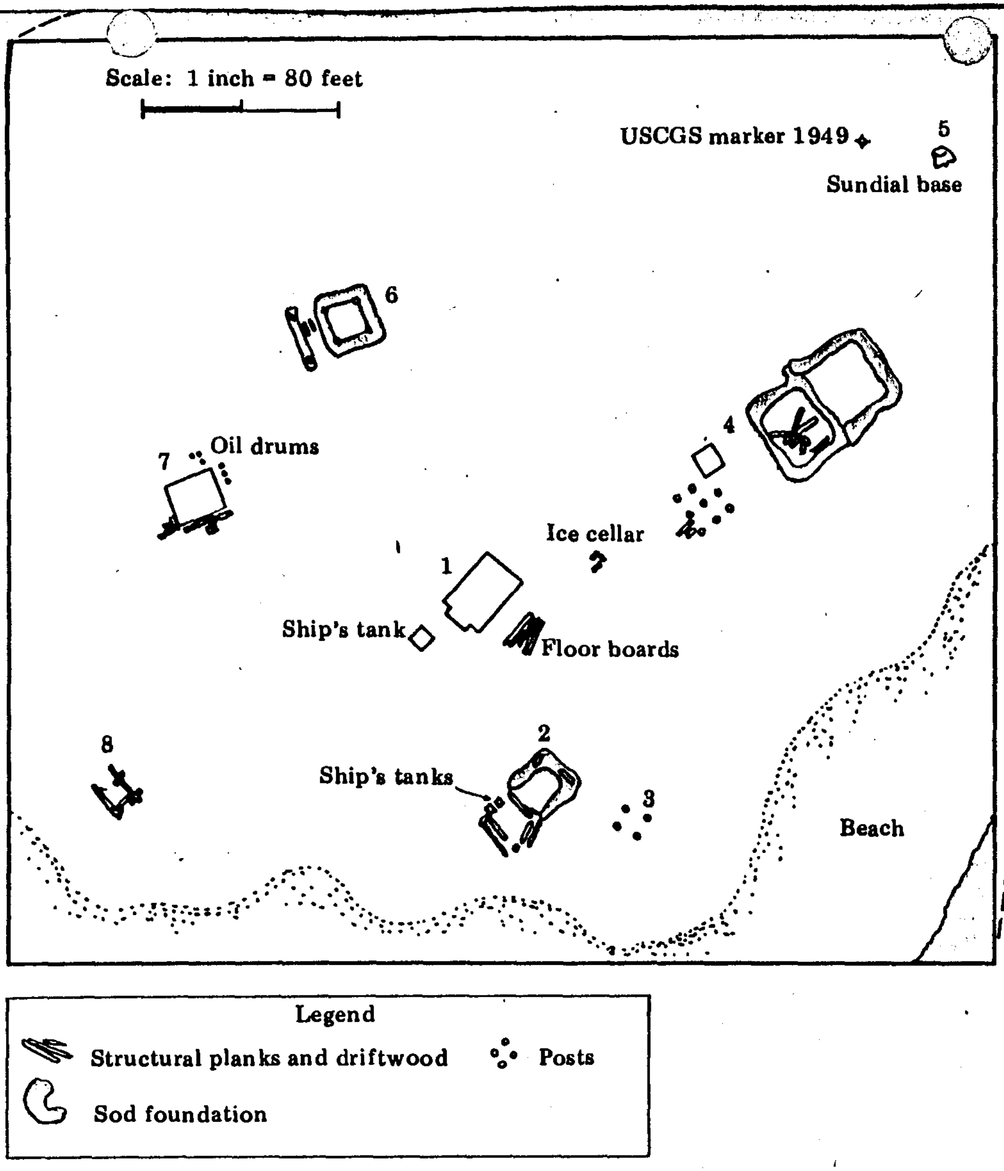
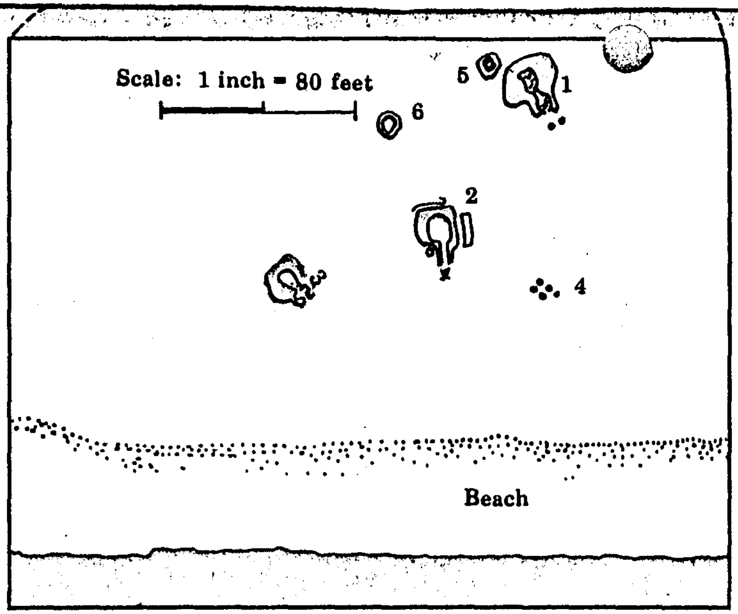




### East Point

1. Sod house ruin.
2. Sod house ruin.
3. Sod house ruin.
4. Broken posts of unknown use.
5. Sod ruin, possibly ice cellar.
6. Sod ruin, possibly ice celler.

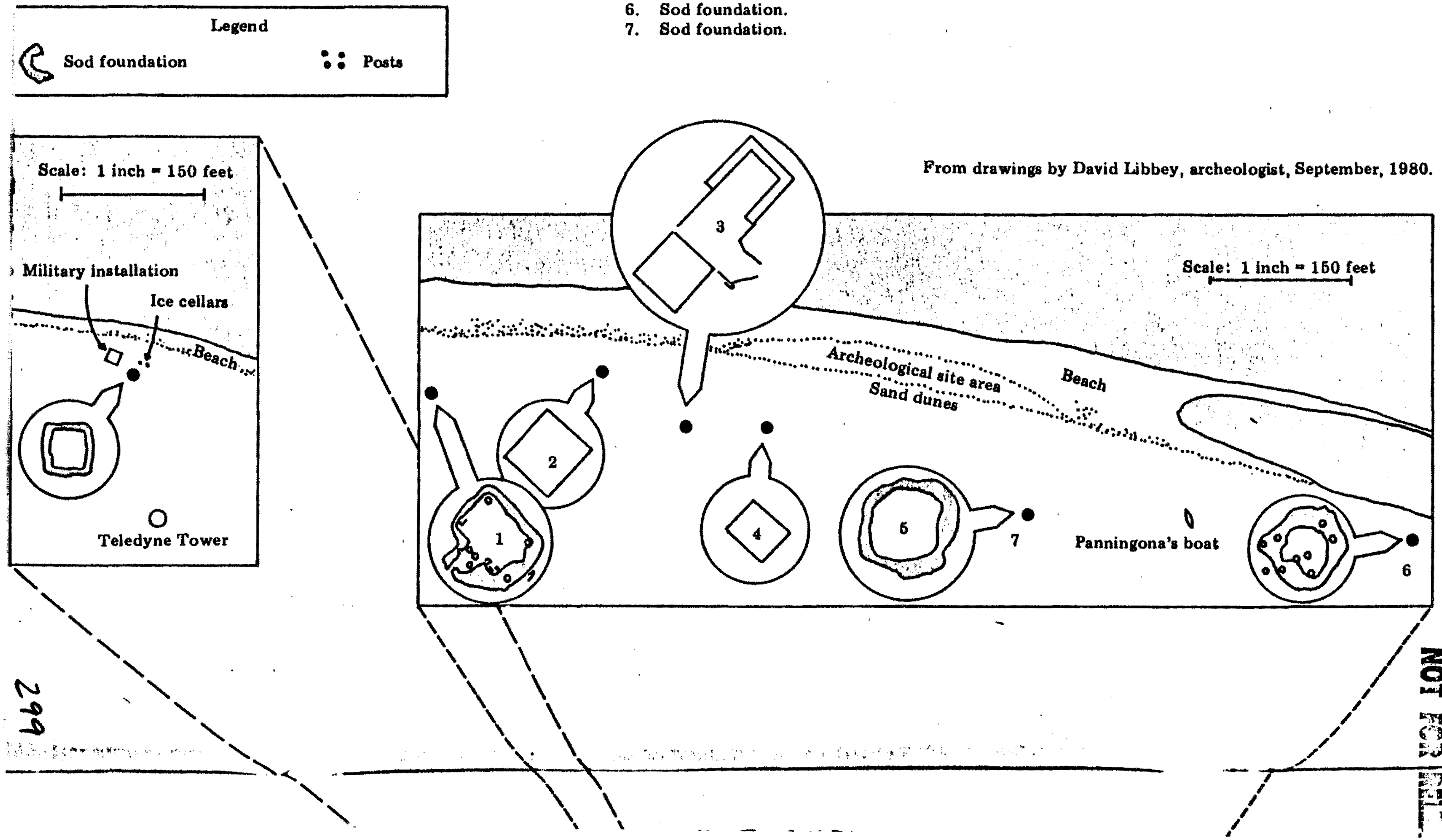
### Leffingwell's Camp

1. Wood frame house. Built by Samuel Panningona in 1923. Now owned and used by his daughter Mary Akootchook.
2. Original site of 1. Sod foundation and part of workshop remains.
3. Cache and drying rack ruin. Built by Panningona.
4. House foundation, small wood structure, and piling. Remains of Leffingwell's house, 1907-1914.
5. Concrete sundial base left by Leffingwell and USCGS marker.
6. House foundation. Remains of house built by Harland Okomailak around 1940.
7. Wood floor for 8'x12' tent built by Panningona.
8. Woodrack to dry and store driftwood. Built by Panningona.

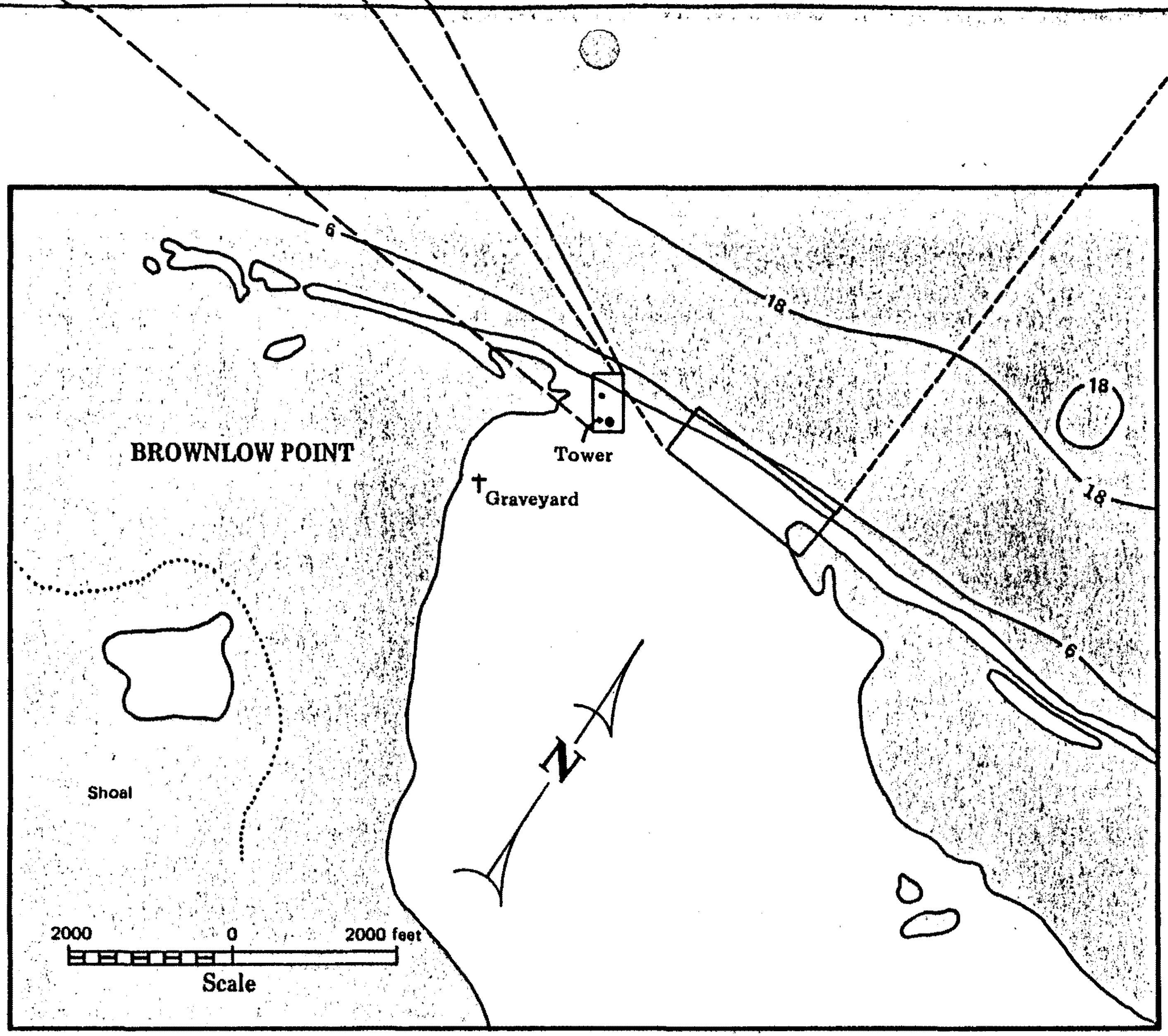
From drawings by David Libbey, archeologist, September 1980.

**Structures**

1. House foundation.
2. Wood frame house with metal roof. Originally part of Leffingwell's house on Flaxman Island. Rebuilt on Brownlow Point by trader Henry Chamberlain in the 1920s or 1930s.
3. Wood and sod house. Built by Chamberlain in the 1920s.
4. Framework for sod house. Built by Agñiiñ or Oyagak family.
5. Sod foundation.
6. Sod foundation.
7. Sod foundation.



From drawings by David Libbey, archeologist, September, 1980.



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Harold Kaveolook, Inupiat teacher at Kaktovik for eighteen years, describes this final village move this way:

> ...That fall the village had to move to the new site and all 16 houses were moved by the first part of September...(1964) The village had to be moved. It was unhealthy to some of our people. Some of the crude houses of the families did not have foundations and were sitting on the ground and when the spring thaw came, at least three houses would be flooded and filled with water on the floors. We worked with John Melville, who was the sanitation supervisor working with the village Health Aides, and there was no finer man than John to work with. He made the move easier for us. It was good to see the village sitting on its own townsite. No threat of moving the village occurred anymore. For years the camp had spread all kinds or rumors that they will move the village somewhere and this caused unrest among the village people. That was one of the reasons to obtain a townsite for the village as a priority, but the most important reason was that the thawing made the original site unhealthy for our people. It was really the happy moment of the village to obtain its own townsite (Kaveolook 1977:15).

A new cemetery is located just to the southeast of the village, on the village townsite. At least four unmarked graves are located here, including the grave of Fred Gordon, who died in March 1977. The three marked graves are:

Forrest Linn (youngest son of
Born December 1, 1961 Alfred Linn Sr. and Ruby Okpik
Died September 7, 1974 Linn)

Dorothy Panipak Gordon
Born Sept. 16, 1909
Died February 1, 1973

Riley Tikluk
Born May 29, 1935
Died October 17, 1976

Village sources: Harold Kaveolook, Flossie Lampe, Alice Faith Tikluk

## PIPSUK - PIPSUK POINT

TLUI Site

Location: Northeast part of Barter Island, on the point across from the airport and just southeast of the present village site.

Meaning: Named after Pipsuk, grandson of Tigutaaq, a former longtime resident of this area (Hopson 1977)

Pipsuk's grave is located here. According to one legend, Pipsuk drowned here in the lagoon while fishing from a qayaq. His body was fished with a seining net, hence the name Qaaktugvik (Kaktovik), which means "seining place".

Pipsuk reportedly worked for the surveyor Leffingwell, and was the grandson of Tigutaaq, who used to live both in this area and in the Canning River delta area. Tigutaaq was the husband of Mary S. Akootchook's mother's sister, Julie Nasugilook.

He was on the crew of the trading boat Hazel in 1933, when the botanist Isobel Hutchison made her trip from Pt. Barrow to Martin Point (Hutchison 1937: 139).

Pipsuk's grave is marked with an old wooden cross, the horizontal part of which bore the capital letters: PIPSUK. However, part of this cross has been broken off so that only the SUK remains.

A long time ago, around 1940, two Kaktovik girls dug up Pipsuk's grave. (They were about twelve years old at the time). Working during the summer night of 24 hour daylight, after their parents were asleep, it took them three nights to get it dug up. When they finally got the lid open, they saw what looked like a lady with very long hair and with beads around her neck. They were so scared that they immediately closed the lid and recovered the coffin with sod.

Village sources: Mary S. Akootchook, Perry Akootchook, Anonymous

## QIKIQTAQ - MANNING POINT - "Drum Island"

TLUI Site

Location: Just east of Barter Island, between Kaktovik Lagoon and Jago Lagoon.

Meaning: Big Island

This is a heavily used spring and summer camping area. Its main use is for migratory bird hunting from mid-May to mid-June. Caribou are also hunted from here in late spring and summer. People camp both on the point and on the mainland opposite.

One summer in the late 1940's, Qikiqtaq was used to herd a large group of caribou into the water where they could be killed from waiting boats. Some women and children were standing on "Drum Island" as the men drove the caribou onto it from the mainland. At one point the herd was coming right at the women. One woman took off her jacket and swung it round and round over her head, which luckily caused the caribou to veer off into the water.

Village sources: Georgianna Tikluk, Archie Brower, Mary Ann Warden

## TAPKAK - Bernard Spit

TLUI Site

Location: Bernard Spit is actually a barrier island just northeast of Barter Island.

Meaning: Spit

The Andrew and Susie Akootchook family had a house on the western part of Bernard Spit, due north of what is now the Barter Island landing strip. They lived here off and on between the mid 1920's and the mid 1940's. Their daughter Elizabeth Akootchook Frantz was born here on October 22, 1929.

Village sources: Mildred Sikatuak Rexford, Perry Akootchook

# TIGUTAAQ

TLUI Site

Location: Canning River delta, by the Tamayariak River where it joins the Canning.

Meaning: Tigutaaq was a well-known man who had a house at this site.

House ruins belonging to Tigutaaq and others are at this site. A grave marker is also at this site or nearby.

Tigutaaq lived both in this area and in the Barter Island area. He lived and trapped at Barter Island in the early part of this century, before it became a settlement. He was the husband of Julie Nasugiluuk, Mary S. Akootchook's mother's sister. His grandson, Pipsuk, is associated with one legend of how Kaktovik got its name (See Pipsuk Point).

Tigutaaq was on the crew of Gus Masik's trading boat Hazel when the botanist Isobel Hutchison made her trip from Barrow to Martin Pt. in 1933. When they reached Flaxman Island, he remained there and his grown son took over until they got to Martin Pt. Hutchison refers to him as "Old Tigutaak", and Mary S. Akootchook has verified that he was already an old man in the 1920's, when she was small. (Hutchinson, 1937)

Village source: Mary S. Akootchook.

## KAYUTAK

TLUI Site

Location: On the coast near the Canning (Kuugruaq) River delta, and about 2 or 3 miles west of Kanigniivik.

Meaning: Kayutak is the name of the family who lived here.

An old house ruin is here, and old utensils, etc. have been found. The house belonged to Paul and Mae Suapak Kayutak, parents of Annie Soplu of Kaktovik.

Other indicators of this site are a large log half-buried in the sand, and several large rocks. According to village people, this is the only place along the Alaskan Beaufort coast where one must be careful of rocks when travelling in a boat. Kaktovik people hve questioned whether there may not be another Boulder Patch in this area.

Village sources: Danny Gordon, Herman Rexford, Mary Sims, Johnny Anderson, Olive Gordon Anderson.

## KANIGNIIVIK – KONGANEVIK PT.

TLUI Site

Location: East of the Canning (Kuugruaq) River delta, on the west side of Camden Bay. Cabins were located both on the tip of the point itself, and on the mainland near the small spit and lake, directly south-southeast of the point.

Meaning: "reindeer pond" (Orth, 1967) Long ago, Eskimos were driven to this point by the Indians so the Indians could starve them and kill them all. But the Eskimos hunted seal and fish and lived, while the Indians watched at the narrow part of the point. The Eskimos lived, and the Indians had to leave when they ran out of food.

U.S. Census 1939: 24 people.

The area is know for its caribou hunting, both in the past and presently. In the old days, people would catch caribou here in the summer by driving them out on the point, blocking the path between the caribou and the mainland. Now, <u>Kanigniivik</u> is one of Kaktovik's most important caribou hunting areas, in both summer and winter. In ~~the past two years~~ 1978 and 1979, Kaktovik people ~~are known to have~~ hunted here during ~~the months of~~ November and January as well as July, August, September. ~~and November - i.e. not just during ice-free months.~~

The cabin by the small lake on the mainland belonged to Richmond and Annie Ologak and their family. Richmond's brother Paul Patkotak also lived here.

Richmond and Annie's daughter Pearl had a son, Adam Pingo, who died and is buried here. Pearl now lives at Tuktoyaktuk, N.W.T., Canada.

Charlie Kupak used to have a house near <u>Kanigniivik</u>. His two children are buried here: one was named Benjamin Silamiok. Charlie went off to Canada, where he died.

<u>Village sources</u>: Ruby Okpik Linn, Maggis Linn, Tommy O. Gordon, Danny Gordon, Wilson Soplu, Archie Brower.

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# KATAKTURAK

TLUI Site

Location: On the west side of the Katakturak River, about six miles due south from the coast.

Meaning: Named after the Katakturak River; "Kataktu" means "you can see a long way".

This is where the moviemaker Charlie Kimrod is buried. Kimrod, a moviemaker for Captain Louis Lane, was in Alaska helping to make the first white man's picture of walrus. He had been on a Brooks Range sheep hunting trip with Henry Chamberlain (see TLUI Mid Beaufort Site Brownlow Pt.) and Captain Larson. They were returning to the coast by dog team, when they hit a storm and Kimrod froze to death. Larson assumed that Kimrod was lost and died out on the ocean. But two reindeer herders, Apayauk and Wilson, discovered the body here at this spot and buried it here. Levi Griest, now of Barrow, thinks the government should mark this grave and put it on the record (North Slope Borough, ~~1979~~ 1980).

<u>Village sources</u>: Levi Griest (Barrow), Archie Brower

# NUVUGAQ - POINT COLLINSON ("POW D")

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TLUI Site

Location: The point and spit in Camden Bay, just east of Simpson Cove and west of Marsh Creek.

Meaning: Nuvugaq means a point of land which juts out into the ocean, such as the one here.

Point Collinson was named for Captain Richard Collinson of the H.M.S Enterprise who explored along the north coast of Alaska in 1851 and in 1853-54. (Orth 1967: 231.)

Nuvugaq, an old village site, is now an important campsite and waterfowl hunting area for Kaktovik residents. The explorer Ejner Mikkelson found numerous abandoned Eskimo houses here in 1908, and felt it must have been a pretty large village at one time (Neilson, 1977a: 38).

George Agiak, whose family used to have a house at Nuvugaq in he 1920's stated that he remembers seeing an old house at this site that belonged to Captain Roald Amundsen.

Nuvugaq was also tried as a site for a trading post, but was apparently never a successful one. Stefannson, in his book My Life With the Eskimo, describes visiting the trader E.B. "Duffy" O'Connor here in May of 1912. O'Connor had come here from Nome with his store of trade goods the summer before, but had not had a successful trading year. According to Stefansson, the country was not rich in foxes, and besides, the explorer Leffingwell already had a trading establishment at Flaxman Island, only sixty miles to the west. Stefansson came here and put up a store for Captain C.T. Pederson. It was located across, "on the other side" from where the old DEW line facility is. Jack Smith dynamited out a hole for the house. However, he apparently did not remain too long at this location, returning instead to his post at Foggy Island (Mid Beaufort Site 12).

During 1913-14, two ships of the Canadian Expedition wintered here. In the spring of 1914, the expedition consumed about 20 ptarmigan daily for two or three months. Most of these ptarmigan were secured within 15 miles of their camp (Leffingwell 1919: 65).

George Agiak's family and the Ologak family both lived at ~~Nuvueq~~ Nuvugaq off and on during the 1920's. Agiak's mother Tuuluk and Richmond Ologak were brother and sister, and their mother Eve Kignak also lived with them here at this site.

Levi Griest and his family (Kunagraks) moved here in late 1924 and built an iglu. Levi lived here off and on until 1935. They also had some ice cellars here. Levi thinks there are still some remains of their house at this site, and when interviewed in March, 1979, he wanted to get a "skidoo" so he could go inspect it (North Slope Borough ~~1979~~ 1980).

The Air Force DEW Line Station know as "POW D" was built here in the 1950's and some Kaktovik people worked here. However, now all the military buildings are abandoned.

Nuvugaq continues to be an important campsite for waterfowl hunting, especially in May and early June. Several of the Kaktovik families go there for a few days to a week or more, and hunt seals and ugruk as well as brant, pintails, and oldsquaws. The site is used later in the summer for fishing, and at various times throughout the year for caribou hunting. Arctic fox are trapped here during winter months.

Village sources: George Agiak, Wilson Soplu, Levi Griest, Mildred Sikatuak Rexford, Jane Akootchook Thompson.

## KUNAGRAK

TLUI Site

Location: Camden Bay, at the mouth of Marsh Creek, on the east side. For exact location, see the spot marked "cabin" on the U.S.G.S. map, Mt. Michelson (D-2) quadrangle, Scale 1:63,360.

Meaning: "Kunagrak" is the name of the family that lived here.

John Kunagrak built a large ice house here, and used it for a trapping cabin for quite awhile. His son Levi in Barrow ~~had~~ has told Wilson Soplu of Kaktovik that ~~he~~ (John) used to store all his tools, including his siklaq (ice pick) and shovel, down inside this ice house, and leave them there while he was gone. Alfred Linn Sr. of Kaktovik also lived here for a year, and trapped foxes. There are no graves at this site, as far as Wilson Soplu knows.

About two miles ~~to the~~ east of this site is ~~Iqalukirak~~ Iqalugliurak Creek, an especially good one for fishing. ~~(Iqaluk means fish), (this creek is called Carter on the U.S.G.S. map, but Wilson had never heard of this English name).~~ (On the USGS map as "Carter Creek," this English name was unfamiliar to Kaktovik resource people) The word Iqaluk means fish, and Iqalugliurak means "little river with lots of fish".

Iqalugliurak
~~Iqalukirak~~ Creek is especially good for fishing during the month of June. Arctic char (iqalukpik) and arctic cisco (qaaktaq) are caught around here.

Village sources: Wilson Soplu, Mary S. Akootchook.

## AANALLAQ - ANDERSON POINT

TLUI Site

Location: Anderson Pt. itself is just to the east of Camden Bay, between the Bay and the mouth of the Sadlerochit River. However, the place referred to as Aanallaq extends from Anderson Pt. to about two miles southwest of Anderson Pt., to the spot marked "Koganak" on the USGS map.

Meaning: "At the head of the bay".

The Ologak family, now of Kaktovik, lived and herded reindeer here for many years. Their daughter Masak (Evelyn Gordon) was born here on June 9, 1925. The family had a house near the spit marked "Koganak" on the USGS map, on the east side of the small lake (see Mt. Michelson A-1 Quad, Scale 1:63.360). Kunagrak, Patoktak, and Annik ~~Anyik~~ and their families also had cabins here on the west side of the lake and herded reindeer.

This area was an especially good one for keeping reindeer because the land here is high - almost like a low hill - which made it relatively easy to see the deer and keep track of them. Every spring, Ologaks would take their reindeer herd from here up the Sadlerochit River to the mountain valley behind

Sadlerochit Springs, for calving. Then when summer came, they would return here with the calves.

Qaggualuk (Levi Griest), son of John Kunagruk, first lived here with his family during 1924. He found many sheep on the Hulahula, so they had enough provisions for the winter. He also had a trapline that started here and went inland west of the Kadleroshilik River. The ocean area around Aanallaq was very good for catching seal. It was not good for setting up a fish net in winter. But it did have tomcod (uugaq) which could be pulled out right at the edge of the icebergs. That summer Qaggualuk and his family caught some 500 molting brant (nilingat) along towards the Canning River and hauled them to Aanallaq for the winter. (~~Griest interview, 1979;~~ North Slope Borough, 1980; Okakok, 1981: 607).

Fred Klerekoper and Roy Ahmaogak visited Ologaks here at Aanallaq on April 15, 1937, and again on April 22 on their return journey to Barrow. They had coffee here, and Ologak told Klerekoper that there were sheep in the mountains. (Klerekoper, 1937)

Phillip Tikluk of Kaktovik remembers living at ~~Aanllaq~~ Aanallaq when he was about six years old (1943). He was the son of Ellis Tikluk and of Ologak's daughter Faith who died when he was very young. One of his memories is of his grandfather Richmond Ologak erecting a long pole here at Aanallaq, which he used as a lookout tower for spotting caribou. Ologak saw the big piece of driftwood floating by in the ocean, went out with his new rowboat, tied a rope around it and towed it to shore. Then he dug a big hole in the dirt, "just like you would for a grave," and put it in. This pole is still here.

Paul ~~Patoktak~~ Patkotak's son Brian was born at Aanallaq while the family was living here. Patkotak was a brother of Richmond Ologak.

Several graves are located at Aanallaq. Adam Alisuarak, grandfather and great-grandfather to many Kaktovik residents, died here about 1923 or 1924 while he was living with is daughter Tuuluk and her husband Annik (see above). He is buried somewhere along the little river flowing into the small lake where the families lived. Other people buried in the area of Aanallaq are Paul Patkotak's daughter Mary, Charlie Kupak's daughter Rosie, and Alice Napageak's daughter.

Now, Aanallaq is an important spring camping place and migratory waterfowl hunting area for Kaktovik people. A common practice is to make a base camp at Aanallaq in late May - in 1978 tents were set up at the spot marked "Koganak" on the USGS map - and then make overnight trips to the mountains to hunt squirrel and marmot.

The hills near Aanallaq are said to be excellent for picking berries. Annie Ologak, who died in 1980, was very knowledgeable about this.

Village sources: Mildred Sikatuak Rexford, Mary Sirak Akootchook, Wilson Soplu, Levi Griest, Goerge Patkotak, Ruby Linn, Alfred Linn Sr., Phillip Tikluk.

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## SADLEROCHIT SPRINGS

TLUI Site

Location: Near the Sadlerochit River where the mountains begin, at the 1000 foot contour line.

Meaning: "Away from the mountains" or "area beyond the mountains".

In the 1920s and 1930s, Kaktovik people brought reindeer herds to the Sadlerochit Springs area each spring for calving. Arriving in March, the first calves were usually born in April. In June the herd was taken back to the coast.

Sadlerochit Springs is an important snow season camping area. In the spring, it is not unusual for 30-40 village people to be camped here together.

Grayling (sulukpaugak) are in the creek here which flows into the Sadlerochit. One woman has fished for them from a rubber boat, and her husband has set short nets for them.

## SANNIQSAALUK

TLUI Site

Location: On the east side of the mouth of Kajutakrok Creek, between the Sadlerochit and Hulahula Rivers. For exact location, see the spot marked "cabin" on the USGS map, Flaxman Island (A-1), Scale 1:63,360.

Meaning: "The place where there are cabins built of logs all running in the same direction".

Phillip Tikluk Sr. of Kaktovik was born here in a tent on January 25, 1937 when it was "really blowing" outside. He is the son of Ellis Tikluk and of Ologaks' daughter, Faith, who both died when he was very young.

The remains of one of the log cabins here were visible to the author on May 21, 1978, when she made a snowmachine trip along this part of the coast.

<u>Sanniqsaaluk</u> is presently used as a camping area and as a base for caribou hunting: in spring of 1977, two Kaktovik families stayed here in a tent and hunted caribou nearby. Another got one caribou here in July ~~1980.~~ 1981.

Village sources: Daniel Akootchook, George Akootchook, Philip Tikluk, Mildred Sikatuak Rexford.

## PATKOTAK

TLUI Site

Location: At the mouth of Nataroaruk Creek, between the Sadlerochit and Hulahula Rivers.

Meaning: Patkotak was a brother of Richmond Ologak, Susie Akootchook, and Tuuluk, all direct ancestors of present-day Kaktovik residents, and this site is named after him.

This is one of the places where Paul Patkotak and his family had a house.

Village sources: Isaac Akootchook

## SIVUGAQ

TLUI Site

Location: On the Hulahula River, about ten miles from the coast.

Meaning: Long, high bluff area.

Sivugaq is where the main trail from Barter Island joins the Hulahula River. The bluffs here are a landmark and resting place on trips to and from the mountains, as they provide some wind protection. They are also a favorite sliding area for children. Unidentified ruins are at this site (Hopson as cited in Nielson 1977).

## FIRST FISH HOLE

TLUI Site

Location: About twenty miles inland on the Hulahula River.

Meaning: This site is known by the English name, First Fish Hole.

This is one of Kaktovik's most popular fall, winter and spring fishing areas, and an important traditional stopover and camping place on trips to the mountains. People fish here for whitefish (iqalukpik) and grayling (sulukpaugaq); fishing for whitefish is especially good here in the fall. The site is also good for "pike" (paigluk), a fish species that has not been positively identified.

No old ruins exist at this site but people now living in Kaktovik have been using it since the 1920's.

Aroung 1940, in April, the Presbyterian minister Fred Klerekoper came by airplane from Barrow to Barter Island. Finding no one there, he followed the Hulahula River inland. He found the Kaktovik people all camped at <u>First Fish Hole</u>, and landed his plane. ~~there~~. Klereloper served holy communion inside a tent. It was so cold the grape juice froze in the glasses before the people had a chance to drink it.

<u>Village sources</u>: Danny Gordon, Mildred Rexford, Archie Brower, Olive Anderson, Perry Akootchook.

## SECOND FISH HOLE

TLUI Site

Location: About forty miles inland on the Hulahula River, just south of the mouthes of Old Woman and Old Man Creeks.

Meaning: This site is known by the English name, Second Fish Hole.

This is one of Kaktovik's most popular fall, winter and spring camping and fishing areas. In some years, many, many whitefish (iqalukpik) may be caught here, as well as grayling (sulukpaugaq). Some families leave a tent up all winter at this location, from October through April. They may spend several weeks at a time here, using it as a base camp for hunting caribou, sheep, and small game. It is not uncommon for 30 or more people to be camped here at one time.

In the 1920's and 1930's, Fred and Dorothy Panikpak Gordon and Tom and Agiak Gordon would bring their entire families here in the spring, by dog team: a two day trip from Barter Island. They would stay until the river started breaking up. The return trip to Kaktovik was often difficult due to lots of water and so little snow: everybody including children had to help pull the sled.

Thomas Napageak's mother Ikiakpuk used to walk from Sadlerochit Springs to Second Fish Hole in one day and go fishing, all with a baby on her back.

Village sources: Danny Gordon, Olive Anderson, Wilson Soplu, Tommy Uinniq Gordon.

## KATAK - THIRD FISH HOLE

TLUI Site

Location: Inland on the upper reaches of the Hulahula River, a few miles south of Kolotuk Creek.

Meaning: "To fall down, or fall off"

The remains of a house belonging to Fred Gordon are located here. He was the father and grandfather of many Kaktovik people, and used to take his entire family here. It is an important present day fishing spot and camping place and serves as a base for sheep and caribou hunting. Lack of sufficient snow cover or too much river overflow sometimes prevents people from reaching this site.

Village sources: Betty Brower, Archie Brower

## KANICH

TLUI Site

Location: At the headwaters of the Hulahula River.

Meaning: "sources of the river"

This is Kaktovik's main winter base camp for sheep hunting. The Agiak family lived here off and on during the winter for several years, beginning in the late 1930's. (North Slope Borough, 1980: 96) The river branch to the right is an important source of firewood.

Village sources: Archie Brower, Betty Brower, Nora Agiak.

## UPILLAM PAANA

TLUI Site

Location: At the Okpilak River delta, just to the east of the Hulahula River delta.

Meaning: "Mouth of the river, without willows".

The whaler, Ned Arey, and his family had a house around here. The explorer Ernest de Koven Leffingwell talks of visiting here in May 1907 right before he, Ned, and Ned's son Edward Gallagher explored the Okpilak River up as far as the west fork. They returned to the coast on July 11, and ~~Leffinfwell~~ Leffingwell was here with the Areys until August 1 (Leffingwell 1919). For more information on the Areys, see "History and Residence Chronology: Tommy Uunniq Gordon".

The Hopson family used to live here, and this is probably where they were living when Olive Gordon Anderson and her mother Agiak Gordon used to visit them. Olive remembers spending the night at Hopson's with her mother, and using a sleeping bag which her feet stuck out of. Eben Hopson would tease her, telling her that the mice were going to come eat her feet in the night.

Village sources: Olive Gordon Anderson, Archie Brower

## NAALAGIAGVIK - AREY ISLAND

TLUI Site 19

Location: In the middle of Arey Island, about 5 miles west of Barter Island.

Meaning: ~~Naalaiagvik~~ Naalagiagvik means "where you go to listen". Arey Island is named after the commercial whaler and explorer Ned Arey, grandfather of Annie Soplu of Kaktovik.

Arey Island is a prehistoric and historic village site. In 1914, the ethnologist Diamond Jenness of the Canadian Expedition was employed in examining this site, and he thought there may have been 30 or 40 old house ruins here (Leffingwell, ~~p. 67)~~ 1919: 67). Several old sod and log structural remains were visible at this site during an inspection made by the author in August, 1978.

The Akootchook family sometimes lived on Arey Island. Isaac Akootchook was born here on March 31, 1922, and Roy Akootchook on January 7, 1926. The family had a reindeer herd from 1922 until 1936, and they often kept them at this site.

Agiak Gordon, wife of Scottish trader Tom Gordon, used to go here to hunt and trap and to look for artifacts. The story goes that she used to be able to communicate with the birds. She would tell a bird in the Inupiaq language that she wanted to be shown where the artifacts were. The bird would answer back by alighting on the place, calling out and flapping its wing. Then she would go to that place and start digging, and sure enough she would find artifacts.

Now, Naalagiagvik is a key migratory bird hunting camp in late May and early June. It is also a traditional seal hunting camp in spring and summer. Fish nets are set around the island in July and August, and arctic char (iqalukpik), arctic cisco (qaaktaq) and pink salmon (amaqtuq) may be taken.

Village sources: Olive Gordon Anderson, Isaac Akootchook, Jane Akootchook Thompson, Tommy Uinniq Gordon, Mildred Sikatuak Rexford, Georgianna Tikluk.

## IGLUKPALUK

TLUI Site

Location: Iglukpaluk ~~Igulkpaluk~~ is on the western end of the northern coast of Barter Island. On the USGS map as "Elupak (Site)" it is mislocated on both the USGS map and the original TLUI map. It is not at the base of the spit as shown, but is actually about a half mile to the

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east, on the coast which faces north. It is on the last high point of land before the land slopes downward to the lakes and the spit.

Meaning: "A big house seen from far away". The site is named for Scottish trader Tom Gordon's big white house, which was built at this location in 1923.

In April of 1918 Hudson Stuck and his party visited Stefannson's base camp at Barter Island, but it is unknown whether this camp was right at the ~~Iglupaluk~~ Iglukpaluk site or farther to the east. It was an extensive building, half underground. Stuck did not meet Stefannson, who was away at the time. "We were hospitably received by Captain Hadley, who was in charge, with two other white men and several Eskimo women and children and a great deal of stuff. The schooner Polar Bear, belonging to the expedition, lay in the ice." (Stuck, ~~p 304).~~ 1920:304)

Tom Gordon established his trading post here in 1923, and his family began living here. They gradually (over a period of years) moved the trade goods from Demarcation Bay to here at ~~Iglupaluk.~~ Iglukpaluk (North Slope Borough, 1980:134) (~~See Tommy Uinniq Gordon, History and Residence Chronology)~~ ~~Kaveolook states:~~ Former Kaktovik schoolteacher Harold Kaveolook describes this in his History of Kaktovik and its Schools:

> ...Tom Gordon built a trading post with the help of his Eskimo crew and settled down on Barter Island. There were a few families that settled near Gordon's trading post about a mile to 12 miles around the island, but the place was never a village...the people would congregate at Gordon's trading post from the vicinity on occasions such as the Fourth of July or Christmas and disperse to their homes after the celebration.

> Their livelihood was hunting, trapping and fishing...(Kaveolook 1977: 2).

Levi Griest, now of Barrow, may have been one of the first Inupiat to visit the new trading post. He made a trip here to get flour the year it opened, in 1923. (North Slope Borough, 1980: 140)

In the early years of the post, Indians would occasionally visit. But the visits were sometimes surreptitious. One time Tom's wife, Agiak Gordon, got an order to make a pair of sealskin and caribou hide mukluks. When they were finished, she took them out on the tundra and left them for the Indian to pick up. Sure enough, the next day they had been taken. Another time, an Indian stole a parka from the trading post. But he brought it back because it was too small!

Isobel Hutchison, in her book North to the Rime-Ringed Sun, provides a glimpse of what life was like at Iglukpaluk in 1933. First, she tells about passing by Iglukpaluk in September of that year:

> ...The west wind allowed us to hoist all sail, and leaving Flaxman at 7 am we came past Barter Island...about midday, and saw on the shore the trading post of Mr. Tom Gordon, the veteran Scottish whaler and trader (since 1933 a naturalized American subject). His house from this distance, white with a black roof, exactly resembled some Hebridean farm-house. Tom Gordon has spent nearly fifty years in Arctic Alaska, married a native wife, and reared a large family of strapping half-breed sons and daughters to continue the Clan Gordon in this remote part of the

> world. When I visited him later for a couple of days at his hospitable invitation, I found Mr. Gordon still hale and hearty, surrounded by is children and grandchildren, though the problem of feeding so many mouths was no easy one, and were it not for the introduction of the reindeer...it would be well-nigh impossible in a bad hunting year...(Hutchison 1937:148).

Then, on October 25, 1933, Charlie Gordon took Isobel from Martin Pt. to <u>Iglukpaluk</u> in his dogsled, for a two day visit. Here is her description:

> ...A short distance farther on we reached the trading post of Tom Gordon - a white frame building not unlike a Scottish croft - and were greeted by Mr. Gordon, a tall grizzled Scotsman still in his early sixties, and a crowd of sons, daughters, and grandchildren - most of them bearing well known Highland names, and looking for all the world like dark-eyed sons of Harris or Skye. Their mother was dead, but Mr. Gordon had married another native wife, a kindly little woman who was an expert needlewoman, and during the couple of day which my visit lasted she was engaged in dressing reindeer skins to make a new parka for her husband.
>
> Mr. Gordon entertained me very hospitably, though apologizing for the lack of meat. Stores were at a low ebb, but the reindeer herd owned by his sons was expected at any moment from the hills, and indeed arrived on the morning of my departure, though I did not see it. The lack of meat was made up for by beans, stewed raisins and prunes, and toasted bread - the women

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made huge batches of bread daily and were expert bakers.

Though I only intended to remain one night, a blizzard arose on the day following my visit and detained us till the next morning, and the time was passed in the room occupied by Mr. Gordon and his wife, next door to the capacious kitchen which housed the rest of the family - Mr. Gordon pacing to and fro as if he were still on the deck of his ship, waving a constant cigarette and describing to me some of the adventures of his youth when he too, like my host of Martin Point, had run away from home to follow the sea, and never returned.

Mr. Gordon has five sons (a sixth was unfortunately drowned close to Barter Island while boating in 1932), Mickie, Charlie, Fred (always known as Spike), Alec and Donald, and three daughters, Nora (married), Jean, and little Olive, an engaging child of nine, the youngest of the family. The elder sons were also married, with families of their own. Mickie lived some miles to the eastward, not far from Demarcation Point, but as he was on a visit to Barter Island I met him there. As there was no school nearer than Barrow, 400 miles distant, the education of the children was a problem and in spite of her intelligent appearance, little Olive could not yet read or write...(Ibid; pp.166-168).

~~Note~~: (Hutchison made two mistakes in her descriptions of the Gordon family, quoted above. The native wife that she refers to (Agiak Gordon) was actually the mother of all the Gordon children except Mickey and Dan, who drowned. And

Olive was almost eleven years old at the time of the visit, rather than nine years old)

The Gordon family used to have a reindeer herd here at Iglukpaluk. Joe Arey worked for them as their herder. Hutchison describes him taking the deer from Iglukpaluk to Martin Pt. in late October, and selling one to Gus. The reindeer skins for her parka and leggings made by Mrs. ~~Aeey~~ Arey also came from this herd.

The Presbyterian Elder Niniuk and his family used to come to Iglukpaluk from their home in the mountains every October, after a snowcover made dog team travel possible. Olive Gordon (Anderson) used to look forward to this visit because Niniuk's children Jonas Ningeok and Mamie Matumeak always brought her spruce gum, which she used for chewing gum. Jonas Ningeok now lives in Kaktovik, and Mamie visits often from Barrow.

Gordons used to have a very large ice cellar at this site. Here they would put up fish, especially arctic cisco (qaaktaq) which they caught ~~frm~~ from the spit. These would be stacked in long rows, in layers. Now, the only ~~visibly~~ visible remains at Iglukpaluk is an old ice cellar. Most of the area was plowed over and the physical appearance altered at the time of DEW line construction.

Tom Gordon's big white house was moved several times and divided in half. Now both houses are still in use at Kaktovik's present townsite: one as a residence and the other as the village store.

Now, Iglukpaluk is a very popular summer fishing area. Whitefish (iqalukpik), arctic cisco (qaaktaq) and flounder (~~natagnaq~~ nataagnaq) are taken by hook and line and in nets.

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Village sources: Olive Gordon Anderson, Mildred Sikatuak Rexford, Tommy Uinniq Gordon, Herman Aishanna, ~~Nora~~ Nora Agiak

## TIKLUK - AKOOTCHOOK HOUSE SITE

TLUI Site

Location: Southwestern part of Barter Island.

~~Meaning:~~

This site was the first place on Barter Island where the Andrew Akootchook family lived. They built a house here about 1919-1920, and spent about two years here before moving to Arey Island. Fenton Tigalook, Andrew Akootchook's older brother, also lived here with his wife Elsie Iqarina and children Vern, Ellis and ~~Priscilla~~ Prisilla. Ukumailak's family's house is also here. According to Kaktovik resident Wilson Soplu:

> "They stayed here for quite awhile. The houses that they lived in...look like little hills now. The woods that they put up have fallen down. Some (ruins) have been eroded away. I believe it's Tigluk's family's house. Their house was on the west side and it has eroded. But the houses that are not too far are still there and they are still noticeable. Akootchook's house, who has always lived here, is becoming unnoticeable because of the white men." (North Slope Borough 1980:194).

# QAAKTUGVIK - KAKTOVIK (first location)

TLUI Site 15

Note: The North Slope Borough's publication Kaktovik, Alaska: An Overview of Relocations (Nielson, ~~Jon~~ 1977) includes a detailed map of Kaktovik's various locations.

Location: Northeast part of Barter Island, on the spit just where the airport hangar and runway are now located.

Meaning: Kaktovik means "seining place".

This is a prehistoric village site. In 1914 Diamond Jenness of the Canadian expedition counted between 30 and 40 old house sites on the spit running east from Barter Island (Leffingwell, 1919). Former Kaktovik schoolteacher Harold Kaveolook also documents this in his History of Kaktovik and its Schools:

> ...There had been a large village at one time many years back which had been abandoned. Only the ruins are there. The people of that village were whalers because there were whale bones: heads, jaw bones, vertebrates, vertebrate discs, ribs, and shoulder blades among the ruins. The Akootchook family used to tell us that from the old village site the vertebrate discs were placed on the beach all the way from the village to the edge of the shore as steps for a walkway. The story goes that the people were driven from their village to the Canadian side by

> our people through fighting. To this day the people from Canada and Greenland confirmed this by telling the people the same things, i.e. that they were driven east by the Alaskan Eskimo (Kaveolook, ~~pp. 1-2)~~ 1977: 1-2)

This was the location of Kaktovik until 1947 when the U.S. Air Force decided to build an airport on this site and the village had to move. Present-day Kaktovik people built houses here in the 1930's and early 1940's and possibly earlier. Herman and Mildred Rexford built their house here in 1940, in the middle of where the airport runway is now. Georgianna Tikluk, daughter of Fred and Dorothy Panikpak Gordon, was born "right under the airport hangar" on March 15, 1946.

The North Slope Borough's publication Kaktovik, Alaska: An Overview of Relocations provides the following information on the forced move from this site:

> In July 1947...The U.S. Air Force began a large scale build-up of material and construction of a 5000 foot airstrip and hangar facility on the once isolated island. These marked the first stages of the DEW Line construction....
>
> The Air Force began the support phase of its Kaktovik base with the constructon of an airstrip which paralleled the beach and followed a long spit of land sheltering Kaktovik lagoon. For the Inupiat residents of Kaktovik, the decision of the Air Force to begin construction at this location (Nelsaluk) had drastic and irrevocable consequences, for the engineers had selected

> their old village site for their runway and hangar facilities. The Air Force abruptly informed the stunned residents that they would have to move immediately, presumable under authority of PLO 82 of 1943 which had withdrawn lands in connection with the prosecution of the war. No specific military withdrawal had been made. Bulldozers hauled the dozen sod and driftwood structures and several frame buildings 1,650 yards up the beach to the Northwest where the village was to be relocated. Needless to say, this unexpected and previously unannounced dismantling of their village caused the Kaktovik people considerable grief, hardship and dismay.. Equipment and some operators were provided by the Air Force but most of the labor came from the village. Inevitably, there was destruction and personal loss, and many ice-cellars (used for food storage) were buried or abandoned. However, it was almost impossible for the villagers to effectively protest the move because very few spoke any English or understood what was happening, or why. Moreover, there were children as old as 14 who had never seen a white man until the arrival Air Force (Nielson 1977:3-4).

Mildred ~~Siktauk~~ Sikatuak Rexford has stated that they moved their house from this site in 1947, after the white people (taniks) came. She remembers that the first military ship came on August 10, 1947. Mildred's two younger brothers George and Daniel, who were age 15 and 14 at the time, would hide every time these taniks came around, as this was the first time they'd ever seen strange white people.

Many artifacts and small items from the old village site are buried under the airport hangar and the gravel runway.

Village sources: Mildred Sikatuak Rexford, Georgianna Tikluk

QAAKTUGVIK
~~OAATUGVIK~~ -KAKTOVIK (second location)

TLUI Site

Note: The North Slope Borough's publication, Kaktovik, Alaska: An Overview of Relocations (Nielson, ~~Jon M.~~ 1977) includes a detailed map of Kaktovik's various locations.

Location: Northeast part of Barter Island, on the north coast where the spit joins the main part of the Island.

Meaning: Kaktovik means "seining place".

The Akootchook family's house, and what is now referred to as the "old" cemetery, were at this site before there was any village here. The Akootchooks were living here in October 1933 when the Scottish botanist Isobel Hutchison visited them. Hutchison writes: "At this house of Andrew (Tom Gordon's brother-in-law, a native licensed by the Presbyterian Church at Barrow as a preacher, and a faithful adherent of that church) we stopped for a cup of hot tea, and made the acquaintance of his wife and family. The house was the usual Eskimo dwelling of driftwood, but contained a sewing machine beside the stove and bunks, and the walls were decorated with pictures and texts." (Hutchison, ~~p. 166).~~ 1937: 166)

Fred Klerekoper and Roy Ahmaogak also visited Akootchooks here, in April 1937. They spent the night on their return trip to Barrow, after going to Demarcation Point. Klereloper's diary, which includes a picture of Andrew Akootchook, states:

> We come to Akootchook's home. There is a polar bear cub in the house. To enter this place, you go through a snow entrance into a snow hallway. Many entrances lead from it. Here are Kayaks, pieces of sheet iron, and room of dogs. Inside are ten children and a polar bear cub. Andrew has just been elected president of the reindeer company. He is the father of 13 children. Behind the house is a cemetery (Klereloper, ~~p. 10):~~ 1937:10)

Andrew's oldest son Perry Akootchook, who was eighteen years old at the time of this visit, had accidentally caught the polar bear cub in a trap the previous month. He remembers that the pet cub was playful just like a puppy dog, biting at one's hand but not hurting it. The family took the bear to Barrow by boat in July, and Perry doesn't know what happened to it. By this time it weighed 400 pounds.

The village of Kaktovik was moved to this site by the Air Force, in 1947. (See Kaktovik, first location). When Harold Kaveolook came to teach at Barter Island in August, 1951, there were about eight houses and eight families living at this site, with 86 adults and children. Then in the spring of 1952 and the spring of 1953, several families moved back to Barter Island from Herschel Island, Canada, swelling the population to 140-145. (Kaveolook, 1977)

The North Slope Borough publication: Kaktovik, Alaska: An Overview of Relocations, states:

> The new village site was along a slowly eroding section of beach and in the landing pattern of the airfield. Houses were rebuilt and new cellars dug and, fortunately, the village cemetery, located on the plateau behind the new site was not then in danger and left undisturbed.
>
> The village was relocated again in 1953 because of changes in the DEW Line layout and new road construction. This move was accomplished in the same manner as the previous one, with the new site located further to the west and a little further back from the beach. This site was near where the main installation is now located and within a quarter-mile of the old cemetery (Nielson, ~~and NSB Planning Dept.~~ 1977b:4-5).

(Note: The 1953 relocation was so close to the 1947 relocation, that they are considered the same site.)

Other than the cemetery, an old ice ~~celler~~ cellar is virtually the only remains that can be seen at this old village site. However the area has been used so much by the DEW Line installation for storing equipment and supplies, etc., that it can't be expected that much in the way of village evidence could remain here.

The cemetery is located on Air Force DEW Line property, and is pretty much surrounded by the DEW Line installation and paraphenalia. There are 12 unmarked graves here, and the following marked ones:

| | |
|---|---|
| Leffingwell Nipik<br>Born December 23, 1908<br>Died July 9, 1929 | (very old, worn sign, barely readable; this may have been the son of Olokomayuk) |
| John Apayauk<br>born August 20, 1935<br>Died April 3, 1954 | (Grandson of the famed whaler of Barrow, Apayauk) |
| Edward T. Akootchook<br>Born April 8, ~~1957~~ 1953<br>Died January 3, 1954 | (son of Isaac and Mary S. Akootchook). |
| Candace M. Brower<br>Born October 31, 1957<br>Died August 29, 1958 | (daughter of Archie and Betty Brower) |
| Leonard Gordon<br>Born December 3, 1956<br>Died July 31, 1959 | (son of Danny and Ethel Gordon) |

Village sources: Flossie Lampe, Nora Agiak, harold Kaveolook, Perry Akootchook

## TAPQAURAQ - MARTIN POINT and TAPKAURAK SPIT

TLUI Site

Location: The area referred to as Tapqauraq is just to the east of the Jago River delta, about 10 miles east of Barter Island. Tapkaurak Spit extends from Martin pt. southeast almost to Griffin Pt. Ruins are on the point across from Taqkaurak Entrance, and on the widest portion of the spit.

Meaning: Tapqauraq means "little narrow spit".

U.S. Census 1939: 18 people.

The small island (denoted by the word "ruins" on USGS maps) in Tapqauraq Lagoon just east of Martin Point is the site of (the late) Dan Gordon's old house. He was one of the sons of Tom and Agiak Gordon and brother and uncle to many Kaktovik residents (Hopson as cited in Nielson 1977). This island has been a good location for finding waterfowl and gull eggs. The water in this area is too shallow for boating except quite close to the island.

When Kaktovik people talk about Tapqauraq today, they are generally referring to the house ruins on the Tapqauraq Spit (Map ___)

On Tapqauraq Spit are the ruins of a cabin that belonged to the trader Gus Masik, and a driftwood and sod house that was the home of Bruce and Jenny Nukaparuk. Much insight into the life at Tapqauraq Spit in the 1930's is given in Isobel Hutchinson's book North to the Rime-Ringed Sun. Hutchinson spent six weeks here at Tapqauraq in the fall of 1933. As a guest at the trader Gus Masik's cabin, she was able to observe first-hand the lives and comings and goings of the Inupiat in the region. Her recorded observations about these ancestors of present day Kaktovik residents reinforce their own oral accounts of their lifestyles during the 1930's. Several of these observations will be quoted and described here. (As well as under other site headings).

Hutchinson arrived at Martin Pt. on September 15, 1933, via Gus Masik's schooner Hazel. She describes her arrival this way:

> About sixteen miles from Barter Island we rounded a long narrow sandspit surrounded on all sides by the sea, and entered a lagoon about a mile wide, which divided the spit from the mainland. About 2 p.m. we anchored off the flat sandy shore, on which stood the ruins of an old native house, one little Eskimo hut made of driftwood, and the quaint "round house" of wood, turf, and canvas (built by himself) which was Gus's trading post (Hutchinson 1937:149).

Hutchinson describes how they were greeted by a chorus of dogs and by Bruce Nukaparuk, who lived next to Gus in the driftwood hut just mentioned. Nukaparuk (or Nokipigak) was very glad to see them because his wife and four children were on a visit to Barter Island and he had been alone for some time (Ibid, 149).

Jenny, Bruce's Nukaparak's wife, was a sister of Mrs. Charlie Gordon, Tom

Gordon's daughter-in-law (Ibid,: 157). Hutchison painted a picture of Nukaparuk's cabin at Martin Pt. The painting and a photograph of Bruce Nukaparuk, are included in her book. (Ibid: 152, 168)

The Presbyterian Elder Niniuk, who worked on the Hazel, and Gus Masik are also in this photograph. A few days after they all arrived at Martin Pt., Niniuk returned to his home which was a few miles to the east: "On the 19th of September the sea outside our lagoon was already so much frozen that Gus and Bruce had great difficulty in pushing the boat out through the ice with the motor, to try to hunt seal for dog-feed, and finding no seal, returned home early. The lagoon was still ice-free, however, and Gus took old Niniuk across it by boat, leaving him on the mainland to walk some miles down the coast to the eastward where his home was." (Ibid: 156).

Hutchinson states that Gus Masik's house on Tapqauraq Spit was built of logs and "warmly banked with turf...it consisted of a single room lighted by two skylights, and was approached by a canvas-covered entry and storehouse with wooden compartments for the four dogs." (Ibid: 151-152) There is a photograph of Gus standing beside his house and dog team on page 148 of Hutchinson's book.

Gus Masik was of Estonian origin.

> He had been a member of the Canadian Arctic Expedition under Vilhjalmur Stefanson, and in 1918 had been second in command of a party of five who drifted for 184 days on the ice of the Beaufort Sea to discover its movement. He was also probably the most travelled 'dog musher' north of the Arctic Circle, having covered in that region in Alaska more than 25,000 miles with dogs...(Note: Hutchison is obviously talking about white dog mushers only)...He was almost equally familiar with the coast of Arctic Siberia from East Cape to Kolyma river. Though now a naturalized American citizen, Russian and Estonian were the languages he had spoken in his boyhood...(Ibid: 140).

Hutchinson describes Inupiat people visiting at Martin Pt. during her stay:

> On the 10th of October we were surprised by the sudden barking of the dogs just as we had finished breakfast, and when Gus ran out, he found a team from Barter Island with a native called George (son-in-law of Tom Gordon)...(Note: This is George Agiak)... who had managed at considerable risk to cross to us from the west. He had tea and spent a few dollars in trade (though the usual mode of exchange was by fox skins, these were scarce in 1933).
>
> This was the first of several trading visits from natives, which continued throughout the rest of my time at the cabin. Our second visitor arrived on the 14th of the month - a stout jolly Eskimo by the name of Homer...(Note: This is Homer Mekiana now of Anaktuvak Pass)...accompanied by a friend, both from Barter Island. There were scarcely seated when another native arrived from the east. This was Joe Arey, reindeer herder to Mr. Tom Gordon's family. His mother was the widow of a well-known white whaler, Ned Arey. She was a clever seamstress (like most Eskimo women) and Gus had already sent a message to her by Paul...(Note: This is Paul Kayutak)...asking her to sew fur

> clothing which I would require before setting out on my sled journey for the east.....(Ibid: 162).

Hutchinson later visited Mrs. Arey at *Pukak* to have her fur clothing fitted (see *Pukak*). Mrs. Arey received some articles from Gus's trading post as part-payment in kind for the parka. These included white woolen undergarments, three-cornered needles for sewing skins, calico material, and tobacco. (Ibid: 164).

On the 30th of October, *Tapqauraq* had more visitors, this time from the mountains:

> All the next day the wind blew a blizzard again, but on the 30th of October it cleared and two young lads arrived from the mountains with mountain sheep meat to sell. Gus bought a carcass for twelve dollars, as I was very anxious to taste the meat, which is quite good and not unlike home mutton, though coarser...
>
> ....The two lads who brought the meat were intelligent fellows, and were much interested in my pictures of Greenland and in an Eskimo book which I had with me (Mr. George Binney's *Eskimo Book of Knowledge*), sitting pouring over its pictures for nearly an hour. They were also able to tell me a little of conditions farther east, and of the Anglican mission at Shingle Pt., which I would pass in my journey from Herschel to Aklavik...(Ibid: 168).

Then on November 1, Paul Kayutak's two sons (one of these was Jonas) stopped by on their way from Barter Island to "their home not far from Demarcation." (Their home was at *Pinuqsraluk*) They came in for a meal and to warm up, and were going to spend the night at Mrs. Arey's house at *Pukak*. (Ibid: 169).

In addition to these observations concerning the people of the region, Hutchinson had some remarks about the natural phenomena she observed at *Tapqauraq*. She tells about a "blizzard of great violence" which hit on the 18th and 19th of October and left a large pressure ridge: "The north side of our sandspit island presented an astonishing spectacle, being piled with great square blocks of ice - the "pressure ridge" of ocean ice - which was crushed up to a height of twenty feet or more all along the outside of the spit". (Ibid, : 164-165).

She points out how it is Canada's river, the "Mother Mackenzie", that provides the driftwood which supports human life all along the Alaskan Beaufort seacoast - for Native and trader alike. She gives examples of the many different uses to which this driftwood is put - not only for Gus Masik's heating, but for his house and furniture: "Without the Mackenzie, indeed, life is these regions would be impossible" she states. (Ibid,: 170).

Tommy Uinniq Gordon is very familiar with the area of *Tapqauraq*, and refers to Gus Masik's place as *Tapqauraq*. When he was a boy, he and his family lived in Gus's house here for one year, while Gus was away.

Fred Klereloper, in his published diary, also mentions stopping here at Gus Masik's place on April 21, 1937.

Village sources: Tommy Uinniq Gordon, Frances Lampe, Archie K. Brower

## UQSRUQTALIK -GRIFFIN POINT

TLUI Site

Location: On the east side of Oruktalik Lagoon, between the Jago and Aichilik Rivers, about 20 miles east of Barter Island.

Meaning: "Place where there is oil on top of the ground."

Uqsruqtalik is one of Kaktovik's main and most popular summer camps. It is the site of an old village, which was in existence in 1918 when Hudson Stuck and his party stopped here. Stuck mentions stopping briefly at this village and shaking hands, before travelling on to Annun for the night.

John Olsen's trading post was originally here at Uqsruqtalik. He was a Norwegian trapper who later became a good friend of Tommy Uinniq Gordon's. He had also been a partner with Gus Masik on several expeditions (Hutchinson 1937).

Isobel Hutchinson visited Olsen here on October 17, 1933, on her way back from visiting Mrs. Arey at Pukak. She was served coffee, and canned peaches and cheese from his store. Near the end of October, Olsen came to Tapqauraq and accompanied Hutchinson and Charlie Gordon to Iglukpaluk. (Ibid, 1937)

Hutchinson also mentions that John Olsen was planning to take his dog team to the hills when the trapping season began on the 15th of November.

Sometime between 1933 and 1937, Olsen moved his post over to Imaignauraq. This was about when Fred Gordon, son of Tom and Agiak Gordon, started living at Uqsruqtalik full time. Before this, Fred had used Uqsruqtalik for a fish camp. He used to walk to Barter Island in the summer, to buy flour and other supplies. Fred got his house at Uqsruqtalik from Irving Singatuk, who had moved to Pukak. Fred lived at Uqsruqtalik with his wife Dorothy Panikpak for many years and they raised their family here. Two of their children were born here: Frances Lampe on April 15, 1940 and Thomas K. Gordon on September 27, 1943. Fred and Dorothy continued to return to their house here into the 1970's, even though they moved to Barter Island in the mid-1940's. Dorothy children and grandchildren and other Kaktovik people go to Uqsruqtalik during July and August. They camp across the lagoon from Fred and Dorothy's house. Their stays may last for up to two months, returning to Kaktovik only long enough to get mail, etc. Some permanent tent frames have been built out of lumber and driftwood, so only the canvas needs to be put up and taken down each summer. In addition, Fred and Dorothy's house is still used as a shelter cabin.

At Uqsruqtalik, people fish for whitefish (iqalukpik) and arctic cisco (qaaktaq), and hunt seal, ugruk, caribou, and brown bear. Occasionally, a polar bear may be taken. The area south of Uqsruqtalik, around the Niguanak River, Niguanak Hills, and Jago River is an important caribou and squirrel hunting area. The word Niguanak means "place where one waits for some animals to come".

Village sources: Georgianna Tikluk, Frances Lampe, Danny Gordon, Tommy Uinniq

# PUKAK

TLUI Site

Location: Pukak is the area around Pokok Lagoon and Pokok Creek (the latter are USGS map spellings), on the coast a few miles to the east of Uqsruqtalik or Griffin Pt. The site Pukak should not be confused with Pokok Bay on the USGS maps, which is farther east; it is actually Humphrey Bay.

Meaning: Pukak was the name of a village once located on the east end of Pukak Lagoon.

This present day spring and summer camp used by Kaktovik people is near the site of an historic, and perhaps prehistoric, Eskimo village. "The Eskimo name 'Pokang' is shown in this area on John Simpson's native map, 1853, as the farthest point seen by the Point Barrow natives" (Orth, 1967).

Irving and Martha Singatuk and family used to live at Pukak. (Their daughter Hope is the wife of Alec Gordon of Inuvik, N.W.T., the brother and uncle of Kaktovik residents. Their son Leffingwell lives at the Bar 1 DEWLine Site in Canada).

The Areys also used to live at Pukak. Mrs. Arey, or Ekayauk, came down to her house here from her tent in the mountains so she could make a reindeer skin parka for Isobel Hutchinson. Hutchinson visited here twice in late October to have the parka fitted, and Martha Singatuk helped make the parka hood. Leffingwell Singatuk was off hunting in the mountains at the time. In addition to making the parka, Ekayauk gave Hutchinson a silver lemming skin, and "two brant geese for the pot"...The children also brought her "the body of a small brown bird (perhaps a 'kinglet') with a blood-red crest, found frozen by the door - a little explorer from Yukon forests evidently blown far out of its course by the blizzard, to perish in the frozen north. The natives said they had not seen such a bird before..." (Hutchinson, 1937:164).

Paul Kayutak and family moved here to Pukak from Pinuqsraluk in about 1934, and built a house. Kayutak's wife Mae Suakpuk was the daughter of Mrs. Ned Arey. Kayutak's daughter Annie Soplu lives in Kaktovik; their daughter, Teva Gordon, lives in Inuvik.

Now people travel to Pukak every spring to camp and hunt waterfowl. Eider ducks and snow geese are the main species taken. Parka squirrels and an occasional seal may also be hunted. Commonly, people may leave a tent set up at Pukak when they return to Barter Island by snowmachine in the late spring. Then they return to Pukak by boat in early July, after the ice has gone out. This is often a prime time for caribou, seal and ugruk hunting, as well as arctic char fishing. In the summertime, the caribou come out on the sandpits by Pukak, to escape the bugs. In late August, 1978, two beluga whales were taken at Pukak, and a whole school of them could be seen.

Village sources: Herman Aishanna, Danny Gordon, Tommy Uinniq Gordon, Annie Soplu.

## IMAIGNAURAK - HUMPHREY POINT

TLUI Site

Location: At the base of the small spit on the west side of what is labelled Pukak Bay, at the location marked "cabin" on the USGS map.

Meaning: "Place of new sod houses"

U.S. Census 1939: 24 people.

Two mistakes were made when the U.S. Coast and Geodetic Survey mapped this area about 1950. What appears on the map as "Pukak Bay" should actually be "Humphrey Bay". "Humphrey Point" is actually here at Imaignaurak rather than on the east side of the bay.

The trader Jack Smith spent the winter of 1923-24 here after successfully trying to go over to Canada to buy furs.

This is where John Olsen, a Norwegian trader, had his trading post after he moved it from Griffin Pt. In June after the ice broke up, Tommy Uinniq Gordon would fish with John at Pukak Bay and they'd put up the fish in the ice cellar at this site.

John ran a "business" of buying fish and seal from people, storing it, and then selling it back to them at the same price he paid them for it. He did this to help people out. For example, in the summer he would buy 5 gallons of seal blubber from Uinniq for $2.50, and fish for 5¢ a piece. Then Uinniq would buy it back in the winter, for the same price. Uinniq also sold and bought seal meat from him in the same manner. The only things John made money on were the white fox that he bought and sold, and the fish that he caught himself.

Fred Klerekoper and Roy Ahmaogak apparently visited this site in April 1937. Klerekoper mentions spending the night at John Olsen's trading post in his published diary. A picture of John Olsen with his fox skins and a polar bear hide, is on page 16 of the diary (Klerekoper 1937:11,16). The polar bear hide shown is probably from a bear shot by Tommy Uinniq. Uinniq used to sell his polar bear hides for about ten dollars a foot.

John Olsen died here of pneumonia in the fall of 1942. He had gone to Barrow that year and bought a boat, and died not too long after his return. He was probably around sixty years old when he died.

The Fred and Dorothy Gordon family have a long history of use of this site, and it is still a hunting, fishing, and stopover place for Kaktovik people. Emanunaruk is the name of the dry lake just south of this site.

Village sources: Levi Griest, Tommy Uinniq Gordon, Betty Brower, Archie Brower, Danny Gordon.

## IGLUGRUATCHIAT

TLUI Site

Location: On the coast between the Jago and Aichillik Rivers, on the point between Pukak (Humphrey) Bay and Annun Lagoon.

Meaning: This point of land, called the Inupiat, is incorrectly labelled "Humphrey Pt." on the USGS map. Humphrey Pt. is actually on the west side of Pukak (Humphrey) Bay. See notes for Imaignaurak.

Village sources: Betty Gordon Brower, Archie Brower.

## ANNUN

TLUI Site

Location: On the coast between the Jago and Aichilik Rivers, between Annun Lagoon and Beaufort Lagoon.

Meaning: Oil seep.

Hudson Stuck and his party stayed one night at the native village of Annun, in April 1918. Here is his description:

> Here were none but two old women and some children (the men had gone to Demarcation Point to traffic with the trader there), and they were most kind and helpful. They pulled off our fur boots for us, turned them inside out and hung them up to dry (an attention that is part of the hospitality at every genuine Eskimo dwelling, and almost corresponds to the water for washing the feet of the East); they helped to cook dog-feed and insisted on washing our dishes after supper. Then they sought our gear over to find if any mending were needed, and their needles and sinew thread were soon busy. Nothing could be more solicitous and motherly than the conduct of these two old women, and when I gave them each a little tin box of 100 compressed tea tablets, having first proved to them that one tablet could really make a good cup of tea, they were so pleased that they danced about the floor. (Stuck 1920:308)

Annun Point is best known to Kaktovik people as the site of an oil seepage, which they call pitch. The oil was formerly used as heating fuel, because all the wood around this site was wet. In the winter this "pitch" is brittle and can be chipped off; but in summer it is soft, some areas are like quicksand. In fact, caribou and birds have gotten caught in it, getting sucked in and never coming out again. Both Tommy Uinniq Gordon, who lived at Demarcation Bay, and Betty Gordon Brower, who lived at Griffin Pt., used to come and get this fuel to burn in their stoves. However, it was extremely sooty and had a strong odor. According to Uinniq, it would be impractical as a fuel source today because one would have to be constantly washing one's floor, and the outside of one's house would turn black. They used to be able to smell the smoke from this fuel ten miles away.

Annun Point had a shelter cabin where Tommy Uinniq would spend the second night on the three-day, sixty mile trip from Demarcation Bay to Barter Island.

Village sources: Tommy Uinniq Gordon, Betty Gordon Brower.

## NUVAGAPAK -Nuvagapak Point

TLUI Site

Location: This point was mislabelled on the USGS map as being at the VABM site and airport. Actually Nuvagapak is the larger point of land to the northwest, between the VABM site and Annun (Angun Pt.)

Meaning: Big point

Unidentified house ruins are at this site.

Village sources: Archie Brower

## ATCHILIK

TLUI Site 7

Location: On the west side of the delta of the Aichilik River, near the lake.

Meaning:

Old ruins are at this site, and it is a former and present camping and fishing area for Kaktovik residents. Some consider it the best river for grayling within their present land use area.

In November 1933, when Isobel Hutchinson was travelling by dog team with Gus Masik from Martin Pt. to Herschel Island, they stopped here at the "cluster of ruined houses". They spent the night here in a cabin which had been occupied by Gus Masik's former trading partner, Harry Knudson (Hutchinson 1937:174-175).

Village sources: Danny Gordon, George and Nora Agiak.

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# SIKU - ICY REEF

TLUI Site 6

Location: On the reef, near the delta of the western mouth of the Kongakut River.

Meaning: Siku means "ice".

This is an old and probably prehistoric village site. In August 1849, the explorer N.A. Hooper observed two boats and several huts here (Nielson 1977a:29).

The former commercial whaler, Ned Arey, was living here in his cabin with his family when Hudson Stuck and his party stopped for lunch in April 1918. He is the maternal grandfather of Annie Soplu of Kaktovik. Stuck provides a glimpse of the Arey's life here:

> ...A big pan of tender caribou meat was immediately set cooking in the oven and the table was soon spread with a fine meal to which we did full justice. After many years' whaling, Arey began prospecting for placer gold on the mountains behind this coast, and for ten years pursued his search from the Colville River to Barter Island without finding anything that he thought worthwhile. He now occupies himself with trapping and has a grown married son who is a mighty caribou hunter and trapper, besides a number of younger children, so that the establishment has something of a patriarchal air. We were told that his son's - Gallagher Arey's - catch of foxes was the largest of the whole coast, going well above one hundred.
>
> I found Arey a very modest, intelligent man full of information of the country and or recent explorations...I left Ned Arey with the feeling that he was entitled to his island, and glad that Mr. Leffingwell had given it to him...(Note: Stuck is referring to Arey Island) (Stuck 1920:).

Siku is the birthplace of Tommy Uinniq Gordon, son of Mickey and Rosie Piyuulak Gordon, and a present-day Kaktovik resident. He was born here in April 1921. The site still has a marker (which looks like a small telephone pole) and two old houses, including one that belonged to Uinniq's father Mickey. Uinniq used to camp here on the first night of the 3 day, 60 mile trip from Demarcation Bay to Barter Island.

Residents at Siku during the 1930's included Taktuk and his family, and Paul Kayutak and his family, who were living here in April 1937 when Fred Klerekoper and Roy Ahmaogak visited. A picture of these residents at Siku is in Klerekoper's diary, at the top of page 14. (The caption under the picture is incorrect; the captions on page 14 and 15 should be reversed.). Taktuk, the father of Neil Allen, now of Nuiqsut, is at the extreme left. Mae Titus, Neil Allen's sister, is third from left. She is the hunchbacked girl that Klerekoper refers to. She lived with Paul Kayutak and his family, and now lives in Anchorage. Paul Kayutak was the father of Annie Soplu, now of Kaktovik, and Teva Gordon, now of Inuvik, N.W.T.

The small delta of the Kongakut River just south of Siku is an important fishing area for whitefish (iqalukpik). Historically, the Kongakut River was one of the main travel routes into the mountains for hunting sheep, caribou, and small game, and for trapping and fishing.

Village sources: Tommy Uinniq Gordon

## PINUQSRALUK

TLUI Site 5

Location: On the coast just to the northwest of Demarcation Bay, on the west side of the large creek. Between "Pingokraluk Lagoon" and "Pingokraluk Pt." on the USGS map.

Meaning: Place where there are Pingos. Pina means mounds or sand dunes by the rivers and river deltas.

In 1929, Tommy Uinniq Gordon's father Mickey bought a house at Pinuqsraluk for $200, plus $50 for the things inside. He bought it from Joe Arey, son of the whaler Ned Arey. They lived there until 1933. The house was originally built by a white man named "Old Man Store". There is another old house at Pinuqsraluk that belonged to Ed Arey, the half brother of Joe Arey. He gave his house to Tommy Uinniq Gordon when he (Ed) moved to Herschel Island in 1941. Joe Arey's grave is located at Pinuqsraluk.

Putugook moved here from Kanigluaqpiat, in about 1931. Then about two years later he moved to Siku.

Isobel Hutchinson stopped at a group of cabins here in November, 1933, when the trader Gus Masik was taking her by dog team from Martin Pt. to Herschel Island. Among those living here were the Mickey Gordon family and the Kayutak family. (Mo Suakpuk Kayutak was a sister of Joe and Ed Arey). Hutchinson and Masik visited at Mickey Gordon's home.and family welcomed them (Mickey was at Barter Island visiting at the time). They offered them some of the reindeer stew that was simmering in a pot on the stove, but Hutchinson and Masik declined. Hutchinson wrote: "The laws of Eskimo hospitality give the stranger access to his house and larder even should there be scarcely enough to feed the host"s own family" (Hutchinson 1937:176).

Fred Klerekoper and Roy Ahmaogak stopped at Ed Arey's house at Pinuqsraluk twice in April 1937. On the trip east, a boy put a small seal on their sled for dog feed. On the trip west, Klerekoper baptized two of Ed's children (Klerekoper 1937:11,15)

The remains of several structures are still visible at Pinuqsrluk: three houses are still standing. Tommy Uinniq's house is the one that is leaning due to beach erosion.

A small graveyard is south of the houses. Although letters are barely visible on the woodern markers, the following names and dates could be made out:

Hit Arey Alonik,
Died Jan. 2, 1922;

Annie 1918;

Joe Arey
Died May 15, 1936
[Joe Arey starved to death in the mountains and was brought and buried here: Jacobson and Wentworth, 1981)]

Both the names Alonik and Annie are written with reverse n's. Lawrence Malegana is also buried here.

Village sources: Tommy Uinniq Gordon

## KUVLUURAQ

TLUI Site

Location: On the end of Icy Reef, on the spit on the west side of Demarcation Bay. Marked on the USGS map as "Kuluruak (Site)"

Meaning: "A small thumb located in the spit."

This was where Loren Apayauk had a house. He built the house in the summertime, and then went off to get some caribou. But when he came back, the spit the house was on had turned into an island and he couldn't even get to his house. So he built another one at Demarcation Bay West-Side. Apayuak was one of the reindeer herders present at Barter Island when Frank Daugherty, the Local Reindeer Superintendent from Barrow, visited there on April 17, 1937 (Bureau of Indian Affairs 1938).

Lawerence Malegana built a house here at Kuvluuraq because there was a good supply of wood here...he was tired of hauling wood so far to his mainland house (See Demarcation Bay - West Side). However, he died just before freeze-up and never did live in this new house. His grave is at Pinuqsraluk.

It is felt this may have been a poor site for a house because of the lack of freshwater.

Village sources: Tommy Uinniq Gordon

## DEMARCATION POINT - WEST SIDE

TLUI Site

Location: On the west side of Demarcation Bay, at the head of the Bay.

There may be a grave here, that of Loren Apayauk who used to live here. He built a house here after he was unable to reach his house at Kuvluuraq (see Kuvluuraq). He was one of the reindeer herders present at Barter Island when Frank Daugherty, the Local Reindeer Superintendent from Barrow, visited there on April 17, 1937 (Bureau of Indian Affairs 1938).

Paul Kayutak used to live at this site, and Lawrence Malegana had a house here. He had a wife and 4 or 5 children (including Johnny, Rebecca, Dorcas and Leah). He could read and write for local reindeer herders. He also would draw the different marks for reindeer ears that were used to show ownership.

Village sources: Tommy Uinniq Gordon, George Agiak

## OLD MAN STORE

TLUI Site

Location: On Demarction Bay, about 1.5 miles east of the mouth of the Turner River.

This is where Old Man Store's cabin was located. It was probably built in 1916 (Hopson 1977 as cited in Nielson 1977a). An acquaintance of Tommy Uinniq Gordon, Old Man Store was a white man who was never known by any other name. He used to feed Uinniq boiled caribou meat. He may have been a whaler from Herschel Island. He died at this location in 1928 or 1929. Sometime after he died, Uinniq cleaned up his ice house here and began using it as his own.

Village sources: Tommy Uinniq Gordon

## KANIGLUAPIAT

TLUI Site

Location: Demarcation Bay, by the small lake where Kagiluak Creek flows into the Bay.

Meaning: "The group of people way over at the farthest place" (i.e. over towards the Canadian border)

This is where Putugook lived, until about 1931. The creek near here is named for him on the USGS map. Putugook (his name means "Big Toe") was a fine trapper, he was especially good at getting wolves. He could howl like a wolf and knew how to attract them. He went to Barrow about 1943, and died the following year of influenza after a severe windstorm. His daughter, Alice Makalik (Putugook) used to live at Kaktovik and was well-known to Kaktovik people. She died in Fairbanks in the spring of 1979.

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# PATTAKTUQ - GORDON

TLUI Site

Location: On the east side of Demarcation Bay, at the base of the spit.

Meaning: *Pattaktuq* means "where the waves splash, hitting again and again." *Gordon* is named after the Scottish whaler and trader Tom Gordon, who established a trading post here in 1917.

U.S. Census 1939: 25 people

Tom Gordon established a trading post here in the summer of 1917, with the help of his brother-in-law Andrew Akootchook. They built a log house and warehouse, an outpost for the H. Liebes and Company of San Francisco. The Akootchook family lived here with the Gordon family for about a year before the Akootchooks moved to Barter Island.

Nora Agiak, daughter of Tom and Agiak Gordon, was about six years old when they first moved to Demarcation from Barrow. She remembers that between 1918 and 1922, Indians used to visit them here at Demarcation. They always used to talk about Ft. Yukon, but she's not sure if that's where they were from. Nora's family would know when the Indians were approaching, because they would shoot three times as a warning. Then the Gordons would answer back with three shots, signalling that it was all right for them to come. They visited once in January and February, and another time in August, when they came to meet the fur trading ship. When they came in August, Nora remembers them walking around in the water with their moccasins, and then trading their moccasins for sealskin mukluks. They would always try to trade their wolverine skins and their dry meat. Their dry meat was very good as it was made from fat caribou. These Indians already knew the older Eskimos that were living around Demarcation Pt. They were friendly, and didn't try to steal anything or hurt anyone.

Episcopal Archdeacon Hudson Stuck and his party visited the trading post here the year after it was established. Stuck's Inupiaq guide George Leavitt helped give a religious service at the Tom Gordon family's home. A lengthy description of this 1918 site visit is excerpted from A is excerpted from *A Winter Circuit of Our Arctic Coast*.

> That night, the 3rd April, we reached Tom Gordon's trading station near Demarcation Point, four or five miles within Alaskan territory. This new station is an outpost of the same San Francisco fur house that Mr. Brower represents at Point Barrow, and they have yet another east of Herschel Island. Mr. Gordon was for a number of years resident and trading at Point Barrow, and this was his first season here. A warehouse and a combined store and dwelling, still unfinished, rose stark from the sandspit, in the style that commerce knows not how to vary from the Gulf of Mexico to the Arctic Ocean.

The place was swarming with natives, come hither from the inland rivers and mountains for the spring trading, and since there was nowhere else to stay they stayed at the store. Gordon seemed to keep open house for them, there was cooking and eating going on all the time. Which was his own family, I never really distinguished amongst the numbers of women and children who all seemed equally at home. Several of the women wore no garments save fur trousers and a woolen shirt with two large holes cut in it for their naked breasts, that their children might apply themselves thereunto with greater facility.

Tom Gordon, I found a man of the extreme good nature and hospitable generosity that this state of things would imply. I had difficulty in doing business with him at all. I desired to make some arrangements for George's return to Point Barrow that he might pick up here his necessary supplies and not have to haul them all the way from Herschel Island, for four hundred odd miles is a long way to carry everything one needs. I had cached a little stuff at Flaxman Island for him, procured from the fugitive trader; I wished to purchase here the best part of what he would still need, and leave it. But is was hard to make Mr. Gordon take payment for anything. I had brought a sack of mail for him; the first he had had in seven months, and he was so overjoyed at getting it, at hearing news of the world and of his long-time home at Point Barrow, that he wanted to give me everything I tried to buy, and it was only when I made him understand that I would buy what I wanted at Herschel Island if he would not sell it to me, that he yielded.

Crowded beyond all comfort as the place was, it rejoiced me that the people were here, for they were, mostly, of the roving, inland Eskimo bands of the Turner, the Barter, the Hulahula and the Canning rivers, that are very hard to visit and that we should otherwise not have seen at all - as we did not see any of the Colville, Kupowra or Sawanukto people. The north coast, in the main, affords no winter subsistence comparable with that of the west coast; the ice commonly holds fast too far off shore for sealing; and the inhabitants resort to the mountainous inl

When I had vainly waited a long time to see if the relay cooking and eating would come to a natural term, Mr. Gordon advised me to "pitch right in and talk," and with George as the best interpreter available I spoke to them; his English being more ample along religious lines owing to his constant attendance at church than one would gather from its general meagreness, and, as I had already discovered, his knowledge and understanding of the fundamentals of Christianity, fairly good. So I spoke as simply and as cheerfully as I could of the Resurrection, this being still Easter week; of the meaning of the cross and the empty tomb. They stopped their cooking and eating and washing dishes and listened with the keenest attention, and when I was done some of them asked questions that set me going over the whole ground again, so that I suppose I was talking to them for nearly two hours.

Amongst the motley throng in ragged, greasy furs were one or two hard-faced young women whose tawdry velvet cloaks and stained silk shirtwaists spoke of the proximity of white men with money to waste, and I reflected that the degradation of woman bears the same unmistakable marks on the Arctic coast as on Broadway, and that perhaps whaling expeditions are not the only ones that tend to the demoralization of the Eskimos. Their soiled incongruous finery was much more indecent than the naked breasts of the teeming mothers.

When our service was done, and George and I had sung a hymn from the Point Barrow book, in which many tried their best to join, the cooking and eating and washing dishes were resumed and it was long after midnight when the company settled down to rest, the whole floor of store and dwelling being covered with sleeping forms, so that when I had occasion of some dog disturbance to arise in the night, it was with the utmost difficulty that I was able to make my way to the outer door.

Even in Franklin's day the neighbourhood of Demarcation Point was much resorted to by the Eskimos, and since the establishment of the trading-post will undoubtedly stimulate resort and in all probability a village will be built, this would be a favourable spot for a mission if it were not for the complication which the international boundary and the proximity to Herschel Island introduce. Any work set on foot here by the Bishop of Alaska would inevitable aid the trader at this place at the expense of the Hudson's Bay Company at the other, already hard pressed by competition east and west; that is to say, by drawing people hither would put more business in the hands of San Francisco furriers. More cogently, though the influence upon commerce cannot wisely be ignored, it would inevitably impair work of the Herschel Island mission from the same cause. The most feasible arrangement would be to set up at this spot a branch of the Herschel Island mission, although even that would doubtless arouse commercial jealousy and ill-will. The intrusion into the missionary jurisdiction of Alaska would, I am sure, be not only allowed but welcomed by Bishop Rowe, since some bands of Alaskan natives would be served that there is no present possibility of reaching from the Alaskan side. Having little patience with such artificial restraints as international boundaries in matters of this sort, I would advocate a moderate subsidy from the American Board of Missions to the Bishop of the Yukon territory, to cover the cost of maintenance of the branch. That bishop could visit Demarcation Point on the journey that he is compelled to make to Herschel Island, while it would be quite impossible for the Bishop of Alaska to visit it at all. Then a second man at Herschel Island, with a roving commission, could follow the migration of the inland fold, with a sub-base at this place. I call to mind the noble disregard to political boundaries with which the missionaries of the Church of England evangelized the Yukon country long age. What have political boundaries to do with the spread of Christianity?

> We did not leave until 10 the next morning, and in an hour we passed within sight of the monument erected by the international survey a few years ago, and into British territory. In passing the boundary we passed the mouth of a river - one of many small streams that debouch upon this coast - which "being the most westerly river in the British dominions on this coast, I named it the 'Clarence' in honour of His Royal Highness the Lord High Admiral," writes Franklin. The duke of Clarence four years later became king of England as William IV. (Stuck 1920:310-313).

Tom and Agiak Gordon's youngest child, Olive, was born here on December 28, 1922. The next year, 1923, the family moved to Barter Island and Tom started the trading post at Iglukpaluk.

After Tom left, he gave the Demarcation Bay establishment to his son Mickey. Mickey continued to run it as a trading post until the late 1920's. He and his family lived here off and on until the early 1940's, and when Mickey died in 1943 ownership of the house passed to Mickey's son Tommy Uinniq.

When Isobel Hutchinson and Gus Masik passed by Pattaktuq on their journey to Herschel Island in November 1933, the trading post building was deserted, as the Mickey Gordon family was living at Pinuqsraluk. Hutchinson also mentions two other empty houses here. One belonged to a native named Frank, and this is where her party spent the night (Hutchinson 1937).

Other families who lived at or near here in the 1920's and 1930's were the Ikpiaruks, the Mukaparuks, and the Kayutaks, Niel Allen's father, and a white man named Charlie Lou. Lou is remembered by Tommy Uinniq Gordon as "living off the country." Unniq never knew Charlie Lou, but he remembers being carried to Charlie Lou's house on his mother's back.

In the 1940's, while Uinniq was living at Herschel Island, some surveyors moved into his house at Pattaktuq without his permission. They installed an oil stove, and they took some of his valuable things - a piece of mastodon tusk which he had there, as well as the spears and arrowheads which he had found. (North Slope Borough, 1980: 136 -139).

In the 1950's, DEW Line Construction began in the Demarcation area. Uinniq lost the old trading post house at Pattaktuq because the DEW Line hauled too much gravel from the spit, causing the house to be washed away.

As evidenced by the number of sites, Demarcation Bay was and is a good fishing and hunting area. People hunted ducks in and around the Bay, especially oldsquaw (aqhaaliqs). They hunted caribou around the bay and several miles inland. They also fished all along the spit extending out from Pattaktuq. They hunted polar bear by going due north from Pattaktuq and sheep by going south up the Kongakut River. Demarcation Bay is still used as a camping, hunting and fishing area, and as a stopover place when Kaktovik people are making boat trips to and from Canada.and country still frequented by herds of caribou.

## YEARLY CYCLE

The subsistence patterns and activities of Kaktovik residents (see Figure 1) are determined largely by whether snow is on the ground, and the existence of open water allowing for boat travel.

During the snow-free months, usually mid-June through September, overland travel by snowmachine is not possible. However, by early July the sea ice has melted enough to make the coastal areas accessible by outboard-powered boats. Thus the entire coast from Foggy Island to Demarcation Bay is what might be called the "summer subsistence area". Motorboat access to inland areas by means of the rivers is normally not possible because of shallow water.

The snow season, from October through May, greatly expands the range of land used for subsistence. Snow cover permits travel across the tundra of the coastal plain, and access to the camps along the Hulahula and Sadlerochit River drainages of the Brooks Range. During the snow season "the mountains" are the single most important place for subsistence activities. April and May are considered the best months for travelling overland by snowmachine because these is still snow on the ground and also many hours of daylight.

The first snow flurries begin in August, but the snow usually does not accumulate until mid-October. The colder weather of late August signifies the time to begin whaling. Whaling occurs only in the fall at Kaktovik, not during the spring as in other North Slope villages. At the beginning of the fall migration, hunters may travel as far as 20 miles out to sea to hunt whales; later, in September, the whales pass closer to shore and may be taken within two

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Figure 4. Kaktovik yearly cycle.

Patterns indicate desired periods for pusuit of each species based upon the relationship of abundance, hunter access, seasonal needs, and desirability.

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Winter | | | Spring | | Summer | | | Fall | | Winter | |
| Whale | | | | | | | | | | | | |
| Seal/ Uguruk | | | | | | | | | | | | |
| Walrus | | | | | | | | | | | | |
| Polar bear | | | | | | | | | | | | |
| Birds/ eggs | | | | | | | | | | | | |
| Invertebrates | | | | | | | | | | | | |
| Caribou | | | | | | | | | | | | |
| Moose | | | | | | | | | | | | |
| Grizzly Bear | | | | | | | | | | | | |
| Furbearer hunt/trap | | | | | | | | | | | | |
| Small Mammals | | | | | | | | | | | | |
| Sheep | | | | | | | | | | | | |
| Freshwater fish | | | | | | | | | | | | |
| Ocean fish | | | | | | | | | | | | |
| Berries/ Roots/ Plants | | | | | | | | | | | | |

miles of Barter Island.

Hunting can go on for several weeks before whales are taken. Then it may take another week of work, often in cold and stormy weather conditions, to cut up, transport, divide and deliver the whale meat, maktak and baleen to each household.

After a rest from all the whaling activity, people start readying their snow machines and thinking about heading for the mountains. They usually wait for freeze-up and sufficient snow cover before leaving. After crossing the narrow channel between Barter Island and the mainland (Tunuiguun), they travel southwest to a place called Sivugaq, where the main trail starts onto the Hulahula River and then follows it southward into the Brooks Range foothills.

People go into the mountains for periods ranging from a few days to a month at a time. The average stay is one to two weeks. Sometimes parents alternate on their trips, so that one parent is home to take care of the children who must remain in the village to attend school. If both parents go, older children are left, although neighboring relatives are nearby to help them out. Trips to the mountains peak in early November and extend into mid-December when lack of daylight becomes a problem and hunting decreases.

The principal "snow season" camps of Kaktovik people are located along the Hulahula River and Sadlerochit Rivers. On the Hulahula, people usually erect wall tents near 1st, 2nd, or 3rd Fish Hole for convenient ice fishing. On the Sadlerochit, camping areas are less defined, being anywhere from north of Sadlerochit Springs to the Kekiktuk River and beyond. Extended family groups and others usually camp together. Their tents are heated with wood-burning stoves fueled by willows gathered nearby.

People hunt primarily caribou and sheep during the fall. The best time of year for sheep hunting is late October through November, when the mountains are accessible by snow machine and the sheep are fat. As with caribou, the lack of daylight causes sheep hunting to come to a virtual halt in mid-December.

Trapping is one subsistence activity that continues through the darkest months. Red and cross fox fur "starts getting good" about the first of November, and these animals are trapped from the camps in the mountains. Wolves and wolverines are hunted and trapped from the mountain camps beginning about the first of December. These animals are also trapped on the coastal plain, often around Barter Island.

Polar bears are also hunted during the darkest months. Bears are not usually taken until after freeze-up, because they are far out on the pack ice. People generally hunt them only in the vicinity of Barter Island.

At Thanksgiving and during the Christmas holidays, everyone returns from the mountains to the village to celebrate. Thanksgiving and Christmas feasts are held, at which whale meat and maktak are distributed, along with caribou, sheep meat, and fish. There are also Eskimo dances, games, and snow machine races.

In January and February, people start returning to the mountain camps. Trips to the mountains increase in March and April, as there is more daylight and it is slightly warmer. Winter fishing at the Hulahula River fish holes is best from late February through early April. Some caribou are also taken during this period, and an occasional moose may be shot. Sheep hunting may take place, but to a much lesser extent than in the fall. According to one Kaktovik hunter, sheep are good for eating until the middle of May. Wolf and wolverine fur is also good until May, but wolverine fur starts turning red, making it less desirable.

April and May are the most important months for taking arctic ground squirrel and ptarmigan, and even a few marmots. This is due to the availability of the animals, combined with accessibility and long hours of daylight. Hunting and trapping for squirrels peaks in May, when their fur is still good and when snow machine travel is still easy. Although ptarmigan may be hunted all year, hunting is best during April and May when they congregate in large flocks. The last trips to the mountains for the spring season are often made to get squirrel and ptarmigan.

Migratory waterfowl hunting begins along the coast in late May or early June. The birds appear as soon as there is some open water. Sometimes the last trips to the mountains are combined with the first trips for waterfowl hunting. People commonly set up tents in the Camden Bay area along the coast, then head inland to the mountains for squirrel, hunting ptarmigan along the way. Then they return to the coastal camp and hunt eiders and brant, if the birds have arrived by that time.

In early June, waterfowl hunting usually takes place closer to Barter Island, since it is now harder to travel by snow machine. People may set up camps on the mainland southeast of Barter Island, on Arey Island, or at other locations, depending on where the flocks are flying by. Stays at these camps range from overnight to two weeks. Seals can be taken also, and some people may get an occasional caribou.

Later in June subsistence activities slacken because there is no longer enough snow to travel any distance by snow machine, yet the coastal waters are frozen so boat travel is impossible. When the people still had dog teams, they could travel out over the ice to hunt seals, as June is very good time for hunting them. They could also put packs on the dogs and travel inland to hunt caribou or small game. Small game hunting is not as good in June as earlier because squirrels and marmots are shedding and ptarmigan have divided into isolated pairs for mating making them harder to hunt.

The legal season for caribou begins July 1, and, if any are seen along the coast, people excitedly begin to hunt them. July is also the best month of the year for catching (arctic char) *iqalukpik*. In early July, after the ice is melted and people can maneuver their boats through Kaktovik Lagoon they begin setting their nets. Char fishing continues to be good into August, and about August 1 the (arctic cisco) *qaaktaq* appear in the nets. August and September are the best months for arctic cisco fishing. (Wentworth, 1977a)

## Resources and Utilization Patterns

Kaktovik residents depend primarily on caribou, sheep, bowhead whales, fish, waterfowl and other birds for their subsistence. Seal, polar bear and furbearers also provide essential elements. Grizzly bears may be taken occasionally, but they are not hunted actively. Sometimes a walrus is taken, but these animals are uncommon in the Beaufort Sea. A few people pick berries, wild rhubarb and roots to round out the subsistence diet. Driftwood is gathered from the beach and used as a supplementary heating source by some families. The following discussion provides further information on the important resource species. Table 4, represents the relative position (importance) of the biotic resources used in Kaktovik during the 1970's. (Wentworth, 1979a)

Table 4. Biotic resource summary for Kaktovik (1970's)

| Resources | Kaktovik Coastal/Inland |
|---|---|
| Bowhead Whale | 1 |
| Beluga | 2 |
| Seal | 2 |
| Ugruk | 2 |
| Walrus | 0 |
| Polar Bear | 2 |
| Caribou | 1 |
| Moose | 2 |
| Sheep | 1 |
| Grizzly Bear | 0 |
| Furbearers | 2 |
| Small Mammals | 2 |
| Invertebrates | 0 |
| Ducks | 1 |
| Geese | 1 |
| Owl | 0 |
| Ptarmigan | 2 |
| Bird eggs | 2 |
| Freshwater fish | 1 |
| Ocean fish | 1 |
| Flora | 2 |

Inland = Inland/Freshwater orientation
Coast = Coastal/Marine orientation
1 = Primary subsistence resource
2 = Secondary subsistence resource
0 = Rarely utilizing/occuring subsistence resource

Table 5.

## BIOTIC RESOURCES COMMONLY USED BY KAKTOVIK RESIDENTS

| English | Inupiaq | Scientific |
|---|---|---|
| Big Game | | |
| Caribou | Tuttu | Rangifer tarandus |
| Dall Sheep | Imnaiq | Ovis dalli |
| Moose | Tuttuvak | Alces alces |
| Brown Bear | Aklaq | Ursus arctos |
| Furbearers/Small Game | | |
| Arctic fox | Tigiganniaq | Alopex lagopus |
| Red fox | Kayuqtuq | Vulpes vulpes |
| Wolf | Amaguq | Canis lupus |
| Wolverine | Qavvik | Gulo gulo |
| Mink | Itigiaqpak | Mustela vison |
| Weasel | Itigiaq | Mustela erminea |
| Arctic ground squirrel | Siksrik | Spermophilus parryii |
| Hoary marmot | Siksrikpak | Marmota caligata |
| Marine Mammals | | |
| Polar bear | Nanuq | Ursus maritimus |
| Bearded seal | Ugruk | Erignathus barbatus |
| Ringed seal | Natchiq | Phoca hispida |
| Spotted seal | Qasigiaq | Phoca vitulina |
| Walrus | Aiviq | Odobenus rosmarus |
| Beluga whale | Qilalugaq | Delphinapterus leucas |
| Bowhead whale | Agviq | Balaena mysticetus |
| Birds | | |
| Common eider | Amauligruaq | Somateria mollissima |
| King eider | Qinalik | Somateria spectablis |
| Black brant | Niglingaq | Branta bernicla |
| Snow goose | Kanuq | Chen caerulescens |
| Canada goose | Iqsragutilik | Branta canadensis |
| Pintail | Kurugaq | Anas acuta |
| Oldsquaw duck | Aaqhaaliq | Clangula hyemalis |
| Ptarmigan | Aqargik | |
| Willow ptarmigan | Akrigivik | Lagopus lagopus |
| Rock ptarmigan | Niksaaqtuniq | Lagopus mutus |
| Snowy owl | Ukpik | Nyctea scandiaca |
| Birds' eggs | Mannik | |
| Fish | | |
| Arctic char | Iqaluk | Salvelinus alpinus |
| Whitefish | Iqalukpik | |
| Arctic cisco | Qaaktaq | Coregonus autumnalis |
| Least cisco | Iqalusaaq | Coregonus sardinella |
| Broad whitefish | Aanaakliq | Coregonus nasus |
| Round whitefish | Savigunaq | Prosopium cylindraceum |

Table 5. (continued)

BIOTIC RESOURCES COMMONLY USED
BY KAKTOVIK RESIDENTS

| English | Inupiaq | Scientific |
|---|---|---|
| Fish (cont'd) | | |
| Ling cod | Tittaaliq | Lota lota |
| Grayling | Sulukpaugaq | Thymallus arcticus |
| Chum salmon | Iqalugruaq | Oncorhyncus keta |
| Pink salmon | Amaqtuq | Oncorhyncus gorbuscha |
| Arctic flounder | Nataagnaq | Boreogadus saida |
| Fourhorned sculpin | Kanayuq | Myoxocephalus quadricornis |
| Lake trout | Iqaluakpak | Salvelinus manaycush |
| Pike | Paigluk | (not positively identified) |
| Arctic cod ("tomcod") | Uugaq | Boreogadus saida |
| Smelt | Ilhuagniq | Osmerus mordax |
| Blackfish ("old man fish") | Anayukararuak | Dallia pectoralis |
| Berries | | |
| Blueberry | Asiaq | Vaccinium uliginosum |
| Cloudberry | Aqpik | Rubus chamaemorus |
| Cranberry | Kimminnaq | Vaccinium vitis-idaea |
| Greens/Roots | | |
| Wild potato | Masu | Hedysarum alpimnum |
| Wild Rhubarb | Qunulliq | Oxyria digyna |
| Forest/Vegetation | | |
| Driftwood | Qiruk | |
| Brush, willow | Uqpik | |

## Caribou (Tuttu)

### Introduction

Caribou (Tuttu): Seasonal land use for caribou hunting is dependent on the movements of the caribou. The calving area of the Porcupine caribou herd is inland from Barter Island, covering the coastal plain from the Canning River into the Yukon Territory. After calving in late May and early June the herd comes together in huge post-calving aggregations and wanders widely over the North Slope, from the Canning River to as far as the Mackenzie River delta in Canada. In the fall the Porcupine herd migrates to its winter habitat on the south side of the Brooks Range in Canada and Alaska. Some stragglers and scattered groups of caribou may remain on the north side of the Brooks Range throughout the winter.

Caribou hunting opportunities for the residents of Kaktovik are usually greatest from early July to late August, but can fluctuate widely depending on the sea ice conditions and movements of the herd. The other main caribou hunting periods are from late October to late November when there is enough snow for overland travel by snow machine and the days are not yet too short, and from late February through March and April when there are longer daylight hours and better weather conditions. Most winter caribou hunting occurs in the mountains along river valleys. But people occasionally hunt caribou on the coastal plain, especially at favored locations like Kanigniivik (Konganevik Point).

During May (occasionally earlier) all rivers are again flowing and most snow has disappeared at lower elevations, so access to any caribou is very limited. Major hunting efforts begin again in early to mid-July when open water occurs along the coast allowing for travel by boat (Jacobson 1979).

Caribou remains the staple and most preferred land mammal in Kaktovik's subsistence diet. It can be a source of fresh meat throughout the year: meat which provides high levels of protein, vitamins and minerals, especially when fresh. It is also eaten frozen and dried, and is a very important part of the holiday feasts.

Caribou hides may be used for garments, boot soles, and for blankets. Several people presently wear caribou mittens during cold weather, and caribou mukluks made from the skin of caribou legs are commonly worn. Hides are often used to sit or sleep on when people are camped away from the village (Jacobson 1979).

The summer, fall, and spring hunting periods are also the times when the bull caribou are fattest, and the meat is best. Caribou hides are most desirable for garments and boot soles in July and August, and best for blankets and boot legs from late October through November, when the fur is thickest.

Numbers of caribou taken at Kaktovik are a function of the movements of the herd, environmental conditions, time available for hunting, and success of other hunting pursuits. No exact figures on yearly harvests are available, but village leaders have estimated that an average yearly take is 100 animals (Aishanna, H. 1973 as cited in U.S. Dept. of Interior 1974: A.K. Brower, pers. comm. 1979). Estimated yearly takes for recent years are: 1977 - 100; 1978 - 90; 1979 - 40; 1980 - 80 (Jacobson and Wentworth 1981; Pederson and Caulfield

1981a).

In July when there is open water, people travel extensively along the coast by boat to search for caribou. Hunters usually cannot go inland by boat because the rivers are too shallow, except for the lower six or seven miles of the Canning River.

The coastal area directly south of Barter Island and eastward to the Jago River delta is one of Kaktovik's most intensely used summer hunting areas. People hunt here mostly in July after the ice has gone out of the lagoon. In May and June small numbers of caribou are taken here in conjunction with spring waterfowl hunting, though access may be limited due to break-up conditions and lack of snow. The mainland southwest of Barter Island along Arey Lagoon is also quite important.

Farther east of Barter Island the coastal area from Tapqaurak Point to Pokok Bay is heavily used for summer caribou hunting. Within this area, Uqsruqtalik is probably the most popular campsite. People go to Uqsruqtalik in July, and may spend several weeks there fishing and hunting. During July 1977 several families camped at Uqsruqtalik and at least fourteen caribou were taken.

Tapkauraq and Pukak are also popular places to camp. At least one family goes waterfowl hunting at Pukak each spring, leaves the tent standing, and returns again in July to hunt caribou. Present caribou hunting extends beyond Pukak to the Kogotpak River mouth and Nuvagapak Lagoon. People may also hunt caribou at Demarcation Bay if very few caribou have been seen closer to Barter Island, or if they are on their way to or from visiting relatives in Canada.

West of Barter Island, Aanallaq and Sanniqsaluk may be used as bases for caribou hunting in July and August. Although the entire coast is used, the area from Nataroarok Creek to the eastern shore of Camden Bay appears to be very important. Nuvugaq in Camden Bay is another will used caribou hunting location, where people often camp.

In some years the Porcupine caribou herd post-calving aggregations are not within reach of Kaktovik hunters. During the summers of 1978, 1979, 1980, and 1981, the Porcupine caribou herd passed to areas east of Barter Island and into the Yukon Territory before Kaktovik people were able to do any travelling. This situation occurred in late June and early July at a time when ice still covered much of the Beaufort seacoast, thus boat travel was impossible or extremely limited. Later in July, when boating did become possible, it appeared that virtually every member of the Porcupine caribou herd had left the area. In 1979 no caribou were reported taken by Kaktovik hunters during the entire month of July.

In August, scattered groups of caribou often appear near the coast in the areas of Kanigniivik and the Canning River delta. These caribou probably belong to the Central Arctic herd. This has been a particularly important hunting area over the past few years, when few caribou have been available earlier, as described above.

Almost everyone in Kaktovik hunts at Kanigniivik. Several people also hunt from Kanigniivik to the delta of the Canning River's main channel, up the channel as far as it is navigable, and from this area up to Agilguagruk (Brownlow Point). While most of this hunting is in August, people hunt at Kanigniivik throughout the year, particularly in the fall and winter.

The caribou subsistence information for the Canning river delta area supports the results of studies and surveys by Alaska Department of Fish and Game biologists, which show that caribou tend to congregate on the sandbars and delta of the Canning and nearby sandspits to avoid wet, soggy tundra and be in the breeze away from mosquitoes (Cameron, R. and K. Whitten 1979 pers. comm.). According to Kaktovik hunters, caribou often go to Flaxman Island during the spring and summer, to be in the wind and escape the bugs and the heat. They are sometimes hunted there, as well as along the coast from Agilguagruk to beyond the Staines River and around Bullen Point. (MB 41) People have emphasized the importance of the whole delta area for caribou habitat.

While travelling the coast, hunters commonly go ashore to scan the surrounding terrain for caribou. Caribou are often spotted right from camp. Hunters may maneuver their boats closer to the animals and then go after them on foot. Sometimes caribou are shot from the boat. Dead caribou are carried or dragged back to shore and then butchered at the camp. In mid-August of 1979, about 15 caribou were taken in the Konganevik Point and Canning River delta areas. Nearly all of these were skinned and quartered on the spot, then carried to the boats. Back at camp, the task of butchering was completed. Prior to rut bulls are preferred because they are the largest and fattest.

Replacement of dog teams with snowmachines has altered land use for caribou during summer months. When people had dogs, they could put packs on them and travel inland when there was little or no snow cover. The dogs could also fjord rivers and river deltas, which is impossible with snowmachines. Of course these trips were very time consuming, involving several days or weeks of walking. Dogpacks were made out of seal skin, and one dog could sometimes carry the meat from an entire caribou. Trips inland were usually made in August. It was common to walk 20 to 30 miles inland in search of caribou, and occasionally people walked all the way to the mountains.

### Fall and Winter Hunting

A reduction in caribou hunting takes place in September and early October because this is the time of subsistence whaling; virtually the entire energies of the village are devoted to the pursuit of whales.

During October, after enough snow has accumulated, the inland caribou hunting areas become accessible. A few people may get an early start by taking their snowmachines over to the mainland in a boat, but most wait until the Kaktovik Lagoon is frozen before heading for the mountains.

The Hulahula River's 2nd Fish Hole is one of the most intensely used areas for winter caribou hunting. Hunters radiate out from this winter camp in every direction, looking for the animals. Many people hunt the Hulahula drainage area between 2nd and 1st Fish Hole, and from 2nd Fish Hole upriver to Kolotuk Creek. The area between this stretch of the Hulahula and the Sadlerochit River drainage is also intensively hunted. People normally hunt as far south as Katak Creek, Karen Creek and the Kekiktuk River, along the north side of Lake Schrader, and west to the upper Sadlerochit River, the Fire Creek drainage, and north to the southern slopes of the Sadlerochit Mountains, They often camp along the Sadlerochit River, and hunt across the foothill country to the Hulahula River.

The Okpilak River drainage is another winter caribou hunting area, especially from about as far south as the Hulahula River's 1st Fish Hole inland to Okpilak Lake. People also hunt the Okpirourak Creek drainage. They may travel from Barter Island and follow the course of the Okpilak River or they may come over to the Okpilak from 2nd Fish Hole, travelling in a northeasterly direction. The foothill area from 2nd Fish Hole to Kingak Hill near the Hulahula, and across to the Okpilak and Okpirourak drainages is another important winter caribou hunting area.

Some winter caribou hunting is done on the Jago River drainage, as far inland as Marie Mountain. East of the Jago, two important winter caribou hunting areas are in the Niguanak Hills between the Jago and the John River, and the Niguanak Ridge area just to the south.

Another widely noted winter caribou hunting area is Kanigniivik. One hunter took five caribou at Kanigniivik in early November 1978, and saw about 20 others. He also hunted there in February 1979. People have emphasized that the area immediately west of the Staines River, from the coast to about 30 miles inland, is especially important winter caribou habitat.

## Spring Hunting

In spring, caribou hunting continues in the Hulahula, Sadlerochit, Okpilak and Jago River winter use areas. More hunting goes on across the coastal plain and in the foothills and mountain valleys due to increased daylight and slightly warmer temperatures. The most territory is covered at this time of year. Occasional trips are made up the Okerokavik River and to the foothill country of the Aichilik River. Until the 1940's, when people were living at Uqsruqtalik and other coastal locations, they often found caribou in an area surrounding the Okerokavik River and its branches, due west of the Angun River headwaters.

Occasionally in late winter or early spring, people travel to the Canning River in the vicinity of Ignek Valley and Shublik Island, and hunt caribou as far upriver as the Marsh Fork. They may travel via the north side of the Sadlerochit Mountains, or up the Sadlerochit to Fire Creek and over to Ignek Valley. Formerly, they travelled to this area by dogteam up the Canning from their homes at Agilguagruk (Flaxman Island) or other coastal locations. One person has told how her family went caribou hunting every spring along the entire length of the Staines River.

In the 1920's and 1930's, when some people had reindeer herds, they combined caribou hunting with reindeer herding. They travelled with their herds and pack dogs to the mountains in the fall, sometimes hunting caribou along the way. One family went up the Okpilak and Okpirourak Rivers in the fall and winter, and then over to the Hulahula River. Reindeer calving took place in the spring a few miles north of Old Man and Old Woman Creeks. They would then took the herd over to the Sadlerochit Valley near the Springs, and down the Sadlerochit River in May and June to Nuvugaq in Camden Bay, to the Canning River delta. All this time they hunted caribou if they saw any. They often stayed at Sanniqsaaluk on the way back to Barter Island in the summer. This type of overland travel during summer months was commonplace with dog teams. Another herder brought his reindeer up the Sadlerochit River each spring from his family's home at Aanallaq and they calved behind the Sadlerochit Mountains.

When Kaktovik people had dogs, they had to hunt more caribou to keep them fed. Besides the meat, the dogs were fed the "blood and guts" of the caribou, which was also made into soup for them.

### Dall Sheep (Imnaio) -

Dall Sheep (Imnaio) The traditional Inupiat Dall sheep hunting season is from mid-October until mid-December. Although the regular sport hunting season for sheep is from August to early September, the animals are not accessible to Kaktovik hunters at this time; thus in 1979 a special Dall sheep hunting season was created to meet local subsistence needs. Some sheep hunting has also occurred from January to March, but this was usually only when people were short of meat, as the sheep are thinner and not as good at this time of year.

The upper Hulahula River is by far the most intensely used sheep hunting area. Hunting begins at the entrance to the mountains near the 2nd Fsh Hole and continues all the way up to the headwaters, called Kanich. The hunting area includes most of the tributary creeks. The TLUI sites Katak (or 3rd Fish Hole) and Kanich are chiefly associated with sheep hunting. A nearby stream in known locally as "200 sheep creek".

People hunt sheep in the Sadlerochit mountains beginning a few miles south of Sadlerochit Springs. There is an important sheep camping area near Sadlerochit Springs. The upper Sadlerochit River in the Franklin Mountains, the creeks along the eastern side of the Shublik Mountains and third Range, and the Whistler Creek area at Neruokpuk Lakes are other locations where sheep are occasionally hunted.

During the mapping done in 1978, most hunters interviewed stressed the upper Hulahula drainage as their most important sheep hunting area. However, during recent years there has been increased hunting in the upper Okpilak, Jago, and especially the Aichilik River drainages. Hunting on the Okpilak begins at about Okpilak Lake, and on the Jago drainage near Marie Mountain. On the Aichilik River, people begin hunting near the 1st Fish Hole.

Formerly, the Kongakut River was very important for sheep hunting. These sheep supplied winter meat not only for local Inupiat but also for overwintering commercial whalers at Herschel Island. The Kongakut sheep population was very low into the 1930's due to overharvesting associated with whaling, but by the late 1930's and early 1940's many sheep could again be found on the Kongakut.

The number of sheep taken by Kaktovik hunters has fluctuated greatly, with only a few killed in some years to as many as fifty in other years. From 1977 through 1979 the average take was about 36 animals. The take varies according to whether or not they have had a successful whaling season, the number of caribou available, and snow cover, weather and travelling conditions in the mountains. Cold temperatures, lack of snow cover, overflow areas in rivers, and long hours of darkness can make for arduous hunting conditions.

The sheep harvest is a mixture of ewes and rams. Large rams are often hard to get to and difficult to retrieve, however they are the biggest and the fattest. Unlike caribou, rams are still very good tasting even when they are in the rut. All of the sheep meat is eaten, including parts of the intestines and the feet. Meat from the sheep head is considered a delicacy.

Sheep hunting in Kaktovik is more of a village than an individual activity. Most of the sheep are taken by four families, who then share the meat with the rest of the village. Others also hunt, however. In November 1977 one Kaktovik woman shot five sheep herself. The meat is widely shared, and sheep meat and sheep soup are a very important part of the communal feasts at Thanksgiving and Christmas. Sheep horns are sometimes used to make jewelry, fishing lures and other items.

## WHALES

Bowhead whale (Agviq)
Beluga whale (Qilalugaq)
Gray whale (Agvigluaq)

Bowhead Whale (Aguiq); Beluga Whale (Qilalufaq); Grey Whale (Aquigluaq); Bowheads are the whales that are hunted actively. Kaktovik's bowhead whaling season occurs during the westward migration of bowheads off the Beaufort seacoast, from late August until early October. Whaling in Kaktovik is similar to other North Slope villages, except there is no spring whaling season in Kaktovik because the open leads are too far from shore. Whale hunting is generally done within ten miles of land but sometimes as much as twenty miles offshore.

Over the past few years up to seven crews with about five people each have participated in the hunt. The crews use small outboard-powered boats, usually 14-22 feet in length. They communicate with each other by citizens band radio: when one crew has struck a whale, the other crews get there as fast as possible to help kill it and land it. In the whaling seasons of 1979 and 1980, hunters from the village of Nuiqsut joined the Kaktovik whalers because of unfavorable conditions in their own area.

Crews normally go as far west as Aanallaq and as far east as Uqsruqtalik to look for whales. They may occasionally go as far east as Humphrey Point, but they try to stay closer to shore when they go this far. A consideration when whaling is not to get too far from Barter Island, because when a whale is taken, it must be towed back home. Hauling a 30 to 50 ton whale, even when six or eight outboard powered boats are helping, may take several hours under the best of conditions. If the weather is stormy or visibility is poor, (which is often), it can take one or more days. The farther the whale has to be hauled, the greater the chance that the meat will spoil. This is true even if the air temperature is cold because the thick layer of blubber does not allow the carcass to cool. Therefore speed in bringing the whale home and butchering it is a prime consideration.

Many days are not good for whaling, as the seas must be relatively calm and the visibility favorable. Often, the fog rolls in or sudden storms come up, forcing the whaling crews back to shore.

The earliest date that Kaktovik hunters have seen a whale is August 21. Whale sitings can vary considerably from day to day. Some days whalers may see few or no whales while out. Other days they may see 15 or 20. The last stage of migration is when the big females and their calves come through.

When crews are out whaling, people in the village may keep a vigil, climbing on rooftops and watching for returning boats with binoculars. If a whale is taken a boat bearing a raised flag will return with the exciting news, or the village is informed by C.B. radio. Then they will help the crews land it and pull it up on shore, using large pulleys and heavy equipment. Women erect a wall tent on the beach, and begin fixing hot coffee and tea for the crews and workers. Older men and others gather up the butchering tools and begin sharpening the knives. The women cook fresh maktak and the intestines if they haven't spoiled and children pass them out. Everyone in the village is involved in one way or another.

After a whale is butchered, the meat and maktak is divided among the captain, crews, and the rest of the village. The captain saves "the captain's share", that portion from the "belly button" to the tail, and then distributes it at Thanksgiving and Christmas, and Nalukatuq feasts the next summer. The shares for the crews and for each village house are divided into equal portions. There is also a portion for the Presbyterian church in Fairbanks, and some families send part of their shares to relatives in Anaktuvak Pass, Barrow, Inuvik, or other villages. In 1981, over half of the meat and maktak went of places outside Kaktovik, a whole plane load went to Nuiqsut.

Whaling is perhaps Kaktovik's most important community activity. It stresses the cultural values of large group cooperation and sharing of resources, and is a way of passing these values to the younger generation. Almost every able-bodied man is on a whaling crew; a few women also go out whaling. Older men serve as teachers, telling others how to cut up and divide the whale. School is closed for the event, the store closes, and all other community activities cease as people busy themselves with the whale.

According to older residents Kaktovik was a prehistoric whaling site with whale bones used for a walkway to the beach (Kaveolook 1977; Okakok 1981). In historic times, however, there was no whaling at Kaktovik prior to 1964. This had to do with unsuitable ice conditions and with a lack of equipment. Although mere speculation, it may also have been that people were too busy hunting other species during fall time in preparation for the long winter, and could not afford to go whale hunting and risk not catching a whale.

Although in historic times there was no whaling at Kaktovik prior to 1964, people now living at Kaktovik went whaling before 1964. Around 1927, one Kaktovik man helped catch a whale at Napaqsralik (Cross Island - MB 11) northeast of Prudhoe Bay. He was on the crew of Taaqpak, a well-known whaler:

> Taaqpak had a new boat, which he had gotten from Captain C.T. Pedersen, who used to run a fur trading schooner up and down the Beaufort seacoast. There were five people on our crew. I used the rifle and another fellow the harpoon. This whale also had a young whale with it, but it sank when we shot it. Our boat had a sail, which we took down after we'd killed the whale. It took us three days to haul the whale to Taaqpak's camp (Takpaam Inaat -MB 25). We had to throw away the meat because it had spoiled during this time, but we kept the maktak. I do not know how much the whale weighed, but I remember that the bone was eleven feet long (Agiak pers. comm. 1978)

As men from other parts of the North Slope have married Kaktovik women, they have brought their whaling skills and equipment with them and helped reestablish whaling in Kaktovik. Kaktovik people have always eaten maktak, which they obtained from other villages before they began whaling at Kaktovik.

Kaktovik people occasionally catch beluga whales. They are usually taken incidental to the hunt for bowhead whales in the fall. One family saw a large school of belugas swimming near Pukak, the last week of August 1978; they killed two of them. Several other beluga whales were seen close to the north side of Barter Island in 1980, and at least six and as many as 20 were

TABLE 6. Whales taken by ~~Kaktovik Whales~~ the village of Kaktovik between 1964 and 1981

| Year | Crews | Number Caught | Date | Approximate Length | Sex | Approximate Location |
|---|---|---|---|---|---|---|
| 1964 | | 2 | | | | One taken about one mile northwest of Bernard Spit. One found dead off Humphrey Pt. (Imaignaurak) |
| 1973 | | 3 | | Small ones, between 30 and 40 f~~eet.~~t. | | One taken one mile off eastern part of Bernard Spit. Other 2 taken between Jago Spit and Griffin Pt. (Ugsruqtalik.) |
| 1974[a] | 2 | 2 | Sept. 10 | | | |
| 1975[b] | 2 | | before<br>Sept. 24<br>(lv. empty space) | | | |
| 1976[c] | 7 | 2 | Sept. 20 | 1371 ~~cent.~~ cm. | male | ~~First whale -~~ About 2 miles northeast of Jago Spit. ~~off Barter.~~ |
| | | | Sept. 27 | 914 ~~cent.~~ cm. | | ~~Second whale -~~ Off Barter Island's Arey Spit, just north of Iglukpaluk. |
| 1977[d] | 5 | 2 | Sept. 28 | 55 ft. | male | 2-4 miles north of Barter Island. |
| | | | Oct. 1 | 30 ft. | female | 2-4 miles north of Barter Island. |
| 1978[e] | 5 | 2 | Sept. 21 | 36 ft. 4 in. | male | Offshore from Barter Island; washed up at Camden Bay. |
| | | | Sept. 26 | 43 ft. 9 in. | male | 10-15 miles offshore from Griffin Pt. |

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Cynthia - why [illegible]

~~Kaktovik Whalers~~

Table 6 (continued). Whales taken by the village of Kaktovik between 1964 and 1981

| Year | Crews | Number Caught | Date | Approximate Length | Sex | Approximate Location |
|---|---|---|---|---|---|---|
| 1979[f] | 7 | 5 | Sept. 20 | ~~41 ft.~~ 1270 cm | male | East of Griffin Pt. and 3-5 miles offshore. |
| | | | Oct. 6 | 1067 cm | female | Shallow water less than 1/2 mile north-northeast of Barter Island. |
| | | | Oct. 8 | 1030 cm | male | |
| | | | Oct. 10 | 1075 cm | male | |
| | | | Oct. 11 | 1075 cm | male | Shallow water close to Arey Island Pt. |
| 1980[g] | 5 | 1 | Sept. 14 | 9.15-10.67 m. | male | Near Pukak |
| 1981 | 5 | 3 | Sept. 8 | 56 ft. | female | About 5 or 6 miles northwest of Jago Spit. |
| | | | Sept. 11 | 47 ft. | male | Just north of Tapkaurak Spit. |
| | | | Sept. 22 | 53 ft. | female | About 7 miles northeast of Jago Spit. |

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[a] Fiscus, 1975
[b] Marquette, 1976
[c] Marquette, 1978
[d] Marquette, 1979
[e] Braham, 1980
[f] Johnson, 1981
[g] Marquette, 1981

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caught. A few belugas were also taken at Uqsruqtalik in 1980 right where people set fishing nets. No beluga whales were taken by Kaktovik in 1981.

Gray whales have been observed occasionally. During the fall of 1979, a gray whale was seen close to Arey Island.

### Fish

Fish Several different fish species inhabit the Beaufort Sea and the area's rivers. Many are taken for subsistence. Other smaller fish species are food for seals and whales, and are thus an important link in the subsistence food chain even though they are not taken directly by subsistence users.

Summer subsistence fishing occurs in the coastal waters, river deltas, and from the barrier island during the ice-free months of July, August and September. People usually set gill nets, although rods and reels are sometimes used near the village and at the fish camps. People presently fish as far west as Foggy Island and as far east as Demarcation Bay. They set up fish camps at places such as Koganak Inaat (Koganak's camp - MB 35), Agliguagruk (Brownlow Point), Nuvugaq (Collinson Point) and Uqsruqtalik (Griffin Point) where they may remain for several weeks.

After freeze-up and all through the snow season, people travel inland up the Hulahula and other rivers, where they fish through holes in the ice. They camp near the deep pools and open water springs where the fish overwinter. In the springtime, especially, they fish through the ice of the Neruokpuk and Okpilak Lakes in the Brooks Range. Usually a simple hook and line is used, attached to a willow stick. The common fishing method is referred to as "hooking".

Presently, winter fishing may take place as far west as the Canning (Kuugruaq) River and as far east as the Kongakut River. Until the mid-1940's, present-day Kaktovik people also relied extensively on fish in the rivers west of the Canning, especially the Shaviovik and the Kuparuk River.

### Actic char (Iqalukpik)

Arctic char (Iqalukpik) Land use for arctic char is probably the most varied and extensive of any fish species. In summer, sea-run char are caught all along the coast, around the barrier islands, and up the navigable portions of the river deltas. Char are the first fish to appear in the nets after the ice goes out in early July, and they are caught into late August.

Freshwater resident arctic char are taken inland on the rivers during the snow season, by fishing through holes in the ice. A smaller variety than the sea-run char, they are sometimes called iqalukpiayat because of their small size (5" - 18" long).

### Whitefish:

Arctic cisco (qaaktaq) are the most common whitefish species. They begin appearing in the nets about the first of August, usually after the arctic char run peaks. The artic cisco run is at its prime anywhere from August through early September. They are almost always taken in the ocean, by netting or seining. The word qaaktaq is similar but should not be confused with the word qaaktuq, which means seining and is part of the word Qaaktugvik (Kaktovik) which means

"seining place". An arctic cisco tagged west of Prudhoe Bay (Kavearak Point) in August 1978 was caught one year later at Uqsruqtalik (Griffin Point) 170 miles away. Another tagged at Prudhoe Bay in July 1981 was caught at Uqsruqtalik in August of the same year.

Least cisco a whitefish species similar to arctic cisco, is taken in the lagoons, river deltas, and particularly the small lakes and streams of the river drainages. People distinguish it from the arctic cisco by its blackish gray fins instead of white ones, and by its narrower, "skinnier" body. It is much less common than arctic cisco A least cisco tagged off the end of the Prudhoe Bay dock on July 25, 1977 was caught at Uqsruqtalik, on August 14, 20 days later.

Broad whitefish (anaakliq) is a relatively large species of whitefish found in the Canning River drainage. It is usually taken in the deeper lakes and channels of the Canning River delta, during July through September. Occasionally it is taken in the winter at fishing holes farther inland on the Canning.

Round Whitefish (Savigunaq) is similar to broad whitefish, only with an orange color. Much less common than the broad whitefish, it is found in the same areas of the Canning. Formerly, Kaktovik people caught both broad and round whitefish in the Sagavanirktok River.

### (Ling cod or burbot) Tittaaliq

Small numbers of ling cod may be taken inland on the Canning River during the snow season. Formerly, they were taken during fall and winter on the Kuparuk and some of the other larger rivers besides the Canning. It appears that they have been taken only on the inland portions of rivers, at least 10 miles from the coast.

### Grayling (Sulukpaugaq)

Grayling is a major subsistence species taken in many of the area's rivers and river deltas. Late summer, after freeze-up, and then again in spring are the most likely times to catch grayling.

### Pink salmon (Amaqtuq)
### Chum salmon (Iqalugruaq)

Pink Salmon; Chum Salmon; are occasionally taken in nets in July and August, especially near Barter Island. The year 1978 was a big year for pink salmon all along the Beaufort seacoast.

### Arctic flounder (Nataagnaq)
### Fourhorn sculpin (Kanayuq)

These two species appear occasionally in the nets during summer ocean fishing.

Sculpin are usually not eaten because they are too boney.

### Lake trout (Iqaluakpak)

Lake trout During the snow season, lake trout are caught in the Neruokpuk Lakes of the Brooks Range by fishing through the ice with hook and line. Often 25 to 35 inches long or more, they are the largest fish species taken by Kaktovik people.

Paigluk, which Kaktovik people believe to be pike, are occasionally taken in the Hulahula River, mainly at 1st Fish Hole. They are also caught in other rivers. This species has not been positively identified. It is described as "sort of an ugly fish", having a large lower jaw, white meat and pink stripes. It does not resemble a picture of a pike: it may be a resident type salmon.

Tomcod (Uugaq) and Smelt (Ilhuganiq) are small fish that may be caught at various times of year along the Beaufort coast, with nets in summer and with hook and line in winter. In summer they are sometimes taken near the spits off Barter Island. In October and November, people fish through the ocean ice for them at Iglukpaluk and north of Barter Island.

Blackfish (Ayukararuak) are also called "old man fish" by the local people. They are small fish (up to about one foot in length) that may be taken along the rivers through the ice, in winter and spring. Rivers where they have been caught include the Canning, Hulahula and especially the Aichilik.

## Intensity of Fishing by Area

### Summer ocean fishing

During the summer, virtually the entire village participates in the subsistence fishery. Fishing activity is most concentrated off the coast and around the spits of Barter Island, all around Bernard Spit and Arey Island, and in Oruktalik Lagoon off Griffin Point. People may camp at Iglukpaluk, Naalagiagvik (Arey Island), or Uqsruqtalik (Griffin Point) while they fish, or they may simply go out by boat each day to check their nets. This area is very good for arctic char beginning in early July and for arctic cisco (qaaktaq) (arctic cisco) beginning in August. People often find 20 or more fish each time they check their nets. and it is not uncommon to catch 50 fish in a day. In 1978, one woman had 300 char by July 28.

During 1978, several (pink salmon) were caught in nets off the coast of Barter Island. This was a very unusual event, and many villagers had never seen pink salmon before. A very small number of chum salmon are also caught in most years.

Kaktovik people catch Arctic flounder off Qikiqtaq (Manning point or Drum Island), Arey Spit, and in Kaktovik Lagoon between Qikiqtaq and the mainland.

A popular summer fishing camp is Uqsruqtalik, where people may dry large quantities of fish for winter use. They fish in Tapkaurak Lagoon, Oruktalik Lagoon, Pokok Lagoon, and on either side of the long and narrow barrier islands which form Angun Lagoon.

Formerly, many small arctic char were taken in the summer in the delta of the Kongakut River's western branch, near the traditional site Siku. People also fished in summer all along the spit known as Pattaktuq (Demarcation Point), and occasionally do so today when travelling in this region. The spit used to extend further into the Demarcation Bay, but Air Force DEWline operatons in the early 1950's removed a great quantity of gravel from it, causing a channel to be formed, and the fishing reportedly has not been nearly as good in the Bay since that time.

West of Barter Island, Nuvugaq spit in Camden Bay and the eastern part of Camden Bay near the traditional site Anallaq, are other summer fishing places for arctic char and arctic cisco. The little river between Nuvugaq amd Aanallaq, called "Carter Creek" on the USGS map, is known for its arctic cisco and arctic char. The Inupiaq name for this river is Iqalugliurak, which means "Little river with lots of fish". The best time for netting these fish is in June, after the river opens up. (North Slope Borough, 1980: 185)

The Canning River drainage is known for its variety of fish, being the only river in the Arctic National Wildlife Refuge where Kaktovik people find broad whitefish and ling cod. During summer and early fall the Canning River delta is one of the most important fishing areas. Almost everyone in the village has fished here at one time or another during the summer. In the land use mapping, the place most often noted was the main channel of the Canning from near the mouth to about ten to fifteen miles upriver. This stretch of river is especially noted for its grayling taken in early fall, and broad whitefish taken in summer. The latter are also caught in the largest lake south of the main channel (between the main channel and the Tamayariak river) and in the Tamayariak River and the system of small lakes to the south. Two different Kaktovik women emphasized, in separate interviews, that the broad whitefish taken in the Tamayariak River and lakes area "are big ones, and fat!" People catch arctic cisco in this area also. The larger lakes to the east of the Tamayariak River (south of VABM "Walker" and north of VABM "Noon" on the USGS map) are too shallow for fishing.

Agilguagruk (Brownlow Point) at the northern tip of the Canning River delta is another important fishing area. Several families may camp here during the summer. Nets are set in the ocean north-northwest of the Point, and in the lagoon inside the spit, just to the east of the Point. Arctic cisco is the main species taken, followed by char. Arctic flounder and sculpin (kanayug) (sculpin) are caught occasionally in the nets here too. Summer fishing for char also occurs along the coast southeast of Agilguagruk, as far as the main mouth of the Canning River.

Summer fishing for char and arctic cisco takes place in several places off Flaxman Island. People have noted the inland sides of both eastern and western ends of the island, especially the area west of the Panningona cabin and Leffingwell historic site.

Moving further west, Kaktovik people sometimes fish for char and arctic cisco in the vicinities of Pt. Hopson, Pt. Gordon, and Savagvik (Bullen Point). The large triangular shaped bay between Pt. Gordon and Savagvik, and the river emptying into it, are known for good summer fishing.

Some families may travel to the Shaviovik River delta and as far as Foggy Island for summer fishing, camping at traditional sites such as Koganak Inaat and Ekoolook Inaat. These are usually the people who lived in this area in their youth. At the Shaviovik River delta they fish for char, arctic cisco, and least cisco (iqalusaaq). During summer of 1981, a group of several Kaktovik people fished at the Shaviovik River. They caught many grayling and some char

Formerly, Kaktovik people caught three whitefish species in the Sagavanirktok River delta: broad whitefish, round whitefish and arctic cisco. People were especially dependent on the fish in this area in 1941, when they lived at Kaniqluq at Prudhoe Bay. The area was particularly good for arctic cisco, which was caught around Siklaqtitaq Pt. McIntyre and Pt. Storkerson.

### Snow season fishing

The Hulahula is by far the most important winter fishing river to Kaktovik residents. After freeze-up, people travel to 1st Fish Hole and to 2nd Fish Hole where they set up camp. Almost everybody in the village fishes at one or both of these locations during the year. When travel conditions permit, most people also go up Katak or 3rd Fish Hole, beyond Kolotuk Creek. They catch mostly arctic char and some grayling at 1st and 2nd Fish Holes, and char at Katak. The area around 1st Fish Hole is especially good for char in the fall, from about 5 miles north of the camp to 2 miles south.

At 2nd Fish Hole, overflows often make for good fishing. For example, in late April 1979, some 20 people camped here for a week. They caught 14 char on April 23, 39 on April 24, 300 on April 25 when the river overflowed and 150 on April 26. A single grayling (sulukpaugaq) was taken on April 24. One person who used to go to 2nd Fish Hole in the old days often caught enough fish in a short time to fill two gunny sacks.

The Sadlerochit and Okpilak Rivers are much less important for snow-season fishing than the Hulahula, but they both contain grayling. One fishing place for grayling is the area downriver from Sadlerochit Springs, where the water stays open much of the year. Short nets have been set, and one woman catches fish from her small rubber boat. Grayling are also caught in Okpilak Lake and the other lakes to the north.

Neruopuk Lakes is where people go if they want to catch lake trout (Iqaluakpak). Often 25 to 35 inches long or longer, these are the biggest fish available. The best chance to catch them is during the dark winter months. Holes several feet deep may be chiseled or drilled through the ice. In late November 1978, people caught about twenty of the big lake trout, and several smaller ones.

The Canning River drainage provides winter as well as summer fishing. In this regard, the Canning may be equal to the Hulahula in overall importance for subsistence fishing. The winter fishing is not near the delta but further inland. Especially important areas seem to be along the braided sections and at the warm springs near Ignek and Nanook Creeks. There are "lots of fish holes" in the braided area south of the Staines confluence with the Canning. Also, the braided area for about ten miles duwnriver from Shublik Island is noted for char, Sulukpaugaq, and ling cod (tittaaliq). One long-time resident remembers fishing with his father several years ago at the Canning River. They caught many ling cod by using spears.

Formerly when Kaktovik people were living at the traditional sites along the coast, they would make fishing trips up the Canning River in the fall and at any time during the snow season , staying several weeks or longer. Now, however, trips as far as the Canning are usually made in the spring when there are long daylight hours for travelling. A group may travel the coastal route from Barter Island to the Canning River delta, then follow the river inland. Or they may travel inland along the Sadlerochit or Hulahula Rivers and cut over along the north side of the Sadlerochit mountains, to the Canning. Most people do not make this trip every year chiefly because of its distance. But they are familiar with the variety of fish species found in the Canning.

People now living at Kaktovik used to fish through the ice of the Shaviovik, Kavik, Sagavanirktok and Kuparuk Rivers during the snow season. They caught char, grayling, arctic cisco, and black fish (Anayukararuak) at the confluence of the Kavik and Shaviovik Rivers, and at warm springs called Sigsinak at about the 400 foot contour line along both these rivers. In the Kuparuk River they caught "big tittaaliq (linged)" and grayling. The Kuparuk River from 6 to 25 miles inland was a particularly important winter fishing area for these species. The grayling caught in the Kuparuk "were lifesavers" during the winter of 1941, when some Kaktovik people wintering at Kaniqluq in the Prudhoe Bay area were very short of food.

According to Kaktovik people, the Jago River has "no fish whatsoever". There are some smelt in the summertime in the Jago River delta, but they are very hard to get because the water is so shallow.

The Aichilik and Kongakut are both very good fishing rivers. Kaktovik people often fished in these rivers until the mid-1940's, when they lived at traditional sites such as Uqsruqtalik , Pinuqsraluk, and at Pattaktuq near the

Canadian border. Now that people have congregated at Kaktovik, they have not used these rivers so often. The good fishing spots remain well-known to them however, and the people may utilize these areas in the future. The Aichilik River is said to be one of the best places for catching grayling. In early spring 1980, a group of three people fished at the Aichilik River. In winter 1981 another group went fishing on the Kongakut, even though no one had fished there for several years.

The Aichilik River is locally known as the best river for grayling in the entire Arctic National Wildlife Refuge area. When people were living at Uqsruqtalik and other coastal locations, they went up the Aichilik regularly for grayling and char. "First Fish Hole" on the Aichilik is located at the 1000 foot contour line just before entering the mountains. The second fish hole, known especially for grayling, is several miles further inland near the large tributary which enters from the west.

On the Kongakut River, one important fishing area for char was where the Pungautilik River empties into the Kongakut. Another was on the Pagilak tributary. Char and grayling were caught in the large bend in the river near the 2000 foot contour line. This area was known for its many willows, which provided fishing rods as well as firewood. It was an important winter camping area. Nearer the coast, the stretch of river about six to ten miles inland on the east branch of the Kongakut was another winter fishing area.

# DUCKS AND GEESE

Black brant (Niglingeq)

Oldsquaw (Aaqhalliq)

Ducks and Geese. Waterfowl are hunted mostly in the spring, from May through early June, although less intensive hunting continues throughout the summer and into September. People set up camps at various places along the coast, so they will be there when the flocks pass overhead. Because the birds' arrival coincides with the end of school it is easy for waterfowl hunting to be a family activity. Extended families camp together. Stays at the camps range from a few days to over a month, but are most commonly one to two weeks.

Virtually the entire village goes spring waterfowl hunting. Those who do not or cannot hunt are given birds by those who do.

Black brant (Niglingaq), is the main species hunted in the spring. Brant are prized for their freshness and flavor. People also commonly hunt pacific eider (amauligruaq), king eider (qinalik), snow geese (Kanuq), Canada geese (Iqsragutilik), pintail duck (Kurugaq) and oldsquaw (Aqaaliq). Oldsquaw are the most numerous of the waterfowl. Although more of these are taken than any other species, they are not highly prized and are usually taken incidental to other forms of hunting or when fishing nets are checked.

One very popular place to hunt waterfowl in the spring is Nuvugaq, the spit on the east side of Simpson Cove in Camden Bay. Although Nuvugaq is often referred to as "POW D" because of its proximity to the old DEWline Site, people do not actually camp at the Site. The campsite is just at the base of the spit, west of March Creek and on the shores of Simpson Cove. People hunt in a wide area around the spit and coastline, however, depending on how far north the birds fly over. Sometimes families camp at Aanallaq on the eastern shores of Camden Bay, and hunt waterfowl in nearby coastal areas. On the opposite, western side of Camden Bay, Kanigniivik (Konganevik Point) and the small bay directly to the south are known as good hunting sites for brant.

In 1977, some people camped at Nuvugaq from mid-May to mid-June, returning occasionally to Kaktovik for mail, bingo and movies. At least four families camped at Nuvugaq beginning late May 1978, and two families at Aanallaq.

Uqsruqtalik (Griffin Point), located 25 miles east of Barter Island, is another popular waterfowl hunting camp where several families go each year. While camping here, they hunt Oruktalik Lagoon up to Tapkaurak Point and all around the narrow spit and coastline from Griffin Point to Pokok Lagoon. One family hunts waterfowl every year at Pukak, setting up a tent in late May. They usually return to Kaktovik in mid-June, then get their tent when they go back to the area by boat in July. During the land use mapping, people emphasized this area for brant, snow geese, and eider ducks.

Close to Barter Island waterfowl camping and hunting areas vary according to where the migrating flocks pass over. The most commonly used hunting site during recent years has been the south end of Qikiqtaq or Manning Point spit, about four miles from Kaktovik (Manning Point is also locally referred to as "Drum Island", because of the many discarded fuel drums in the vicinity). If

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birds pass farther out from the mainland, Naalagiagvik on Arey Island is a very popular camping spot. The lakes southwest of Barter Island are also hunted, and sometimes waterfowl hunting camps are set up along the banks of the Okpilak and Hulahula Rivers just south of the delta. In the mapping, this area was noted for brant and geese.

In 1978, at least three families camped at "Drum Island" off and on from late May through late June. In 1979, six families camped there in early June. By June 5, one family had taken about 35 brant. They also saw geese, eiders, and oldsquaws.

Stays at camps close to Barter Island tend to be of shorted duration, with more frequent travel to and from the village. For example, if one member of the family has a job, the rest of the family stays at the camp while he or she travels back and forth. Some people make day trips to the western or southern sides of Barter Island or to Bernard Spit when the ducks and geese are flying, and may go as far as the lakes south of the Jago Delta. Later in the summer, after the sea ice goes out, waterfowl may be hunted by boat in Arey, Kaktovik, and Jago Lagoons. In 1978, the black brant westward migration passed over Barter Island between August 15 and August 30, and some birds were shot from the nearby spits.

Although the sites and areas just detailed are those most commonly used for waterfowl hunting, people may hunt ducks and geese along the entire coastline from Flaxman Island to Demarcation Bay. Travel to the more distant areas is usually by boat in July after the ice goes out, and is often in combination with fishing or caribou hunting. In the mapping, two families emphasized Agilgaugruk (Brownlow Point) and the spit directly southeast for waterfowl. Flaxman Island is occasionally hunted and is remembered for brant and eider ducks by those who used to live there. In the fall, one family usually hunts geese in the lake system south of the Tamayariak River.

During summer boating trips, some people hunt waterfowl in Pokok Bay and Angun Lagoon and on the seaward side of these spits. One person emphasized that good waterfowl hunting areas occur at Beaufort Lagoon from Angun Point to Nuvagapak Lagoon, and Siku Lagoon from Siku entrance to the eastern mouth of the Kongakut River. This person also hunts ducks and geese in Demarcation Bay and outside Demarcation spit to the Canadian border.

Some people collect small numbers of bird eggs each spring. They consider them a delicacy. Eider duck eggs and, less commonly, glaucous gull and oldsquaw eggs, seem to be most commonly collected, usually from Arey Island or Tapkauraq Spit. Jago Spit used to have many eider duck eggs, but people do not find them there anymore because the spit has eroded.

One Kaktovik resource person feels the Aichilik River delta area is the best nesting place for black brant. This area is not commonly hunted.

The barrier islands from Flaxman Island west, including the Maguire, Stockton, and especially the McClure Island groups, are remembered by older people as having many eider duck eggs.

Eiders have sometimes been seen along the coast by Kaktovik residents as late as December. Several years ago, while a Kaktovik man was in the mountains, he saw a flock of eiders fly by during December heading south.

Seals. Kaktovik people hunt three species of seal: Bearded seal Ugruk , ringed seal (Natchiq), and spotted seal (Qasigiaq). They hunt seals for the oil, for the meat, and for the skins. Seal oil is a necessary element in the Inupiat diet and is also used for storing and preserving food. (Wentworth, 1979a)

Seals are hunted throughout the year although few are taken. Most seal hunting occurs by boat July into September all along the coast, both inside and outside the barrier islands. With plenty of open water and long days, seal hunters can cover large areas. At other seasons, hunters can sometimes travel out considerable distances on the sea ice by snowmachine searching for seals along open leads.

The most intensely used summer seal hunting area extends from Pukak Bay on the east to Nuvugaq and Simpson Cove on the west. The Canning River delta and all around Flaxman Island to the southeast of Brownlow Point is also important. The sea ice hunting may extend as far east as Pukak Lagoon and as far west as Brownlow Pt.

Two traditional spring seal hunting camps are at Naalagiagvik on Arey Island, and on Tapkauraq Spit, but many of the other traditional sites along the coast may also be used for seal hunting. In August 1977, people dried a large quantity of beardeed seal meat at Uqsruktalik.

Ringed seal and bearded seal are taken much more commonly than spotted seal. Ringed seals are by far the most numerous seal and occur year around, but bearded seals are highly prized so are probably hunted more activelyeven thoughthey are more dispersed. Spotted seals are the least common and present only during summer months. One local resource person emphasized two coastal areas as important spotted seal habitat: Aanallaq (Anderson Point) to the Hulahula-Okpilak delta and Demarcation Bay to the Canadian border.

People express different seasonal preferences for seal hunting depending somewhat on whether or not they are interested in the hide. Some consider spring the most important time for sealing, when days are long and the animals are often seen lying on the ice. However, ringed seals are shedding at this time (May) and their hides are not prime until August or September. One Kaktovik hunter said that June is an excellent time for seal hunting but he no longer takes seals then because he no longer owns a dog team, and the ice is too rough and wet for a snowmachine at that time.

A typical August seal hunt will usually take hunters offshore 5 or 10 miles, but sometimes up to 20 miles depending on the boating conditions and distribution of the ice. They travel among the floes of drifting ice, searching mainly for bearded seals. Hunters are constantly looking, studying the ice and scanning the water. Bearded seals seem to prefer big ice floes, often several acres in size, particularly the floes with gradual sloping sides rather than a steep edge that is more difficult to climb upon.

While seal oil and meat remain an essential part of the Kaktovik diet, few seals are taken compared to former times because there are no more dog teams. Most people gave up their dog teams by the late 1960's; the last year there wasa dog team in Kaktovik was in 1971 or 1972. In the words of one hunter, the need for gas to feed snowmachines has replaced the need for seals to feed dogs. To this he attributes the present abundance of seals in the Barter Island area.

However, people do not see this lessened dependence on seals as a permanent change. The rapidly rising price of fuel makes some hunters talk of going back to dog teams, which would mean taking more seals again. The importance of seals as a potential, as well as actual, food source keeps people concerned about their abundance and protection.

Walrus (Ainig) are not often seen as far east as Kaktovik. Over the past twenty years only five of six walrus have been taken by Kaktovik hunters. In the mid-1950's, three Kaktovik teenagers took the first walrus that had been seen in several years. At first they thought it was a strange looking bearded seal.

During July of 1978 a young walrus was taken one-half mile from Barter Island, and in August of 1981 a walrus was taken close to Bernard Spit. In 1975 or 1976 a few walrus were seen during the fall whaling season, but were not harvested. A small number of walrus were again seen during the whaling season in 1981.

Furbearers. The dark winter months are very important for trapping and hunting furbearers. Some people go to the mountains to hunt or trap wolves, wolverines, and red and cross fox, while others concentrate on Arctic fox on the coastal plain. Furs are used locally in making parkas and ruffs, or are sold to the village corporation or directly to a fur buyer. Furs and especially fur ruffs are a necessity for protection from the chilling Arctic wind, particularly when travelling.

The arctic or white fox, (or tigiganniaq), is trapped mainly along the coast and on the coastal plain. In recent years, most people have set their traps on Barter Island, and on the barrier islands, lagoon ice, and coastal area between the Sadlerochit River and Uqsruqtalik (Griffin Point). Arctic fox traplines are usually within ten or fifteen miles of the coast, but Arctic fox are occasionally taken further inland or in the mountains. In March of 1978, an arctic fox was taken at the Hulahula River's First Fish Hole and another in the Sadlerochit Valley. Arctic fox have been seen as far inland as Kanich, the headwaters of the Hulahula River.

In earlier times, when many present day Kaktovik people lived a more nomadic lifestyle, they trapped arctic fox all along the coast. One man's trapline went from Beeche Point to Foggy Island. One woman trapped with her father from Bullen Point to the Canning River delta, and on Flaxman Island and all the way up the Staines River. (North Slope Borough, 1980: 145-147). Two Kaktovik men were trapping partners, with a trapline extending along the coastline from Barter Island to the Canadian border. Another Kaktovik man trapped the coast from Demarcation Bay to the Aichilik River, and in a large area between the Aichilik and Sikrelurak River, near the coast to several miles inland.

The arctic fox population can fluctuate widely from year to year. During the winter of 1976-77, well over 100 fox were taken, while during 1977-78 only two were taken. Most people did not even see any tracks that winter. The next year the numbers were up again, and fox harvests have remained high - well over 100 each year, through 1981.

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During the past three trapping season; 1979-1981, a forty year old Kaktovik woman has been the most successful arctic fox trapper. Each year she has taken between 35 and 50 foxes, all in the Barter Island vicinity. Her sons often accompany her, and she is teaching them to trap.

People are cautious around animals, especially fox, that they suspect may have rabies. One trapper told how an arctic fox once rushed directly at him. He hit the fox in the head with a shovel, killed it, then burned the fox because he feared rabies. In 1976 nearly every dog at Barter Island had to be destroyed because of contracting rabies from an arctic fox. An entire family also had to undergo rabies vaccinations.

Red Foxes (Kayuqtuq) and cross foxes (Qiangaq) (different color phases of the same species) are trapped mainly in the mountains, though occasionally they may catch them on the coastal plain. They set the traps along the Hulahula drainage from Kingak Hill in the foothills, almost all the way to Kanich in the headwaters. Old Man Creek drainage and the entire lowland area between the Hulahula and Sadlerochit Rivers, including the area around Neruokpuk Lakes, is good for fox trapping. One man got 5 red fox along the Jago River in the vicinity of Marie Mountain, in March 1978.

Formerly, red and cross fox were taken inland on the Kongakut River, often from a base camp at the Pungautilik tributary. They were also taken inland on the Canning; the white trader Henry Chamberlain had a house near where the Canning joins the Staines River where trappers could take their furs.

People generally take fewer red and cross fox than arctic fox. Each year, 4 or 5 trappers may each get 3 or 4 of these animals. Most of the red fox trappers are men, but one 50 year old woman is regarded as the most skillful in the village at setting fox traps.

Most wolves (Amaguq) and wolverines (Qavvik) are trapped or shot in the foothills of the Brooks Range. The Hulahula, Sadlerochit and Okpilak River areas are most commonly hunted.

A particularly good area for finding these animals in winter is between and including the Hulahula and Sadlerochit River drainages, from about the Sadlerochit Spring on the north to Kikiktat Mountain and the Neruokpuk Lakes on the south. This terrain is characterized by gentle slopes and open country where one can see long distances, yet it is protected from the strong winds of the coastal plain by the Sadlerochit Mountains and foothills of the Hulahula and Okpilak Rivers. Wolves and wolverines are often first seen low in the drainages where willows occur, since this is where their prey is found; caribou are usually in low places feeding close to the rivers, and these same areas are good hunting for ptarmigan and squirrel. Wolves are also encountered in the upper Hulahula River area during fall when people enter the mountains to hunt sheep. Occasionally a wolf is trapped on the coast.

One resource person feels the month of January is probably the best time to trap wolves. The short daylight hours make it difficult for the wolves to find food, making them hungrier then, and hungry wolves are easier to trap. This may also be true for wolverine. By the end of January 1979, six wolverine and two wolves had been taken.

Another hunter has kept track of all the places where he has shot or trapped wolves and wolverine over the past several years. He has sought them both on the coastal plain as far west as Mikkelson Bay, and in the foothills from the Canning to the Okerokovik River. However, most have been taken in the Hulahula, Sadlerochit and Okpilak River foothill area: seven out of ten wolverine and ten out of twelve wolves. The other two wolves were both taken very near the coast.

During the winter of 1980-81, a total of 5 wolves and 7 wolverines were taken. Several wolverines were seen along the coast. Four or five were trapped on Barter Island, and another was seen at the freshwater lake near the village.

Two village men are the most active in pursuing wolves and wolverines; however, other men and women also hunt and trap them. Wolf and wolverine ruffs are a sign of a good hunter, or that one comes from a family of a good hunter. More durable than fox ruffs, they are the best protection from the Arctic wind that a person can have.

Although rare, mink have been seen on the north side of the Brooks Range, especially during recent years. In the fall of 1977, a mink was trapped at 2nd Fish Hole on the Hulahula River. A few others were taken at the same location during the winter of 1978-79. In November 1980 two or more mink were seen at the Aichilik River in the area of 1st Fish Hole.

One long-time Kaktovik resident captured a mink at Demarcation Point in the 1940's. It was the first mink he had even seen and, at first, he did not know what it was. But he received $10.00 for it from the trading post.

A small number of least weasel (naulayuq) are trapped in mountain valleys incidental to other species.

The river otter (pamiuqtuuq), or (Enhydra lutris), has appeared also. A few otters were seen in the upper Hulahula River during fall of 1977. Tracks of otters have been observed along the Canning River.

Porcupine (Qinaglud) are sometimes seen in the upper portion of the Hulahula River, though none are known to have been taken in recent years.

Lynx (niutuiyiq) have been observed from time to time on the north side of the Brooks Range. The impression is that lynx used to be more common than they are now. In 1964, a lynx was seen on the Hulahula River between 1st and 2nd Fish Holes. A few other lynx were also seen in the summer of the same year right on the coastline. During the winter of 1971 or 1972 a lynx was again observed between 1st and 2nd Fish Holes (NW of Kingak Hill) on the Hulahula River.

The following short story is told about a lynx: One time a lynx jumped on the backs of two caribou, one caribou on his left, the other on his right. The caribou ran but the lynx held on and would not let go. When they came to a tree one caribou went on one side of the tree and the second caribou on the other side. Bang! no more lynx." (anon pers. comm. 1979)

Polar bear (Nanuq). When hunted actively polar bears are usually hunted out on the ice, seaward of the barrier islands. Kaktovik's main hunting area extends from the Hulahula-Okpilak River delta on the west, to Pokok Lagoon on the east. Hunters may go as far as ten or more miles out after polar bear. One man shot a bear about six miles northwest of Barter Island in 1965. He got another one in 1977, off Tapkaurak Spit near Oruktalik entrance.

Polar bear may be killed opportunistically when people are out camping or looking for other game. In 1968 a man was camped at Agliguagruk (Brownlow Point). He was working on his snowmachine carburetor that had iced up and heard the sound of footsteps close by, which turned out to be those of a polar bear, so he shot it. In 1975, a woman shot a polar bear while her family was camped at Uqsruqtalik (Griffin Point). Polar bears have occasionally been seen inland several miles, sometimes even in the mountains. One village elder shot a polar bear in the mountains in Canada about 1946; at first sight he thought it was a caribou. Another time, three men chased a polar bear by dog team several miles inland, up the Okpilak River but did not catch it.

In November 1977, polar bear tracks were seen along the Hulahula River, about 20 miles from the coast. In April 1980 two Kaktovik hunters saw a polar bear sow and cub on the northeast edge of the Sadlerochit Mountains near Itkilyariak Creek.

In recent years, polar bear have almost always been taken in the vicinity of the village, occasionally within a few feet of a person's house. Fall and the dark months of winter are times when polar bear may be frequent visitors to the village. They are often attracted to the Barter Island dump, or to a whale carcass on the beach. Bears which enter the village are considered dangerous, especially the "skinny ones".

Not all polar bears seen around the village are shot. In most years, mothers with cubs are left alone. Occasionally bears will appear during summer months; these are usually ignored or scared off.

Since passage of the Marine Mammal Protection Act in December 1972, it has been illegal to sell unprocessed polar bear hides to non-Natives. Before the Act, hides sold for $25 or more per foot. There is probably less incentive now to hunt the bears actively; however, hides are very valuable if made into articles of Native clothing such as boots, mittens or coats. Polar bear mittens, especially, are important cold-weather gear for village people.

Although polar bear hunters are interested mainly in the hides, the meat is usually eaten if the bear has enough fat on it. According to village elders, "skinny bears will make you sick". Fresh polar bear meat is considered an important side benefit though a few villagers prefer not to eat it saying it is too rich. When a hunter kills a bear the news travels fast and the meat is shared with others in the village who would like some.

The number of polar bears taken varies considerably from year to year, and is related to ice conditions and the number of bears attracted to the village during fall and winter. In 1977, 5 were taken, all between October 20 and November 23. In 1978, one was taken, in November. In October and early December 1980, approximately 28 polar bears were taken when they were present in the Barter Island area. Virtually every family in the village shot at least one of these bears, some got several. 1980 was not the first year that people at Barter Island have taken large numbers of polar bear. About 1941, eleven polar bears were taken by one family alone.

Into the 1940's and 1950's, when present day Kaktovik people lived at other coastal locations, polar bear were hunted at other places off the Beaufort seacoast. One hunter went polar bear hunting by dog team each year out on the ice due north of Demarcation Bay, sometimes about 30 miles out. Late April was the best time for these hunting trips. He also often hunted polar bear between Angun Point and the Kongakut River delta, out two or three miles beyond the barrier islands.

Another Kaktovik man got his first polar bear near the family's sod house on the Beaufort coast just west of Herschel Island in Canada, in April of 1950. His father had gone inland to hunt wolves, and he, 13 years old at the time, was alone with his sisters. The bear was bothering the dogs, and he shot it when it came right at him.

A Kaktovik woman who grew up at Flaxman Island hunted polar bear with her family on the western part of the island, and off of Agilguagruk in the fall. One of the Inupiaq names for Flaxman Island is Sigak, (commonly spelled Sirak) which means "place where polar bears go to get covered up with snow and have their cubs." This Kaktovik woman's Inupiaq name is Sirak, because she was born on Flaxman Island just after her family moved there in 1921.

A Kaktovik man who grew up at Foggy Island and Pole Island hunted polar bear around Pole Island and the McClure Islands, in fall and early winter, and then again in April.

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Brown Bear (Aklaq). Kaktovik people occasionally take brown/grizzly bears (*aklaq*) when they see them. In recent years the village has taken about two bears per year.

Brown bears killed by Kaktovik hunters are generally taken inland during April or early May while there is still sufficient snow and ice for travel by snow machine, and also during July when as occasional bear may be seen close to the coast. Brown bears are taken strictly on an opportunistic basis. (Jacobson, 1980)

The people say that the Sadlerochit River darinage has many brown bears. Every spring they see them in the Sadlerochit River valley. One was taken near the Neruokpuk Lakes in May of 1978, and on top of one of then hills near the Kekiktuk River in late April 1979. The latter was a large old boar with a hide so dark it looked like a black bear. In April 1978, people tried photographing a brown bear in its den in the Sadlerochit Valley, but the picture didn't turn out. One man said he particularly likes to eat their fat. Large chunks of the fat are cut into thin strips then fried like bacon. He thinks the fat from polar bear is not as good as brown bear although he has eaten a lot of the former.

Kaktovik people occasionally have trouble with nuisance bears. In 1975 or 1976, three had to be shot at the people's summer camp at *Qikiqtaq* (Manning Point). In April 1980, a brown bear emerged from a vacnat tent at *2nd Fish Hole* on the Hulahula River and chased a woman. Her husband shot it. In late July 1981, a brown bear tore up a new tent left at a CAnning River delta camp.

## Moose (TUTTUVAK)

Moose (TUTTUVAK). The village of Kaktovik usually takes one or two moose per year. Moose are not specifically hunted after; they are taken on an opportunistic basis. In former years moose were not commonly seen in Kaktovik's land use area, but the moose population in the Arctic National Wildlife Refuge and adjacent areas of the North Slope has been increaseing.

Moose are most often taken in the Sadlerochit Valley, and in the foothills along Old Man Creek, Okpilak River, and Okpirourak River. They are more commonly seen along the Sadlerochit River, even at its mouth, than along the Hulahula River. One man finds them along the Kekiktuk River and on the Sadlerochit side of Kikiktat Mountain.

Moose often congregate in the Ignek, Ikiakpaurak and Ikiakpuk Valleys, and along the Canning River, between these valleys. Kaktovik people have seen several moose together there at one time. People sometimes make hunting trips to this area in the spring. They also take moose occasionally on the other side of the Canning River along the Kavik River and in the foothills near its headwaters.

In the late 1940's, three present day Kaktovik hunters traveled far up the Firth River by dog team and shot two or three moose near the U.S.-Canada border. In 1976, a moose appeared on the coast just southeast of Barter Island, and was shot. Another one was seen at Manning Point in this same area, in early July of 1979, but was left alone.

Because moose in any numbers are relatively recent arrivals to this part of the North Slope, there is not as strong a cultural tradition built around hunting them as there is for other species. However, it is the nature of the subsistence hunter to adapt to whatever is available. One middle-aged hunter, show has actively hunted caribou, sheep, seal and other animlas all his life, got his first moose in the fall of 1980 in the foothills near Okpirourak Creek. He said it was his forst moose, and probably his last.

Most people prefer caribou to moose, and a few do not like moose. It is shared widely in the village among those who do like it, however. In 1979, moose soup was served at the Thanksgiving feast.

**Rodents.** Arctic ground squirrels (siksrik) emerge from their winter dens in March and April. Hunting may take place anywhere, but is usually along the banks and sandy mounds of the major rivers, especially the Jago, Okpilak, Hulahula and Sadlerochit. Hunting is often best in the river deltas and in the lower reaches of the rivers within 5-15 miles of the coast. Two of the most intensely used areas are the Jago River delta and the Hulahula -Okpilak River delta, fom the coast to several miles upstream. People also hunt the entire drainages of the Jago and the Okpilak, up to their sources. Traps and .22 caliber rifles are used for taking squirrels.

The Sadlerochit River for several miles around Sadlerochit Springs is another area where many people hunt ground squirrels. The entire Sadlerochit River drainage is hunted, up to and including the Kekiktuk River tributary over to Neruokpuk Lakes, but the Springs area up to ten miles north of the Springs seems to be most heavily hunted.

People also hunt ground squirrels along the Hulahula from the coast up to 2nd Fish Hole where the mountains begin, and along the Old Man and Old Woman Creek tributaries near 2nd Fish Hole. Hunting is especially intense in the vicinities of 1st and 2nd Fish Hole.

The banks and lowland areas around the Neruokpuk Lakes are good places for ground squirrels hunting, as are the lowlands between Neruokpuk Lakes and the upper Sadlerochit River south of Okiotak Peak.East at the Jago River, people may hunt squirrels in fairly alrge areas covering most of the Niguanak and Sikrelurak River drainages, including the Niguanak Hills. They may occasionally hunt them along the Aichilik and Egaksrak River. Formerly they hunted them on the Kongakut River, especially in the area where the river makes the big bend.

West of the Sadlerochit River, some squirrel hunting is done near the mouths of Marsh and Carter (Iqalugliurak) Creek, from Camden Bay to four or five miles inland. On the Canning, squirrels may be hunted in conjunction with spring fishing trips, up near the warm springs close to Ignek and Nanook Creels and several miles farther inland. In summer months, they may be hunted in thelarge mound areas of the Canning River delta, near the main channel.

Two or three of Kaktovik's fmailies like to go hunting for marmots Siksrikpak each spring. They travel up Itkilyariak Creek, a Sadlerochit River tributary, and hunt marmot on the edge of the mountains between Itkilyariak Creek and the Sadlerochit Springs. Marmots also occur in some of the rocky areas at Neruokpuk Lakes. They emerge from winter dens later (May) than ground squirrels.

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The Kaktovik Subsistence Economic System.

The Inupiat Eskimo living in the area of what is now the ANWR have always sustained themselves by living off the meat, fish and fowl taken directly from the land and sea. Their culture is based on this close economic relationship with the land. This is what is meant by "subsistence economic system". The contemporary Kaktovik economy is a merging of subsistence and monetary elements, operating within the Inupiat cultural context. (Wentworth, 1979a)

The North Slope Inupiat have been living in a combined subsistence and cash economy since the late 1800's. Some of the ancestors of Kaktovik residents, both native and white, were commercial whalers working out of Barrow and Herschel Island. Commercial whaling declined by about 1910, and fur trapping took its place as the main source of cash income. Kaktovik people combined subsistence with trapping and reindeer herding as they moved seasonally from place to place.

As already outlined under "History", Kaktovik people began working for wages in the late 1940's. This increased their economic security by adding to the subsistence economy and providing an alternative to the less stable cash economy of trapping and reindeer herding. Despite these and many other changes, however, subsistence has remained the main provider of protein, the foundation of the native diet, and the source of certain Arctic cold-weather clothing. It has also provided the basis for the relationship with the land, the group activity, and the sharing of resources that is central to the Inupiat culture. (Wentworth, 1979a)

Until the 1970's, the Barter Island DEW-Line Site and related construction were the main sources of local wage employment. Although full-time as well as temporary seasonal jobs were available at the site, the rigid 9 hour a day, 6 day a week schedule left no time for subsistence activities except during vacations. Cross-cultural problems also made work at the Site unpleasant for many. As a result, many local people chose not to take advantage of these jobs. By 1981, only 3 Kaktovik Inupiat were still working at the Site.

Since the 1950's there have always been a few jobs in the village - at the post office, the store, or the school. However, more village jobs became available after passage of the Alaska Native Claims Settlement Act (ANCSA) in 1971, and creation of the North Slope Borough in 1972. By the late 1970's people were working for the North Slope Borough, the village corporation organized under ANCSA, and in Borough funded village housing and public building construction.

The new village housing and associated costs have greatly increased people's needs for cash. They now must make house payments, and pay ever-rising electricity and fuel bills (Table F). This in turn, has made it necessary for them to work longer hours. However, the North Slope Borough jobs are generally more flexible than the DEW-Line jobs allowing more time off for subsistence activities.

The great increase in the number of local jobs in the late 1970's brought much more money into the village than had ever been present before. Many other changes have also taken place in a very short time span. In addition to new

## Table F Kaktovik Fuel Prices
## 1977-1981

| Fuel | Date | Price | Date | Price | Date | Price | Date | Price | Date | Price | Date | Price | Date | Price |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Stove oil 55 gallon drum | 07/77 | 45.10 | 05/78 | 104.50 | 11/78 | 64.90 | 06/79 | 64.30 | | | 08/81 | 95.70 | 10/81 | 109.45 |
| Gasoline 55 gallon drum | 09/77 | 68.75 | 05/78 | 68.75 | 11/78 | 69.30 | 06/79 | 69.40 | 02/81 | 120.00 | 08/81 | 102.85 | 10/81 | 123.75 |
| White gas 5 gallons | 10/77 | 15.00 | | | 11/78 | 16.50 | | | | | | | 10/81 | 28.75 |
| 2 cycle oil 1 qt. | 07/77 | 1.56 | | | 05/78 | 2.00 | | | | | | | 10/81 | 2.16 |
| Propane 100 lb. bottle | 07/77 | 67.50 | 06/78 | 88.00 | | | 06/79 | 78.00 | | | 08/81 | 91.00 | 10/81 | 170.00 |

housing, a high school, a gymnasium with a swimming pool, and a public safety building have been built, and a fire hall and new community center-medical clinic are soon to follow under the North Slope Borough's capital improvement program. Villagers now have satellite T.V. and telephones in every home.

The many outward changes, however, have not brought a similar inward change in socio-cultural values. Although the village corporation must and does operate as a profit-making business, ideas of sharing money and other resources in the present take precedence over making money for the future. The economic system operates through the strong kinship ties and alliances of the extended family, as everyone in Kaktovik is related. Sharing is especially prevalent with Native food but also with store bought goods. For example, families go camping together and think nothing of sharing hundreds of dollars worth of store-bought food with everyone in camp. Except for a very limited amount of arts and crafts production relying on local fish and wildlife resources, Kaktovik people do not operate private businesses. The only real entrepreneurs in the village are two non-Natives.

In Kaktovik, as in other North Slope Inupiat villages, people's decisions about earning and spending money and what is important often differ from the outsider's viewpoint. In any society, the amount a person wants to earn is influenced by what he wants to spend it on; but in any society, earning and spending patterns are, at least in part, culturally determined. In Kaktovik, an important reason for earning and spending money is to buy better subsistence equipment such as snowmachines, outboard motors, and rifles to be a more successful hunter, a very important cultural value. A person's standing within the community is directly related to success as a food gatherer. Similarly, people use their cash incomes to support relatives or to buy goods to share with them, just as subsistence harvests are shared. (Wentworth, 1980)Much money is also spent on plane tickets to visit relatives in other villages, or to have them visit Kaktovik. In this sense the airplane has replaced the dog team in carrying on the cultural tradition of travelling great distances to visit - a tradition that existed before the Inupiat of this area lived in permanent villages.

Some North Slope employers operating in Kaktovik become disillusioned with hiring local Inupiat people because "they won't stay at jobs" even when offered very high wages. This is an illustration of how differing cultural values influence economic choices about wage work. Cross-cultural problems arise when non-Native employers apply their own cultural standards in an attempt to understand Inupiat behavior.

In any society, a person will work only up to the point at which the costs of working, in terms of time given up, equal the benefits. When the costs of giving up this time begin to exceed the benefits, measured in money, the person quits. For the Inupiat, this point is often reached earlier than in the non-Native society, because the value to him of what he could buy with that extra money is not worth giving up the extra time. Put simply, giving up that extra time is just not worth the price.

Furthermore, after a certain point, the "price" of time spent working may be very high to the Inupiat because it is time away from subsistence activities. (Wentworth, 1980)
Although cash incomes and the needs for them are increasing as already outlined, one thing that cash income cannot buy is Native food (nikipiaq). Of course, spending money on better hunting equipment and spending time

maintaining it is an indirect way of buying Native food. But the food itself cannot be purchased directly; it must be worked for or earned by hunting. In the American society, a large component of any family's budget is for food. But in Kaktovik, the need for Native food (nikipiaq) can't be met with the cash budget; therefore, beyond a certain point, people would rather spend their time hunting than earning the cash. The price of food in the local store, its inconsistent availability, and the lack of locally available fresh meat and produce at any price add an additional incentive to subsistence hunting (Table 8).

The economic theory of the supply of labor provides further insight into Inupiaq economic behavior in the wage economy. In any society, people's attitudes about earning money are influenced not only by what they want to buy with it, but by what they have to give up to earn it. The economic theory of the supply of labor is based on this latter principle. To get a person to work, you must pay him to give up his leisure time. The more hours of leisure time he gives up, the more valuable his remaining leisure time gets, so the more he must be paid for each hour given up. This same principle also applies in Inupiat society, only more so because of subsistence. People must either give up subsistence while they are working, or do it during their leisure time, which makes their remaining leisure time just that much more valuable.

This time conflict between wage work and subsistence is reconciled in a variety of ways. Some people are employed only seasonally. In some families the wife works leaving the husband free to hunt. If the husband is working the wife may go hunting with her sons or other relatives. (Worl 1979) People who work at the DEW-Line Site schedule their annual two month vacation around the hunting activities most important to them. One man who retired from the DEW-Line Site after 25 years now hunts year-round for younger members of his extended family. The more flexible work schedules of the North Slope Borough jobs allow people time off for subsistence activities. "If we need meat, our boss won't hold us", one hunter says.

Because subsistence is an extended family and group activity and because subsistence harvests are shared, the time conflict between work and subsistence exists more at the individual level than at the group or village level. Still, however, the very high wages paid in Kaktovik not only reflect higher living costs, but are also a reflection of the "price" people pay to give up a measure of freedom inherent in the lifestyle they have been used to.

Another way culture influences economic decisions and earning patterns has to do with what might be termed "cultural skills". An Inupiaq working for wages may be very skilled at his work. But chances are, it's not the area in which he is <u>most</u> skilled. His best skills are not necessarily obvious in the village, but become apparent out on the land and sea.

When an Inupiaq works for wages, he is almost always working for a non-Inupiaq. He is being supervised and told what to do by someone else, but when's he is hunting or travelling on the land, sea or sea ice, he is his own boss. Moreover, he is likely in charge. His superior knowledge, endurance, and ability to cope with the weather and terrain may make the non-Inupiaq supervisor feel like "the supervised" if the two travel together. If the non-Inupiaq gets caught in a survival situation, he may be depending on the Inupiaq. In the 1950's, for example, there was a DEW-Line supervisor at Barter Island who reportedly "didn't like Eskimos". Among other things, he

Table 8.

## Kaktovik
## Staple Food Prices - 18 items

| Food item | Unit | Fairbanks[a] 6/13/78 | Kaktovik[b] 6/16/78 | Fairbanks[a] 7/6/79 | Kaktovik[b] 7/3/79 | Fairbanks[a] 10/12/81 | Kaktovik[b] 10/3/81 |
|---|---|---|---|---|---|---|---|
| Round steak[c] | 1 lb. | 3.22 | none (4.08) | 4.21 | 4.20 | 3.04 | none (4.30) |
| Hamburger[c] | 1 lb. | 1.79 | none (2.03) | 2.52 | 2.25 | 1.59 | none (2.57) |
| Pork chops[c] | 1 lb. | 2.84 | none (3.57 | 2.49 | none (3.34) | 2.52 | none (4.37) |
| Chicken[c] | 1 lb. | .79 | none (1.68) | .79 | 1.50 | .85 | none (1.69) |
| Tuna Fish | 6.5 oz. | 1.03 | none (1.39) | 1.07 | none (1.39)[d] | 1.49 | 2.13 |
| Spam | 12 oz. | 1.73 | none (1.96) | 1.54 | 2.29 | 2.15 | none (2.20) |
| Pink salmon (canned) | 15.5 oz. | 2.40 | none (3.00) | 2.21 | none (3.00)[d] | 3.09 | 4.82[e] |
| Butter | 1 lb. | 1.65 | none (2.83) | 1.84 | 2.51 | 2.13 | 5.35 |
| Evap. milk | 14.5 oz. | .50 | .72 | .56 | .72 | .70 | 1.31 |
| Flour | 10 lb. | 2.90 | 4.48 | 3.40 | 4.69 | 4.01 | 8.06 |
| Sugar | 10 lb. | 3.24 | 4.84 | 3.47 | 5.10 | 4.77 | 12.96 |
| Eggs | 1 doz. | .94 | none (1.61) | .90 | 1.72 | 1.20 | 1.85 |
| Rice | 28 oz. | 1.17 | 1.68 | 1.25 | 1.60[e] | 1.69 | 3.28 |
| Tomato soup | 10.5 oz. | .31 | none ( .52)[d] | .37 | .54 | (.44 not used in total) | none (price not avl.) |
| Grapefruit juice | 46 oz. | 1.22 | none (1.95)[d] | 1.34 | 1.99 | 1.95 | 3.57 |
| Coffee | 3 lb. | 10.80 | 15.35[e] | 10.44 | 15.37[e] | 8.26 | 16.63[e] |
| Loose tea | 1 lb. | 4.24 | 4.85 | 4.31 | 5.00 | (5.19 not used in total) | none (price not avl.) |
| Pilot bread | 2 lb. | 2.07 | 2.66 | 2.29 | 2.89 | 2.67 | 3.67 |
| Totals | | 42.84 | 59.19 | 44.99 | 60.10 | 42.12 | 78.75 |
| Kaktovik prices as % of Fairbank's prices | | | 138% | | 134% | | 187% |

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[a] Average of two stores

[b] Prices in parenthesis are what the item would have sold for if available. Kaktovik got meat in their store October 6, 1981, after two months without any due to spoilage problems in shipment.

[c] Fairbanks proces are for fresh meat except for frozen chicken; Kaktovik prices for frozen meat.

[d] Previous year's price.

[e] Price extrapolated to fit size of container.

would not allow them to shop at the DEW-Line store or use the other facilities even if they were employed there. However, one time he became lost in a severe snowstorm between the DEW-Line site and the DEW-Line's lower camp one-fourth mile away. The personnel at the lower camp notified the village people and they went to look for him. They found him just 500 feet from the site sitting in his tracked vehicle in a state of shock with the door wide open. They had to help him out because he couldn't move. He felt that they saved his life. He later opened the DEW-Line store and gave them whatever they wanted for free, and from that time on he always liked Eskimos.

In at least two other instances, Kaktovik people have saved DEW-Line employees from freezing to death. Both men became lost during severe weather while driving their tracked vehicles, some distance out on the ice and the other on the mainland southwest of Barter Island.

A principle of international economics states that world production will be most efficient if each country produces not necessarily what it can produce better than any other country, but what it can produce best. Northwest Alaska Inupiat leader Tony Schuerch has stated "I'm sure the Eskimos are going to survive as a people, because survival is that thing we do best" (Magdanz, 1979: 19). Likewise in Kaktovik, subsistence related skills are what the people do best.

Subsistence-related skills notwithstanding, however, Kaktovik people must earn enough money to meet the high cost of living in modern Kaktovik. House payments of several hundred dollars per month, and fuel, electricity, water and telephone bills are the price of "going modern". Energy prices, especially, are unbelievably high on the North Slope. Energy and imported food costs rise not only due to world trends and inflation but also as transportation costs rise (Tables 7 and 8). Fuel oil and gasoline are almost twice as high in Kaktovik as in Fairbanks, and propane is 3 to 6 times as high depending on freight method. In October 1981 Kaktovik food costs were 87% higher than Fairbanks, which is already 33% higher than the national average. This difference between Kaktovik and Fairbanks food prices has been widening rapidly. In 1978 and 1979, Kaktovik food prices were only about 35% higher than Fairbanks. This widening price difference is typical of what is happening between urban and rural Alaska generally as energy prices and transportation costs to "the bush" rise (Table ; Cooperative Extension Service, 1974-1980).

In addition, irregular air freight service due to Arctic weather conditions, associated time delays, and lack of economies of scale keep the Kaktovik store from being able to stock fresh milk and produce and many other items. The nutritional importance of subsistence in such an environment is obvious. While much of the modern Inupiat diet comes from store-bought foods, these tend to be foods of low nutritional quality. Even the frozen beef, chicken and pork, which is much more popular in Kaktovik than canned or frozen vegetarian items, is not as nutritious as Native foods. Subsistence harvested meats and birds are high in protein and low in fat. They contain some essential vitamins and minerals not found in domestic meat and poultry. Caribou and seal have twice the protein as an equivalent amount of beef. Marine animals have many times more Vitamin A and ten times as much iron than beef, and ptarmigan has twice the thiamine as chicken. Seal and whale oil, which is 100% energy, is polyunsaturated and does not predispose one to heart disease (Cooperative Extension Service, 1974; Worl 1979, Hurwile 1977, Milan 1979; Nobman, 1978).

Several attempts have been made to place an imputed dollar value on the subsistence resources that rural Alaskans depend on, to estimate the loss in dollar terms if they could no longer secure food by hunting and fishing (U.S. Department of Interior 1974). Assuming that each Kaktovik person conssumed 500 pounds of subsistence harvested meat and fish each year (Ibid 1974) at an average imputed price of $4.00 per pound (T-bone steak was over $7.00 per pound in October 1981) the gross dollar amount for each man, woman, and child would be $2000 per year. For the village of 175, it would be $350,000 per year. However, if the government were to pay for losses of Native food by giving people store bought substitutes, this would likely insult and anger the people, as it would be regarded as an affront to their culture and a form of welfare that took away their ability to lead productive lives (Association of Village Council Presidents, Adams, 1981). In the words of one resident:

> "Several years ago, the government came to Kaktovik with free handouts of beef roasts and chicken because they thought we were short of caribou. This didn't consider the people's feelings. It's sad when Eskimos move to town and try to make duck soup out of chicken, and caribou stew out of beef. It's sad because it's just not the same. When I'm in town and can't get any Native food, I can't really get used to it because I never feel filled up. My body is still craving something, it isn't satisfied."

The incorporation of store-bought foods in the diet means that subsistence is no longer necessary for physical survival, but the amount of change which has already occurred has not been without a price in human health. The partial move away from hunting and gathering food buying has been accompanied by increases in dental cavities, anemia, diabetes and heart disease (Nobman, E.D. 1978). Average death rates among young North Slope Inupiat appear to be more than four times higher than the U.S. average, probably due to increased accidents and suicides in recent years (Kruse et al, 1980: 19, Table 3-3). While Alaska's 70,000 Natives make up only 15% of its population, they account for 43% of all suicides, 38% of all homicides,, and 60% of all alcoholism deaths (Lenz 1980). In this context, traditional food gathering activities contribute to mental health by providing necessary stability and cultural identity. Subsistence activities strengthen the family unit, provide meaningful work, and fulfill needs for personal self-reliance, self-esteem, and self-fulfillment (Hurwitz 1977).

Kaktovik's Mayor Archie Brower has stated "The Brooks Range all the way to the ocean is our garden. We feed on that - the sheep, caribou, fish, seals, and whales" (Brower 1979). The essence of the economic importance of the fish and wildlife to Kaktovik people lies not only in their needs and preferences for subsistence foods, but in their ability to provide their own food from the area in which they live.

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Villages outside Study Area Boundaries

Evidence of man's use of the Porcupine caribou herd through time is available at sites both in Alaska and Canada. Archaeological evidence (Irving and Harington 1973, as cited by U.S. Department of State 1980) show that man has been using caribou for at least 27,000 years, apparently extending back before tha las glaciation. Work sone at sites occupied up to 1500 years ago near Old Crow, Yukon Territory, receals a subsistence economy centered primarily on the interception of spring and fall migrations of caribou (Morlan 1972 and 1973; Cinq-Mars 1974). Morlan's investigations (1972; 1973) of the Cadzow Lake site and the Klo-kut site sow isgns ov the imoprtance of caribou by the high percentage of caribou bones in faunal remains, and in the continuity of caribou evidence over many years throug changes in accompanying material goods from stone axes to bullets.

The Athabascan people, specifically the Vunta Kutchin of the Old Crow area and the Netsit Kutchin of the Chandalar area in Alaska, were traditionally nomadic groups whose life cycle basically centered around the hunting of big game animals. The seasonal migration of caribou was the most important natural phenomenon whic influenced the way of life (Stager 1974). Caribou were the most important game species and until the early 1900's, were often hunted using surrounds or enclosures (Balikci 1961; McKennan 1965). Corral areas with long wing fences were constructed and groups of caribou drifted or were dirven into them. Warbelow et al. (1975) studied and recorded many of these surrounds in Alaska and Canada.
These surrounds show the large amounts of communal effort expended in obtaining caribou. The use of surrounds declined after the introduction of the rifle to the Kutchin people, and hunters changed from the traditional group hunting strategies to single hunter strategies; however, one surround north of Old Crow was used into the 1950's (Balikci 1961). Another indication of the Atapascan people's dependence on caribou during pre-contact and early contact times were the periods of starvation that ensued in years when caribou were unavailable to them.

Caribou form the Porcupine caribou herd are still bitally important to people in rural villages of Alaska and the Yukon Territory today. The two villages most dependent on the caribou resource are Old Crow, Y.T and Arctic Village, Alaska, as they are inland villages with little of no access to marine resources. Other villages that hunt Porcupine caribou are Kaktovik (see "Resources Harvested"), Venetie, Fort Yukon and Chalkyitsik in Alaska, and Fort McPherson, Inuvik, Aklavik, Arctic Red River and Tuktoyaktuk in the Northwest Territories. The use of caribou in all these villages depends on the availability of animals near the village; in some years caribou migration routes or wintering areas may not bring caribou near enough to the village to make caribou hunting feasible. Thus the caribou harvest can vary greatly from year to year. Despite a general shift during the 1900's from a dependence on subsistence resources to an increased dependence on imported foods, the subsistence use of game resources has clearly remained strongest in small isolated villages. (U.S. Department of State 1980). Most of the Inupiat and Athapascan villages within the range of the Porcupine caribou herd fall into that category. Emphasis will be given here to current uses of caribou in Arctic Village and Old Crow, as available information indicates that these two villages still rely most heavily on the caribou resource.

Arctic Village, Alaska, is located on the south side of the Brooks Range at 145 west longitude, 60 north latitude, in the valley of the East Fork of the Chandalar River. The village is at the northern limits of the boreal forest. The present population is approximately 125 people. (Pederson and Caulfield 1981b). Work done by McKennan (1965) and Hadleigh-West (1963) provides baseline information on lifestyle and culture of the Netsit Kutchin of the present Arctic Village area, and documents subsistence use of resources. Annual activities in Arctic Village are still closely tied to the harvest of fish and wildlife resources. Caribou is the most important source of food, with moose, fish , Dall sheep, waterfowl and small mammals also important.

Caribou are often available near Arctic Village from August to April, although, as previously mentioned, there are years when changes in migration routes or wintering areas may bring very few caribou near the village. Fall hunting is usually conducted near the village of from hunting camps on Old John Lake. Winter hunting usually includes the use of snowmachines which gives the people an opportunity to hunt farther from the village. When caribou are not available, moose, fish , and Dall sheep may be taken in larger numbers (Pederson and Caulfield 1981b).

Old Crow, Yukon Territory, is located on the north bank of the Porcupine River at 139 west longitude and 67 north latitude. The present population is about 206 including white residents (Stager 1974). The country around Old Crow continues to supply much of the needs of the people; both bame and fur are still gathered. Work by Stager (1974) in 1973 showed that 55% of the food needed by Old Crow people in 1973 came from the land. Of this food, caribou was the most important. In addition to caribou, people harvest fish during the summer, moose, muskrats and waterfowl during spring, and rabbits and ptarmigan when available.

The major hunt for caribou is in the fall. In September large numbers of caribou pass through the Old Crow flats and cross the Porcupine River heading for their wintering areas. At this time they can be taken on land or by riverboat. Almost every male older than 11 years joins in the caribou hunt (Berger 1977). There is some hunting of caribou in winter and in spring depending on the year (Stager 1974).

Of the other Canadian villages utilizing caribou form the Porcupine herd, Aklavile and Fort Mc Pherson are most important. Because they are geographically located on the edge of the Porcupine herd's range, the Northwest Territory villages have a varied take of caribou in different years. The same is true of other interior Alaskan villages that may take Porcupine caribou from year to year. Villages such as Chalkyitsik no longer focus great effort on caribou hunting but will take them when available (U.S.

Department of State 1980). Venetie and Fort Yukon also take animals when they are available. It must be emphasized, however, that a great deal of sharing and trading of resources occurs between villages. If caribou are not available in Fort Yukon, they may trade salmon to someone in Arctic Village for caribou. An elagorate network of exchange exists for "country produce" so that even those who are unagle to provide subsistence resources for them selves are able to receive it from their friends or relative (Berger 1977). In early 1981, a number of people from Venetie, Fort Yukon, Chalkyitisk, Beaver and Birch Creek visited their relatives and friends in Arctic Village, and since caribou were generally accessible within five miles of the village, used their visit as an opportunity to take caribou (R. Caulfield, pers. comm.).

Caribou harvest information is most villages is sorely lacking. Harvest estivmates that are available are based on interviews conducted in the villages or on various voluntary reporting systems. The importance of the caribou is the diets of rural residents is also poorly documented. While cultural importance of the caribou has been recorded (Berger 1977; Balikci 1963; McKennan 1965), only sporadic attempts at presentation of hard data on numbers of animals harvested and the percentages of them in rural diets are found. A recently established program in Kaktovik and Arctic Village by the Alaska Department of Fish and Game Subsistence Division will attempt to fill some of these data gaps and preliminary information should be available in the spring of 1982 (Pederson and Caulfield 1981b).

Table ___ summarizes caribou harvest in various villages. The harvest estimates are rough but give an idea of the variations in harvest on a yearly basis. The table does not include information on rural residents living outside of villages; these people harvest caribou opportunistically as well. The total annual Native harvest in Alaska and Canada is estimated at 3000-5000 caribou (LeBlond 1979).

Table ___ Caribou harvest estimates in the 1970's for selected Alaskan and Canadian villages.

| | | | |
|---|---|---|---|
| 1972-1973[a] | Arctic Village | 1000 | (LeBlond 1979)[b] |
| | Venetie, Chalkyitsik, Fort Yukon | 100 | |
| | Aklavik, Inuvik, Fort McPherson, Arctic Red River | 2000 | |
| | Old Crow | 600 | |
| 1975-1976 | Arctic Village | 800-1200 | (ADF&G 1978 as cited by U.S. Dept. of State 1980). |
| | Canada | 1500-3000 | |
| 1977-1978 | Arctic Village | 200-300 | (LeBlond 1979)[b] |
| | Old Crow | 470 | |
| | Fort McPherson | 350 | |
| | Aklavik | 114 | |
| | Inuvik, Arctic Red River | 100 | |
| 1979-1980 | Arctic Village | 3 | (P. Car. Tech. Comm. 1981) |
| | Venetie, Chalkyitsik, Fort Yukon | 0 | |
| | Old Crow | 800 | |
| | N.W. Territories | No. infor available | |
| 1980-1981 | Arctic Village | 500-600 | (Pedersen and Caulfield 1981a) |
| | Venetie | 200-300 | |
| | Fort Yukon | 80-100 | |
| | Chalkyitsik | 0 | |

[a] When a two-year period is indicated, it is generally July 1 of one year to June 30 of the following year.

[b] Assembled by the author from various sources.

The importance of caribou in the diet of rural residents is not well documented and needs further research and documentation. A 1973 survey in Arctic Village revealed that about half of the per capita village meat and fish comsumption cam from caribou (U.S.D.I. 1974). In 1977-1978, fifty percent of survey respondents in the village harvested caribou -- this in a year when caribou harvest was below average (Alves an Kruse 1978). Estimated annual per capita caribou harvest in Arctic Village has ranged from two to five in the past ten years (U.S. Department of State 1980).

Outside of Arctic Village in Alaska, the role of caribou in diets appears to be much less significant. Alves and Kruse (1978) found that only 9% of the survey respondents in the Yukon-Porcupine Region reported harvesting caribou in 1977-1978. It must be noted that this is just a one year survey, and other years may show very different subsistence patterns.

In Old Crow, Stager (1974) found that something over half of the diet needs of the community are met by fish and game. He reports that an estimated 145,550 pounds of flesh were consumed in the village in 1973, 102,500 of which were game. Most of the game meat consumed was caribou flesh.

The utilization of the Porcupine caribou herd is clearly important to villages that lie well outside of the immediate Arctic Coastal Plain study area. The impacts of changes in the status of the Porcupine caribou herd on these villages will need to be carefully evaluated.

In Canadian coastal villages the use of marine mammal resources is important to the coonomy and lifestyle of the residents. Communities of the Mackenzie River delta (Inuvik, Aklavik and Tuktoyaktuk) and the "Rim" (Sachs Harbour, Holman and Paulatak), are partially dependent on subsistence uses of natural resources for their livelihood. Significant in terms of this report are the beluga whale and the ploar bear.

Beluga whales are harvested in the Mackenzie portion of the Beaufort Sea. Whales enter warmer waters of the bays near the Mackenzie River delta during early July and remain until the middle of August. Hunting may occur throughout this period (Brackel 1977). Whaling for beluga whales is not regulated and approciamtely 120 whales are utilized in a year (Brackel 1977). Whale products are used primarily domesticly although some products such as muktuk are occasionally sold. Sharing of whale meat and muktuk is common; beluga maktak is often shared with relatives in Kaktovik and other Alaskan and Canadian villages. The importance of beluga whales to the economy and diet of Mackenzie villages may be more a mtter of preference than economic necessity; a variation in diet, and the sport and recreation of the hunt with opportunities for socialization are all important factors in whaling (Brackel 1977).

Polar bears represent a substantial component of the cultural and economic base of the Inuit people of the Canadian western arctic (Stirling et al. 1975). There is direct economic value in polar bear hides, and in recent years the principal motivation for polar bear hunting has been the sale of hides (Stirling et al. 1975). Fur exports are an important source of cash in the economies of Mackenzie villages and "Rim" villages. According to Brackel (1977), marine furs (white fox, polar bear and ringed seal) provide 5% of the earned income in the Mackenzie economy, with Tuktoyaktuk having the largest percentage, and 19% of the Rim economy, with Paulatuk having the largest percentage. In addition to economic value, the polar bear harvest contributes to the sociological and cultural values of the region.

Polar bears are the least abundant of the marine fur species but the individual hides have the most value. The average price received by hunters was $1000 in 1974 (Brackel 1977). Brackel (1977) also states: "Polar bears warrant special attention because their value and socio-economic importance overshadow other marine furs.....Polar bear exports, worth $17,000, make a sizeable contribution to marine fur income in the Mackenzie economy".

As with most subsistence and resource use information, data is scanty on the domestic use of natural resources. Additional research is needed in Canadian communities as well as in Alaska.

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# Archaeology and Early History

## Introduction

Section 1002(c) of the Alaska National Interest Lands Conservation Act (ANLICA) authorizes oil and gas exploration on the arctic coastal plain in the Arctic National Wildlife Refuge in a manner that avoids significant adverse effects on the fish and wildlife and other resources. The bill requires, however, that this activity must be preceded by the inventory and assessment of all these resources. An analysis must also be made of the possible impacts of oil and gas exploration and development on these resources. Finally, the bill requires development of procedures intended to minimize and/or mitigate these impacts.

This section, responds to these requirements by discussing archaeological and early historic resources with three purposes in mind. These are: 1) to indicate what is and is not known about the archaeological and historic resources of this and, when pertinent, adjacent areas; 2) to provide an analysis of the possible impacts of oil exploration and development, and; 3) to suggest procedures that will insure the avoidance and/or mitigation of all of these impacts.

## Data Base

The boundaries of the study area have been superimposed over a section of the arctic coastal plain for administrative and geologic reasons. These boundaries accurately define an area administered by the Fish and Wildlife Service that private industry desires to explore for oil potential due to existing knowledge about the geologic history of the area. However, although these boundaries are convenient for the purposes for which they are intended, they are of little value in thinking about the early historic and archaeological values of the area.

Historically, native and white populations in the arctic exploited a variety of resources requiring them to use not only the whole arctic plain but the water to the north and the hills and mountains to the south. In addition, even this larger area did not provide all of the resources needed, or wanted, by the peoples of the study area so they participated in trading networks that made additional resources available. Understanding the importance of the archaeoligical and early historical resources of the study area they will require placing them in this larger context of adaptation to a northern environment. An additional consideration requiring expansion of the this discussion is the fact that early explorers and scientists visited the study area in connection with work that examined it as a part of the larger "north". This idea of the north as a very special place pervades many of the reports of the early work of scientists and others familiar with the area. However, in order to keep the size of this section within reason only information absolutely necessary for providing a clear understanding of the archaeology and early history of the study area will be presented.

Achieving the goal of presenting what is and is not known about the study area will first reqire a brief discussion of the history of investigation of the area. This discussion will include reports of early expeditons whose goals were primarily exploration, and those of later scientific investigations. Completion of this preliminary step will allow a discussion and analysis of the known culture history of the area along with what is not known but of potential scientific importance for understanding the archeological record of this part of the north.

Written history of the area of study begins with Captain John Franklin's report of exploration in the year of 1826 (Franklin 1828). The Royal British Navy sent Franklin on an overland expedition intended to map the Arctic seacoast in connection with their effort to find the northwest passage between the Atlantic and Pacific Oceans. He spent the months of July and August on the Arctic coast between the mouth of the Mackenzie River and Foggy Island. He named the Clarence River, Demarcation Point, the British and Romanzoff mountains, Mt. Copleston, the Canning River and many other geologic features. He reports visiting a trade fair located on what he called Barter Island. Since that time, however, this spot has become known as Arey Island (Leffingwell 1919).

Franklin returned to England at the end of this his second expedition, but disappeared on his next journey into the north. However, his work and that of those who followed him investigating his disappearance led to the completion of the basic mapping of the Arctic coast of Canada and, to a lesser extent, Alaska. Franklin's journal provides much information about the country between the Mackenzie and Foggy Island as well as the first descriptions of the natives who inhabited that part of the coast. It is also a fascinating description of the trials and tribulations encountered by those who chose to enter some of the most isolated, difficult, and demanding country ever explored.

The next expedition to enter the study area was commissioned by the Hudson's Bay Company and led by Dease and Simpson in 1836 (Dease and Simpson 1837). Exploring the northern coast and closing the gap between the maps of Franklin and one completed earlier, by Beechey, of the country to the west was their purpose. They named the Franklin Mountains after John Franklin and reported a native village at Demarctaion Bay, but much of their information was regarded as inaccurate or unreliable by later investigators (Leffingwell 1919).

This expedition was followed by several sent out in search of information about the disappearance of Franklin. Reports of these trips were written by several junior military officers (see Leffingwell for bibliographic references). Of some special interest is the journey of the Enterprise (Collinson 1854), because he commanded the first vessel to overwinter in the study area when his ship was frozen in at Flaxman Island not far from the mouth of the Canning River. Collinson attempted to travel from Flaxman Island to Barter Island but turned back due to bad weather. He does, however, report several possible Native village sites between the two islands.

Collinson's work encouraged others to sail eastward from Barrow and soon whalers started advancing a little further to the east each year and eventually reached Herschel Island. Seven ships were reported to be overwinting there during 1849-95. Hunting parties from these ships traveled as far west as the Aichilik River in the study area. More importantly, the concentration of these ships required that large quantities of meat be provided. While these needs were met partly by the efforts of the ships crews, they also relied heavily on the native population to provide meat and other goods in return for trade items. The presence of these goods, including guns, acted as a magnet to draw Eskimos from as far as Anaktavuk Pass. Along with these goods the natives encountered for the first time alcohol and a variety of diseases carried by the whalers. In 1865 there was a measle epidemic among the Mackenzie Eskimo which, evidently, substantially reduced the size of the population.

Contact between natives and whites became more intense during the late eighteen sixties with relatively major demographic changes occurring. From this point on, pre-contact subsistence patterns were constantly under pressure to change and the following quote summarizes the unfortunate occurrances of the next 40 years:

> After the appearance of the American whaling fleet along the Mackenzie Delta coast in 1889, and with the increasing association between the indigenous population and the whalers wintering at Herschel Island and elsewhere, the effects of epidemic disease and the disruption of aboriginal social patterns accelerated rapidly...At the same time as Eskimos were being decimated by disease, local aboriginal culture was being submerged beneath a wave of American and Alaskan Eskimo introductions...The latter were either brought to the area as caribou hunters by the whaling ships, or had moved in on their own in search of new hunting and trapping grounds after the North Alaskan caribou herds had been killed off to supply the excess demands of the whaling fleet...Aborginal Mackenzie Eskimo culture could probably be considered to have become extinct between 1900 and 1910.(McGhee 1974).

From the presentation thus far it should be clear that very little was known of the Mackenzie Eskimo before they all but disappeared. They are mentioned only infrequently in the literature of the explorers and little or no effort was made to learn their customs and history.

Fortunately, just as the Mackenzie people were disappearing the first scientific expedition whose specific purpose was to study the northern Eskimos arrived in the area. This expedition, which arrived in 1908, was led by Vilhgalmur Stefansson and Robert Anderson under the auspices of the American Museum of Natural History. Anderson spent a winter living with the natives in the Hulahula River and provides much ethnographic information (Anderson 1919). These people were apparently mostly western Eskimo that had moved from Barrow and the Anaktuvuk Pass areas.

Stefansson was able to reconstruct some information about the Mackenzie people from two informants (Stefansson 1919). He indicates that there were five distinct groups scattered from about 100 miles east of the Mackenzie River to the Demarcation Point or Icy Reef area. The group of concern here were called the Kigisktarugmiut which were named for the main village of Kiguklayuk on Herschel Island. They occupied the area from Shingle Point to the east of Herschel Island to Demarcation Bay on the west according to Stefansson. However, based on work completed later it appears that these people's territory may have extended as far west as Barter Island (McGhee 1974).

Stefansson and Anderson led the Canadian Arctic Expedition back to the north shortly after their first visit. Stefansson lost his ship the Karluk to the ice although he was not on board at the time. The terrible events that followed were some of the most harrowing reported in the exploration literature. Most of the ships company died although several lived through an incredible human saga.

Anderson's ship made it to Camden Bay where it overwintered at Collinson Point. The crew included Diamond Jenness who conducted the first scientific archaeological excavations at Barter Island. These excavations were brief but established the fact that the spit running east from Barter Island, where the modern landing strip is now located, was a large archaeological site. The arctifacts he recovered resembled those found in the Barrow area that have been assigned to an early Eskimo tradition named the Thule. The significance of this find will be discussed later.

At about the same time as, or a little earlier than, Anderson entered the country Ned Arey and S.J. Marsh arrived to prospect for gold. Little is known of Marsh, but, according to Leffingwell (1919), Arey spent 11 years in the study area and was the first white man to enter the headwaters of the Canning, Hulahula, Okpelak and Jago Rivers. He was also the only full time non-Native resident in the area.

Other scientific parties were also started to enter the area. In 1890 Turner discoverd the Firth River. He was followed by Funston in 1894 and Peters and Schrader in 1901 who were mostly interested in the geography and geology of the area. In addition, a surveying team of the United States Government established the border between the United States and Canada (Leffingwell 1919).

The next scientific investigator to appear in the study area was Earnest de K. Leffingwell (Leffingwell 1919) who records his exceptional work in a fascinating report to the United States Geological Survey. He first entered the north in 1906 as a co-leader of the Mikkelson-Leffingwell expedition which was less than successful, because their ship was trapped in the ice and crushed leading to the departure of Mikkelson. Leffingwell stayed on and during the next decade spent nine summers and six winters in the study area. Given present operating costs in the north, it is of some interest that he did this at a cost of $30,000 and without the support of the Survey or any other institution. Instead, he whaled and traded in an effort to support himself. Leffingwell presents the first accurate chart of the north Alaskan coast, a detailed study of ground ice, a detailed discussion of physiography including past and present glaciation and an analysis of the processes of erosion and deposition under polar conditions. In addition to this scientific data he provides excellent discussions of techniques for living and working in a harsh and unyeilding environment. His description of the process he used in mapping the coast and some of the interior mountains is truely an example of accurate and complete documentation setting a standard for that type of work. In naming many features on his maps he used Native names when he could. This contradicted the traditional policy of naming geographic features for patrons, teachers, government agents or previous explorers and explains the large number of features bearing native names that appear on modern maps of the area. His book is the single best source that is available about this part of the north, and is headquarters on Herschel Island is deservedly listed on the National Register of Historic Places.

While focusing on the historic activities of explorers, prospectors and scientists, this section has not yet discussed the archaeological and historical data about the original natives of the area except in the context of what tidbits could be gleaned from these early writings. Now the focus will be shifted to a discussion of archaeological research that can be used to understand the early human history of the area. Due to the limited amount of work reported for the study area, it will be necessary to expand the discussion to adjacent areas.

The first survey to be conducted in the study area covered the sea-coast from Flaxman Island at the mouth of the Canning to Barter Island (Giddings 1954). This survey located only one small prehistoric mound and an unreported number of historic sites.

Giddings does not provide an exact provenience for the prehisotric site, but places the location "on the eastern shore of Camden Bay, a few miles south of Anderson Point" (Giddings 1955,97). The site is described as a single half-underground house with a shallow midden surrounding it; it is partially eroded into the sea. Acording to Giddings, the styles of bow frames, arrow stems of antler, sealing darts and other artifacts present indicate the site may be earlier than Ekseavik which he dated to the late 14th and early 15th centuries based on dendrochronology (Giddings 1952). Unfortuantely, Giddings' 1955 article is not a report of survey, and no information about other sites or photographs of artifacts from the reported site are included.

The divide between Kongakut and Firth River drainages, Mancha Creek, a tributary of the Firth River, and 40 miles of the upper Kongakut River were superficially covered by survey in 1953 (Ricciardelli 1954). Several caves located 400 to 800 feet above the valley floor in difficult to reach locations were examined and found to be sterile of cultural evidence. Creek banks, old terraces, weathered ridges, willow patches, confluences of tributary streams and other spots the author thought were favorable were examined for prehistoric sites with the same results. Several sites associated with gold mining were evidently located, but the report contains no details. The author also makes vague reference to "cultural material...of the post-contact period" (Ricciardelli 1954).

During the summer of 1961 a survey was conducted in the vicinity of Peters and Schrader Lakes and the foothills and valleys of the Shublik and Sadlerochit Mountains immediately to the north and west. The major objective of this project "was to explore the unglaciated treeless tundra in this narrow constricted zone between the mountains and the sea. It was desired to test the hypothesis that this was a natural route for prehistoric man through this part of the northland. The region selected for investigation seemed to offer a logical unimpeded low-level route for early man into North America" (Solecki et al. 1973).

One of the author of the report had for years hypothesized that this area held a high potential for early sites in North America (Solecki 1951). Although they were far from definitive, the results of this survey did very little to support the hypothesis.

A total of twelve sites that were considered by the authors to be prehistoric were located. Four are termed multicomponent, but none were stratified. Rather, components were identified by extracting artifacts that appeared to fit into traditionsthat had been previously defined based on work done elsewhere. One of these sites contained British Mountain, Denbigh Flint Complex, and Eskimo components. One consisted of British Mountain and Eskimo components, while another contained Denbigh, and Eskimo artifact groups. One of the Denbigh sites had an unidentified component with it. The remaining prehistoric sites either yielded single components or were not identified; two were Eskimo, four were Denbigh and three were unidentifiable. Seven historic tent rings were also located and mapped.

The authors of the report place some of their sites into what may be termed settlement types. Unfortunately, the criteria for these types are never discussed and it is impossible to do more than guess about how they are defined. It appears that sites located on good vantage points for spotting game and having few artifacts are called hunting sites, while sites containing larger numbers of artifacts or those in more sheltered areas are defined as habitation sites. One site is designeated as a hunting site that is also a workshop. The authors discuss the fact that many of these sites are either multi-component or are located very close to each other, and attribute this to similar adaptations to similar environments. This is an assumption based on scattered results from fragmentary glacial geology studies that seem to indicate that the last glaciation did not effect much of the foothill and slope area. While there is no reason to refute this hypothesis, it should be remembered that it has not been conclusively proven by scientific testing.

In responding to legal requirements to identify and evaluate archaeological sites on its lands the U.S. Fish and Wildlife Service has been conducting archaeological investigations on the Arctic Wildlife Refuge for several years. The results of these investigations are still not completely analyzed but some preliminary conclusions can be discussed here. The investigations conducted included survey and limited testing of selected areas of the upper Hulahula River, the foothills around the Kongakut and Canning Rivers and the coast in the Demarcation Bay and Barter Island areas. In addition to this survey and testing program, other areas have been visited as the chance arose.

These investigations have resulted in the identification of more than 40 archaeological and historic sites which combine to cover the period of the last 6000 years. Unfortunately, the sites that may represent an early occupation have not yeilded enough, or the right type of, artifacts to provide secure dating. These possiblly early sites are exclusively small lithic scatters with no "type specimens" present and there was no charcoal or other material dateable by the C-14 method.

At least two and possibly three Thule village sites have been identified in and adjacent to the study area. These sites are scattered along the coast with one located at Barter Island, one at Arey Island, and one at Icy Reef in the Demarcation Bay area. Only the site at Barter Island has been dated and this was through comparison, by Jenness (Whister ), to collections from Barrow. Unfortunately, very little remains of this site because it was almost totally destroyed by the construction of the airport on the island. Only a very few scattered remains can be identified, and occasionally an isolated artifact will erode out of the runway. Only a brief visit was made to the site on Arey Island and placing it in the Thule period is not well substantiated becuase this placement rests only on the feeling of the observer that it is "old" Eskimo. The site at Icy Reef is also not dated with any confidence because it too was only visited briefly and it could be more recent. Several of the sites located in the foothills may result from older Eskimo occupation, but, here again, not enough material was collected to place these sites in a cultural tradition with any degree of confidence.

Most of the sites found during this survey were occupied at one time or another during the last two hundred years. They range in size and importance from a large semi-permanent caribou hunting village with several assoicated burials through concentrations of several tent rings or sod houses some which have one or two associated burials to caribou fencees and, finally, to single tent rings.

Seemingly, the most important of these sites is Turner River Overlook which, is located in the northerly foothills of the Brooks Range. In addition to providing a view of the Turner River and its tributaries, Demarcation Bay and the Arctic Coast, it provides an excellent location at which to await the spring and fall migrations of the Porcupine caribou herd. Limited testing at the site provided evidence of an intensive occupation over an extended period of time. At lest three living floors seem to have been identified as have several firepits. Resting on these floors structrual remains such as medium sized wood structrual members that are usually associated with semi-permanent dwellings. The remains of what appeared to be sod also were identified. Many artifacts made from wood, bone, metal and lithics have been recovered along with the partial remains of at least 18 people . Thousands of fragmented caribou bones have also been identified.

Artifacts that are smiliar in material and construction to those found at Turner River have been found at two fences usually associated with caribou hunting and at tent rings in the Demarcation Bay area. It is possible that these sites were used by one group of people in exploiting a variety of resources in the area.

Although the artifacts present in these sites suggest that they were occupied sometime during the middle to later eighteen hundreds, there is no memory of them in the traditions of the people, most of whom are Western Eskimo, presently living in Kaktovik. This fact and the report of Stefansson that the Mackenzie Eskimo were beginning to die in large numbers and pretty well all dead by the beginning of this century indicate that these sites may represent that last occupation by this group of what is now northeastern Alaska.

Other sites found during the survey represent the remains of the native and white communities that have moved into the country in the last 80 years and will be discussed in the section on recent history and subsistence.

Summarizing these reports of archaeological investigations, it is reasonable to say that thus far little is known of the archaeology and early history of the study area and those areas immediately adjacent to it. All of these surveys were conducted over very limited areas and were extensive rather than intensive in nature in that they were intended to learn as much as possible about broad areas rather than concentrate on small regions and survey them completely. All surveys focused in on locations where the archaeologists expected to find sites based on previous experience and none of the efforts spent much time looking for sites in areas suspected of having low probabilities for yeilding sites. The work of the Fish and Wildlife Service led to the following conclusions about site location (Wilson nd) which seem to be reasonable given the limited archaeological work done so far.

Conclusions

1. Although the density of sites on the Range (Arctic National Wildlife Refuge) is not as high as in areas to the west, it is still high enough to justify definite concern in management decisions.

2. Sites tend to be located on higher ground where wide panoramas are visible, or on modern or fossil river banks.

3. Sites appear to be particularly dense at the mouths of canyons where the foothills end and the Slope begins.

4. There are also many sites on the coast.

5. No sites were found in the mountains high above the Hulahula or Kongakut Rivers probably because of difficulty of access.

6. No sites were found on the Arctic Slope at any distance from the rivers.

The author of the Fish and Wildlife report stresses the tentative nature of these conclusions (Wilson unpubl. data) and in the following quote details the reasons they are not to be relied on too heavily:

> One point that should be very clear from this discussion of field methodology is that this survey was extensive rather than intensive in nature. In an effort to cover as much ground as possible only areas that appeared to have high potential were intensively sampled. Many areas that appeared to have moderate to marginal possibilities as site locations were either completely ignored or only partially sampled. Areas that did not have the appropriate geomorphologic or microenvironmental profiles to fit out preconceptions about "good" areas for site locations were completely ignored. Even in areas of high potential, test pits were always shallow and no serious attempt was made to investigate several apparent paleosols identified during the summer, although pollen samples were taken and will eventually be processed and analyzed.
>
> These characteristics of the survey were known in the planning stage and although not regarded as ideal, accepted, because in the initial stages of research design general information over the larger area was needed. However, one characteristic of the ground cover in the area caused investigators to have some serious doubts about how well sites in the area had been located and this was the relative thickness of the tundra mat in the surveyed area. Experience in other areas covered with tundra indicates that there is a good possibility that we may have missed some sites because time was not taken to sink test pits as often as would have been ideal (Wilson nd).

The limited amount of work done thus far in and adjacent to the study area leaves many questions to be answered about the cultural remains of the area. The questions involve the chronology of the cultural sequence, the processes that produced this chronology and the behavioral significance of the cultural remains present. In order to make the limitations of this knowledge clear it is necessary to provide a general discussion of what is known or suspected about the cultural remains of the northern area of Alaska and northwestern Canada so that they can be compared to those of the study area. Comparing the two will verify the limited nature of the knowledge of the study area and result in a list of archaeological questions that need to be answered for the study area. As will become clear during the discussion, even the more general history is only incompletely understood and some of the questions developed for the study area will have relevance at this general level.

Table 1 presents one author's provisional outline of North Alaskan Culture history (Hall 1981). It represents the only attempt that is available in the literature of the area, at synthesizing this information and will structure the discussion that follows. Prior to discussing the table, however, two omissions should be mentioned; these are the British Mountain Tradition and certain finds from the Old Crow Basin.

| | | | |
|---|---|---|---|
| Late prehistoric Inupiat (Western Thule) | A.D. 900-1858 on coast; ca. 1300-1858 in interior. | Walakpa: 840±90 B.P.=A.D. 1110. Some radiocarbon dates from Alyeska Pipeline corridor may date sites occupied during this period. | Nuwuk and other sites around Barrow, Walakpa, Nunagiak, Agergognat, Liberato Lake, Swayback Lakes, Tukuto Lake, Lake Betty, Kinyiksukvik, Etivluk Lake and others. |
| Kavik (Kutchi) | A.D. 1450-1850 | Atigun: 115±140 B.P.=A.D. 1835; 360±100 B.P.=A.D. 1519; 310±140 B.P.=A.D. 1640; 168±34 B.P.=A.D. 1782, etc. | Kavik, Atigun. |
| Late prehistoric Inupiat (Western Thule) | A.D. 900-1858 on coast; ca. 1300-1858 in interior. | Walakpa: 840±90 B.P.=A.D. 1110. Some radiocarbon dates from Alyeska Pipeline corridor may date sites occupied during this period. | Nuwuk and other sites around Barrow, Walakpa, Nunagiak, Agergognat, Liberato Lake, Swayback Lakes, Tukuto Lake, Lake Betty, Kinyiksukvik, Etivluk Lake and others. |
| Kavik (Kutchi) | A.D. 1450-1850 | Atigun: 115±140 B.P.=A.D. 1835; 360±100 B.P.=A.D. 1519; 310±140 B.P.=A.D. 1640; 168±34 B.P.=A.D. 1782, etc. | Kavik, Atigun. |
| Punuk | ca. A.D. 900 | — | Nunagiak |
| Birnirk | A.D. 500-900 on coast; interior apparently not | Anderson Point: 1130±200 B.P.= A.D. 820; 1160±240 B.P.=A.D. 797; 1090±300 = 867 A.D. Kugusugaruk: 1430±90=A.D. 527; 1146 ±95=A.D. 811; 1430±190=A.D. 520; 1146±95A.D. 804. South Meade #1: 1260±65 B.P.=A.D. 690; 1340±55 B.P.=A.D. 610; 1420±110 B.P.=A.D. 530. | Anderson Point, Birnirk and other sites in Barrow area, Walakpa, South Meade #1. |
| Old Bering Sea | ca. A.D. 500 | — | Birnirk and other sites in Barrow area. |
| Ipiutak | A.D.0. - A.D.700; may have co-existed with Birnirk for some time. | Five dates on material from the Feniak Lake site, in the Noatak drainage, which is comparable to Anaktuvuk Pass Ipiautak, average A.D. 500. | Anaktuvuk Pass, Itkillik Lake. |
| Norton | 1500B.C.-A.D. or slightly later | Gallagher Flint Station: (Hearth 1 2920±155 B.P.=970 B.C.; (loc. 1A) 2620±175 B.P.=670 B.C.; (Loc. 5) 1975±125 B.P.=25 B.C.; 2540±185 B.P.=590 B.C.; (Loc. 7) 1735±150 B.P.=A.D. 215; 2640±180 B.P.=690 B.C. and others. | Sites in Barrow area, BAR-095, Walakpa, Sisraruq, Avak Point, Tukuto Lake, Kayuk and Avingak in Anaktuvuk Pass, numerous sites along Alyeska Pipeline corridor including Gallagher Flint Station. |
| Choris | | Other radiocarbon dates from Alyeska Pipeline corridor may date sites occupied during this period. Dates on the brief Avingak occupation at Anaktuvuk Pass range from 1500 to 3000 years ago. | |
| Walakpa | ca. 1500 B.C. | Walkpa: 3400±520 B.P.=1450 B.C. | Walakpa and Coffin. |
| Denbigh Flint | ? 2300 B.C. - 500 B.C.? | Punyik Point: 3660 ± 150 B.P.= 1710 B.C.; another date of 650 B.C. was discarded as being too late. No Name Knob: 3440±160 = 1490 B.C.; 3855±155 = 1905 B.C. Blip: 3480±180 = 1530 B.C. Mosquito Lake: 5 dates ranging from A.D. 20-40±150 to 880-900±165 B.C.; a sixth date (2040 + 170 B.C.0 believed to be culturally invalid. | , Kurupa Lake, Etivluk Lake it Anaktuvuk Pass, te and other sites along the e corridor. |
| Tuktu | ? 4500 B.C. - ? area may have been uninhabited for a period before Denbigh times. | Tuktu: seven dates range from 4500 B.C.-200 B.C., but earlier dates believed correct on basis of dated sites outside Northern Alaska. | rtu, Lisburne, sites along l .s corridor. |
| Lanceolate Point | 6000-5000 B.C. | Mesa: 7620± 95 = B.C. | Kahurok, Mesa, Naiyuk (Anaktuvuk Lisburne, Bedwell (Putu site). |
| Fluted Point | ca. 6500 B.C. | Putu: 6090±150 B.P= 4140 B.C.; 8454 ± 130 B.P.= 6504 B.C.; 11,470±500 B.P.= 9520 B.C. | tes, Lisburne, Putu, nds elsewhere? |

The British Mountain tradition was originally identified in a site located on the northern Firth River (McNeish 1956) and its investigator thought it to be quite old. Later work in Canada provided a secure date of 5400 BP (Gordon which was more recent than originally thought. The report of Salwin et al., summarized earlier, identified this tradition as occuring in the foothills of the Brooks Range just south of the study area. However, some scholars doubt the existence of the tradition (Dekin ). For the purposes of this report, the possibility that the Tradition does exist will not be rejected but the 5400 BP date rather than an earlier one will be used. Rather than try to place the tradition in Hall's chronology, it will be considered separately and, its existence and possible relationship to Hall's Paleo-Amerind will be apotentail research question.

The problem of the Old Crow finds also requires discussion because there is a relatively widely accepted date of 27,000 B.P. for a caribou bone flesher from that area (Irving and Harrington 1978). Those who accept this date tend to disregard the facts that the flesher was secondarily deposited and that it very much resembles tools seen in modern Athapasckan camps during the historic period. Even if these facts are ignored, it is difficult to discuss these finds further because the archaeological evidence is so limited and confusing that there are no other locations where convincing supporting finds have been made. Other data such as paleogeography, climatic history and vegetation that could help clarify the situation are also incomplete. So, while these finds can not be totally disregarded and should be added to Hall's chronology the likelihood of encountering them in the study area is not very high.

In returning to Hall's cultural sequence it is necessary to make some general comments about its utility. When Hall proposed this outline he explained that any attempt to establish a chronology for this area must include a set of compromises. The lack of scientific archaeological investigations in northern Alaska has led to a situation where there are areas of disagreement between archaeologists about some of the criteria used to place assemblages into groups. For example. there are disagreements about which sites should be included in Ipiutak. There is also disagreement about the relationship to the modern Inupiat of the cultures that make up the Arctic Small Tool Tradition. Some archaeologists see a continuum from the ASTT to modern Eskimo while others suggest they may only be related in some indirect way that is not well understood. In addition, the relationships between Norton, Charis and Denbigh is confusing at best. Finally, there ae dicrepancies in radio-carbon dating that have not been adequately adressed.

These discrepancies of chronology are only part of the problem reflected in the limited scientific archaeology that has been done in Northren Alaska. The goal of archaeology is more than collecting and cataloging archaeological specimens; it is understanding the human behavior associated with the specimens and their distribution. It asks not only what and where tools were used by a group but why, where and how. It also seeks answers to questions about other aspects of behavior besides those directly reflected in tool use and distribution such as the size of the groups involved and the structure of social relations they had both within and between small groups.

Most of these behavioral questions have yet to be addressed in any meaningful way by the archaeological community working in northern Alaska. Without answers to some of these questions, the names assigned to "cultural tradition" have little meaning in behavioral terms. Rather they are little more than names of collections of similar artifacts that have only limited behavioral significance. What significance in behavioral terms they do have is derived from inferences about how these tools and their locations may have facilitated subsistence activities. Thus, if an archaeological site is located where fish are available and contains leisters it is reasonable to assume the people were there to fish. Until archaeologists can go beyond these simplistic statements about the things they study, it will not be possible to feel secure in thinking that the cultural traditions they discuss mean very much. However, rather than rejecting Hall's chronology as inadequate the practical alternative is to use it as the best one available while keeping its limitations in mind, and to hope that future research in the north and in the study area in particular will help to eliminate some of these limitations.

Review of the table shows that the culture history of northern Alaska has been occupied for much longer than has the study area . Whether this is due simply to the limited amount of investigation completed thus for, or to the fact that the bearers of the American Paleo-Arctic, Paleo-Amerind and Northern Archnic Traditions never occupied our study area is not clear. There is, however, no reason to reject the possibility that they may have been present in the area, and this possibility should be investigated in future work there as a research question.

The status of the Arctic Small Tool Tradition in the study area is even more unclear than it is for northern Alaskan in general. While the relationships between the cultures of the tradition are vaguein the larger area, (as discussed above) it has at least been possible to make tentative distinctions between them. As was suggested in discussing the work done in and near the study area, the few sites thus far indentified have not yielded collections large enough to even be positive they represent the Tradition itself. Certainly, it has not been possible to assign these sites to specific cultures. Here again, it is reasonable to believe that future work, particularly if it covers a wider geographic area, will yield sites containing inventories adequate for the purposes of assigning them to a specific culture. If enough of these sites are discovered and if investigations are structured appropriately it may even be possible to make inferences about some of the behavior associated with them or, at least, to test some hypotheses about this behavior.

It is presently difficult to be sure of the specific relationship of the older sites at Barter and Arey Islands to those Birnirk sites to the west. As was mentioned earlier, Jenness thought the collection from Barter Island was similar to collections from Barrow, but the fact that this work is almost 70 years old suggests that additional comparisons are appropriate. Because the site at Barter Island has been almost totally destroyed, the best way to do this would be to conduct excavations at Arey Island and compare the collections recovered to those from Birmirk sites to the west. It is also possible that this would also result in some tentative conclusions about whether Old Bering Sea and Punuk peoples ever got as far east as Barter Island. Excavation at Arey Island would also provide very valuable information about what a trading site looked like from an archaeological perspective.

Those sites Hall includes in his Athaspackan Tradition are all in the Brooks Range and our study area does not extend that far south so it is not very probable that future work will find sites from this tradition. However, one caveat should be made. Stefansson (1914) indicates that Indians from the Arctic Village area used the Hulahula River as a travel route when attending the trade fair at Arey Island which Franklin may have observed, and it may be possible that survey on this river will identify Indian sites.

There have been many Eskimo sites dating to within the last 200 years identified in and near the study area. Of these the most interesting due to its size and complexity is Turner River Overlook which is out of the study area. However, there is no reason to believe that the site is unique in that it was seemingly located primarily to effeciently exploit caribou. The possibility that there may be more sites of this kind should be investigated during future work. These sites hold a tremendous potential for providing data about a wide range of archaeological questions based on the theories of cultural ecology. There are also definite possibilities that other caribou fences and tent rings representing early modern Eskimo will be identified and questions about their structure and function and how they are related to the larger sites in the area may be addressed.

Thus far this section has discussed what is known about the study area and adjacent lands, suggested foci for future work, and indicated that this additional work is necessary due to the almost incomplete archaeological record for the study area. It is now necessary to turn to specific questions of impact assessment and mitigating procedures. The procedures suggested should be completed in such a way as to insure that the questions addressed here or others of archaeological importance are addressed.

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# Recreation

"When Alaska Recreation is viewed from a national standpoint, it becomes at once obvious that the highest value lies in the pioneer conditions yet prevailing throughout most of the Territory... In Alaska alone can the emotional values of the frontier be preserved... Alaska is unique among all recreational areas belonging to the United States because Alaska is yet a wilderness" (Marshall 1938:213).

The following discussion of recreation excludes subsistence use by local rural residents. Local use of the resources on the ANWR is deeply entrenched in a subsistence lifestyle that is covered in the subsistence section of this study.

Recreational use of the ANWR is varied and is related to wildlife or wilderness values. Recreationists are attracted to the ANWR because of these values not easily found elsewhere, especially in the lower forty-eight states. Recreationists usually choose a recreational experience in the refuge because of its outstanding wilderness characteristics, opportunities to explore a remote, untamed area, an opportunity to view wildlife, and a chance to experience solitude and tranquility. Solitude and tranquility are considered very important parts of a wilderness experience by most visitors (Hendee et al. 1968; Rossman et al. 1977). Esthetically, the ANWR offers exceptional opportunity to experience pristine arctic and subarctic habitats. Lucas (1980) indicated that some wilderness visitors placed priority on recreational opportunities while others placed priority on finding a natural ecosystem. No such research has been conducted on visitors to the Arctic. This is a definite need.

The most common form of recreation in the refuge is hunting, followed by backpacking/hiking and floating rivers. Hunters, both guided and non-guided, seek Dall sheep, moose, caribou and brown bear. Other recreational pursuits on the refuge include wildlife observation, photography, mountain climbing, cross-country skiing, fishing and nature study. In connection with subsistence activities, or solely for recreation, local residents also engage in snowmobiling and dog mushing.

Available data on recreational uses of the ANWR is very limited. Two surveys were conducted during the 1970's giving a base of information on recreational use; no annual surveys have been conducted on the refuge. A 1975 survey (Ritchie 1976) estimated 281 sampled visitors (exclusive of industry and research personnel, Native community residents, and DEW-line site employees) to be 75% to 90% of the total visitation. Most people visited the refuge between June 1 and September 15. Warren (1980) estimated 435 visitors in 1977, exclusive of subsistence users. Visitation in the 1970's increased over that of the 1960's. Recreationists, particularly hunters, increased rapidly in numbers in the early 1970's, and then leveled off to a more steady increase after 1974 (refuge files). The above mentioned studies were completed within the boundaries of the pre-ANILCA Arctic "Range". With the addition of 9 million acres to the refuge new visitor use estimates are being made. The best estimates of yearly visitation to the entire refuge, exclusive of subsistence users, is 900-1000. Visitation to this area is low because of cost, access and limited facilities.

Visitors to the refuge come mostly from Alaska and the contiguous Pacific states and most are between the ages of 25 and 45 years old (Warren 1980). The average stay in Warren's study was 10.6 days for hunters and 13.4 for non-hunters. These visitors seek a recreational experience with many different goals -- hunting, experiencing the wilderness, photography, etc. Not all goals require a true wilderness setting; some recreational experiences are available in non-wilderness settings. Management goals of the Arctic NWR until this time have been to preserve the option of a true wilderness experience for those types of recreationists who require it for their recreational experience. This direction is expected to continue into the future.

It is difficult to isolate recreational uses of the study area from the remainder of the refuge area, especially the contiguous Brooks Range. Many recreational experiences rely on a continuous trip from the mountains, across the coastal plain to the coast or vice versa. Every year, visitors hike from Barter Island to Arctic Village, or from drop-off points in the Brooks Range to Barter Island. The esthetic values of such trips have never been measured, but nowhere else on the coastal plain of Alaska is this experience still available across undisturbed habitat, with the Brooks Range in such close proximity to the ocean(Fig.1).

Recreation on the study area is based on the natural features and natural resources of the area including vegetation, wildlife resources, and the scenic and esthetic resources which are difficult to quantify. The potential for high-impact recreational uses such as snowmobiling in the study area is not great; a low use, high quality level of primitive recreational experience is appropriate.

There are no recreational facilities in place on the study area, and none are planned. The abandoned DEW-line sites at Camden Bay and Beaufort Lagoon may occasionally be used by recreationists.

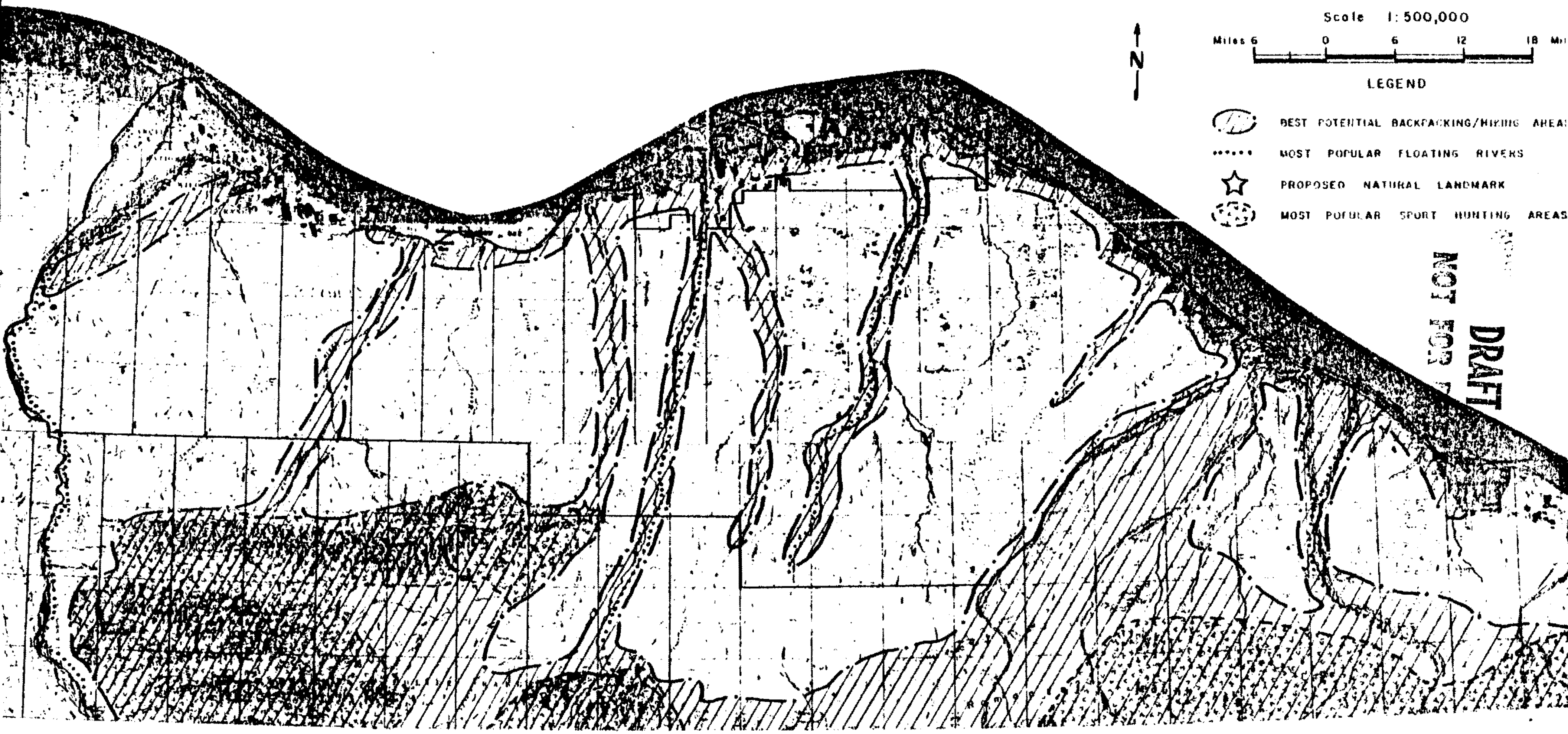
Present recreational use on the coastal plain study area is light, but Warren (1980) states that of all the refuge visitors, 4.1% of the hunters and 17.9% of the non-hunters visited the western part of the coastal plain, and 4.1% of the hunters and 26.3% of the non-hunters visited the eastern coastal plain (Fig. 2). This would indicate approximately 90-110 annual visitors to the coastal plain study area. More definitive information on the numbers of visitors is needed for the entire refuge as well as for the coastal plain area.

Visitors usually arrive on the coastal plain via commercial air service to Kaktovik or Prudhoe Bay and by aircraft charter from there to their destination. Kaktovik (Barter Island) is served by Wien Air Alaska and Air North; Prudhoe Bay (Deadhorse) by Wien Air Alaska. Other visitors may arrive by foot, hiking from drop-off points deep in the Brooks Range or from Arctic Village. Visitors floating rivers begin trips on rivers within the Brooks Range and float north to pick-up points on the coast or on the coastal plain. Some kayak groups float to the coast and then paddle in the lagoons to Barter Island. The river corridors are especially important to most visitors because they serve as navigational aids and they provide easy hiking routes across otherwise difficult terrain.

Recreational activities conducted on the coastal plain study area include nearly the same activities as those already mentioned for the entire refuge area. The highest use of this area is probably by backpackers/hikers, and, secondarily, by boaters. Hiking is good along the coast and along the

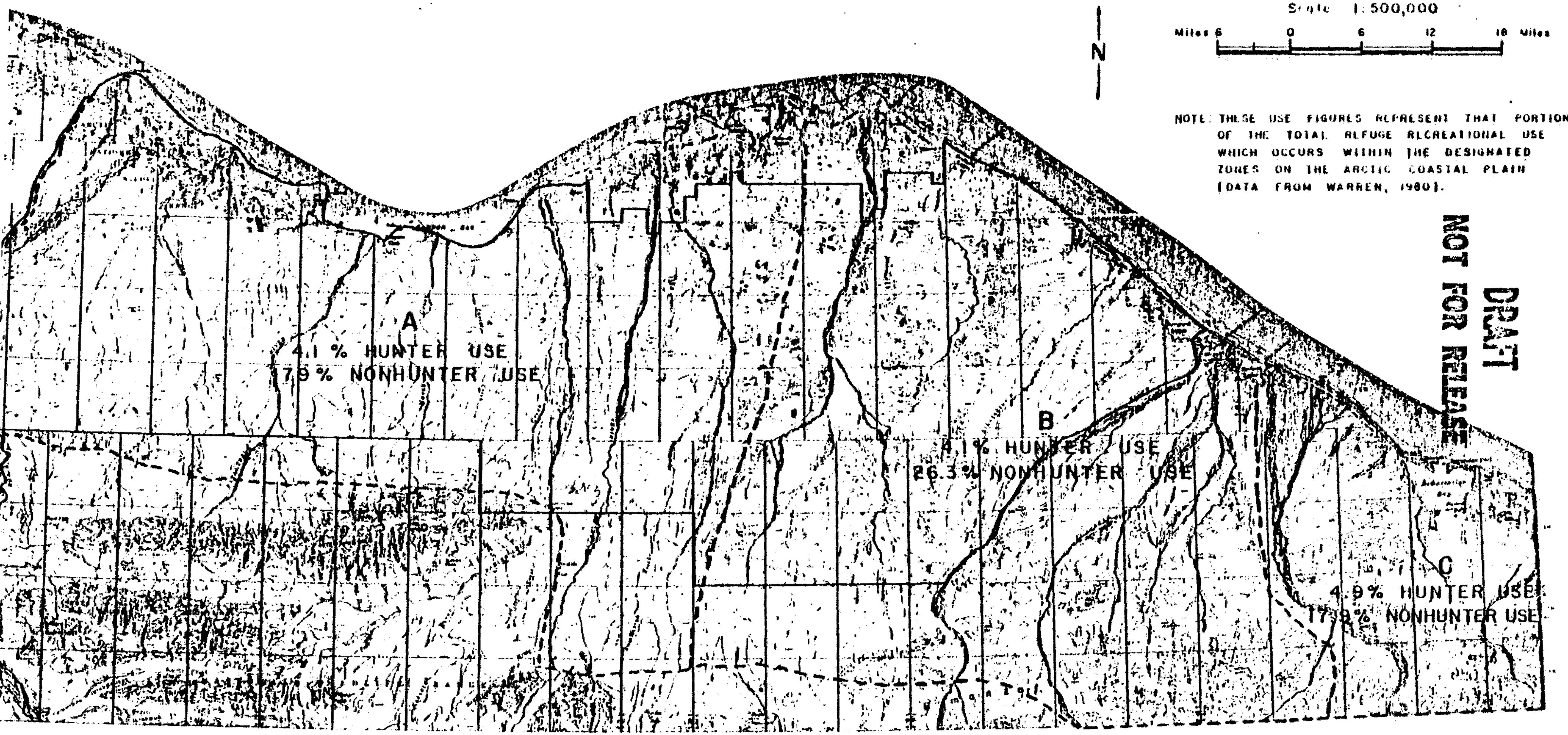
# ARCTIC COASTAL PLAIN BASELINE STUDY

FIG. 1 RECREATIONAL USE MAP



# ARCTIC COASTAL PLAIN BASELINE STUDY

FIG. 2 DISTRIBUTION OF RECREATIONAL USE BY HUNTERS AND NONHUNTERS



NOTE: THESE USE FIGURES REPRESENT THAT PORTION OF THE TOTAL REFUGE RECREATIONAL USE WHICH OCCURS WITHIN THE DESIGNATED ZONES ON THE ARCTIC COASTAL PLAIN (DATA FROM WARREN, 1980).

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river courses in the coastal plain. Cross country hiking is difficult because of wet, tussocky terrain. Most hikers are probably enroute from the mountains to the coast when traversing the coastal plain. Boaters utilize rafts or kayaks to navigate the river courses; the more popular floating rivers are the Canning, Hulahula and the Jago. Canoes are not a very practical craft on the rocky, shallow north slope rivers. Hunting is not as popular on the coastal plain as it is in the mountains because there is no Dall sheep habitat; however, one hunting guide does operate in this area. The area is not yet assigned to him as an exclusive guide area by the state as he is still in the process of application. Hunts are guided for caribou and brown bear. Other recreational activities include wilderness enjoyment, nature study, photography, fishing and wildlife observation. These activities may be the major purpose for the trip, but are more usually done in conjunction with other recreation such as hunting or backpacking. The residents of Kaktovik engage in snowmobiling and cross country skiing on occasion. (Fig 3).

Specific numbers of participants engaging in these activities are difficult to obtain. Some information is available from air charter operators, but not all visitors utilize charter services. There is a definite need to more accurately and routinely obtain visitor information for the entire refuge area. Annual information on visitor numbers, activities, length of stay and destinations would be useful management information.

# Wilderness Values and Natural Landmarks

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## Qualifications for Wilderness classification

The Wilderness Act of 1964 addresses six characteristics to be considered in a wilderness evaluation:

1. Size
2. Naturalness
3. Opportunities for solitude
4. Opportunity for primitive and unconfined type of recreation
5. Ecological, geological, scientific, educational or historic values
6. Posibility of returning to a natural condition

Size: The unit considered here (960,000 acres) meets the size characteristic, i.e., the unit exceeds 5,000 acres and is of sufficient size as to make practical its preservation and use in an unimpaired condition.

Naturalness: With few exceptions the entire area is primeval. Exceptions are the three military reservations on the coast and some lands on Barter Island. Throughout the rest of the area the works of man are substantially unnoticeable. Some tractor tread marks near the coast are visible at times. On some maps these tracks are incorrectly noted as a tractor trail. The tracks are the result of some random travel approximately 25 years ago. The tracks are substantially unnoticeable at this time.

Opportunities for solitude: The 960,000 acres of primeval lands offer excellent opportunity for solitude. The opportunitites for solitude are further enhanced by the wilderness status of the land immediately south and east. To the west of the unit land is used primarily by the oil and gas industry. A minimal amount of recreational use comes across the border. The Arctic Ocean lies north of the area.

There are no designated trails for wilderness travelers, but most travel occurs along river courses. However, even in close proximity to another party, the meandering shape of stream valleys provides adequate opportunity for seclusion.

Opportunity for primitive and unconfined type of recreation: The characteristics that provide opportunity for solitude, already mentioned above, also provide the situation for primitive and unconfined recreation, especially hiking, skiing, photography, wildlife observation and wilderness enjoyment. A special feature of the unit is the openness and unconfinement.

The land is an undulated plain carpeted with very short vegetation. The vegetion, except for some willow thickets on stream bottoms, is less than a foot in height. A visitor, and the wildlife too, is conspicuous on this open plain. To the north the view is down to the Arctic Ocean with its ice flows and ice cakes. To the south the view is up to the highest mountains in the Brooks Range. East and west the flowered plain extends in undulating waves further than the viewer can see.

The shallow valleys of the numerous streams that flow north across the unit to the Arctic Ocean provide good camping sites. Gravel outcrops on the plain above provide a camp site with very broad views. The streams in the area are not navigable by conventional power boat and most are not handily navigable by canoe. Rafts or kayaks provide the best crafts for river running.

The Arctic Ocean beach reef system is composed of sand and small gravel. The beach, with the Arctic Ocean to the north and the broad coastal plain on the south and the general absence of man's work offers extensive primitive and unconfined camping and wilderness enjoyment opportunities.

Ecological, geological, scientific, educational, and historic values: The ecological, geological, scientific and educational values are the interdependent values that constitute wild lands. The geologic formations of beach gravel and sand formed by the Arctic Ocean are used as nesting and resting sites for marine and other wild birds. Bearded seals and harbor seals rest on the ocean spits and gravel reefs. During early winter polar bears excavate their dens in the snow drifts that form where creeks, especially Marsh and Carter Creek, have worn declivities into the earth. Where streams become slower as they reach the ocean they form deltas with many small ponds and marshes that are nesting sites for waterfowl and shore birds that feed in the ocean and along the beaches. Caribou, grizzly bear, wolves, fox, and muskoxen inhabit the unit. The lower coastal plain is an important calving area for the Porcupine caribou herd.

Many historic sites are located within the unit, primarily along the coast. Historic sites and traditional land use sites are often considered one and the same.

This stretch of Arctic Coastal Plain is the last such area in Alaska that has not been committed to man's activities. As such, it has extremely high values as a remaining example of the natural coastal arctic ecosystem. Its ecological, scientific and educational values as such an example are almost incomparable.

Possibility of returning to natural conditions: The military reservations at Camden Bay and Beaufort Lagoon are slowly returning to natural condition throughout the process of beach erosion, thermofrosting and frost tilling. The Fish and Wildlife Service is slowly removing some of the man-made objects from the sites. If all man-made objects are removed the sites will assume a natural condition in less than 200 years.

The military reservation and some other refuge lands on Barter Island should be excluded from Wilderness classification because of the lack of naturalness, proximity to the town of Kaktovik and little possibility of returning to a natural condition in a reasonable time.

### Natural landmarks

Two sites within or immediately adjacent to the study area have been recommended for inclusion in special recognition systems. Bliss and Gustafson (1981) note that Sadlerochit Mountains and Warm Springs have been nominated for inclusion as a National Natural Landmark site. The goal of the National Natural Landmarks Program, established in 1963, is to inventory and characterize sites that best illustrate the diversity of our nation's natural heritage. The approximate size of the site is 93,313 ha. The Sadlerochit Mountains themselves lie outside of the study area; the Sadlerochit Springs lies on the boundary of the area. This nomination was made because it contains the furtherest north population of Dall sheep in North America and because of the warm water aquifer and lush vegetation (Bliss and Gustafson 1981).

An additional site has been nominated for consideration for inclusion in a statewide system of Ecological Reserves. The Jago River drainage, according to Stenmark and Schoder (1974) contains "a complete array of tundra and flood plain vegetative and animal types typical of the North Slope." The complete river drainage from headwaters to mouth is included in the proposal; much of the proposal is included in the study area.

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# Chapter VIII
# EXPLORATION ASSUMPTIONS

The Secretary directed the U.S. Geological Survey to provide the Fish and Wildlife Service with a set of exploration assumptions, which the Service would use as a basis for developing the initial report of the baseline study. These assumptions were used primarily in preparation of the impacts analyses sections of the baseline study report.

However, for the purposes of this baseline study, the USFWS considered these assumptions as a starting point for defining the study. The stipulations attached to the assumptions (Attach. II) were also considered to be a starting point for developing more detailed site-specific operating stipulations that would address the unique environmental conditions of the ANWR Arctic Coastal Plain. The USFWS also considered all possible seismic exploration techniques and periods of activity when developing this baseline study. The following materials are the exploration assumptions as provided to the Service by U.S. Geological Survey on 26 May 1981:

## Assumptions Regarding Exploration Activities for Use on Forecasting Human and Environmental Impact on Fish and Wildlife and Their Habitat in the Arctic Refuge Study Area

General: These assumptions reflect the current operating stipulations and the types of support facilities that would be necessary to carry out exploration within the study area. Exploration would involve surface geologic investigations, and seismic, gravity, and aeromagnetic surveys. The exploration activities are described as operational scenarios in order to provide a framework for quantifying the possible range of impacts. The scenarios represent our best judgement on how industry would approach the exploration of this area. Two scenarios are provided: (1) a scenario for broad reconnaissance level surveys, and (2) a scenario for area specific surveys. The scenarios are intended to describe in general terms the type of activities involved, time and method of operation, and equipment that would likely be used. The scenarios are not intended to reflect the specific programs which industry would propose subsequently for Departmental approval.

Operating stipulations have been developed based on experience gained in arctic operations. The environmental evaluation in the baseline study should take into account those stipulations when forecasting the type and magnitude of potential impacts. The stipulations are contained in attachment I of this paper. It is our understanding that the baseline study and the environmental impact statement on exploration activities, as required under Section 1002 ANILCA, will serve as a basis for modifying the earlier developed operating stipulations to ensure that exploration activites within the study area would be carried out in a manner that protects the wildlife and their habitats.

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## Exploration Scenarios

The exploration scenarios are premised on the basis that the seis- mic field work will be restricted to the winter field season.

Scenario 1--Reconnaissance Level Surveys
Under normal circumstances, winter field exploration would start in mid-October or early November. The first winter field season will likely be devoted to carrying out reconnaissance level surveys.

Seismic surveys: A reconnaissance level seismic survey would involve running seismic traverses to form a grid pattern. The grid pattern would extend to the boundaries of the study area. Up to 2,200 line miles may be required, depending on the grid pattern selected. The grid pattern may range between a spacing of 3 by 6 miles and 6 by 6 miles, depending on geologic factors. The seismic traverses would be oriented to form a grid of lines parallel and perpendicular to anticipated structural trends. As many as four seismic crews may be required to complete a reconnaissnance level survey for the entire study area within one field season. The operating procedures are discussed under the section titled Opera- ting Procedures Using Different Seismic Energy Sources.

Gravity surveys normally would be conducted concurrently with the seismic surveys. A grid pattern on a spacing of ! to 1 mile would be established and gravity meter readings would be taken at the points where the grid lines intersect. ✓

Geologic and aeromagnectic surveys likely would be conducted during the summer. A tent camp likely would be used to support the geologic survey team. The transportation of crew could require up to 5 hours of helicopter flight time daily. These flights would be less than 1,500 feet above ground.

The aeromagnetic surveys would be flown at an altitude of 1,500 feet or more with the flight lines spaced 5 miles or more apart to form a grid. Approximately 1 month may be required to complete the survey because of weather conditions.

Scenario 2--Area Specific Seismic Surveys
Once ~~One~~ reconnaissance level surveys are completed and the data ana- lyzed, subsequent regional or area specific seismic surveys may be required. The objective of these surveys would be to better define any apparent structures in the underlying strata identified by the reconnaissance surveys. These surveys would be conducted in a similar manner as those at the reconnaissance level and would require similar type and degree of logistical support. ✓

The major difference between reconnaissances and area specifc surveys is the spacing of the grid pattern. The spacing for the area specifc grid pattern would be much closer, i.e., between a 1 by 1 mile to 1 by 3 miles spacing. As much as 1,000 seismic line miles for area specific surveys may be required. The area specifc surveys would probably be limited to particular regions within the study area, but might also be utilized to fill in data points missed during the reconnaissance level survey. Up to two crews may be required to complete this effort in one field season.

However, industry may wish to extend this over at least two additional field seasons.

Logistics to Support Reconnaissance and Area Specific Surveys
These exploration activities will require establishing a temporary base camp to house and feed the crews. A tent camp or a sled- mounted trailer camp would be used, depending on the time of the year and type and diversity of field work to be done. A tent camp would have from between 12 to 16 tents and house about 20 people. A trailer camp would be comprised of up to 20 sled-mounted trailers for use as offices, shops, living quarters, and other support facilities. A D-7, or similar size tractor, would be used to pull a string of four trailer. The gross weight (GW) of a single trailer is 42,000 pounds or less and would exert between 5 and 6 pounds per square inch (psi) of ground pressure. The GW of a D-7 tractor is 51,300 pounds and would exert about 6.3 psi ground pressure.

Supplies and personnel probably would be transported to the camp by aircraft. Normally, about three supply flights would be required each week to maintain a seismic crew which averages about 45 people. Crew changes would occur every 2 to 3 weeks. A twin turbine, medium size STOL type aircraft is commonly used for these purposes. In addition, helicopter support will be required to transport supplies, equipment, and personnel in the study area, e.g., Bell 206. The helicopter flights are normally at 1,500 feet, or less, above ground level.

Operating Procedures Using Different Seismic Energy Sources
A surveying crew would precede the recording crew to mark the seismic traverses, source points, and locations for the geophones. Source point spacing may vary from 220 to 880 foot intervals.

In actual operations, the geophones are placed along the surveyed line at equal distances on either side of the source point. The geophones are connected by electrical cables to recording instru- ments. Geophones may be layed out along as much as a 5 mile segment (spread length) of the traverse at one time. After the energy from one source point is recorded, the cable and geophones behind the source point would be moved forward in a leap-frog fashion and layed out in advance of the existing spread.

The exploration crew would operate out of a sled mounted, fully self contained trailer camp. The camp string would normally follow the spread in a single line within a few miles of the operation. Vehicular traffic is generally restricted to an area within 300 feet adjacent to the seismic line.

This paper descirbes three methods using different seismic energy sources for accomplishing seismic surveys. Attachment II is a listing of the equipment used to conduct such surveys. The attach- ment lists the gross weight of the equipment and the ground pressure exerted by the equipment.

The conventional approach is to use explosives placed in drilled shot holes 60 to 70 feet deep. The holes are 3 1/2 to 5-inches in diameter and are spaced at intervals between 440 and 880 feet along the spread. The holes are loaded with explosives normally between 50 and 100 pounds of pelletized ammonium nitrate and a 10 pound solid primer charge and cap. Blasting wires are run to the surface and each hole is back filled with the drill cuttings. The charges are normally detonated one hole at a time; however, simultaneous detonation of charges arrayed about the source point may be utilized in special circumstances.

Another method is to use vibration equipment as the energy source. Three or four vibrators are arranged in line at the center of the geophone spread, 40 to 50 feet apart from the source point. The vibrators are activated in unison for 12 to 16 seconds, moved forward in tandem at distance of 18 to 24 feet, and activated again. This process is repeated 10 to 13 times at each source point.

A third method, air shooting, which is a modified conventional method, involves the use of one or more charges, normally up to 5 pounds, layed in a pattern on the ground or attached to stakes 4- to 5-feet above ground at the source points. The total explosive charge detonated at a source point would be up to 60 pounds These explo- sives charges are detonated simultaneously.

Summer Seismic

In the Arctic, seismic surveys have been restricted to the winter season. However, industry recently expressed interest to accom- plishing summer seismic surveys in the National Petroleum Reserve- Alaska (NPRA).

For the purposes of environmental evaluation you may wish to eva- luate the impacts that could possibly result from summer seismic operations. There are many similarities in conducting summer and winter seismic operations. Both are conducted using either the conventional or modified conventional approach discussed above. The basic differences are:
- type of base camp facilities.
- prohibition on the use of surface vehicles.
- the increased use of helicopters.

The summer field season would be June to October. A tent camp would be used as the base of operations. It would be located in such an area to allow for supplies to be transported to the base camp by fixed wing aircraft. The camp would need to be moved about every 30 days to keep pace with the operations. Helicopters would be used to transport the people, equipment, and supplies to the work area. Air compressors, transported by helicopters would be used as the power source for the drilling of the shot holes, if the conventional method is used. Approximately 12 hours of flight time would be required daily, mostly at low levels.

Attachment I

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## Stipulations for Arctic Seismic and Related Geophysical Operations

1. Seismic Survey Operations are to begin only after the seasonal frost in the tundra and underlying mineral soils has reached a depth of 12 inches; the average snow covers a depth of 6 inches. This condition normally occurs during the period of mid October to November 1.

2. Seismic operations will cease when the spring melt of snow begins; approximately 5 May in the foothill areas exceeding 300 feet in elevation; approximately 15 May in the northern coastal areas.

3. Clearing of drifted snow on a lake or river ice surface for aircraft operation and the clearing of drifed snow along a trail, seismic line, or in camp is permitted to the extent it is necessary for safe operation and if it does not disturb the tundra mat.

4. Camps will be situated on gravel bars, sand, or other durable lands where feasible. The leveling of trailers or modules is to be accomplished with surface blocking anywhere there is a vegetative mat.

5. Camps may be located on lake or river ice which is determined to be frozen to the bottom provided that no sewage effluent, fitered waste water, toxic or hazardous materials, petroleum products or solid wastes are allowed to be dumped onto the ice.

6. Exploration activities will employ low ground pressure vehicles of the Rolligon, ARDCO, Trackmaster, Nodwell or of a similar type. However, tractors, equipped with wide tracks or "shoes," may be used to plough snow or to pull the camp trailers. Any other use of tractors will require the written approval of the USGS Regional Manager or authorized representative.

7. All operations shall be conducted with due regard for good resource management and in such a manner so as to not block any stream, or drainage system, or change the character or course of a stream, or cause the pollution or siltation of any stream or lake.

8. Crossing of waterway courses shall be made using a low angle approach in order not to disrupt the naturally occurring stream or lake banks. There will be no blading of streams or lake banks.

9. All operations will be conducted in such a manner as to not cause damage or disturbance to any fish or wildlife resource. This includes, but is not limited to, the following:

   a. No seismic shooting or vehicle operations within one-half mile of any known denning barren ground grizzly (in the upland area) or of any known denning polar bear (near the sea coast or in the lower reaches of major rivers or estuaries). need survey for these

   b. Wildlife are not to be chased by vehicles or buzzed by aircraft.

nesting raptors caribou calving grounds
arctic fox dens nesting waterfowl
wolverine dens

c. Shot holes must be a minimum of 300 feet from any designated anadromous stream except where these waters, at the time of seismic shooting, may be frozen to bottom and the underlying gravels or sands also are frozen. Where required for the completion of critical surveys or tie-ins, variances may be requested, through the USGS Regional Manager or his authorized representative from the appropriate regulatory authority.

10. No hunting will be allowed.

11. All oil spills will be reported to the USGS Regional Manager at the time of the first solid radio contact or other communication occurring after the oil spill incident. Additional fuel handling requirements are:

a. All fuel spills will be cleaned up immediately, taking precedence over all other matters, except the health and safety of personnel.

b. Oil spills will be incinerated in approved receptacles, but not on lake or river ice.

c. The storage of fuel on frozen lakes and rivers is prohibited.

12. All combustible solid waste, including seismic cartons, drilling and mud sacks, if any, and used lubricating oils, will be incinerated or removed. All non-combustible solid waste, including fuel drums, will be removed for approved disposal. An exception would be incinerated ash which may be deposited in a seismic hole which has vented. There will be no burial of garbage or the dozing of any area for the burial of any matter or thing.

13. All fuel containers used, including barrels, must be marked with the operator's name, date and contents.

14. All retrievable shot hole wire will be removed from the study area for approved disposal. Records shall be kept of the amount of shot hole wire used and of that returned for disposal.

15. Shot line shall be left clean of all foreign debris. This shall include but is not limited to, shot wire, explosive boxes, and drilling mud sacks.

16. A snow melter system shall be present with each mobile camp to provide potable water at dry camp sites. In addition, a tank or tanks capable of storing 1,000 gallons of potable water for camp use shall be a part of each camp's equipment, together with necessary hoses, fittings and water pump.

17. Wastewater shall receive treatment conforming to Federal and State requirements for secondary treatment if Arctic tested package treatment facilities are used. If electric toilets or if chemical recirculating sewage facilities are employed, they shall be kept separate from the gray wash and the kitchen wastewater. The chemical effluent from the chemical recirculating facilities may be drained into a shot hole that has vented or into a land-drilled hole, but not to the land surface or to any ice

surface. The liquid level should not be less than five feet from the surface of the ground, and after freezing, shall be filled with cuttings or other clean fill to the surface. Gray wash water and kitchen wastewater will be filtered to remove the solids and the liquid may be discharged to the land surface. All solids and sludges shall be incinerated.

18. The contractor shall protect all survey monuments, witness corners and reference monuments against destruction, obliteration or damage. He shall, at his expense, re-establish damaged, destroyed, or obliterated monuments and corners in their exact position. A record of the reestablishment shall be submitted to the USGS Regional Conservation Manager.

19. The Antiquities Act of June 8, 1906 (34 Stat. 225; 16 U.S.C. 431-433) prohibits the appropriation, excavation, injury, or destruction of any historic or prehistoric ruin or monument, or any other object of antiquity, situated on lands owned or controlled by the United States. No historic site, archeological site, or camp, either active or abandoned, shall be disturbed in any manner nor shall any item be removed therefrom. Should such sites be discovered during the course of field operations, the USGS Regional Conservation Manager will be promptly notified.

20. The foregoing provisions do not relieve the permittee or his subcontractors of any responsibilities or provisions required by any applicable laws or regulations.

21. A copy of these stipulations shall be posted in a conspicuous place in each camp site established for the purposes of geophysical exploration within the Arctic National Wildlife Refuge.

avoid riparian willow stands
minimum 6" snow cover
no tractor trains

Attachment 11

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## WINTER OPERATIONS

| Conventional/Modified Conventional Methods | Tracked | | Wheel | |
|---|---|---|---|---|
| | GW | PSI | GW | PSI |
| 4-5 track mounted drills* | 43,000 | 5.5 | | |
| 1 preloader vehicle | 43,000 | 5.5 | | |
| 1 recorder vehicle | 30,000 | 5.0 | | |
| 1 shooter vehicle | 30,000 | 5.0 | | |
| 4 cable/geophone carriers | 43,000 | 5.5 | | |
| 4 survey crew vehicles | 30,000 | 5.0 | | |
| 1 gravity crew vehicle | 30,000 | 5.5 | | |

*Not required for modified conventional

### Vibration method

| | | | | |
|---|---|---|---|---|
| 4 vibrator units | 56,000 | 5.4 | 45,000 | 5.0 |
| 1 vibrator tender | 56,000 | 5.4 | 45,000 | 5.0 |
| 1 recorder vehicle | 45,000 | 5-6 | 45,000 | 5.0 |
| 4 cable/geophone carriers | 45,000 | 5-6 | | |
| 4 survey crew vehicles | 9,000 | 4.0 | | |
| 1 gravity crew vehicle | 9,000 | 4.0 | | |

### SUPPORT CAMP

| | | |
|---|---|---|
| 12 living trailers | vary | same as tractors |
| 1 Camp Utility vehicle | 42,000 | 5-6 |
| 3 fuel sleds | 36,000 | 5 |
| 1-2 utility trailers | vary | same as tractors |
| 2 auxiliary trailers | vary | same as tractos |
| 1 explosive storage trailer (conventional/modified conventional surveys only) | | |
| Tractor-Operations | | |
| 6 Caterpillar D-7 or similar | 51,300 | 6.3 |

## SUMMER OPERATIONS

(Helicopter Supported)

| | |
|---|---|
| **Modified Conventional** | |
| 2 to 3 Helicopters | 1,000 - 1,500 payload |
| 1 recorder shelter | 600 - 1,200 weight |
| Camp population | 35 - 40 |
| **Helicopter Portable Drills** | |
| 2 to 3 Helicopters | > 2,000 payload |
| 4 or 5 Drills | |
| 4 or 5 Baskets for equipment | |
| 1 recorder shelter | 600 - 1,200 weight |
| Camp population | 45 - 52 |

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# CHAPTER IX. Potential Impacts of Geophysical Exploration

## Introduction

This section describes the potential impacts which may occur to the fish, wildlife and other resources of the Arctic Coastal Plain due to the geophysical exploration program which has been mandated by ANILCA. Earlier chapters have discussed the biological information available about the fish and wildlife species which inhabit the coastal plain and the other resources of the study area. Another chapter discussed the exploration assumptions which will be used. Those will be combined for this discussion of potential impacts of the exploration program. At this time it is not known precisely what techniques, or combinations thereof, will actually be used. The seasons of the year, the logistical support required, or the regulations that will be applied to the program also are not known. Thus for this report, the potential impacts of standard exploration techniques conducted at all times of the year will be discussed with little regard for any regulations which may be applied.

Few studies have been conducted regarding the impacts of a specific seismic exploration program, or of the component parts of such a program. Although there is extensive information available regarding the effects of various construction and related activities, that information is often patchy and of questionable value. For example, a study of the information and knowledge available about the effects of pipeline construction on Alaskan mammals showed that many data gaps exist and that much information is qualitative and anecdotal (Douglass et al. 1980). Nevertheless, the available information and existing data gaps will be discussed.

Detailed analysis of the impacts of exploratory activities would require that the potential actions be separated into impact producing components. For example, a conventional seismic exploration operation may consist of several components:

1. The physical machinery, which includes a drilling machine, vehicles and aircraft which carry crew and machinery around, fuel trucks, and camp units.
2. The activities which occur, including the drilling of shotholes, setting off the explosives, surveying in the lines, and moving the equipmant back and forth.
3. The indirect and support activities, such as water use, wastewater disposal, solid waste disposal, fueling of vehicles and other machinery, and resupply of the camps.

However, in many cases, studies of impacts have not been detailed enough to separate the cause and effect of individual components. Often one exploration technique is tied to one transportation mode. For example, Vibroseis and conventional seismic techniques are transported by ground vehicles. The Pouldier technique, surficial geology, and gravimetric surveys are supported by helicopters. The combination of the factors above leads this report to discuss both the general activities and some specific items of disturbance as follows:

Technique
    -conventional
    -Pouldier

Services
    -fuel
    -water use

-Vibroseis
-ship
Transportation
-surface vehicle
-airplane
-helicopter
-ship

-wastewater disposal
-solid waste disposal
-ice airstrips
-use of existing facilities
General
-noise
-increased human activity

In order to better describe the potential impacts, the following four descriptive categories will be used:

1. Time scale, or duration, of impact
   a) short term - up to two years
   b) moderate term - 2 to 10 years
   c) long term - over 10 years

2. Immediacy of impact
   a) direct - affects an animal or value itself
   b) indirect - affects the prey, food, habitat of an animal, or use or appreciation of a value, rather than the animal or site directly
   c) None - there is no impact

3. Magnitude of impact
   a) low - effects are minor or pertain to small numbers of animals and occur only for short periods of time
   b) moderate - effects are significant for short periods of time, or to small numbers of animals
   c) high - effects are significant for long periods of time or to large numbers of animals

4. Directionality of impact
   a) + effects are positive, such as an increase in population
   b) - effects are negative, such as a decrease in population

The concepts of critical life history stage and seasonality of impact have been combined in an impact matrix (Table 1). Where applicable, such stages as calving, migration, and denning are noted. Seasons are subdivided into spring (May and June), summer (July and August), fall (September and October) and winter (November through April). These periods approximate the physical realities of the region, such as amount of sunlight, snow cover and sea ice cover (Table 2). A set of sensitivity maps has also been developed, which portray very generally by season the areas of the Arctic Coastal Plain in which species or processes occur that are sensitive to disturbance (Figures 1-4).

## Surface Features and Vegetation

The potential effects of the exploration program to surface resources can be subdivided according to exploration technique, transportation technique, service or logistics effects and season. The susceptibility of tundra to disturbance has been discussed by Bliss et al. (1970), Billings (1973), Ives (1970), Dunbar (1973), Webber and Ives (1978), Webber et al. (1976), Bliss and Wein (1972), Brown and Grave (1979), and a number of other sources.

Table 1. Potential impacts of seismic exploration.

Summer
Spring Fall
Winter

Immediacy
D = direct
I = indirect
N = none

Magnitude
1 = low
2 = moderate
3 = high

Directionality
+ = positive
– = negative

Time scale
S = short
M = moderate
L = long

| ACTIVITY / RESOURCES | TECHNIQUE | | | | TRANSPORTATION | | | | SERVICES | | | | | | GENERAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Conventional | Pouldier | Vibroseis | Ship | Surface vehicle | Airplane | Helicopter | Ship | Fuel use | Water use | Wastewater | Solid waste | Ice airstrips | Use of facilities | Noise | Increased human activity |
| Surface Soils/permafrost | D3-L<br>D3-L D3-L<br>D1-M | N<br>N N<br>N | | | | | | | | | | | | | | |
| Vegetation | D3-L<br>D3-L D3-L<br>D1-M | D1-S<br>D1-S N<br>N | | | | | | | | | | | | | | |
| Water resources | | | | | | | | | | | | | | | | |
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| SEASON | JAN | FEB | MAR | APR | MAY | JUN | JLY | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EVENT | WINTER | | | | SPRING | | SUMMER | | FALL | | WINTER AGAIN | |
| SEA ICE | COMPLETE ICE COVER | | | | | BREAKUP | OPEN WATER | | | shorefast ice forms | | |
| LAGOON ICE | COMPLETE ICE COVER | | | | OVERFLOW/BREAKUP | | OPEN WATER | | | ICE FORMS | | COMPLETE |
| SNOW COVER | SNOW COVERS GROUND | | | | BREAKUP | SNOW FREE | | | SNOW COVERS GROUND | | | |
| RIVER ICE | SOLID COVER | | | | OVERFLOW/BREAKUP | OPEN WATER | | | | FREEZE UP | SOLID COVER | |
| LAKE ICE | COMPLETE COVER | | | | | SMALL BREAKUP LARGE | | OPEN WATER | FREEZE UP | COMPLETE COVER | | |

TABLE ~~FIGURE~~ 2. Seasonal cycle of physical events.

## Transportation

The fragility of tundra to disturbance was addressed in an interesting manner by Webber and Ives (1978) when they expressed the opinion that the generalizations about this type of ecosystem are based upon the extremes that can occur in the wet maritime tundras, such as those found on the Arctic slope. In contrast to many more arid tundras world wide, the authors feel that arctic tundras with soils containing 50% to 300% by weight of moisture, would be sufficiently disturbed in their surface energy balance to undergo extremes of thermokarst, collapse and erosion as vegetation is removed. Ives (1970) likewise suggested that the susceptability of tundra to disturbance was inversely proportional to the ice content and mean annual ground temperature.

It is no surprise then, that some of the most evident disruption that has occurred to the tundra environment has resulted from the indiscriminate use of vehicles during the summer over the unprotected tundra surface. In many cases, the damage to surface vegetation and underlying permafrost has persisted as ruts and scars that have remained unhealed for decades! Particularly evident are many vehicle tracks that were made over Alaskan tundra during early oil and mineral explorations of the 1940's and 1950's prior to implementation of restrictions for the types, times, and places where travel could occur.

Studies that have been made of vehicle damage to tundra surfaces (Rickard and Brown 1974; Brown and Grave 1979; Lawson et al. 1978; Hok 1969, 1971; Walker et al. 1977) have generally linked several factors to the causes for vegetation and permafrost disturbance:

1. Repetitive passes of tracked or wheeled vehicles over the same trail

2. High surface pressures exerted,
3. Certain patterns on tread and tracks that tend to break plant parts more severly and gouge surface soils,
4. Passage of vehicles over highly unstable soils, slopes, or where subsequent drainage results in erosion,
5. Use of sharp turns in trails causing lateral displacement of surface materials.

The impact of vehicles varies according to vegetation type, soil moisture, surface pattern or microtopography, and time of year. Everett et al. (1980) rated the sensitivity of several vegetation-microsite categories found in Prudhoe Bay using a single pass of a Rolligon during the summer as a test. They found three high sensitivity categories: dry frost-boil barren, wet graminoid meadow low centers or flat areas, and wet graminoid meadow troughs. Categories of moderate sensitivity included moist graminoid meadow rim, wet graminoid meadow low centers or flat areas, and moist graminoid meadow rims or hummocks. A similar project for vegetation communities in the Arctic Coastal Plain study area is proposed (Everett, pers. comm. 1981).

Vehicles moving over the land surface during the winter cause less damage than summer traffic. However, disturbance can occur. Reynolds

(1981) studied the effects of different vehicles travelling across four tundra vegetation types. Little damage occurred to all types of vegetation from a single pass of low ground pressure vehicles. The greatest damage occurred due to travel of tractor trains. Most disturbance was naturally healed within 16 months, although damage to riparian willow stands was expected to take several years to recover.

The amount of snow cover present in the study area was not indicated for the previous study, but is an important parameter in determining the impact of surface travel. The exploration regulations commonly used require at least 6 inches of snow to be present before vehicles are allowed on the tundra (USGS/BLM 1979; BLM 1980). In the Arctic Coastal Plain study area, snow accumulates slowly and often winds blow off much of the available snow cover. How these meteorological variations would affect impacts of winter overland travel is not known quantitatively, but greater impact can be expected in the study area than in areas of greater snow accumulation further to the west.

The ultimate impacts to the surface and vegetation varies. In extreme cases where the vegetative mat is completely removed, thermokarst erosion can lead to depressions and gullies which do not heal for many years. Aggravated erosion can occur along coastlines, lake shores and river banks (disturbance levels 7, 8 and 9, Radforth 1973). Milder destruction of vegetation can cause localized ground slumping and boggy depressions, increased frost heaving and crack formation. Tussocks may be destroyed and polygon ridges broken. Altered drainage patterns and vegetation associations may follow. Disturbance with the least impact can cause minor tussock damage, brown trails and green trails (disturbance levels 2 to 4, Radforth 1973). The brown and green trails indicate minor disturbance to the vegetation rather than any disturbance to the soil or active layer. They can be an aesthetic problem, however, because the trails are visible, both from the air (primarily) and on the ground. Aesthetic impacts potentially caused by the exploration program are discussed later in this section. Although the total amount of disturbance, in area, would be small in an exploration program, its significance related to wilderness values of the refuge is great. A discussion of wilderness is indluded later in this section. The indirect effects of vegetation or habitat loss to individuals or species will be discussed in later sections.

Snowmobile vehicles can be defined generally as: "a self-propelled vehicle intended for offroad travel primarily on snow, having a curb weight of not more than 1,000 lbs (450 kg), driven by a track or tracks in contact with the snow, steered by a ski or skiis in contact with the snow."

The impacts of snowmobile use in tundra areas have to date been only lightly covered in the literature. While much that has been written has indicated that these machines produce very little impact, most of the work yielding these findings has been directed at "point" impact rather than overall habitat impact. The effects of snowmobiles upon soils and vegetation will vary considerably depending upon time of year and frequency of usage and the weight of the loads passing over the snow surface. Whereas occasional passage by snowmachines over thick snow layers probably results in very slight soil and plant disturbance, studies of controlled compaction by repetitive snowmachine passes have shown that the result may be the production of colder ground temperatures and delayed snow removal during thaw periods. These two factors working over extended time periods may result in lessened plant reemergence in heavily travelled areas and eventual destruction of the native ground cover needed to prevent thermokarst and erosion. This would be similar to, but much smaller in scope than, the impacts produced by other commonly used surface vehicles during the winter.

Utilization of air-cushion vehicles (i.e. hovercraft) for travel over the large areas of treeless tundra is becoming more common every year. The adaptability of hovercraft to the northern environment lies in the fact that mobility is accomplished through the use of an air cushion rather than wheels, tracks or other mechanical devices. Likewise, hovercraft are adaptable for travel throughout most periods of the year when some mechanical vehicles are restricted due to snow, ice, water, etc. To date, only a few studies have been documented where hovercraft operation and habitat degradation were correllated (Rickard and Brown 1974; Abele 1976; Rickard 1972; Abele and Brown 1976). For smaller units (approximately 7 tons), performance tests over tundra near Barrow, Alaska, resulted in very slight damage to vegetation after only one or a few passes. Air flow disturbance was more pronounced on wetter sites with grass and sedge vegetation, while drier sites did show some removal of broadleaf foliage and dead loose vegetation. Actual active soil layer disturbance was minimal in most instances and thaw depth was only slightly affected where vegetation cover was significantly altered (e.g. on tops of dry raised polygons in close contact with vehicle). Surficial signs of vehicle passes ranged from barely to moderately detectable depending upon the type of vegetation and number of passes. Follow-up studies of surface disturbance signs indicated that while tracks could be seen for several years, where no air gap occurred, actual destruction of vegetation either did not occur or reestablishment was not noticeable within the first couple of years. The primary limitation of air cushion vehicles is not their potential damage to the surface, but rather technical limitations such as manoeuvering over inclines or bluffs. If these technical problems are overcome, use of air cushion vehicles may increase, and further studies of their effects to surface resources may be needed.

Aircraft generally have no effect on vegetation, primarily because ice of lakes and rivers or gravel bars are used for airstrips. However, the potential effect of an improperly prepared landing area is demonstrated by the study of the 1974 Cape Espenberg drilling operation (Racine 1977). In this case, one of the more evident signs of disturbance to the site, two years after the activity, was the land-based runway extension for aircraft useage. The effects noted (exposed mineral soils and poor revegetation) were the result of heavy equipment scraping the surface of peat mounds, hummocks, and tussocks. Another example of early blading for airfield use on the ice-wedge polygon tundra at Umiat is shown by Rickard and Brown (1974). The potential effects of blading airstrips on ice is discussed in the fisheries section. Aspects of aircraft disturbance to animals will be discussed in other sections.

### Exploration Technique

Potential disturbance to the vegetation and ground surface comes from the seismic techniques which may be used. Drilled shot holes produce a small hole in the ground surrounded by a mound of cuttings which are usually swept back into the hole, leaving a small amount of loose dirt. The impacts of shot holes are minor, althought they are visible on the ground (Reynolds 1978). The Vibroseis technique may leave more noticeable, although still minor effects. The vibrating pad of the machine compresses the insulating snow cover and perhaps the vegetation mat as well. Minor freezing of vegetation or breakage of stems can occur. The Pouldier technique, when conducted during snowfree months, can cause a brown trail effect, visible primarily from the air. Apparently the blast dislodges dead plant parts from the tussocks and scatters the debris (Reynolds pers. comm. 1981). This is thought to be primarily a visual anomoly, however. The nitrogen in the explosives may additionally affect the vegetation as a fertilizer and cause temporary green trails of more luxuriant growth. Winter use of the Pouldier technique should cause no damage to the tundra. Surface geology, gravimetric and magnetometric techniques will not directly cause damage to vegetation or soils.

### Miscellaneous Operations

Fuel and other toxic substance spills are another potential impact from the exploration program. Aircraft, surface vehicles, drilling machines, and camps all require fuel to operate. Additionally, most vehicles and machinery also use oil, lubricants, hydraulic fluid and other materials which may be toxic to vegetation. The effects of small scale miscellaneous fluid spills will be local and minor. Fuel spills, however, could cause moderate to great impacts depending on their size and location. Terrestrial spills would likely have minor impact if they remain localized; if they contaminate lakes, rivers, drainages, or coastal waters, however, the impact would be greater. Chronic fuel spills can have greater long term impact than single occurrences.

Numerous studies have been conducted regarding the effect of spilled crude oil on vegetation and aquatic systems (Walker et al. 1978; Everett 1978; Sextone et al. 1978; Linkins et al. 1978; McCown et al. 1972; Deneke et al. 1975; Brown and Berg 1980). Fewer have been conducted using refined fuels (Walker et al. 1978; Sextone et al. 1978; Deneke et al. 1975). The impacts of spills to aquatic systems, marine mammals and fish will be discussed later in this section.

While the complexity of the effects of oil spillage upon arctic vegetation is not fully understood, observations made by the sources above and others include:

1. Potential increase in the depth of the soil active layer,
2. Greater disturbance resulting from spills during nonwinter periods of the year,
3. Potential disruption of the surface albedo, with a resultant change in the energy transfer to soil and permafrost layers,
4. Potential long range effects due to persistence of contaminants,
5. Differential physiologic responses by species within affected communities,
6. Differential community responses within differing environmental conditions,
7. Significant decrease in levels of primary production particularly in aquatic systems, and

8. Differential responses by species to the spillage of crude versus refined petroleum products.

In vegetation studies, Walker et al. (1978) found that plant sensitivity to spilled oil varied by species and soil moisture. Lichens, mosses and most dicotyledons showed little recovery. Sedges and willows were quite resilient. Dry sites were most sensitive and wet sites were the least sensitive. Diesel fuel produced more damage than crude oil. However, Bergman et al. (1977) reported that all aquatic plant life was destroyed in a contaminated pond at Storkersen Point. Because the vegetation in the study area is generally drier than that further to the west and there are fewer lakes, ponds and wet tundra areas which are important to waterbirds, the effects of a fuel spill may be greater than in the Prudhoe Bay area. A sensitivity mapping effort would be of value for the study area.

The effects of fire in arctic tundra in Canada have been discussed by Cochrane and Rowe (1969), Cody (1964), Bliss and Wein (1972), McKay (1970) and in the Alaskan tundra by Racine (1979, 1980), McKendrick and Mitchell (1978), Melchior (1979), Barney and Comiskey (1973), and Hall et al. (1978). Viereck and Schandelmeier (1979) have developed an annotated bibliography of Alaskan Fire effects that currently lists 715 entries to the literature pertaining to fire within the state. The bibliography will be revised annually and is available to users through the University of Alaska computer system in Fairbanks.

Fires in the tundra have played a regular role in the natural dynamics of the ecosystem. Unlike the situation within the boreal coniferous or coniferous-tundra systems, where fires may be frequent and of a large scale, tundra fires are considered to be generally less common, smaller in size, and less destructive. It is believed that frequently wetter soils, a lack of abundant combustible biomass, and absence of larger erect woody species have contributed to the "characteristic" patterns of burning tundra (Bliss and Wein 1972). Natural occurrence of tundra fires in the Arctic Coastal Plain is rare; however, man-caused fires may be produced during the summer by the use of explosives, aircraft accidents, or the burning of oil spills.

Wildfire in the tundra ecosystem produces four effects that are of major concern:

1. Destruction or modification of vegetation,
2. Modification of the relationship between permafrost and active layers of the soil profile,
3. Physical alteration of habitat due to thermokarst, wind and water erosion,
4. Loss or kill of wildife resources

Studies of several past burned areas have shown that there are certain common observations during the recovery period. Frequently there is the appearance of very active vegetation regrowth within the first few years following the burn. Often the regrowth populations will demonstrate different species compostions from those of the original populations (Racine 1979, 1980; Wein and Bliss 1973; and others). The success of opportunistic species and reestablishment of original populations may be related to several factors:

1. Earlier and deeper annual development of active layers,
2. Higher available nutrient and mineral levels needed for growth,
3. Enhanced root growth and microbial activity,
4. Removal of excess fuel and litter materials causing stabilization of the environment

Many of these phenomena remain to be thoroughtly documented, but the effects of tundra burning and regrowth seem to be consistent for northern areas.

Waste water disposal is not expected to produce any impact in the coastal plain study area due to the limited amounts of effluents commonly produced. The impacts of water use will be discussed in the fisheries section.

## Habitat Rehabilitation

Any discussion of impacts to surface resources must include consideration of the efficacy of rehabilitation efforts. The literature dealing with the revegetation and recovery of disturbed tundra communities has grown significantly in the past two decades. Alaskan studies have been documented by VanCleve (1977), Mitchell (1970), Lawson et al. (1978), Johnson (1981), McGrogan et al. (1971) and others. The importance of rehabilitation practices on the north slope of Alaska is underscored because of the potential for thermokarst, wind and water erosion upon surface soils. The reestablishment and stabilization of soils in ice rich areas, particularly on slopes, may present problems in healing that surpass the regenerative power of the natural vegetation.

The difference between rehabilitation and revegetation must be understood. Rehabilitation implies the attempt to return the land to its original condition. Revegetation, on the other hand, implies the utilization of introduced plant species on an interim basis to stabilize the surface, to be followed by the natural recolonization of local species. Revegetation techniques may be used as a part of a plan to restore deteriorated habitats.

In cases where the vegetation mat has become bladed off the surface, attempts have been made to place the mat back in its original place to prevent thawing and slumping. In general these attempts have been unsuccessful and further illustrate that permafrost-tundra equilibrium is a delicate balance between the insulating properties of the organic mat and soil layers. Where gullying occurs, the establishment of drainage patterns which approximate the natural and avoid channelization is one factor that is considered in rehabilitation. Where drainage has been moderated, natural vegetation may begin reestablishment.

Where the native species are not able to successfully recolonize the disturbance, reseeding with mixtures of native and/or nonnative species may be necessary. Colonization of native species is often slow due to several factors. Typically, plant growth is slowed because of the shortened growing season (50 to 80 days) and severe climatic conditions (e.g. prolonged freezing temperatures, reduced quantities of metabolically useful water, high levels of wind and ice crystal abrasion, etc.). The collection of seed material from native stocks may be nearly impossible because native species revert to vegetative propagation for most repreduction and seed production is greatly reduced in number and/or biability (Mitchell 1970).

Occassionally a major component of a restoration plan may involve the application of nutrients or fertilizers to depleted areas without reseeding. A number of attempts have been carried out to determine how additional nutrient levels can effect new or established plant communities. In the Canadian effort by Bliss and Wein (1972), the applications of various formulations of nitrogen and phosphorus to arctic shrub-heath communtiies have produced interesting results. Available nitrogen may be a strong limiting factor in the production of new plant tissues; phosphorus is not a major limiting factor to new growth; and nitrogen levels are maintained in the upper organic layers and disruption of these layers will potentially result in a discontinuity of efficient nutrient cycling within the ecosystem.

Some studies carried out in Alaska have indicated that varietal differences within northern adapted species, particularly of grasses, may be more significant than previously expected. Varied success was obtained when collections of several northern grass species were tested over a wide range of habitats. The impact of this means that attempts at revegetation may be of limited success unless specific cultivars have been developed for compatibility with environmental conditions. One such cultivar, Arctic Bluegrass *(Poa glauca)* has been developed for use on the western north slope (USGS/BLM 1979). However, many introduced plant populations will require ongoing maintenance efforts to continue their existence until sufficient time has elapsed to allow native species to reestablish original cover. The time frame considered here may be in the order of several years.

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# Birds

## Introduction

The potential impacts of seismic operations on migratory birds include:

1) disturbance due to increased human activities, including air traffic,
2) locally increased predation due to animal attraction to camps,
3) direct effects due to oil (refined fuel and lubricant) spills, and
4) habitat alterations

The amount of information available on short term disturbance effects and other impacts is large. However, some of the studies present conflicting results. In general, disturbance to birds can cause a number of short term impacts:

1) lower nesting density,
2) lower hatching success,
3) nest abandonment,
4) increased stress during molting,
5) increased predation on eggs or chicks.
6) increased energetic stress during staging and migration

The effects of long term disturbance have not been determined. The experimental disturbance studies conducted on the Yukon North Slope, 1972-1975, documented short term (day-long to several weeks-long) effects on nesting, molting, and staging birds, but could only speculate on long term effects and recommend further long term disturbance research (Platt and Tull 1977; Schweinsburg 1974; Gollop et al. 1974 a, b, c; Schweinsburg et al. 1974; Salter and Davis 1974; Gollop and Davis 1974; Wiseley 1974; Davis and Wisely 1974; and Patterson 1974)

## Disturbance

Aircraft disturbance of barrier island and shoreline colonial nesting birds is of concern because aircraft traffic tends to follow the coastline when ceilings and visibility are low. Gollop et al. (1974b) found that helicopters were more disturbing to nesting brant, common eiders, glaucous gulls and arctic terns than fixed wing aircraft on the Yukon coast. Of those species, brant and arctic terns were most susceptible. Human presence in nesting colonies was found to be more disturbing (by interrupting incubation and exposing eggs to avian predators) than aircraft overflights. They provided several recommendations to alleviate shoreline nesting colony disturbance.

Barry and Spencer (1967) concluded that helicopters flying at low levels were the most disturbing factor to nesting and molting birds within a 2.5 km radius at a drill rig at the Mackenzie Delta, N.W.T. Hatching success of nests was lower in the area surrounding the drill rig as compared to an undisturbed control area.

In experimental disturbances Barry and Spencer (1967) found that:

(1) Whistling swans left their nest when a helicopter hovered over it at an altitude of 10 m.
(2) Whistling swans left their nest when a human walked within 1500 m of

it (Typically on ANWR they leave if one approaches to within 300 m, Spindler, unpubl. data).

(3) Molting swans and white-fronted geese sat tight and did not fly when a helicopter flew overhead.

(4) Helicopter flights at 90 m flushed flocks of Canada geese and flushed sandhill cranes off their nests.

(5) Whistling swans, arctic and red-throated loons, white-winged scoters and oldsqauw were flushed from the river channel by a passing transport barge.

Schmidt (1970) witnessed the dessertion of a whistling swan nest that was discovered with no eggs on 14 June 1970: "On 15 June a helicopter from an oil company landed on the strip to support geologists camping at Nuvagapak Point. The pair of swans seemed extremely frightened and flew off to the east. These birds did not return to their nest and they were note seen in the area again. Two pintail apirs and one green-winged teal pair left the pond area adjacent to he strip after several helicopter landings on the strip".

Overall whistling swan densities on the coastal plain of ANWR are lower than areas surveyed farther west, but within the ANWR concentration areas, densities are as high as or higher than elsewhere on the North Slope. Disturbance in the form of aircraft overflights, human pedestrian and vehicular traffic and habitat alteration could reduce the ANWR swan population (Timm 1978; T.C. Rothe unpubl. data; Martin and Moitoret 1981; Sarvis pers. comm.). However, if such disturbances are excluded from the swan concentration areas during late-May to mid-September, the period when swans are present, populations most likely would not be affected (See Map B-1).

More than most other waterfowl species, snow geese are sensitive to disturbances, including aircraft overflights at most altitudes below 3050 m and especially below 55 m (Barry and Spencer 1976; Davis and Wiseley 1974; Salter and Davis 1974; Wiseley 1974). During a close overflight (within 2-3 km and up to 3050m altitude), snow goose flocks will take off and fly 2-5 km before landing again (Davis and Wiseley 1974; Salter and Davis 1974). If disturbances continue and are frequent it is likely that the birds will expend unnecessary energy to escape the disturbances, hence preventing them from accumulating the fat reserves usually acquired before the fall migration (Patterson 1974). Juvenile snow geese staging on the Yukon North Slope in 1973 increased their fat reserves by an amount equal to the fat accumulated prior to the arrival on the North Slope (Patterson 1974). Snow geese on the Yukon North Slope were found to spend 57% of their time feeding during staging. In experimental trials and modelling 0.5 fixed-wing aircraft overflights per hour would cause a reduction of 20.4% in the amount of energy juvenile snow geese store; similar rates of helicopter overflights would cause a 9.5% reduction (Davis and Wiseley 1974). Snow geese probably do not habituate to aerial disturbances since they react to aircraft overflights on the wintering grounds, many areas of which have had frequent aircraft traffic for decades (Spindler pers. obs.). Wiseley (1974) found that snow goose feeding flocks rarely approached closer than 800 m of ground-based ~~and~~ noise simulation. There is also documentation of snow geese abandoning the Howe Island nesting colony on the Sagavanirktok Delta for the remainder of one nesting season following frequent helicopter overflights (Gavin 1980; Welling et al. 1981).

Canada geese breeding on the arctic coastal plain of ANWR were noted to be easily disturbed early in incubation (Spindler 1978a) and when forced off ther nest by human presence, were noted to be slow in returning to the nest, hence exposing it to egg-eating predators (Martin and Moitoret 1981).

Wright and Fancy (1980) detected subtle differences in nest density of a few bird species (Lapland longspur, semipalmated sandpiper, Baird's sandpiper, pectoral sandpiper and snow bunting) between an area adjacent to an active drilling pad and a nearby control area in the vicinity of Pt. Thompson. Small scale habitat differences between the two areas, and inherent spatial variation in abundance for some species were thought to be the causal factors in the different nesting densities of the two areas. Helicopters servicing the drill rig were observed to flush many birds from their nest, but a reduction in nest density underneath the helicopter regular flight path was not observed.

Although Wright and Fancy (1980) concluded that there were similar species diversity and species equitibility values between the drilling area and control area, suggesting similar community structure, there were lower overall populations of total birds and numbers of bird species in the drilling area as compared to the control site.

Gollop et al. (1974d) state that with respect to small terrestrial birds:

> "statistically significant differences were noted in the reproductive success of Lapland longspurs on control, human and aircraft disturbance sites."

At Pt. Thomson there were no statistically significant differences in nesting success between the area near the drill rig and the control area (Wright and Fancy 1980). They also did not find any pattern of increased nest failure in close proximity to pedestrian traffic. Those findings are in contrast with those of Spindler (1978), Martin and Moitoret (1981), Timm (1979), Olson and Marshall (1952), and Barry Spencer (1976) who noted that various species (notably arctic and red-throated loon, Canada goose, Brant, Common and King Eiders, and whistling swans) are sensitive to nest failure induced by the adults being flushed from their nests frequently, hence exposing them to predators and abandonment.

A 60% decrease in waterfowl usage of a small North Slope lake resulted from 4 days of repeated floatplane landings (Schweinsburg 1974). Following the initial 4 days of disturbance on the small lake, populations stabilized at the reduced level. Schweinsburg et al. (1974) noted that repeated disturbance of a Mackenzie Valley lake caused a low density waterfowl population to become tolerant of floatplane overflights and landings. However, they added that "longer term effects of disturbance, such as higher mortality of young or desertion of molting areas by adults, are an additional possibility." Sterling and Dzubin (1967) determined that Canada geese deserted traditional molting grounds when subjected to harassment. Wiseley (1974) found that white-fronted, Canada and snow geese, and whistling swans turned back or diverted away from noises resembling gas compressors.

Population of molting waterfowl at Herschel Island were not significantly affected by aircraft disturbance. However, ducks were driven from the land into the sea by aircraft (Gollop et al. 1974c). Swimming and feeding activities of oldsquaws appeared to be unaffected by disturbance. Surf scoters appeared to be more sensitive to disturbance than oldsquaw. In contrast to the above findings, S.R. Johnson (unpubl. data) reported that the normal 24 hour feed-rest cycle completely disappeared in groups of molting oldsquaw at Thetis Island when helicopters and small boats arrived to work in the lagoon waters in August 1980.

Oldsquaws molting in a lagoon near the Pt. Thompson drilling rig possibly habituated to continued helicopter traffic since they were not as easily disturbed by overflights as were oldsquaw in a relativly undisturbed control area (Wright and Fancy 1980). Complicating that conclusion, however, was the differing bird group sizes and coastline configuration of the drilling and control areas.

Derksen et al. (1979) reported that overflights of single engine aircraft at 1500 m above ground level caused escape responses 9 times out of 10 by molting brant and Canada Geese. Single engine airplanes elicited maximum reaction at altitudes less than 600 m. Multiengine aircraft at flight altitudes between 750-1800 m caused "escape to water". An example of extreme disturbance was apparently caused by a helicopter 10 km away from a flock of brant. Part of the flock swan 4.5 km in 42 minutes before arriving at a far shore.

The effects of disturbance on nesting gyrfalcons was studied by Platt and Tull (1977). They reported: "There was significant difference in the productivities of successful Gyrfalcon nests between those nests that were disturbed by helicopter overflights and those that were not disturbed." However, they noted that disturbed birds did not reoccupy nest sites the following year, possibly chosing a new nest site or not nesting at all. Helicopters "invariably" disturbed gyrfalcons by passing at an altitude of 150 m. Siginificantly less disturbance occurred at 300 m and none at 600 m. Gyrfalcons became habituated to human approach on foot over a several day period.

The increase in avian predators (ravens, jaegers, gulls, and foxes) near drilling sites and camps has been reported (Berry and Spencer 1967; Brink 1978; Eberhardt 1977; and Brink 1978). However, Wright and Fancy (1980) did not note the expected increase. Barry and Spencer (1967) found that gulls and jaegers took advantage of exposed eggs in snow goose nests when the adults were flushed by a helicopter.

### Oil spills

Oil Spills can directly or indirectly affect birds. Direct oiling of birds can cause a decrease in the insulating value of their feathers, often leading to death or illness from ingesting the material while preening. Only small amounts of oil are required to damage developing eggs (Biderman and Drury 1980). Indirectly, oiling of ponds and lakes can decimate the invertebrates and plants which waterbirds use for food and cover (Bergman 1977).

### Habitat alterations.

Winter surface travel may have a minor effect on bird habitat. Damage to lake shores can lead to erosion of the shoreline and subsequent draining of the lake (Derksen pers. comm.). Because of the low number of lakes in the study area, the loss of a lake could be significant. See the vegetation section of this chapter for information on other potential habitat alterations.

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## Caribou

### Introduction

The reader is referred to Chapter VIII for a detailed description of seismic exploration techniques that were considered in this evaluation. Reference is also made to the preceding section on baseline caribou information, especially the subsection on the effects of disturbance on caribou.

### Winter/Surface Access Seismic Programs

The potential effects on caribou of conventional (subsurface detonations) versus surface vibrator methods are essentially the same and therefore are addressed under the category "Winter/Surface Access Seismic Programs".

Porcupine Caribou Herd: Review of historical records indicates that large numbers of caribou, presumably the Porcupine herd may have wintered on the arctic coastal plain and foothills during the late 1800's (Skoog 1968). The only recent references of Porcupine herd animals wintering in the study area is that of Roseneau et al. (1974) and Roseneau and Curatolo (1976). More recent evidence obtained from radio telemetry studies and other observations indicates that such wintering caribou are most likely members of the Central Arctic Herd (Cameron, per. comm.; Curatolo and Roseneau 1977; Jacobson 1979). Although significant numbers of the Porcupine herd have not wintered in the study area in recent times, it could occur at some time in the future.

The earliest that caribou of the Porcupine herd have been reported in the vicinity of study area was by mid-May in 1975 (Roseneau and Curatolo 1976). In other years the arrival date in the study area has varied between mid-to late-May (Roseneau and Curatolo 1976). A majority of the herd has left the study area by mid to late July in most years.

Assuming that any winter surface seismic program authorized on the study area would be limited to when there is adequate snow and ground frost conditions (approximately from November to early May) such operations will have minimal direct contact with the Porcupine caribou herd.

In connection with previous seismic exploration programs elsewhere in the arctic there have been numerous cases reported of caribou becoming entangled in abandoned seismic geophone wires (Alaska Department of Fish and Game personnel pers. comm.). The extent of injuries and mortality to caribou from entanglement with seismic wires has not been quantified. Because materials such as wire deteriorate extremely slowly in the arctic, the continued littering of wire by seismic crews constitutes an increasing cumulative problem which will have negative effects on caribou for a long time.

If the Porcupine herd continues to follow its current use patterns in the study area, the effects of a winter surface seismic program will be limited primarily to influences on vegetative habitat. A complete discussion on the potential effects of this technique on the vegetative resources of the study area is provided in Chapter IX of this report.

A comprehensive field analysis of the uses of vegetative habitats of the study area by the Porcupine caribou herd has not been done. Observations in the study area (Calef and Lortie 1963; Roseneau and Curatolo 1976) as well as definitive studies on the Western Arctic calving grounds (Kuropat and Bryant 1980) confirm that most female caribou select upland tussock meadows (Eriophorum sp.) for calving. Following calving, most caribou move to lower tussock communities on the coastal plain following snow ablation.

Of the entire array of seismic techniques evaluated in this study the winter/surface access methods usually cause the most damage to vegetation. Tussock communities are one of the most vulnerable vegetative types found in the study area. Studies of vegetative damage caused by contemporary seismic operations elsewhere in the arctic indicate that with appropriate equipment adequate snow conditions, well scouted travel routes and effective monitoring by surface protection specialists the potential for significant damage can be reduced considerably (Reynolds, pers. comm.). This does not mean, however, that there will be no significant visual effect to vegetation. In considering the overall extent of tussock communities of the study area and the remainder of calving and post-calving range of the Porcupine caribou herd, the losses of vegetative resources resulting from a properly conducted seismic program will most likely be minimal and will not significantly influence forage resources needed by caribou.

Central Arctic Caribou Herd: Use of the study area by members of the Central Arctic Herd (CAH) is described in the preceeding section on baseline caribou resource information. A conventional winter/surface access program in the study area may come in direct contact with caribou of the CAH. As reported in the preceding section, scattered groups of caribou believed to be members of the CAH have been observed during the winter either in or near the study area (Roseneau and Curatolo 1975; Jacobson 1979). Detailed information on the numbers, distribution, movements, and overall status of these caribou in the study area is lacking . On-going radio-telemetry studies to obtain further data on the status of the CAH in the study area as well as throughout its general range are being conducted on a cooperative basis between the Alaska Dept. of Fish and Game and Arctic National Wildlife Refuge personnel. Until better information is available, statements regarding the potential effects of seismic exploration programs on these caribou must be general in nature and based on comparable situations elsewhere rather than on actual, first-hand knowledge.

Based on existing information, the number of CAH caribou that may be directly influenced by a winter surface seismic program in the study area probably varies from several hundred to a thousand or more (Roseneau and Curatolo 1976; Jacobson 1979). Direct mortality as a result of entanglement in abandoned seismic geophone wires may occur (see Porcupine herd in this section). This potential impact is rated fairly low. The potential effect of forage destruction on the CAH cannot be completely assessed because nothing is known about what vegetative types are used by caribou wintering in the study area. However, because of the relatively insignificant quantity of losses of vegetative resources that are expected to occur under a properly managed seismic program, it is reasonable to believe that no significant impact to CAH caribou forage will occur.

The potential effects of disturbance created by a winter surface seismic program are difficult to quantify due to a lack of adequate baseline data on wintering caribou in the study area. Potential impacts likely to occur to caribou during a winter seismic program can be divided into two broad categories: aircraft disturbance and surface disturbance.

It is expected that supply flights to seismic crews will orginate from centers such as Deadhorse, Umiat, Barter Island and possibly from temporary supply sites at Kavik, Camden Bay DEW Line site and Beaufort Lagoon DEW Line site. Temporary landing fields will be constructed on frozen lakes within reasonable distance of an operating crew. Supply flights are expected to be on at least a bi-weekly basis with additional flights as necessary. Landing sites will change as the crew progresses over the study area. Thus the potential aircraft disturbance to caribou will not be a constant factor nor will it be located at a fixed location throughout the exploration program.

The actual impact that will occur to caribou from aircraft supply flights will depend on the location of landing sites and flight lines with respect to where caribou maybe at the time of a supply flight. If caribou happen to be near a landing site and directly under an approach or take-off route they could be disturbed by aircraft coming or leaving. Aircraft disturbance of caribou could also occur along the flight path to the landing site, expecially if low level flights are made. There is also the chance of purposeful harassment which is always difficult to enforce.

Although wintering caribou can be encountered nearly anywhere in the study area, more encounters are likely to occur along the northeastern flank of the Sadlerochit Mountains near Salderochit Springs and along the foothills east to the Aichilik River (Jacobson 1979). The effect of aircraft disturbance on caribou is difficult to determine due to the uncertainty of when, where and how it will occur. It is also extremely difficult to prove that the disturbance exceeds a threshold of tolerance and results in a significant negative effect to an individual or group of caribou. Some of the types of negative influences aircraft disturbance in the study area may cause are:

1) Injury of animals during panic running,
2) Displacement of caribou from a critical winter habitat,
3) Increased energy expenditure due to both physical and psychological stress,
4) Running at cold temperatures could promote pulmonary disorders (this has been observed in reindeer),
5) Pregnant caribou may experience a higher rate of miscarriage.

Surface disturbance of caribou during a winter surface seismic program in the study area may occur as a result of direct encounters with snow mobiles, heavy equipment, humans on foot and with trails, berms and tracks left in the snow by seismic operations. As stated above, the southern foothills region of the study area is where encounters with caribou are most likely. In general, the items 1-5 identified above with respect to aircraft disturbance could occur to some degree as a result of surface disturbances especially from fast-moving vehicles such as snow mobiles. If caribou are chased or harassed by surface vehicles the negative affect of the disturbance will be greatly increased. Caribou encountered by surface crews are likely to move away from the general area of activity. The consequences of such displacement are not known. It is suspected, however, that displacement of caribou from certain areas may influence the success or failure of subsistence hunters. This concern is discussed later in this chapter.

Numerous studies and observations have been made with respect to caribou encounters with obstructions (Klein 1979). Free movement of wintering caribou in the study area may be impeded to some degree by barriers created by seismic lines. Observations made during seismic exploration programs on Banks Island in the Canadian Arctic found that caribou encountering seismic lines would often turn and move parallel to the line (Urquhart 1973). The barrier effect created by bulldozed lines was greater than on lines where there was no bulldozing (Urquhart 1973). Old, drifted-in seismic lines seem to present less of a barrier than new lines (Urquhart 1973). Wintering caribou tend to shift about in response to weather (especially storms), snow conditions and disturbances from predators and humans. The consequences of impairment of the caribou's natural movements by seismic lines in the study area are not known. It is conceivable, however that a reduction in freedom of movement could result in negative effects to caribou by blocking access to feeding areas and expenditure of additional energy to move around the obstructions. It is likely that intensive area-specific seismic surveys would be a greater displacement factor in a local area than the reconnaisance surveys. Reconnaisance surveys on the other hand will affect a larger area overall. The barrier effect of seismic trails on caribou movements could be greatly reduced by not bulldozing snow along the lines. The amount of bulldozing on seismic lines could be reduced by using wider skiis on seismic trailers which would allow better floatation over the snow and reduce the need to plow trails.

### Helicopter Transported Seismic Surveys

Porcupine Caribou Herd: Potential effects of a helicopter transported seismic program on the Porcupine caribou herd will vary greatly depending on the season of the year that this technique is employed. The most potentially adverse time would be during the period of May through mid-to-late July (depending on annual variation of caribou use of the study area). It is during this period that large numbers of the Porcupine caribou herd use the study area for calving and post-calving activities. Caribou are more sensitive to disturbance during calving and post-calving than any other time (Lent 1964, Calef and Lortie 1973, Calef and Lent 1976). The potential for significant adverse impact from disturbance is also greatest at this time. Disturbance of the type resulting from a helicopter seismic program could interfere with caribou use of critical calving and post-calving areas. Displacement from preferred habitats could contribute to reduced productivity (Calef and Lent 1976). Disturbance on the calving grounds can also interfere or prevent establishment of cow-calf bound which is essential to the calf's survival. If proper bonds are not formed and separation occurs, calf mortality is greatly increased (Calef and Lortie 1973). Disturbance of nursery bonds and post-calving aggregations by helicopters could stimulate stampedes causing adults and calves to be trampled and injured. Stampedes would also increase the number of separations between cows and calves and cause significant levels of mortality to occur. Above-ground detonations at this time would also constitute a significant disturbance factor.

On the other hand, helicopter seismic programs conducted throughout the rest of the year (excluding May-late July) would have the least effect of all techniques on the Porcupine caribou herd. Use of this technique would result in less disturbance of vegetation used by caribou. Injury and mortality could occur from entanglement with abandoned seismic wire. Effective monitoring programs will be needed to reduce losses to entanglement.

Central Arctic Caribou Herd: A helicopter supported seismic program in the study area would also effect this herd in varying ways depending on the season of use. Disturbance related impacts described for the calving and post-calving seasons of the Porcupine herd would also apply to the CAH on its calving grounds in the vicinity of the Canning River delta. Post calving aggregations of the CAH also occur in the Canning delta-Camden Bay coastal area. Helicopter disturbance in this area during May-late July could be significant.

A limited number of CAH caribou remain in the study area after calving and post calving. The number that could be affected by a helicopter seismic program would vary from year to year and could be as many as zero to over one thousand or more. If helicopter seismic programs were conducted during times of the year other than May-late July, the impacts to CAH caribou could vary greatly. Because little is known about specific use of the study area by CAH animals other than for calving and post calving it is difficult to predict potential effects. It is likely that disturbance from aircraft (helicopters) would be greater than surface transported seismic crews. This concern must be weighed against the problem of obstructions caused by snow berms left by surface operations which would not be a consideration with helicopter programs.

Surface Geology Programs: It is expected that surface geology programs may also be conducted in conjunction with seismic exploration. The traditional method of access for such activities is by helicopter during the late summer.

Porcupine Caribou Herd: Provided that helicopter supported surface geology studies are conducted during the period of August-May 1, little if any direct impact is expected to occur to the Porcupine Caribou Herd.

Central Arctic Caribou Herd: Portions of this herd are usually present in the study area year round. Of critical concern is the Canning River delta calving grounds, post-calving area, and insect relief areas along the coast of Camden Bay and the Canning River delta. Like the Porcupine herd, the period of August-May 1 would be the time of least impact to CAH caribou.

### Summary

Mandated seismic explorations in the study area may affect both the Porcupine and Central Arctic Caribou Herd. The amount of disturbance caribou will experience depends upon the seismic technique used and the season of operation.

For both caribou herds, the period from mid-May through Julky is critical for calving and post-calving activities. The Porcupine herd uses a majority of the study area during this time, the Central Arctic Herd uses the Canning River delta. During July-August the Central Arctic Herd uses the Canning River delta-Camden Bay area for relief from insects. In the winter, several hundred to a thousand or more CAH caribou frequent the study area, especially southern foothills region.

Winter/surface access seismic programs will not directly affect members of the Porcupine Caribou Herd. Wintering CAH animals may be disturbed by aircraft supply flights, surface vehicles and snow trails and berms. Potential effects could include displacement from winter habitats, deflection of winter movement by seismic crews, snow trails and berms, injury of animals running from disturbing influences, increased energy expenditure, pulmonary disorders from panic running in cold air, and higher reproductive failure due to disturbance induced miscarriages. Injury and mortality may occur as a result of animals from either herd becoming entangled in abandoned seismic wires. It is not expected that damage to vegetation will significantly affect either herd.

Helicopter seismic programs could seriously impact both the Porcupine Caribou Herd and the Central Arctic Herd if conducted during the calving and post-calving seasons (mid May-late July). Helicopter operations during August-May 1 would not directly affect the Porcupine Caribou Herd provided the herd continues to follow recent use patterns.

During the same period (August-May 1) the Central Arctic herd would be most affected in the Canning River delta-Camden Bay area and along the southern foothills region of the study area. The potential for aircraft disturbance is significantly increased with the helicopter programs. Categories of impacts likely to occurare similar to those identified for surface programs except that deflection of movement by trails and berms would not be a factor using helicopters.

Moose

Moose using the Arctic Coastal Plain as summer habitat will be subject to disturbances by low flying aircraft, if helicopter supported seismic or surface geology programs are conducted during the summer months. McCourt et al. (1974) reported that moose reacted to a fixed-wing aircraft flying at altitudes less than 180 m. The degree of reaction was also dependent upon altitude, with few strong reactions to the aircraft flying at altitudes between 60 m. and 180 m. (1 of 24 cases). Strong reactions to aircraft flying at altitudes 60 m. were more common (2 of 15 cases); however, in nearly half of these cases (7 of 16 cases), moose showed no reaction to aircraft flying at altitudes below 60 m. Moose did not react to aircraft flying at altitude above 180 m. The type of aircraft will also affect the degree of reactivity to overflights, with helicopters being much more disturbing than fixed-wing aircraft (Klein 1973). Data are not available that quantifies this expected difference in reactivity by moose to overflights by helicopters versus fixed-wing aircraft.

Reactions by moose to overflights are also dependent upon habitat type. Mould (1977) reported that moose on open tundra reacted more frequently to passing aircraft than when they were located in wood cover types. He also noted that flight distances of moose in open tundra reacting to people on foot were sometimes over 77 m., whereas flight distances when moose were in shrubby areas were less than 100 m.

Reproductive state of moose can also have an effect upon the reaction of moose to aircraft. Agonistic reactions to helicopters were reported for moose in the Yukon Territory, Canada (Rutton 1974). A cow with a 10 month old calf charged a helicopter that attempted to land on a knoll near the pair. On other occasiona, bull moose reared and struck at helicopters that closely approached them during the rut (15 to 30 m.). When the helicopter remained 60 to 90 m. distant from the rutting bulls, the bull usually fled the area.

The ultimate effect of these types of disturbances upon moose populations using the coastal plain is unknown. Displacement of moose from riparian or other habitat types occurring on the coastal plain as a result of the seismic exploration progress would be short term in nature, and moose could be expected to reoccupy these sites once the disturbing agent left the area. Also, the effects of increased energy expenditures by moose as a result of disturbance are unknown, although abundant forage resources available in the summer would suggest little overall impact.

Moose are not present in the study area during the winter, thus would not be impacted by activities at that time.

## Muskox

Muskoxen will be susceptible to harassment from aircraft and ground parties during geophysical exploration on the refuge. The most detailed observations available on the responses of muskoxen to helicopter aircraft are from Miller and Gunn (1979). They concluded that there is an inverse relationship between the intensity and strength of response and the altitude of the aircraft. At 200m above the ground (agl) a greater percentage of helicopter overflights will cause harassment to muskoxen than 400m agl (Miller and Gunn 1979).

Muskoxen typically react to harassment by assuming a group of defense formation. Miller and Gunn (1979) observed that the distance moved by muskoxen after taking up a group formation varied after a helicopter overflight but in only one instance was more than 200m. They did not observe any traumatic injuries as a result of helicopter overflights. It should be pointed out that this is the only condition that could have been visully detected and the energy cost of the responses to the animal and the population over a period of time is unknown (Miller and Gunn 1979). Muskoxen may be subjected to extreme harassment during exploration activities if individual animals or herds are purposely chased from the air. This could have severe consequences for the animals affected resulting in traumatic injuries or direct mortality. Observations of muskoxen approached on the ground suggest that they move a greater distance than when harassed by a helicopter alone (Miller and Gunn 1979). They noted that few herds remained in place in a group formation when a helicopter landed nearby. Reaction of groups in these instances was to drift apart and forage or move away, usually at a center, puntuated by brief walks. Urquhart (1973) noted similar reactions to a helicopter landing near a herd of muskoxen on Bankss Island. The herd initially stampeded, stopped and faced the helicopter, then continued running for about one quarter of a mile.

Urquhart (1973) felt that under certain conditions muskoxen may be seriously disturbed by geophysical exploration activities. In one instance he reported that a herd of muskoxen ran out of sight when approached by overland seismic vehicles. In another instance on Banks Island a calf was reported abandoned when men driving Nodwell vehicles met a herd of muskoxen in a valley.

Avoidance of seismic camps may cause muskoxen to abandon their normal prime winter range at least while the equipment is present (Urquhart 1973). This can affect pregnant cows or individuals in poor condition since they would be displaced to less optimal habitat (Urquhart 1973). Miller and Gunn (1979) recommended that constraints be employed to guard against the potential for causing additional stress leading to increased mortality from helicopter harassment.

Limited loss of favorable muskoxen habitat and riparian willows may occur along overland seismic lines that cross stream channels. This may be of limited extent or may become a moderate impact if cumulative destruction occurs.

## Ringed Seals

Geophysical exploration on the Coastal Plain may cause minor impacts to ringed seals. Relatively few ringed seals inhabit or use the lagoons within the study area; their primary habitat is the fast ice beyond the 3 fathom isobath. However, activities which support exploration may affect seals in offshore waters which are not part of the study area. An attempt has been made to identify impacts which are specific to lagoons, but in many cases, this separation is not realistic or practical.

As discussed in an earlier section, shorefact ice is used during the winter and spring by pregnant female seals for denning and pupping. Some lagoons of the study area may supply such habitat, but good habitat occurs mainly offshore of the study area. Lagoon and offshore waters are also used by seals for feeding during the summer. Thus, activities occurring onshore, in lagoons, on the barrier islands, or offshore may have a limited impact on seals by locally disturbing denning, pupping, or feeding. Indirect impacts may occur because of disturbance caused by shore based facilities or travel to and from the study area. Secondary impacts may be caused by disturbance to ringed seal prey populations.

Ringed seals are most sensitive to disturbance during the denning and pupping period which extends from mid-March to mid-May. Disturbance prior to denning can cause displacement of pregnant females to other areas, and if those areas are less desireable (e.g. unstable pack ice), the growth and development of the pup will be affected. Female seals with pups are especially sensitive. If disturbed, the female may abandon the pup, causing its death (McLaren 1958). For these reasons, undisturbed fast ice areas are essential for maintenance of ringed seal populations (Burns et. al. 1980). A correlation between low ringed seal densities and seismic lines has been shown (Burns op. cit.). It is possible that seismic exploration on the lagoon ice or barrier islands within the study area could affect a few local seals by causing temporary or permanent displacement of pregnant females or abandonment of pups. Traffic along the offshore ice may be necessary to support the exploration program and may also cause limited disturbance to seals. This may be either a short term or long term impact. Further studies are needed to clarify the effect of seismic exploration on ringed seals. One project is proposed for 1982 by the Outer Continental Shelf Environmental Assessment Program (J. Burns pers. comm.).

Arctic cod are one of the main prey items of ringed seals (Lowry et. al. 1981). Cod spawn under the nearshore fast ice in January and February. The eggs develop slowly under the ice for up to three months and the larval stage develops further for two months (Lowry et al. 1979). No information is available regarding the sensitivity of arctic cod eggs or larval stages to seismic impulses, but it is possible that they could be affected locally by seismic activity in the study area or travel offshore. Studies are needed to determine the sensitivity of arctic cod eggs and larval stages to seismic exploration activities.

Another period of sensitivity of ringed seals may be during summer feeding. During this time seals feed extensively after having fasted during the molt. Major food items are nektonic crustaceans and arctic cod (Lowry et al. 1981). Heavy summer feeding may be important for sustaining seals through the winter, especially for pregnant females (Burns op cit.). A small number of seals have been seen feeding in lagoons in the study area, and many are seen offshore. Boat based seismic exploration in the lagoons could disturb seals feeding there. Boats gaining access to the lagoons from deeper waters offshore may cause some disturbance to seals feeding offshore. However, the amount and effect of boat disturbance to feeding seals has not been studied, and the extent of impact to seals in or near the study area cannot be determined. Future studies of this are necessary.

Geraci and Smith (1976) investigated the effects of oil on ringed seals. Adult seals are not greatly harmed during the summer by being directly oiled. Oiling can cause temporary but severe eye damage or kidney problems. Prolonged contact with oil during the winter, however, can cause permanent eye disorders. Unweaned seals in lairs are more susceptible to oil because they have not developed an insulating fat layer and rely on their lanugo, or wooly white coat, for warmth. Oil fouling of the coat will reduce its insulating value. Also, seals under stress can react to oiling with convulsions and death. Stress can occur in the wild, with older seals being more prone to it (Smith and Geraci 1975). It is possible, then, that a fuel spill from a coastal facility or seismic train could cause localized impacts to seals especially during the winter and spring (Lowry et al. 1981). The eggs and larval stages of arctic cod, as well as spawning adults which congregate in nearshore leads, may also be vulnerable to oil spills (Lowry et al. 1979).

There is no information available about the effect of oil on the invertebrate prey of ringed seals. Similar species have shown a variety of reactions to oil from resiliency to sensitivity (Lowry et al. 1979). Further studies are needed to determine the impact that fuel spill may have on ringed seal prey populations and the secondary impact to the seals.

### Bowhead Whales

Geophysical exploration on the study area is likely to produce only indirect or secondary impacts to bowhead whales, rather than direct impacts. Bowheads are not known to use the lagoon systems along the study area, but are seen offshore of the study area, as well as further east, during the late summer and fall (Richardson and Fraker 1981; Lowry et al. 1981). Therefore, any impacts to bowheads from the exploration program would likely be indirect, possibly caused by seismic exploration or associated logistical support along the coast during the period mid-August to mid-October. The main impact to whales near the study area might be the disruption of feeding. Intensive feeding occurs in nearshore waters during the summer and fall (Lowry and Burns 1980; Ljungblad et al. 1980). However, the importance of the zone adjacent to the study area is not known. As disturbance is likely to be localized, the overall impact would be slight.

Early whale studies included observations of disturbance, or lack of it, but those observations are contradictory at best. Within the past two years detailed studies of the effects of disturbance to bowheads have been initiated (Fraker et al. 1981). However, very little is presently known about the short- or long-term effects of disturbance to bowhead whales, and the following discussion presents only a qualitative description of potential impacts.

The potential sources of disturbance to bowheads due to exploration activities can be classified into three major categories:

1. Sounds produced by exploration or facilities
2. Approaching air-or watercraft
3. Toxic substances

Underwater sound can directly or indirectly affect whales. Direct effects include masking of communication, echolocation, or reception of other environmental sounds.

Underwater sound reaching whales can be generated by many sources. the primary source for the exploration program would be boat based seismic exploration, which produces the sonic impulses using air guns or spark-ignited gas explosions. One whale study recorded sounds produced by a seismic ship in the Beaufort Sea (Ljungblad et al. 1980), but was not able to study the reaction of whales, as no whales were nearby. Another study observed a group of bowheads near (within 13 km) a seismic ship and saw no obvious signs of disturbance. However, as it was not a controlled experiment, the authors wre hesitant to draw conclusions from the one observation (Fraker et al. 1981). The use of above-ground explosives, known as the Pouldier technique, may also produce sound detectable in the water.

Aircraft overflights of bowheads may or may not cause disturbance. Some studies have shown that bowheads will dive if overflown, but the reported altitude causing disturbance varies, up to 305 m above sea level (ASL) (Fraker et al. 1981). One observed reported no disturbance down to 150m ASL (Koski cited in Fraker et al. 1981). And finally, one study reported immediate reactions in the spring and little reaction in the fall (Ljungblad et al. 1980). Although the variety of reactions seems confusing, it does show that bowheads may be more sensitive to disturbance by aircraft than other whale species (Fraker et al. 1981).

Bowheads react to boats approaching nearby by both moving away and spending more time submerged. Moderate boat distance (900 m or less) cause orientation away from the boat. Even idling of boat engines at a distance of 3.7 km caused an alteration in the time that whales spent at the surface between dives. However, there is no information to indicate that bowheads completely leave the area after a disturbance episode (Fraker et al. 1981).

The effects of toxic substances to whales is unknown. It is possible that foreign substances might disrupt a whale's ability to locate food by masking its chemoreception. Damage to active epidermal cells is also possible (Fraker et al. 1981). Another potentail impact is the chance that oil would foul the baleen of bowheads, making them less efficient in feeding, or causing the whales to stop feeding (Fraker et al. 1978). Further study needs to be done on this subject. However, since exploratory activities will be fairly localized during the time that bowheads are present near the study area, little impact to whales is expected from toxic substances.

To summarize, the extent of the potential impacts of exploratory activities in the study area to bowhead whales is largely unknown but probably slight. Bowhead whales are present offshore, outside of the study area, and only during the summer and fall. Their main activity during this time is feeding as they move slowly westward during migration. Boat based seismic exploration in the lagoons, coastal exploration using explosives, boat and aircraft traffic, and shoreline facilities might all cause disturbance to bowheads. The short-term and long-term implications of disturbance are unknown.

## Polar Bears

Exploratory activities on the Arctic Coastal Plain may have greater impact on polar bears than any other marine mammal. An especially critical period in the bears' life cycle is denning (Lentfer 1974a). Polar bears are present in the study area during denning, which begins during late October to early November. At this time, pregnant female bears travel to the coastal areas where denning habitat may be found on the fast ice, offshore islands, or on the mainland up to 48km inland. Cubs are born in midwinter, and mother and cubs break out of the dens in late March to early April (Lentfer and Hensel 1980). During the winter most nondenning bears remain offshore, and during the summer nearly all bears are far offshore at the ice edge. Impacts to nondenning bears are generally expected to be minimal. However, occasionally large numbers of bears congregate locally to scavenge on whale carcasses in the fall and may be vulnerable to impact at that time.

Responses of denning female polar bears to disturbance vary. Bears have deserted newly formed dens in October and November due to the presence of investigators (Belikov 1976). In early March a female and an extremely small cub were sighted northeast of Prudhoe Bay, indicating an early exit from the maternal den (Lentfer 1974b). An incident of disturbance to a family group of one female with two cubs by a seismic charge caused the group to leave their den and travel north (Moore and Quimby 1974). One study on grizzly bears indicated that a radio collared female in den showed some movement immediately after seismic explosions but did not desert her den (Reynolds 1979). On the other hand, Belikov (1976) reported observing females with cubs in dens without apparent disturbance, and a female with two cubs at a den in Prudhoe Bay were observed by oil company personnel for several weeks (Lentfer 1974a).

The factors which influence polar bear reactions to disturbance may include the frequency and level of disturbance, distance from the den of the disturbance, and the stage of denning during which the disturbance occurs. Explosives used for seismic exploration would surely cause disturbance, as would numerous vehicles driving by or aircraft landing nearby (Lentfer 1974b). The effect of the Vibroseis technique is unknown at this time, and further study is needed.

The impacts of disturbance to denning female polar bears may be two-fold. If the pregnant female is disturbed while searching for a den, it then may retreat to the pack ice to den, where the substrate is less stable and food supply is less abundant. Denning success and productivity could be significantly reduced. Disturbance of females with cubs may cause neglect or abandonment of the cubs, leading to their death and lower recruitment to the population (Lentfer and Hensel 1980). However, further study is needed regarding the extent and duration of single disturbances, and the long-term effects of such disturbance.

Undisturbed denning habitat is also important for polar bears. Although the number of bears returning each year varies according to ice, snow and weather conditions, it is thought that they show fidelity to birth sites and try to reach the area previously used for denning (Lentfer and Hensel 1980). As discussed in an earlier section, denning habitats include areas which accumulate drifting snow, such as rivers, lake banks and coastal bluffs. These areas could be rendered physically unuseable by heavy machinery traversing or plowing through them, or the areas could be rendered unuseable due to human activity scaring bears away.

Other possible impacts to polar bears include attraction to waste disposal sites or camps, reduction in prey (ringed seal) availability locally, nd direct or indirect contamination by pollutants. Polar bears are attracted to camps and waste disposal sites, where they become nuisances or danger to personnel (Lentfer and Hensel 1980; Woolridge and Belton 1980). Camps located near the coastline would be the most likely sites for such problems, since the coast is a natural travel route for bears (U.S. Fish and Wildlife Service 1976). Although scare techniques are available (Woolridge and Belton 1980) nuisance bears are usually relocated or eventually shot.

Potential reduction in the ringed seal populations is discussed in another section. Pre- and post-denning food supply is important to female polar bears because of the 5-month long denning period during which they do not eat. Lack of an immediately available food supply may be critical to survival of the female and cubs (Lentfer 1974b). Further study is needed on this aspect of polar bear ecology.

Direct effects of oil contamination to polar bears are not well known. One study was initiated last year in Canada. Initial results showed that oil was ingested and metabolism rates increased significantly. Two of the three bears tested eventually died (Hurst et al. 1981). Further studies are needed to determine if wild bears will enter an oil slick or avoid it. Indirectly, a large or chronic oil spill could affect bears through their food chain. However, a spill during the exploration program would likely be small or localized, thus having an overall minimal impact to bear populations Yet an oil spill near a concentration of scavenging bears could have a major impact.

### Other Marine Mammals

Beluka whales and bearded seals are found only occasionally near the study area. Impacts of exploration to these animals are expected to be negligable.

### Fish

The impacts of geophysical exploration may be in the low to moderate range. Several characteristics of arctic fish popultions make them highly sensitive to disturbance. They exhibit slow growth, poor recruitment and late maturity. High concentrations of some species during spawning and in overwintering areas make them especially vulnerable.

Use of explosives in seismic esploratory activity may impact fish. The affects of underwater explosions on fish have been documented by Falk (1973). Results from this study showed maximum lethal ranges of 50 to 500 feet varying with the explosive charge, depth of charge and underlying substrates. Information on the effects of explosives set off adjacent to lakes and streams is not available. It is conceivable that impacts may arise where explosives are in close proximity to critical habitat areas (i.e. overwintering habitat). The Alaska Department of Fish and Game has recommended that pressures generated within a waterbody not exceed 2 pounds per square inch

(Starr et al. 1981). It is though that the Vibroseis technique does not affect fish.

Impacts of water withdrawal may produce long-term irreversible effects. All life stages of a particular species may be located in a single isolated pool or spring. Potential impact woulld be upon the whole genetic population. Ward and Peterson (1976) reported that overwintering pools located in the Sagavanirktok, Canning and Hulahula Rivers become completely isolated (without recharge) when sections of the river freeze solid. Effects of water withdrawal of fish populations includes: direct mortality; indirect mortality, from wast concentration; and, a dewatering marginal gravels containing developing fish embryos and fry. Bendock (1976) reported masses of grayling fry and insects at the surface of one dewatered hole. Impacts of dewatering pools or springs may also cause fish to change overwintering areas and therefore impact subsistence fisheries.

Alternative winter water sources, where minimal impact would occur, are not abundant. Tundra lakes are generally of poor quality and must be treated to be potable, or they are so shallow that they freeze solid (Schallock 1976). Other deep lakes may contain fish populations. Although potential use of water during the exploration program will be small, the potential for affecting overwintering pools or springs is great.

Another potential impact to overwintering fish populations is the deeper freezing of pools or lakes due to removal or compaction of the isulating snow layer. Clearing of large lakes for airstrips is a common practice. If lakes of marginal overwintering capacity are cleared and allowed to freeze down, the fish population might perish. Likewise, compaction of snow over river pools can cause freeze-down and fish mortality.

Environmental contamination from sewage wastes, fuel and oil spills are potentially threatening to arctic fish populations. Domestic wastes entering arctic aquatic ecosystems may cause severe dissolved oxygen depletions particularly during low water, winter conditions when the assimilative capacity is much reduced. Dissolved oxygen depletion can cause direct mortalities and long-term damage to the food structure of arctic waters (Craig and McCart 1974, Schallock 1976).

Increased fishing pressures, if generated by exploration crews could have a great impact to the fisheries. Use by the citizens of Kaktovik of fish in several inland springs is common, and if additive pressure is applied could harm the population.

Craig and McCart (1975) stated that selection in the fishiries for the larger spawning population would disproportionately harvest females therefore reducing the reproductive capacity of the populations.

## Archaeology

Given the large gaps in the data base discussed in the last section, it is particularly important that there be a realistic assessment of potential impacts archaeological sites from exploratory and developmental activities associated with oil and gas. This assessment will make it possible to develop mitigating measures that are adequate for protecting the historic and archaeological resources in the study area.

The assessment that follows divides exploration and development into sets of actitivities in order to assess potential impact of specific actions on cultural resources. The assessment relies on work done in NPRA by USGS (Hall 1980) as well as experience on the Trans-Alaska Pipeline (Cook 1977) and other large projects

Discussion of Mitigation

The mitigating procedures preferred are those that involve relocating a proposed facility or activity. Relocation is preferred to excavation because it allows the preservation of the archaeological site in place which makes it available for future archaeologists to investigate using future techniques. Data collection on the other hand is limited by what we know about archaeological method and theory today. It is also limited by the fact that data recovery projects often suffer from a lack of time to complete them due to the timing of activities. It is recognized, however, that in some cases there may be no realistic alternative to excavation and data recovery, and that these activities are acceptable forms of mitigation in certain limited cases.

Exploration activities can be broken down to seismic lines and logistical support facilities. The impact these activities have will vary to some extent depending on what time of year they occur and how permanent they are.

Seismic lines and wintertrails: Table 1, which has been extracted from the most recent USGS report on cultural resource management in NPRA, summarizes the possible types of damage to archaeological sites that can occur from ground vehicles during seismic testing. As can be clearly seen, the possibility of an archaeological site sustaining damage is much higher during summer than winter. Even during winter there is some possibility of damage to sites located in unfrozen areas and to sites that are not covered by snow or to those that are not on tundra. While this table represents many assumptions not verified by experimental data it also rests on sound judgement and does not exaggerate the potential damage to archaeological sites from travel by ground vehicles. Of course, the amount of damage that could occur would depend on factors such as what type of vehicle is involved and what part of it contacts the ground surface, vehicle load, driver skill, etc.

Based on the recent history of NPRA seismic work (Hall 1980) minimizing potential damage to archaeological sites during seismic operations using surface vehicles would require:

(1) a cultural resource survey of proposed lines and avoidance of all archaeological sites identified.

(2) vehicles should travel in the winter and should be confined to tundra areas.

(3) if travel must take place on bedrock or consolidated and/gravel areas the ground should be frozen and have a substantial snow cover.

If seismic activities rely on helicopter support for placement of testing implements, potential impact to cultural resources is substantially reduced substantially. However, a survey to identify archaeological sites that should be avoided is still necessary, because there is still some potential of damage by explosives and the collection of artifacts by the people working on the tests.

Other Activities: It is also possible that there may be indirect or secondary impacts to archaeological resources from oil related activities. This can occur when people associated with oil exploration and development encounter and loot archaeological sites.

TABLE 2. POSSIBLE TYPES OF DAMAGE TO ARCHAELOGICAL SITES AS A RESULT OF GROUND VEHICLE TRAVEL[1]

| CONDITIONS AT ARCHAEOLOGICAL SITE | EXTENT OF POSSIBLE DAMAGE | NATURE OF POSSIBLE DAMAGE |
|---|---|---|
| Summer | | |
| Any subsurface, with or without ground cover; any ground cover. | Moderate to Extreme | Breaking of cultural objects, loss of association between cultural objects, mixing of components in stratified site, erosion and complete loss of cultural objects, and lowering of permafrost table and subsequent deterioration of organic artifacts, etc. |
| Winter | | |
| Bedrock or consolidated sand/gravel with no sod cover or with thin sod cover with/without denuded areas. | | |
| Frozen ground and substantial snow cover | Probably none. | --- |
| Frozen ground and relatively little snow cover. | None to slight. | Some breakage and/or slight lateral displacement of objects. |
| Unfrozen ground and substantial snow cover. | None to slight. | Some breakage and/or slight lateral/ vertical displacement of objects. |
| Unfrozen ground and relatively little snow. | Moderate to extreme, depending on whether runs in a straight line or turns. | Breakage, lateral and vertical displacement; possible subsequent vehicle erosion with adverse effects. |
| Wet tundra or other unconsolidated ground; upland tundra; sites unlikely but if present. | | |
| Frozen ground and substantial ground cover. | Probably none. | --- |

TABLE 2. CONT.

| CONDITIONS AT ARCHAEOLOGICAL SITE | EXTENT OF POSSIBLE DAMAGE | NATURE OF POSSIBLE DAMAGE |
|---|---|---|
| Winter cont. | | |
| Frozen ground and relatively little snow cover. | Slight to moderate. | Damage to tundra can change thermal regime and cause subsequent erosion. |
| Unfrozen ground and substantial snow cover. | Slight to moderate. | As above. |
| Unfrozen ground and relatively little snow cover. | Moderate to extreme. | As above; potential for extreme erosion. |
| All seasons | | |
| Any condition | Serious. | Injection of fossil hydrocarbons into ground water because of leakage or spillage can cause contamination of organic material and eliminate the possibility of $C^{14}$ dating.[2] |

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[1] This table is intended only as a general summary; experimental field studies would be necessary for a more detailed analysis. Obviously, the type of vehicle involved and the nature of the part of the vehicle that comes into contact with the ground surface, as well as vehicle load, driver skill, etc., will play a role in potential ground damage. This table is based on travel by heavily loaded, tracked vehicles, or vehicles pulling heavy loads on skids, as associated with the seismic program or the movement of drilling rigs, etc.

[2] Potentially this is the most serious problem connected with ground vehicle travel in the Reserve. Studies of the Old Fish Creek Wellsite, where drilling took place 30 years ago, indicate that the effects of oil spills are pervasive and long term; soil samples from a depth of 40 cm. still retain a strong smell of diesel fuel and thaw in some cases reached 70 cm., nearly twice the thaw in adjacent unaffected areas (K.R. Everett, personal communication).

## Human Culture and Lifestyle

### Subsistence and Other Socio-Economic Features

This section complements other sections of this reprt which consider the arctic environment and its wildlife resources. If the abundance or reproductive rates of these resources decline, if their mortality rates increase, or if their habitat is damaged or reduced, the level of sustainable subsistence harvest could decline. This could affect the socio-economics of rural commonities in many ways. While positive impacts such as a stimulated local cash economy, bringing more jobs and social services would benefit local people, any loss of wildlife would unavoidably affect residents dependent on it.

The following section has been divided into two parts. Because Kaktovik would be the most severely impacted of all the villages, it has been addressed separately. Other affected villages are addressed in the second section.

Kaktovik The socio-economic impacts of oil related activities on the people of Kaktovik fall into two broad but related catagories. The first is the physical impact on the land resource base: the historic sites, and the fish and wildlife resources and habitat that are the base of Inupiat subsistence dependence. The second is the impact on the subsistence activities, and on the village and villagers themselves. Both of these impact the Inupiaq culture.

Both types of impact will occur under both seismic exploration and development production scenarios; however, they will be present to a fae greater degree under the development production scenario.

> "The Inupiat culture and lifestyle are currently under stress. Survival of the Inupiat culture as a unique and distinct entity depends upon the viability of its socio-economic subsistence complex and its direct relationship and dependence on the arctic environment." (USGS 1979).

Seismic exploration and, to a far greater degree, petroleum development on the ANWR coastal plain would further exacerbate this stress and further increase existing social and cultural problems, as well as erode the subsistence resource base. We cannot let the tendency to underestimate social impacts and social costs lead us to conclude that whatever social problems may occur can be overcome.

Any impacts on the fish and wildlife or associated habitats of the ANWR coastal plain resulting from seismic exploration will also impact subsistence use for whatever species is involved. For example, if fish in a particular drainage are reduced in number due to impacts at their overwintering area, of if foxes are attracted to or fed at a seismic camp and get trapped or shot, this reduces the numbers of fish or foxes available for subsistence use. This in turn would reduce people's food supply and their income from trapping. Similarly, if a particular species is permanently driven to another area because of seismic activity or damage, this could result in the eventual decline of species numbers due to habitat loss and thus impact subsistence. If caribou, for example, were made less available to people of Kaktovik, this would reduce availability of a primary and irreplaceable source of protein that is essential to thier health and native culture (North Slope Borough Assembly 1987).

If seismic crews are allowed to hunt, fish or trap, this would increase competition for the wildlife resources and increase pressure on the subsistence resource base. It would also likely arouse hostility from local users. Especially significant impacts could occur from increased fishing in the overwintering areas of rivers and lakes, as these areas may already be fished to their limit by the local population and by summer recreational users. The degree of impact on subsistence resources would depend on the types of regulations instituted and the degree to which they were enforced. Invocation of subsistence priority provisions in the State Subsistence Law and ANILCA Subsistence Title (Sec. 804) could mitigate socio-economic impact in this area.

Seismic activity may also have a physical impact on the historic (Traditional Land Use Inventory) sites of the arctic coastal plain, many of which have present-use value as subsistence sites (Jacobson and Wentworth 1981). These sites may or may not have tangible remains, and in many cases their boundaries cannot be easily delimited.

The following quotation is helpful in understanding why historic sites, even without physical remains, have so much value in Inupiat culture:

> Members of the Inupiat and Western cultures operate from distinctly different sets of premises, and the level of mutual understanding may be limited. This difference in values is exemplified in the ways in shich westerners and Inupiat regard land. The Western notion usually derives from some economic or recreational base. On the other hand, to the Inupiat, a landscape contains thousands of sites that are significant in a variety of ways. The meaning of each site is expanded and deepened throug oral traditions and historical knowledge. Each person may hava lifetime of subsistence or social and cultural experiences at many sites, and the experiences and uses are passes from generation to generation. Old occupation sites and landmarks may also have supernatural associations that affect madern Inupiat use. Much of the nalue of a site may be invisible to a non-Inupiat. Nevertheless, alteration of sites constitutes a defacing of history and even may entail a threat of supernatural retribution. As a result of the multiplicity of types of sites and emotional associations, the Inupiat consider a whole array of values that may be unfamiliar to planners or developers. (USGS 1979:45)

Seismic exploration may impact not only the fish and wildlife used for subsistence, but also people's subsistence activities and their daily life in the village. Seismic work may interfere with people's subsistence activities in a variety of ways. For example, work in a particular area where people are used to hunting or fishing could cause the wildlife to temporarily leave that area, making them unavailable for subsistence at the time of year people go to hunt them (see "Resources Harvested"). Or, if the seismic crews are in a particular area at a time of year when people usually hunt there, people may feel they cannot go there because 1) they would feel too uncomfortable or self-conscious under the circumstances, 2) the hunting experience would not be aesthetically pleasing or enjoyable 3) their chances of hunting success would be reduced due to noise or other interference or 4) their cultural group activity and privacy would be disrupted. Alternatively, the people might encounter the seismic activities while hunting and feel angered or annoyed for any of the above reasons. For example, if seismic boats were funning back and forth in the Beaufort Sea north of Barter Island in September, they might alter the migration path of the whales, or the noise and other interference might scare them. Both of these situations would make the whales harder to hunt. If a seismic crew set up camp at Camden Bay in May, Kaktovik people might feel too self-conscious to make their annual trip there for spring waterfowl hunting. Or, if a helicopter was flying low along the coast in July and passed over a herd of caribou, this might cause them to scatter and move inland, making them unavailable to hunters in their boats.

Several families might be camped together at the 1st Fish Hole on the Hulahula River in November or April, only to have seismic crew come along and set up camp near to them. While the people might not show it, they would likely feel angered and intruded upon, as this would be a disruption of their cultural as well as personal privacy.

Finally, if a group of Eskimos encountered a cat train or other seismic activities while traveling to or from a hunting or fishing area they might feel intimidated, or annoyed from having to temporarily halt travel plans, or go "the long way around" to reach their destination.

Of greater long term importance than temporary loss of hunting opportunity or conflicts between seismic crews and subsistence users, however, may be the location of the base camp for seismic exploration. If located at Barter Island, social impacts could be great. Locating a base camp at Camden Bay or outside the ANWR would minimize social impact because local people would interact with it only seasonally or not at all.

In the case of seismic activity conflicts with subsistence users, Kaktovik people would at least have the option of going somewhere else that year. However, stationing a seismic crew at Barter Island would be more permanent and could affect the daily life, culture, and social structure of the entire village. Local people would not have the option of packing up and moving.

To understand the nature of this impact, it must emphasized that on Alaska's North Slope we are dealing with two very different cultures with very different values (USGS 1979). The degree to which the Inupiat have been able to keep their culture, social system and values intact has been a function of their degree of isolation. Although contact with the outside has brought many material and other benefits, the amount of cultural stress and accompanying social problems over the past several years have been directly related to the increased amount of western influence and the rapid changes (Wentworth 1980). Stationing a seismic crew at Barter Island would further alter the cultural composition and character of the village and exacerbate this stress.

In Kaktovik to date, a degree of socio-cultural control has been developed and maintained over these outside influences, keeping them from becoming overwhelming. Non-Native visitors often remark on the friendliness of Kaktovik compared to Barrow, and on the absence of the overt racial tension sometimes exhibited in Barrow. This may be related not only to Kaktovik's smaller size, but to its relative isolation and the greater degree of socio-cultural control Kaktovik people have over their own environment. The few non-Natives that the people deal with on a daily basis are usually known entities - not strangers. And the Inupiat have always been clearly in the majority. Stationing a seismic crew of 50 to 60 people at Barter Island would alter this balance, probably making non-Inupiat the majority for the first time. The degree of impact would depend on where the seismic camp was located on Barter Island, the degree to which it was self-contained and independent from the village, and the rules and regulations that were made and enforced concerning interaction with the village. Impacts would also vary depending on the degree to which the local Kaktovik government was involved in planning for the seismic facility, and solving problems which arise. Although seismic exploration on the Arctic Coastal Plain would create additional job opportunities for Kaktovik residents, there is already an abundance of jobs in the village. Hiring local people as monitors on seismic crews could help mitigate impacts.

Existing outside influences at Kaktovik include the Barter Island DEW Line Site and airport, which have been present for over 30 years. Up to 70 employees live at the Site. While the Site has had tremendous physical, social and economic impact on the village over the years (Nielson 1977; Jacobson and Wentworth 1981) methods of controlling the impact have evolved which now keep this influence at a minimum. The Site is located about one mile from the village, and workers there do not mingle with the village except in a very controlled fashion, such as an occasional sports event. This is both a matter of choice and a matter of policy. Similarly, Kaktovik people do not visit the Site unless they are employed there or are an official guest of a DEW-Line employee. Several non-Natives who work at the Site are a know quantity as they have been there many years. The four or five non-Native males who are permanent residents of Kaktovik are all former or present Site employees.

Problems between the Site and the village have been many. Much of the erosion of traditional cultural values at Kaktovik can probably be traced to influences from the Site or its personnel. Lingering hostility exists over the moves that the Site forced the village to make. (see Historic Sites, Kaktovik 1st, 2nd and present locations). The latest cause of DEW-Line village friction concerns the closure of the DEW-Line airport terminal to use by the village. Aside from these factors, however, peaceful coexistence between the Site and village is usually maintained.

Other permanent non-Native influences present at Kaktovik are the school with eight teachers (most of whom came directly from outside Alaska); three or four maintenance and physical plant employees; four or five construction workers employed by the North Slope Borough's Capital Improvements Program, and three families working for the Borough's Public Safety Dept., the U.S. Post Office and the U.S. Fish and Wildlife Service.

In summertime, the number of outsiders at Kaktovik temporarily swells as more construction workers, geophysicists, Fish and Wildlife Service employees, researchers, hikers and hunters visit the village. Although Kaktovik is a friendly village, attitudes towards non-Inupiat outsiders are noticably cooler during the summer than during the winter when there are fewer of them and each one is a known quantity. Stationing a seismic crew at Barter Island would likely increase this coolness, and could perhaps for the first time even cause overt racial tensions in Kaktovik. Another influx of a predominantly male population would increase the already existing competition between Inupiat and non-Inupiat men for Kaktovik women. This is one area where a certain amount of hostility is already evident. Depending on the degree to which the seismic personnel interacted with the village, the already serious local problems of alcohol and drug abuse could intensify (USGS 1979).

Other affected villages Impacts on the communities which are heavily or partially dependent on the Procupine caribou herd as a subsistence resource will depend on the impacts of seismic exploration on the herd itself. If the herd is not affected by oil and gas exploration (i.e. if the numbers of animals available for hunting remains constant or increases, if migration patterns, temporally or spatially, are not altered, and if bag limits adn seasons do not change drastically), the impacts on subsistence use will not be felt in these villages. However, if the impact of exploration on the Porcupine herd is a negative one, then the subsistence use and the lifestyle of rural residents would also be negatively impacted. The same would hold true for coastal villages which take beluga whales or polar bears -- if the distribution or abundance of these mammals declined, the level of sustainable subsistence and commercial harvest may be reduced.

If caribou are made less available to people of Arctic Village and Old Crow, the largest impact will be in reducing the availability of their primary source of protein. The ramifications of this could be far-reaching. The lack of food may lead to an increased dependence on welfare or other assistance programs for food. Another result may be a change in emphasis to hunting less abundant species such as moose or Dall sheep, altering their populations to a point of less abundance, and in Alaska, possibly invoking the subsistence preference for harvesting game in the Arctic Village area.

Hearings held in Old Crow during the Mackenzie Pipeline Inquiry (Berger 1977) revealed that people there fear that white people may destroy their caribou, and that if the caribou are threatened, the people themselves are threatened. They see the caribou as the essential link between their past and their future, and the preservation and maintenance of the Porcupine caribou herd as of fundamental importance to their survival.

The social and cultural fabric of Old Crow and Arctic Village may also be affected by a reduced number of caribou available for hunting. Cultural bases and social structures which are dependent on hunting prowess and hunter status may change, causing social unrest or confusion in the village.

Effects on the economy of the affected villages are difficult to predict. A possible increase in dependence on outside social programs may change cash flow or cash dependency within the village. More people may have to seek cash employment for greater periods of time creating increased competition for the few available paying jobs or necessitating leaving the village for employment.

Arctic Village may be affected in one additional way from oil and gas exploration on the coastal plain. Increased air traffic to and from Kaktovik or other base camp locations mayincrease the number of planes landing in Arctic Village. This in turn may generate more landing fees for the Tribal government, and may increase the number of jobs available for workers in Arctic Village. It may also increase the supply and diversity of goods coming into the community and may increase use of the lodging facilities in the village. Furthermore, local people could be hired onto seismic crews, increasing employment opportunities.

The impact of a reduced caribou harvest in the other previously mentioned villages that utilize animals from the Porcupine herd will not be as severe as in Arctic Village or Old Crow since the caribou are not as large a component in the subsistence harvest. The lack of caribou in the diet or for trade amy be more of an inconvenience or discomfort rather than a critical shortage. However, certain years when other resources such as marine mammals or fish are not as available in these other villages, the lack of caribou could be more critical.

Since there is such an acute shortage of data on most subsistence use of resources, many impacts are difficult to predict with accuracy. Until we have a more complete data base to use, these impacts will necessarily be rough predictions.

The ramifications of oil and gas exploration are not limited to Alaska, as previously indicated. Since beluga whales also migrate from Alaskan waters eastward to Canadian waters (see "Marine Mammals" Section) impacts on the whale population could impact subsistence use of that population in the Mackenzie villages of the Northwest Territories. Whaling is traditional for coastal Eskimos; if whaling as an activity is lost or reduced it will have cultural ramifications in Aklavik, Inuvik and Tuktoyaktuk. The social, recreational and cultural aspects of whaling would be lost as well as the subsistence food the whales provide.

A limited amount of polar bear migration between Alaska and Canada has also been discovered (Stirling et al. 1975). Since polar bear hides play an important part in the economy of the "Rim" villages of Sachs Harbour, Paulatuk and Holman, and a more minor role in the Mackenzie villages, impacts which decrease polar bear populations which serve to decrease the population may negatively affect the economy and livelihood of Canadians. If oil and gas exploration activities tend to move polar bear populations to the east, the economies of the Canadian villages could benefit to the detriment of the polar bear population. Another impact could involve arctic fox populations which are of very high significance as a furbearer in the "Rim" and to a lesser degree, in the Mackenzie economies. Fox tend to follow polar bears on the pack ice where they clean up the remains of seal kills made by the bears. If polar bear populations were to decline, arctic fox populations may decline, and therefor the economy of the villages may be adversely affected. A baseline study of arctic fox population dynamics and the relative importance of its different food sources at different times of the year would provide greater understanding of bear-fox interrelationships and therefor on the possible effects on the economic base in arctic villages (Stirling et al. 1975)

Recreation. The following section covering the possible effects of an oil and gas program is largely hypothetical, but based on the best available knowledge and information at this time. There have been no specific studies on the various impacts of exploration activities on the activities of recreationists on the north slope or elsewhere; however, various possible impacts are not difficult to project. It must be understood that given the lack of data on recreational use in this area and the uncertainties of predicting recreational use or trends, the following are projections and do not represent a quantification of impacts.

The overall effects of an oil and gas exploration program on recreational opportunities on the coastal plain study area can be expected to be mainly psychological effects on the recreationists themselves. With the exception of above ground explosions, there are probably no aspects of the exploration program that would physically restrain recreationists from participating in their chosen activity. However, the psychological impacts of carrying on a wilderness-based recreational pursuit with a backgound of cat trains, helicopter overflights or seismic booms will likely effectively halt most present recreational activities on the coastal plain of the Arctic NWR. Visitors are expecting some form of a wilderness experience, and seeing any or all of the effects of an exploration program on the environment will especially affect that percentage of visitors to whom wilderness qualities are essential for their experience.

The impacts resulting from seismic exploration will differ somewhat with varying techniques, but will basically be detrimental to the types of recreational activities now on-going if there is seismic or exploratory activity during the period from June 1-September 15. Any change in the esthetic qualities of the wilderness character of the coastal plain will detract from the quality of the wilderness experience.

Equipment and logistical support required for any type of seismic activity, except for an ocean boat-based method, would cause disturbance factors in an otherwise wilderness environment. Although wilderness is not essential to some forms of recreation, such as hunting, visitors to this particular area expect to have a wilderness experience. Most visitors support maintaining the wilderness in a pure state (Warren 1980) and disruption of the wilderness character will likely negatively affect the recreational experience even though the recreational activity itself is not curtailed or prevented. Direct disturbance factors can include such things as noise pollution from explosives, helicopter and light aircraft flights, visual intrusions from the presence of machines, mobile camps and their associated solid waste, and air pollution from diesel engines or generators causing foreign odors in otherwise "pure" air. There has not been any research to identify which, if any, of the above disturbances are most annoying or acceptable to recreationists, how far noise levels carry across the tundra, etc., but attitudes of wilderness users do not allow for man-made disturbances to occur without a change in the quality of their experience. Solitude and tranquility, both important components of a wilderness experience (Hendee et al. 1968, Rossman and Ulehla 1977), will no longer be available. By directly affecting the esthetics of the wilderness area, exploration will indirectly serve to reduce or eliminate recreation from the study area.

One component of exploration that is particularly annoying to wilderness visitors is helicopter flights (J. Liedberg, pers. comm.). Helicopters seem to detract from a primitive recreational experience more than single engine "bush" aircraft. The impact of helicopter flights will be felt in all on-going recreational activities.

Hikers crossing the coastal plain and encountering tracks from vehicles, or other permanent scars from man's activities, would probably be adversely affected. The impact of any recent evidence of man's presence in the pristine environment would have detrimental effects on the wilderness user's experience. Another effect of exploraton that may adversely affect wilderness users is the effect that increased activities may have on wildlife populations. Wildlife observation is an important part of most Arctic Refuge visitors' experiences (Warren 1980). If wildlife are frightened away or become exceedingly wary and difficult to view, this will lower the quality of experience that visitors receive. It may negatively affect the hunter's trip if he is unable to have a successful hunt, and may also negatively affect the hunting guide operation in this area.

Most fixed camp facilities, especially if located off-refuge or at one of the already disturbed DEW-line sites, will probably not greatly impact recreation directly. The largest indirect impact would probably be from visual interference -- on the flat tundra of the coastal plain it is possible to see objects for many miles, and seeing a camp with associated facilities in an otherwise pristine setting would impact the scenic resource and the esthetics of the view.

Use of power boats or airboats in the lagoons and on rivers may negatively affect the experience of a kayaker or river floater, but since the level of this recreational use is quite low on the coastal plain, the impacts would probably be minimal.

Winter seismic activities would have essentially no impact on recreation unless permanent scars or facilities were left in the area. A very limited amount of cross-country skiing may occur in March and April, and would likely be disturbed in the same ways as backpackers and others would be during summer months.

Wilderness and Natural Landmarks Any permanent scars on the landscape will contribute to the ineligibility of the Arctic Coastal Plain study area for inclusion in the Wilderness System. Temporary intrusions of vehicle trains, helicopter flights or tent camps will not impact eligibility of the area. Natural landmark eligibility at the two nominated sites would probably also be jeopardized by permanent damage or permanent evidence of man's activities.

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# CHAPTER X

# IMPACTS OF FURTHER EXPLORATION, DEVELOPMENT AND PRODUCTION OF OIL AND GAS RESOURCES

## Introduction

Subpart D of Section 1002 (c) of ANILCA requires the baseline study report to address the impacts of exploration and development of oil and gas to the Fish and Wildlife Resources of the Arctic Coastal Plain Study Area. Chapter IX addressed to potential impact of exploration. This chapter attempts to address, very generally, what is presently known and what is not known about the effects of oil and gas development on the North Slope of Alaska. It is not possible at this time to predict whether or not oil or gas will be found in the study area, where the reservoir(s) might be located or whether or not it would be economical to develop a field. And, finally, the method and timeframe of development is far beyond the realm of prediction. Nonetheless, the matter must be addressed, not only because of the aforementioned legal requirement, but also because an initial analysis of available information must be conducted before study plans can be designed to fulfill the long-term requirements of the baseline study.

Examples of further exploration, development, production, and transportation of petroleum are found in nearby oil fields on the North Slope of Alaska (figure 1). Currently in production is the well-known Prudhoe Bay unit scheduled to begin production shortly is the Kuparuk River unit just to the West of Prudhoe Bay. The Milne Point unit, located between and slightly North of the previous two, is scheduled to go into production by 1985. To the East and North of the Prudhoe Bay unit is the Duck Island unit which will begin production in 1987. Several areas are currently being explored. The Pt. Thomson unit is just West of the ACP study area, along the coast. The Mikkelson Bay unit is between Prudhoe Bay and Pt. Thomson unit. Further West, the outlying parts of the Kuparuk River unit are still being delineated. The Colville River Delta also contains leased lands and exploration is beginning there. A large block of Federal land, the National Petroleum Reserve in Alaska (NPRA), extending from the Colville River West to the Chukchi Sea, has been explored under the direction of the U.S. Geological Survey. Portions of NPRA will be leased in December of 1981 and possibly in later sales. Other tracts which are scheduled for lease, both onshore & offshore are indicated in Figure 1. Oil exploration is also being conducted off the Mackenzie River Delta in Canada, with development expected to begin within the next (10) years.

A general discussion of an oil development scenario is contained in An Environmental Evaluation of Potential Petroleum Development on the National Petroleum Reserve in Alaska (USGS 1979). Activities are generally conducted in a standard sequence leading to production of an oil field. Geophysical exploration, including seismic techniques, occurs first after several years, exploratory drilling may begin where prospective areas have been found. Another several years of exploration drilling may occur before either a field is delineated or is considered a non-producer (BLM 1981), the non-producing area would subsequently be rehabilitated and abandoned. A producible field may be developed immediately or at a later date depending on the world and national economic situation. A transport system for the oil and gas is another factor in the overall picture. The oil from Prudhoe Bay and associated fields is transported through a combination buried and above ground pipeline. Other schemes for transportation of oil and gas include ice breaking tankers or submarine tankers. Refining of crude oil in site has not been considered for the North Slope. The final phase of shutdown and abandonment logically would follow the end of production, but has not yet occurred on the North Slope (Hanley et al. 1980). Leasing of Federal lands is generally carried outunder the provisions of the Mineral Leasing Act of 1920.

Several other Federal Laws and Regulations may also apply (table 1). On "Alaska Wildlife Lands" (eq. National Wildlife Refuges in Alaska), leasing is conducted through the provisions of 43 CFR 3101.3. A discussion of oil and gas development on Federal lands in Alaska is contained in the report Natural Resource Protection and Petroleum Development in Alaska (Hanley et al. 1980). While development on a National Wildlife Refuge may come under more strict regulations than on other Federal, state or private lands, the general scenario of the development will be the same (Hanley et al. 1980).

Many of the impacts of exploration which were discussed in Chapter IX will also occur during development, although they may be of greater magnitude and duration. Additional impacts which will occur are related to the intensity of the field development, such as spacing and number of well pads, extent of the field, amount and kind of service support required and the type of petroleum transportation system used. See Hanley et al. (1980) for a discussion of petroleum industry field practices. Several other volumes have discussed potential impacts of development (USGS 1979, USDI 1976, BLM 1981; Starr et. al. 1981). The Berger Report (Berger 1977) discusses potential impacts from development in the Canadian Arctic.

# VEGETATION & SURFACE RESOURCES

## Exploratory Drilling

During exploratory drilling light to moderate damage to vegetation and surface resources can be expected. The drilling pad itself will cover over a small area of land. Access roads and airstrips usually are constructed of snow and ice, so would inflict only minor damage. If gravel roads and airstrips were constructed, however, the surface impact would increase proportionately. This is especially a problem because of the gravel source. For exploratory wells the gravel used is obtained from river or stream bars or terraces. Gravel borrow can effect the hydrology of the stream (see fish section this chapter). Techniques which utilize less gravel, such as the "thin pad" concept used in NPRA (USGS/BLM 1979) or using insulation in place of some of the gravel, are available.

Other potential impacts from exploratory wells include oil spills and mud spills. Oil well blowouts are not common, but exploratory wells accounted for 1/3 of all blowouts which occured in the Gulf of Mexico outer continental shelf program during the years 1971-1980 (Danenberger 1980). No uncontrolled blowouts have occured on the North Slope, however, the effects of oil spills have been discussed in Chapter IX.

Drilling muds are usually contained in a excavated and gravel bermed pit. However, the pits may be susceptable to leaching or breaching of the walls. French and Smith (1980), Smith and James (1980) and Hrudey (1980) all report that some leaching of sump materials occur in Canadian Arctic drilling programs but the impacts are not great. Several mud pits on the North Slope experienced wall breaching when the gravel berm of the pit wall gave away, allowing drilling fluids to disperse. Two of those cases, in NPRA, leaked into lakes. However, the long-term impacts of those occurrences are not known.

## Production and Transportation

The incredible proliferation of facilities during the production phase has a large impact on surface resources. Everett et al. (1980) show a 30-year period from before exploration through development in three areas in the Prudhoe Bay field, and sequential development of the road system. Although perhaps less than 1% of the total land surface becomes covered, a much larger area may be directly impacted.

Production well pads are larger than exploratory pads. Additional pads may be need at a later date, which can lead to greater impacts if not previously planned for. For example, an addition may impact a high value wetland which the orignal pad avoided, because the addition is "locked in" to the original pad's site.

Roads, pipeline acces pads, and other linear facilities may affect wetlands by altering the natural water flow regime. This may cause flooding "upstream" and drying "downstream" of the road, thus altering the vegetation community structure (U.S. Army Corps of Engineers, 1980). Other indirect impacts of roads include dust shawdows (Rothe in prep), leaching of dust control or de-icing material, and littering of roadsides with gravel due to grading. The effects of road crossings on aquatic habitats will be discussed in the fisheries section.

Potential effects of the drilling operation and associated materials include:

1) blowout
2) chronic petroleum spillage
3) mud spillage or leaching

Blowouts are not common, either in exploration or development. Danenberger (1980) reported that during outer continental well drilling in the Gulf of Mexico over a 8 year period, only 10% of all blowouts were from production wells. The impacts of oil spills on vegetation was discussed in Chapter IX. Chronic spills, of both crude oil and refined products, also are a problem, but the extent of them is unknown, as are the long term effects.

Mud pits (also known as reserve pits) are constructed to hold the used muds and cuttings from the well. The constituents of mud may vary, but the main ingredients are barite and bentonite, both inert materials additives used to alter pH, kill bacteria, etc., may be toxic. Toxicity varies, of course, according to concentration and sensitivity of the animal species. Used muds generall are stored in mud pits which are either excavated into the soil or constructed of gravel fill, or both. The gravel berms or walls may break, allowing drilling fluids to seep across the land (French 1980). Chronic leaching may occur through improtected walls. And occasionally, mud pits may overflow in spring due to excessive spring snowmelt water (strocbele, pers. comm.). The effect of spilled mud generally will be localized. Impacts either from toxicity or smothering can cause the death of plants and invertebrates (Vander Valk et. al. 1980)

Gravel and other material extraction may create the greatest impact to surface and aquatic resources (Pamphlin 1979). Gravel may extracted from river bars, terraces, or upland sites. Large pit-style sites may be developed to be used later as water reservoirs, and if constructed properly, can cause less harm than shallow scraped sites (Morehouse et. al. 1978; Woodward-Clyde Consultants 1980).

## Caribou Introduction

The development and establishment of permanent oil and gas production facilities within the Arctic Coastal Plain Study Area of the Arctic National Wildlife Refuge could have profound effects on the caribou found there. Exploratory drilling programs would have varied influences on caribou depending on location. timing. number of wells, operation methods. and seasonal restrictions imposed. It is highly speculative at this time as to where. when and how oil and gas production facilities may be constructed and operated in the study area. Therefore, predicted consequences of these activities on caribou can only be general in nature. and must be drawn from the results of studies that have been conducted elsewhere and applied within the context of known caribou behavior and ecology of the study area.

It was mentioned earlier that a considerable number of caribou studies have been stimulated recently in response to questions raised as industrial development accelerated in the Arctic. Major elements of concern that have been identified so far are: the effects of physical barriers on caribou movements. disturbance of caribou by aircraft, road traffic, human presence. off road vehicles and the effect of sound. smell and visual stimuli. Concern has also been expressed regarding the physiological and bioengergetic effects of disturbance on caribou. The following summary of available information on these elements is presented to assist in understanding the predicted consequences to caribou of oil and gas drilling. development and production in the Arctic National Wildlife Refuge.

## Physical barriers

The presence of ancient structures built by early hunters to deflect migratory caribou to ambush sites confirms an intrinsic vulnerability of *Rangifer tarandus* to physical obstructions. In spite of a long exposure to artifical barriers. caribou have not demonstrated a high degree of adaptability to this form of disturbance. On the other hand. caribou fences and associated hunting activities did not apparently impact caribou in a significant manner (Klein, 1980$_b$). The orientation of caribou fences in Northeastern Alaska and Northern Yukon coincide with current caribou migration routes (Warbelo. C. et al. 1974) in an effort to obtain comparative information on the reactions of *Rangifer sp*. to obstructions. Klein (1971) analyzed the experiences of Scandanavian reindeer with highways. railroads and hydroelectric developments. In general, Klein (1971) found that railroads and highways did not seriously obstruct *domestic* reindeer movements. Considerable numbers of animals are killed each year, however, from collisions with trains and cars. The development of a railroad and highway corridor near Trondheim, Norway apparently restricted the movements of a *wild* reindeer herd which ultimately resulted in a overgrazing and reduction of the herd (Klein 1971). In an update to his 1971 paper. Klein (1980$_b$) reported on numerous cases of railroads, highways, hydroelectric projects, pipelines, industrial developments and disturbances which caused obstruction, deflection. delays and disturbance to caribou and reindeer populations in the Soviet Union, Canada, and Scandanavia as well as in Alaska.

Experimental studies of physical barriers and caribou began in Alaska in 1971 at Prudhoe Bay (Child 1973). Using simulated pipelines, initial study results showed that a majority (78-85%) of the caribou encountering the simulation reacted negatively by moving parallel to it rather than crossing. It was also learned that the reaction of caribou to simulated pipelines depended upon age. sex, group size and composition, insect harassment and previous experience. An important observation made by Child (1973) was that gravel overpass facilities functioned considerably better (18% crossing versus 15% crossing) than an elevated "pipeline". During periods of insect harassment. caribou were less reluctant to cross artifical barriers.

Studies initiated by the Alaska Department of Fish and Game in 1974 of caribou reactions to construction of the Trans-Alaska Pipeline found that cows and calves exhibited on avoidance reaction to the oil field. construction activity and haul road during spring and summer (Cameron and Whitten 1976). Bull caribou on the other hand exhibited no avoidance reaction. In addition. a reduced number of caribou crossing the pipeline and road were observed, indicating that the herd was becoming separated on an east-west basis (Cameron and Whitten 1977). By 1977. the avoidance of the pipeline and oil field complex was so strong that evaluations of the effectiveness of crossing structures could not be conducted as planned (Cameron and Whitten 1978). The spring of 1981 marked the 6th consecutive year that the avoidance behavior of cows and calves was observed and documented at Prudhoe Bay (Whitten et al. 1981).

Additional studies of oil field development activities in caribou habitat west of Prudhoe Bay in the Kuparuk River field started in 1978 (Cameron and Whitten 1979$^{c}$). Findings thus far show that an avoidance reaction has not occurred at this location. Insect harassment was found to be an important factor influencing caribou behaviour at road and pipeline crossings. Most road crossings by caribou occurred at or near river drainages (Cameron and Whitten 1980$^{c}$).

Caribou responses to the Dempster Highway in the central Yukon (bisecting winter ranges and migration routes of the Porcupine Caribou herd) have been a subject of considerable concern and study. Surrendi and DeBock (1976) found that caribou responded differently depending on the type of habitat setting - in open tundra areas caribou appeared less inhibited. where-as in timbered areas they were more apprehensive when approaching the road. It was also found that high steep road embankments tended to deflect caribou. as did deep snow banks left by snow plows. The Dempster Highway did not prove to be an insurmountable barrier to caribou. If vehicular traffic and human activities significantly increase, it may become a serious barrier to caribou movements (Surrendi and DeBock 1976).

Seismic lines elicit different responses by caribou apparently depending on a number of factors. On Banks Island. Urquhart (1973) found that newly plowed seismic lines in the snow on tundra areas caused minor deflections of caribou movements. However. winter seismic lines in timbered country were followed to some extent by spring migrations of caribou (McCourt, et al. 1974). Concern has been expressed regarding the consequences of such deflections on energy budgets of caribou (Geist 1975). Miller et al (1972) found that group leadership played an important role in interactions of migrating caribou with barriers. Delays and deflections of spring migrations of gravid female caribou by physical barriers may result in production losses due to greater predation levels. increased separations of cows and calves. higher calf mortality if calving occurs before the traditional calving grounds is reached and due to increased energy expenditure in negotiating the barriers (Miller et al. 1972).

## Aircraft disturbance

A summary of aircraft disturbance studies shows that the reaction of caribou to aircraft varies considerably depending on many factors such as: type of aircraft, elevation. season. setting and group size and composition. Klein (1973) reported greater reaction of caribou to helicopters vs fixed-wing aircraft. Calef et al. (1976) however did not record a difference in reactions as did Klein (1973). Davis and Valkenburg (1979) found that at distances of 100m or less that helicopters elicited greater fright reactions in caribou than fixed wing aircraft. It was also found that helicopters have a greater potential for harassment of caribou due to the ability to stay behind fleeing caribou and chase them indefinitely (Davis and Valkenburg 1979). There is very little data on the effects of heavy aircraft on caribou.

Miller and Gunn (1979) found that responses of Peary caribou to helicopter harassment were inversely related to the altitude of overflight. Aircraft overflights lower than 160m cause potentially, injurious reactions by caribou (Calef et al. 1976: Davis and Valkenburg 1979). Light aircraft operating at distances over 330m usually does not cause injurious or exhausting reactions by caribou (Davis and Valkenburg 1979). It has been recommended that during calving and post-calving (May-August) aircraft harassment can be greatly reduced by maintaining at least 660m AGL (Davis and Valkenburg 1979). Calef and Lortie (1973) reported that post-calving aggregations of the Porcupine caribou herd were especially vulnerable to disturbance, stampeding, trampling, and injuries. In addition to calving and post-calving seasons. caribou are sensitive to aircraft harassment during the rutting season (October-November) (Surrendi and DeBock 1976). Cows and calves or groups of caribou with calves are the most sensitive to aircraft disturbance (Davis and Valkenburg 1979; Miller and Gunn 1979; Calef et al. 1976· Surrendi and DeBock 1976· Klein 1973). Caribou in larger groups tend to be more sensitive to aircraft than smaller groups (Davis and Valkenburg 1979. Miller and Gunn 1979). Stronger disturbance responses to aircraft were observed by caribou in timbered habitat versus open tundra areas (Surrendi and DeBock 1976).

## Surface Vehicular Disturbance

Disturbance reactions of caribou to road traffic has been studied by several authors (Klein 1971; Bergerude 1974$^{a}$; Villmo 1975; Surrendi and DeBock 1976; Johnson and Todd 1977; Roby 1978: and Horeijsi 1981). It is clear that heavy or frequent traffic constitutes a more serious impact to caribou than the road structure (Klein 1971; Bergerude 1974$^{a}$; Villmo 1975), and can result in blocking or deflecting movements. Fast moving vehicles with clouds of snow or dust cause more disturbance to caribou than slow moving vehicles (Roby 1978; Horeisi 1981). Cows and calves are more sensitive to vehicular disturbance than any other group of caribou (Roby 1978). Cameron and Whitten (1976, 1977, 1978, 1979$^{a\&b}$, 1980$^{a}$) attribute observed avoidance of the Trans Alaska Pipeline corridor by cow and calf caribou to vehicular disturbance as well as other factors. During winter, caribou are attracted to roads where snow is compacted and where they are vulnerable to collisions with vehicles (Calef 1974) (McCourt et. al. 1974).

Of all the various types of off road vehicles, the snowmobile and perhaps the air-cushion vehicle have the greatest potential for disturbance to caribou. Wintering caribou that are hunted via snowmobile access were found to be alert and sensitive to disturbance (Calef 1974; Shea 1978).

## Human Presence

The presence of humans is often a disturbing factor, especially if caribou associate potential harm such as hunting with human encounters (Calef 1974). Intensive hunting activites at caribou crossing points on the Taylor and Richardson Highways in Alaska caused delays in crossing (Skoog 1968). A significant factor in caribou avoidance of an active oil drilling site was attributed to the workers attempting to approach and photograph caribou (Wright and Fancy 1980). The presence of man in concentrated calving areas can contribute to separation of cows and calves (Lent 1964). Post-calving aggregations at river crossings (Calef and Lortie 1973) are particularly vulnerable to disruption by the presence of humans which could result in stampedes, trampling, drowning, injuries and separation of cows/calves (Calef and Lortie 1973: Curatolo pers. comm.).

## Sound, smell and visual stimuli

Studies of gas compressor noise simulation found that during spring migration, calving and fly-season movements caribou did not respond when the sound source was beyond 270 meters (McCourt et al. 1974). Calving caribou were reluctant to approach within 200 meters of the sound (Calef 1974). Reactions of reindeer to sonic booms were characterized by Epsmark (1972) as moderate and did not include lasting behavioral changes.

The sense of smell is believed to be the caribou's most sensitive sense (Kelsall 1968). Caribou have been known to detect the scent of humans at approximately 1.6 km. (Banfield 1954, as cited in Kelsall 1968). When caribou encounter a strange scent they often investigate to visually confirm the source (Bergerude 1974$^{a}$). There is paucity of data regarding the effect of foreign odors on caribou.

Visual stimuli are associated with most other forms of human disturbance of caribou. It is believed that part of the influence of physical barriers is due to visual factors (Curatolo. pers. comm.) Part of the reluctance to cross berms, roads and other barriers may be due to a perceived danger of predators being associated with such structures (Roby 1978). It is not known if such associations are acquired as a result of predation or if it is an inherited characteristic. During intense insect harassment. caribou seem to overcome this fear of visual barriers (Child. 1973). In general, caribou seem to be more sensitive to visual stimuli when sounds or smells are also present (Bergerude 1974$^{a}$. Tracy 1977; Roby 1978)

## Consequences of Disturbance

The consequences of some forms of disturbance to caribou have been identified. Direct mortality to domestic reindeer occur at highway and railroad crossings in Scandanavia (Klein 1971). Construction of new roads into caribou ranges has resulted in higher harvest levels because of improved access for hunters (Skoog 1968). Local overgrazing, trampling of vegetation. range abandonment. and population decline of a wild reindeer population in Scandanavia occurred following construction of a railroad and highway which blocked migrations (Klein 1971). In concluding remarks on the consequences of human disturbance Klein (1980$^{b}$) stated·

> "Historically. fractured Rangifer ranges through human development activities have led to range abandonment, herd reduction or extinction. or alternatively. fracturing of herds into smaller but discrete components. In the later situation the total number of animals in the smaller herds has apparently consistently been less than in the original herd they replaced."

The consequences of avoidance probably depend upon the relative importance of the area avoided and the ability of the population to adjust through various adaptations or responses. If female caribou and calves are displaced from calving habitat. Klein (1980b) stated that.

> "the consequences may be lowered calf survival through use of less favorable calving areas (i.e. increased threats to calf survival through unfavorable weather. increased predation and insect harassment and greater presence of other natural or man caused hazards as well as availability of poorer quality forage)."

The consequences of delaying or deflecting spring migrations were identified by Miller et al. (1972) to include: production losses due to greater predation levels, increased separation of cows and calves, higher calf mortality if calving occurs before the traditional calving grounds are reached and due to increased energy expenditure in negotiating barriers.

Disturbance of post-calving aggregations of caribou could cause increased energy expenditure due to stampeding. injuries and deaths from trampling. increased calf mortality resulting from cow-calf separations and increased drownings at river crossings (Calef and Lortie. 1973).

With regard to insect relief habitat Klein (1980b) stated:

> "Loss of access to insect relief areas may reduce feeding opportunity and lead to increased energetic expenditure of the animals, thus reducing growth rates of young and curtailing deposition of body reserves in preparation of breeding and winter."

During winter the consequences of disturbance such as harassment by aircraft or snowmobiles may include: displacement from critical forage areas, loss of body weight due to extreme energy losses from panic running in snow and cold temperatures, injury from stumbling in crusted snow conditions, pulmonary disorders from running in cold temperatures, abortion of embryos, decreased body weight of neonatal calves, poor health of calves at birth, altered behavior of young and increased mortality following birth due to disturbance and stress on pregnant females during the gestation period (Geist 1971).

Disturbance during winter could also cause separation of cows from calves and result in higher mortality of calves and through disruption of social hierarchy involved in winter feeding behavior, reduce the nutrition and survival of calves (Shea, 1978).

In commenting on how caribou populations may respond to disturbance factors, Klein (1980b) stated that:

> "These costs may be met through increased forage intake (if this option is available), altered behavioral patterns (accomodate to the disturbance or abandonment of areas of disturbance), or reduced allocation of energy to other requirements (growth, reproduction and escape from predators)."

In most cases, there has not been enough information on other population factors to determine the ultimate effect of a disturbance at the population level. With regard to this difficulty, on December 18, 1975 Dr. George Calef in testimony before Justice Thomas Berger of the Mackenzie Valley Pipeline Inquiry stated:

> "The establishment of the cause and effect relationship between a project and a population decline is a most difficult task, requiring detailed understanding of the caribou's biology and an intense study over a period of years. I submit that in no case in the past have we had the detailed censuses, the demographic data, or the accurate knowledge of ranges and movements to establish whether caribou have been affected by a major development or disturbance and there have been some in the past such as hunting by whalers and prospectors, and construction of highways, railways, and hydroelectric developments. Therefore we are always left with anecdotal evidence for cause and effect, with suggestions that declines might have been caused by man's activities."

Because of the complexity of caribou population dynamics, behavioral responses, physiological and ecological adaptations it is extremely difficult to accurately determine a specific caribou population's tolerance to a disturbance/displacement factor and know with certainty if a tolerance will be exceeded and a population decline will ensue.

## I. Potential Effects of Exploratory Drilling on Caribou

The potential effects of exploratory drilling activities on caribou vary depending on factors such as the time of year that drilling activity occurs. location of drilling sites, the number of wells drilled, methods used in drilling and the overall time frame under which the program is conducted.

The timing of drilling related activities and location of drill sites are perhaps the most important factors in determining potential impacts to caribou. The period which has the greatest potential for conflict with caribou is from mid-May to mid-July. In most years, large numbers of cow caribou of the Porcupine herd return to portions of the study area for calving (See Figure 2$^{a\ e}$). Following calving (about June 20) cows and calves tend to move northward and sometimes westward in small "nursery bands" over the study area. In late June caribou usually begin to assemble into large aggregations. Most frequently these aggregations have been observed forming in the rolling terrain immediately south of Camden Bay (See Figure 3). Usually there is a movement of the post-calving aggregations towards the east. either along the coast or on a more inland course (this varies from year to year). Usually by mid-July a majority of caribou of the Porcupine herd has left the study area. The period of mid May to mid July also coincides with the calving and post-calving activities of a portion of the Central Arctic Herd (CAH) in the vicinity of the Canning River delta of the study area (See Figure 1).

Activities associated with exploratory drilling (site reconnaissance. site preparation. construction, drilling operations, maintenance and termination activities) during mid-May to mid-July could directly intefere with calving and post-calving activities of the Porcupine and Central Arctic caribou herds. It is well established that cows and cows with calves exhibit a high sensitivity to disturbance during this time of their life cycle (Lent 1964).

Disturbance of caribou in the study area at this time could lead to local avoidance of calving and post-calving habitat in the vincinity of drill sites. during the period of human activity. Avoidance by caribou of the area adjacent to an active drilling site was observed by Wright and Fancy (1980) during the period of June 9 to August 17. Potential consequences in addition to avoidance of drill site areas. would be increased cow-calf separations. injury due to trampling (especially calves) and increased energy expenditure leading to increased calf mortality, as a result of disturbance from aircraft associated with drilling activities. The consequences of distrubance of calving and post-calving activities in drill site areas on a population level are not known (see preceding discussion).

Caribou of the CAH remain in the study area after mid-July, seeking relief from insects by frequenting the coastal areas of the Canning River delta and Camden Bay. Activities associated with drilling in this area during mid-May to mid-August could disturb caribou. During the remainder of the year. varying numbers of the CAH are found scattered throughout the study area. In the winter season, CAH caribou seem to frequent the southern uplands in and adjacent to the study area (along the Sadlerochit Mountains and east to the Jago and Aichilik Rivers). Drilling activities in the study area could interact with these caribou during the winter months.

During the period of mid-August to mid-May there is potential for disturbance of CAH caribou if a drill site is located in an area normally used by caribou. Disturbance would be expected to result from aircraft flights to the site. surface vehicles operating near the drill site, human presence, noise. smells and visual stimuli. It is expected that caribou would be locally displaced from the immediate drill site area. The consequences of such displacement are not known. Caribou may be more sensitive to disturbance of drilling activities during the rutting season (October) however, the consequences of local disturbance during this time are also not known.

If gravel pads are used to construct drill sites, some vegetative habitat for caribou will be destroyed. The extent of such losses are dependent on how many wells are developed and where they are located. Judging from exploratory drilling programs elsewhere to date. the loss of habitat from gravel pads does not appear to be a significant factor for caribou.

II. The Potential Effect of Oil and Gas Development and Production on Caribou

The development of oil and gas production and transportation facilities in the study area constitutes the greatest potential for long term negative impact to caribou of the activities described in this report. It is not known if, when, where or how such development might take place at this time. Therefore. specific details on how caribou would be impacted cannot be developed. If oil and gas resources are developed at any location within the study area. that artificial structures, aircraft and vehicular traffic, human activity with associated sounds, smells and visual stimuli will occur. The permanence. intensity and cumulative nature of these features will exert a powerful influence on caribou.

Because of the demonstrated sensitivity of cows and cows with calves to disturbance. it is expected that those components of the Porcupine and Central Arctic herds would avoid any oilfield development in the study area. The potential consequences of displacement from traditional or preferred calving grounds. disturbance of post-calving aggregations and interference with insect harassment movements are described in the preceding section and only reiterated here. Displacement of pregnant cows or cows with calves from preferred habitat could lead to lower calf survival due to weather conditions. increased predation. and insect harassment. Disturbance could increase cow-calf separations and contribute to calf mortality. It could also increase energy drain on both the cow and calf at an already sensitive time and influence the health and survival of both animals. Injuries such as trampling and drowning can result from stampeding caused by disturbance of post-calving aggregations.

The calving and post-calving grounds of a caribou herd are the one place at which the entire herd can be found together every year. Any development such as a permanent oil field facility there will be encountered by the herd each year. In the case of the Porcupine herd. the calving grounds are a narrow area of Arctic Coastal Plains and foothills restricted by the Arctic Ocean and the rugged Brooks Range. The calving and post-calving activities in this limited environmental are the most sensitive and vulnuerable events in the annual cycle of the herd. The new born calves are susceptible to a variety of environmental factors (weather. predators and seperation from the cow) and have the highest mortality rate of any cohort in the population.

The location of a permanent oilfield and associated transportation facilities in this restricted calving and post-calving area could very likely displace the entire porcupine caribou herd and portions of the Central Arctic herd from preferred or traditional habitat.

As discussed in the introduction, it is difficult to predict with accuracy what effect oil field development and production would have on the long-term survival of a caribou herd. At the present time it is not known how important a particular portion of traditional or preferred calving habitat may be to long term productivity of the herd. The ability of a caribou population to adjust to productivity losses or increased mortality through other mechanisms is not known. The importance of post-calving aggregation in terms of long term stability of a herd is not understood. And, it is not known whether or not cows and calves will habituate to oilfield disturbance over time. Thus far, cows and calves of the CAH have avoided the Prudhoe Bay oilfield for about six years and there has been no observed habituation reported.

Comparisons between the Prudhoe Bay-CAH situation may be of only limited value in predicting the effect of an oilfield development in the study area. The Porcupine herd may have different behavioural characteristics from the CAH (Klein 1980[b]). It has been demonstrated that caribou tend to habituate to obstructions if the caribou are resident in the area of the obstruction. This may be somewhat the case with the CAH at Prudhoe Bay. The CAH do not migrate great distances from the Arctic Coastal Plain and in many years they are year round residents. The Porcupine Herd, on the other hand migrates over much larger distances and normally visits the study area seasonally. Thus habituation to oilfield obstructions and disturbance by the Porcupine Herd may require a longer time than that of the CAH which is generally more resident to the vicinity.

With regard to the CAH, an oilfield development and production operation in the study area may, in conjunction with the existing oilfield at Prudhoe Bay exert additional influence on the herd. If CAH animals are displaced from their calving habitat on the Canning River delta, as well as from the Kuparuk calving area where oilfield development is currently occurring, in additon to the present displacement from the Prudhoe Bay area, there may be few suitable alternative calving areas left for that herd. Again, it is not known if calf mortality will increase from such displacement or if the herd would respond in some other manner to prevent decline.

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## Muskox

Muskox are year around residents on the study area. It is difficult to predict, with any certainty, where drilling might begin or the extent of possible subsequent development on the Refuge. We do know from exploration that has already taken place elsewhere and from developments in and surrounding Prudhoe Bay that there will be a need for water and gravel in large quantities. Millions of cubic yards of gravel and thousands of gallons of water are requred for a Prudhoe Bay scale development. Gravel is an insulator and when used in sufficient quantity provides a stable foundation for roads. airfields, drilling pads and islands and a variety of man made structures.

Gravel used for oil development on the north slope of Alaska has come principally from braided river channels. It is also along river channels that favorable habitat for muskoxen, moose. smaller mammals and bird life is found. Gravel removal from river beds may result in the outright destruction of favorable muskoxen habitat or alter stream hydrology indirectly resulting in habitat loss.

Drilling rigs. pads. mud pits, sewage lagoons, and associated airstrips also deny the use of potential habitat through outright destruction or denial. The zone of habitat loss around occupied man-made structures would likely be larger than just the area occupied by the physical structures due to the effects of disturbance. The extent of this loss cannot be predicted but would last for the time the disturbance stimulus was present.

With commencement of drilling activity on the coastal plain one would expect the level of disturbance/harassment to the muskox population to increase. Increased noise from nearby oil rig machinery. and from both fixed-wing and helicopter aircraft can be expected around drilling rigs and camps. Since exploratory drilling is most frequently a winter activity on the north slope the stress level on muskoxen will be increased at a time when the population is already under maximum stress from natural environmental factors. Miller and Gunn (1979) predict that almost any interference with the distributions of muskox by foreign activities which drive them from their preferred ranges will have a marked effect on the segment of the population concerned.

The long term effects on the muskox population from oil exploration and development are uncertain. The impact on the population will depend on such factors as magnitude and location of development. amount of habitat lost through destruction or denial and the level of disturbance to which the population is unable to habituate. Effects on the population are apt to be insidious and not obvious. Impacts may appear to be isolated and unrelated. but could ultimately be cumulative as activitiy intensifies.

MOOSE

If oil and gas development and production facilities were limited to the coastal plain (i.e. drill rigs. pads. roads, pipelines, etc.) the potential impacts described in the seismic impacts section would still apply. In addition to those impacts, moose using the coastal plain would be subject to human habitation of the area. Moose are normally very tolerant of most human activities (Kucera 1974). However, elevated pipelines may impede movements through a given area (Hinman 1974). Use of the coastal plain by moose appears to be a wandering type of use and the effect of an elevated pipeline on those segments of moose populations using the coastal plain is unknown.

Habitat alterations on a relatively small percentage of the coastal plain would also occur as a result of development but summer use by moose would be only slightly affected. However if development activities were to take place in the more critical wintering habitats along the Canning and Kongakut Rivers. then impacts to moose population could be expected, dependent upon the type of development. Again. the overall effect of development on moose populations is unknown.

Ringed Seals

The impacts of development of oil and gas resources to ringed seals are likely to be similar to. but more intense than. the impacts of exploration. The sensitivities of ringed seals to disturbance were discussed in a previous section on exploration impacts and will only be summarized here.

Further seismic exploration would likely be required before development begins. The impacts to ringed seals discussed in the previous section may become more acute because of the extended period of exploration. The potential impacts can be summarized as:

1. Distuption of summer feeding.
2. Disturbance to Arctic cod eggs or larval stages during development.

Development. production and transportation of oil and gas resources could affect ringed seals primarily in two ways: an oil spill caused by a well blowout or tanker crash. or chronic pollution from small scale fuel or oil spills or other chemcials kept at shore based facilities (Burns et al. 1980).

A catastrophic oil spill may cause either local short term or extended long term impacts. If the spill were to occur within a lagoon system. it is likely that oil would remain mostly in the lagoon, and impacts to seals would be minor. Also if a spill were to occur during the summer, it could be cleaned up fairly easily. thereby keeping the impacts to a minimum. However. if the spill were to occur offshore and during the winter or early spring, the impacts would be major. Adult seals could experience severe eye damage. affecting their feeding. Young seals could be oiled and die. Prey species such as Arctic cod could experience egg, larval stage, or adult mortality. Nektonic invertebrate populations could also be affected. However, the severity of these impacts depends on so many variables that no quantitative description of them is possible (Burns op cit.)

Chronic pollution of waters inhabited by seals may be a greater long term problem than an oil spill. However because the effects of low level contamination of waters to seals or their prey itmes is not known. it is not possible to quantify these impacts. Further studies on these questions is necessary.

One other possible source of impact to ringed seal populations from transportation of oil and gas resources lies in the possibility that ice breaking tankers would be used to carry the oil to the market. If the tankers travel through fast ice areas that are used by seals for denning and pupping. there is the possibility that a large area of seal habitat would be destroyed. The extent of impact depends, of course, on the amount of tanker traffic. the extent of their routes and the timing of the traffic.

Fish

Major problems potentially threatening fishery resources in the arctic during oil development include water and gravel demands, construction impacts. environmental contamination and increased population demands on the fisheries. Water and gravel demands pose the most significant problems. Water is required in all phases of oil development These uses included water for· potable and other domestic uses. drilling operations, make-up water for cement and slurry sand, dust control. ice road and airstrip construction. truck and car washing, coolant for power generators and vehicles and for secondary oil recovery operations. Wilson et al. (1977) summarizes water use demands related to oil development at Prudhoe Bay Camp requirements for geophysical exploration rarely exceed 100 gallons per day (gpd). Exploratory drilling required an average of 40.000 gpd per drill site. Average water usage projected for seven of Husky's Oil Company s exploratory wells was 1.037.000 gallons per well drilled. Potable water demands for Atlantic Richfield's camp facilities at Prudhoe Bay for 1977 were reported between 200.000 to 240,000 gpd. Water used for ARCO s (1977) development drilling was estimated at 50 000 gpd per rig. Service camps at Deadhorse use an estimated 120.000 gpd. Table 2 (Wilson et.al. 1977) shows total projected water use for the Prudhoe Bay Development. winter 1976-77. One of the greatest future demands for arctic water supplies may ensue from secondary oil recovery operations. During recovery operations water is used to restore subsurface pressures to facilitate further oil extraction Wilson et.al. (1977) estimated that this would take 84 to 126 million gpd.

The amount of water needed for oil development contrasted with its lack of availability poses serious threats to fishery resources. particularly during severe winter weather conditions. Impacts of water withdrawal may produce long term irreversible effects. All life stages of a particular species may be located in a single isolated pool where potential impact would be upon the whole genetic population. Ward and Peterson (1976) reported that overwintering pools located in the Sagavanirktok, Canning and Hulahula Rivers become completely isolated (without recharge) when sections of the river freeze solid. Effects of water withdrawal on fish populations includes direct mortality indirect mortality. from waste concentration and dewatering marginal gravels containing developing fish embryos and fry Bendock (1976) reported masses of grayling fry and insects at the surface of one dewatered hole. Impacts of dewatering may also cause fish to change overwintering areas and therefore impact subsistence fisheries.

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Alternative winter water sources. where minimal impact would occur. are not abundant. Tundra lakes are generally of poor quality and must be treated to be potable. or they are so shallow that they freeze solid (Schallock 1976). Other deep lakes may contain fish populations. Wells are under scrutiny because they may ultimately take water from overwintering sites.

Gravel demands for oil development in the 1002c study area may require thousands of cubic meters of material and consequently presents a significant threat to arctic fish communitites. Gravel will be required for road and airstrip constuction; for drill pads in both explortory and production phases of oil development: and in pads for storage areas, living quarters, waste treatment facilities, flow stations and other construction activities.

The affects of gravel removal on fisheries and aquatic habitat in arctic floodplains is well documented by Woodward-Clyde Consultants (1980). They identified five major categories of effects on the aquatic habitat: increased channel braiding, removal of bank and instream cover. migration blockages, entrapment areas and siltation. Increased channel braiding was evident where flow increases had inudated mined areas along rivers and where gravel deposits were scraped to below the waterline. Consequently. depth and velocity were reduced with a resulting decrease in the diversity of the fish community. This alteration also increased the probability of aufeis formation. The presence of aufeis prolongs recovery of the site. as the channel and substrate remain unstable. Siltation persists through the melt-off period and water stored in the aufeis field becomes unavailable for downstream overwintering areas.

Densities of char and grayling were lower in areas where portions of undercut banks were removed to access underlying gravel deposits (Woodward-Clyde 1980). Many other authors have found that reduction of bank and instream cover adversely affects fish populations (Boussu 1954. Haines and Butler 1969. Hobbs 1947 and Hunt 1968). Increased wetted perimeter and decreased depth resulting from gravel mining operations could lead to fish passage blockage. Extensive backwater areas created by mining operations can entrap fish during low flows and cause mortalities by increasing vulnerability to predator and by subjecting fish to suboptimal temperatures and dissolved oxygen concentrations. Siltation becomes an immediate problem during gravel removal operations. Indirect effects arise from erosion of inudated mined areas. Primary affects of siltation are on spawning and feeding areas. The effects of siltation on fish populations has been documented by Cordone and Kelly (1961). Everhart and Duchrow (1970) and Hollis et. al. (1964).

Activities related to road construction, adjacent to rivers and river crossings may considerably impact fish populations. Debris associated with stream crossings could cause jams creating a barrier to fish migration. Barriers could also result from improperly designed and/or positioned culverts. creating high water velocities (USFWS 1970). Spawning grounds could be affected by siltation and erosion from road construction activities. Direct mortality of eggs and fry could arise from movement of heavy equipment over spawning areas.

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Environmental contamination from sewage wastes, fuel and oil spills are potentially threatening to arctic fish populations. Domestic wastes entering arctic aquatic ecosystems may cause severe dissolved oxygen depletions particularly during low water, winter conditions when the assimilative capacity is much reduced. Dissolved oxygen depletion can cause direct mortalities and long-term damage to the food structure of arctic waters (Craig and McCart 1974, Schallock 1976).

Large amounts of fuel will be required for arctic oil development. Field operations may require special constraints for fuel storage in order to adequately protect fisheries habitat. These constraints should directly apply to spawning and overwintering areas, where impacts would be the greatest. Similar problems are associated with possible oil spills in exploratory drilling operations.

Increased population density in the arctic arising from oil development will increase fishing pressure. Several characteristics of arctic fish populations make them highly vulnerable to overharvest. They exhibit slow growth, poor recruitment and late maturity. High concentrations of some species, during spawning and in overwintering areas make them much more vulnerable to exploitation. Craig and McCart (1975) stated that selection in the fisheries for the larger spawning population would disproportionately harvest females therefore reducing the reproductive capacity of the populations.

A summary of impacts related to exploratory drilling, production and development are listed in Table 3.

Table 2 - Total Projected Water Use, Prudhoe Bay Development, Winter, 1976-77

| | Daily Consumption (gpd) | |
|---|---|---|
| User | Minimum Drilling[1] | Maximum Drilling[2] |
| Atlantic Richfield | | |
| Camps | 200,000 | 200,000 |
| Drilling | 160,000 | 240,000 |
| BP Alaska | | |
| Camps | 96,000 | 96,000 |
| Drilling | 51,000 | 102,000 |
| Service Companies | | |
| Deadhorse Camps | 120,000 | 120,000 |
| Totals | 627,000[1] | 758,000[2] |

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[1] Assume 6 rigs operating

[2] Assume 10 rigs operating.

Table  Summary of Exploratory Drilling, Oil Development and Production Impacts on Arctic Fish

| Operational Requirements | Possible Impacts | Effects |
|---|---|---|
| Water Demands<br>Drilling operation<br>Domestic supplies<br>Road and airstrip construction<br>Secondary oil recovery operations<br>Miscellaneous uses | Dewatering overwintering and spawning areas | Direct mortality of all stages of species life history. Reduced water quality stressing fish populations and organisms. Fish movement out of traditional wintering areas effecting subsistence fisheries. May lead to destruction of whole genetic populations. |
| Gravel Demands<br>Road and airstrip construction<br>Drill pad construction<br>Camp and living quarters<br>Miscellaneous uses | Inudation of stream channels, erosion and siltation, increased channel braiding. Increased aufeis formation - limiting flow to overwintering areas. Reduction of bank and instream cover. Physical destruction of spawning and overwintering areas. Creation of fish entrapment areas. Creation of migration barriers. | Direct mortality of fish eggs and fry. Reduced water quality. Reduced carrying capacity. Alteration of migration routes and destruction of spawning areas. Stress/mortality of winter concentrations of fish. Degradation of food organism's habitat. |
| Road Construction Activity | Inudation of stream channel, erosion siltation, fish passage blockage. | Direct mortality of eggs and fry. Degradation of feeding and spawning areas. Alteration of migration routes. Stress - Reduced water quality. General reduction in fish density. |

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Table 5 Continuation

| Operational Requirements | Possible Impact | Effects |
|---|---|---|
| Domestic Waste Disposal | Discharge into rivers and lakes | Decrease dissolved oxygen. Direct mortality of fish, eggs and fry. Alteration of food structure. Fish movement out of traditional wintering areas - impacting subsistence fisheries. |
| Fuel and Oil | Spills into aquatic environment. | Direct mortality and/or stress upon all life history phases. Degradation of spawning and feeding areas. |
| Population Increases | Fishing pressure increase | fish overharvest. Alteration of reproductive capacity by selection of the larger sized spawning females. |

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Archeology

Given the large gaps in the data base discussed in an earlier chapter, it is particularly important that there be a realistic assessment of potential impacts to archaeological sites from developmental activities associated with oil and gas. This assessment will make it possible to develop mitigating measures that are adequate for protecting the historic and archaeological resources in the study area. The assessment relies on work done in NPRA by USGS (Hall 1980) as well as experience on the Trans-Alaska Pipeline (Cook et. al. 1977) and other large projects.

Discussion of Mitigation. The mitigating procedures preferred are those that involve relocating a proposed facility. Relocating facilities is preferred to excavation because it allows the preservation of the archaeological site in place which makes it available for future archaeologists to investigate using future techniques. Data collection on the other hand is limited by what we know about archaeological method and theory today. It is also limited by the fact that data recovery projects often suffer from a lack of time to complete them due to the nature of construction activities. It is recognized, however, that in some cases there may be no realistic alternative to excavation and data recovery, and that these activities are acceptable forms of mitigation in certain limited cases.

Drilling pads, airstripsips and roads. Construction of seasonal drilling pads leads to the destruction or burial of archaeological sites within the construction zone. For this reason, areas where construction of these facilities is planned should first be searched for cultural remains. If these remains are found the facility should be moved to a new location if possible. If relocation is not possible, mitigating procedures such as the excavation of impacted sites will be necessary.

Constructing permanent pads, airstrips and roads has a much higher potential for damaging archaeological sites because it requires much more gravel. Cultural resource work done during previous construction activity in Alaska has indicated that knobs favored as gravel sources also were favored as activity areas by previous occupants of the area. By expanding the area of potential impact to areas having high archaeological potential this more permanent construction increases the likelihood of impacting archaeological resources.

Camps and other facilities. Here again, construction of temporary winter quarters would require prior survey for archaeological sites in that these activities would have a negative impact in these resources. However, as with roads, airstrips and drilling pads the impact of winter operations would be less than summer operations requiring the removal of gravel from areas that have a high potential for archaeological sites.

In the development stage it can be anticipated that permanent roads, drilling pads, camps, airstrips and other construction activities having potential negative impacts on cultural resources will occur. Surveying for cultural resources in areas designated for these facilities is necessary. Locating archaeological or historic sites in these areas and at material sources will, preferably, require finding a new location for the facility. When relocating is not possible appropriate steps must be developed to insure that adequate mitigation occurs.

It is also possible that there may be indirect or secondary impacts from oil related activites. This can occur when people associated with oil exploration and development encounter and loot archaeological sites. Two approaches can help to eliminate, or at least reduce, these impacts. The first requires educating all personnel about the importance of the archaeological sites in the area and the effects of disturbing them, and making these people aware of Federal laws and regulations protecting sites.

The second approach requires extending areas designated for archaeological survey outside of the minimum area necessary to construct a particular facility. Sites located close to facilities can be left unmarked if there is no possibility that they can be harmed by construction activities or associated personnel. If, on the other had, there is a possibility that they will become known or inadvertently damaged, the sites should be posted and occasionally inspected by cultural resource personnel. If a site is easily located and contains items of interest to casual collectors it would be appropriate to collect the obvious artifacts after appropriately documenting them through careful mapping. These artifacts should be stored in an appropriate repository.

## Recreation

The effects of oil development on recreational activities in the study area would be basically the same as the effects of oil exploration. Any development activities will largely destroy the wilderness values and alter or destroy scenic values on a year round basis. A change in the wilderness qualities would discourage wilderness oriented recreation due to a disturbance of the esthetic values. However, some of the developments, such as roads and airstrips, have the potential to increase access for recreational users for whom a wilderness experience is not critical to their recreational experience.

Impacts on recreation will be closely linked with facility development and human activity. Since, with the decision to produce oil, it will already have been decided to give up the wilderness qualities of the area, the overall effect may be to bring about a change in the type of recreationists who visit the area. The new type of recreationist may not need wilderness as much as those people presently attracted to the area; those recreationists needing true wilderness to satisfy their recreational needs will be displaced to other areas where wilderness characteristics are still available. This phenomena of social succession has been noted in other research (Hendee and Stanky 1973).

Facilities such as drilling pads, pipelines, pump stations, treatment stations, camps and power plants would likely physically prohibit recreational activities from taking place, through regulation. The development, even though limited to a relatively small area, would have far reaching impacts on the scenic resource. It would be difficult to hide such development on the treeless and essentially flat coastal plain. The visual impact of such development would have a negative impact on scenic resources, an important wilderness component.

Roads and trails, especially if opened to the public, would have high impact on recreational activities. Roads and trails would provide improved access for recreationists. With increased access recreation use may increase. If access is complete enough, for example, if the Dalton Highway is opened to the public to Prudhoe Bay and a spur road to Camden Bay or Kaktovik is also open, the potential for overuse of the area will exist.

Water consumption or siltation caused by construction may adversely affect floatboating or fishing opportunities in the affected rivers. If enough water is removed from the river, water levels may be lowered sufficiently to inhibit river trips. Recreational fishing may be negatively affected.

Increased aircraft flights will decrease the quality of the wilderness experience for wilderness recreationists far from the development sites. The number of aircraft seen during a one week trip in the Arctic NWR greatly affects the quality of trip experienced by visitors (Warren 1980). Warren reported more aircraft sightings contributed to a lower quality of experience. Airstrips or runways could have beneficial or adverse effects on recreationists. More airstrips would mean improved access for recreational uses of a given area, but a permanent or heavily used airstrip would reduce the wilderness qualities of an area making it less desireable for wilderness-oriented recreation. Increased access may also cause some overharvesting of game by hunters, which may impact subsistence lifestyles.

Odors generated by machines or waste materials will negatively impact esthetic qualities of the area, and therefore recreational uses. The overall increase in activities and disturbance, as previously stated, would remove the opportunity for experiencing the solitude and serenity characteristics of wilderness.

If an increase in recreational use is the result of oil related development, it is possible that there will be a demand for facilities on the Refuge that are not now proposed. This possibility will require prior planning by the FWS.

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## Human Culture and Lifestyle

### Subsistence and Other Socio-economic Features

The socio-economic impacts of petroleun and development and production would be similar to those described for seismic exploration, only many times the magnitude. Impacts would depend on the size of development, its location and location of support facillities, transportation modes and corridors, and many other factors not discernible at this time.

The first category of socio-economic impacts are those which would affect the land and the resource base, and are substantially identical to those outlined in the wildlife resources sections. Impacts on historic (TLUI) sites and subsistence areas and resources could occur both from development itself and from the influx of people from outside the area, whether associated with development or taking advantage of increased access. Damage to or disturbance of traditionally used sites and areas may direct subsistence use form formerly prodictive areas to less familiar areas, resulting in longer and costlier journies and perhaps uncertain harvests. Impacts on TLUI sites and subsistence areas, both terrestial and marine, may also engender feelings of anxiety or hostility on the part of Inupiat residents. Subsistence-related impacts could occur from increased competition for Fish & Wildlife, making subsistence hunting and hunter success more difficult (USGS 1979).

If people could no longer hunt successfully due to development-related impacts on the wildlife resource base, the traditional bases of esteem and leasdership in the village may erode as the outstanding hunters lost status. This would impact the social fabric of the village. The boredon and loss of identity resulting from the loss of a meaningful productive activity could increase alcohol and drug abuse, crime, and other health problems (USGS 1979).

The second category of socio-economic impacts are those that could interfere with the subsistence activitites or socially impact the village and the region.

Oil development in the Arctic National Wildlife Refuge would affect the growth and composition of both the local and the regional population. It could shift the cultural composition of the region to non-native, shift the sex ration of the population to predominately male, and increase racial tensions. There culd be a loss of regional isolation, making maintenance of traditional culture difficult. Effective separation of industrial sites and operations from the village of Kaktovik would minimize potential conflicts and adverse effects. (USGS 1979).

Petroleum development and production could increases the number of jobs in the region and increase opportunities for small business, thereby increasing employment opportunities and local economic stability. This could cause more Inupiat people to move from Barrow and other places to Kaktovik, as well as bringing in more non-Inupiats, increasing pressure on existing housing and intrastructure and on the area's fish & wildlife resources.

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Petroleum production would increase tax revenues, making more money and jobs available to the North Slope Borough and villages. Development in the region could increase investment opportunitites for the Arctic Slope Regional Corporation. It could further increase the area's sslaries, cost of living and regional inflation. (USGS, 1979).

Petroleum development and production could draw increased public attention to the Arctic National Wildlife Refuge and increase the number of visitors, which could in turn increase cross-cultural tensions and impact subsistence activities and village privacy.

The influx of people resulting from development and increased access could impact Kaktovik's social structure, which revolves sround family and kinlike alliances. The village power vase could switch from Native to non-Native, making Inupiat residents feel like political step-children. The resulting loss of self-esteen, together with the increased amount of money available from the increased number of jobs, could intensify the already serious problems of alcohol and drug abuse, and increase crime and other health problems (USGS 1979). The degree of impact would depend largely on the modes of access, and on the controls that were in effect. An overland transportation corridor, for example, connection the Dalton Highway with Kaktovik, would probably have the greatest amont of social impact, especially if it were open to the public. With air and barge transportation, on the other hand, it would be easier to control and or minimize the social impact (Wentworth 1980).

Other villages impacts from production of oil and gas on the Arctic Coastal Plain would be similar to those for oil and gas exploration only many times the magnitude. As stated previously, and effects on wildlife populations would have effects on subsistence uses of those populations and therefore have an impact on local economic and cultural patterns. For villages outside of the immediate production zone direct impacts would be essentially non-existant. Arctic village may see an even greater increase in aircraft flights and helicopter operations than in an exploration phase, which may affect the economy.

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## Wilderness and Natural Landmarks

With the decision to develope the oil and gas potential of the Arctic Coastal Plain, the decision against wilderness classification wil essentially have been made. The development of drilling pads, pipelines, permanent camps, airstrips and the general increase in air and ground activity wil render the area ineligible for wilderness classification. The possibility exists for restoration when and if oil activity ceases; however, to return to area to its present wilderness condition would be extremely difficult. In addition, the impact of the loss of the wilderness status of the ACP would have far reaching inpacts on people who will never visit the area, but derive satisfaction merely from knowing that it is there.

Natural landmark eligibility will be negated with permanent oil development and its related structures. With complet clean-up and restoration, there is the possibility that these sites would again be eligible in the future when and if oil activity ceases.

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# APPENDIX I
## Title X of Alaska National Interest Lands Conservation Act

## Arctic National Wildlife Refuge Coastal Plain Resource Assessment

Sec. 1002(a) PURPOSE - The purpose of this seciton is to provide for a comprehensive and continuing inventory and assessment of the fish and wildlife resources of the coastal plain of the Arctic National Wildlife Refuge; an analysis of the impacts of oil and gas exploration, development, and production, and to authorize exploratory activity within the coastal plain in a manner that avoids significant adverse effects on the fish and wildlife and other resources.

(b)DEFINITIONS - As used in this section -

(1)The term "coastal plain" means that area identified as such in the map entitled "Arctic National Wildlife Refuge", dated August 1980.

(2)The term "exploratory activity" means surface geological exploration or seismic exploration, or both, for oil and gas within the coastal plain.

(c)BASELINE STUDY - The Secretary, in consultation with the Governor of the State, Native Village and Regional Corporations, and the North Slope Borough within the study area and interested persons, shall conduct a continuing study of the fish and wildlife (with special emphasis on caribou, wolves, wolverines, grizzly bears, migratory waterfowl, musk oxen, and polar bears) of the coastal plain and their habitat. In conducting the study, the Secretary shall -

(A)assess the size, range, and distribution of the populations of the fish and wildlife;

(B)determine the extent, location and carrying capacity of the habitats of the fish and wildlife;

(C)assess the impacts of human activities and natural processes on the fish and wildlife and their habitats.

(D)analyze the potential impacts of oil and gas exploration, development, and production on such wildlife and habitats; and

(E)analyze the potential effects of such activities on the culture and lifestyle (including subsistence) of affected Native and other people.

Within eighteen months after the enactment date of this Act, the Secretary shall publish the results of the study as of that date and shall thereafter publish such revisions thereto as are appropriate as new information is obtained.

(d)GUIDELINES - (1) Within two years after the enactment date of this Act, the Secretary shall by regulation establish initial guidelines governing the carrying out of exploratory activities. The guidelines shall be based upon the results of the study required under subsection (c) and such other information as may be available to the Secretary. The guidelines shall include such prohibitions, restrictions, and conditions on the carrying out of exploratory activities as the Secretary deems necessary or appropriate to ensure

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that exploratory activities do not significantly adversely affect the fish and wildlife, their habitats, or the environment, including, but not limited to -

(A)a prohibition on the carrying out of exploratory activity during caribou calving and immediate post-calving seasons or during any other period in which human activity may have adverse effects;
(B)temporary or permanent closing of appropriate areas to such activity;
(C)specification of the support facilities, equipment and related manpower that is appropriate in connection with exploratory activity; and
(D)requirements that exploratory activites be coordinated in such a manner as to avoid unnecessary duplication.

(2)The initial guidelines presecibed by the Secretary to implement this subsection shall be accompanied by an environmental impact statement on exploratory acitivites. The initial guidelines shall thereafter be revised to reflect changes made in the baseline study and other appropriate information made available to the Secretary.

(e)EXPLORATION PLANS - (1) After the initial guidelines are prescribed under subsection (d), any person including the United States Geological Survey may submit one or more plans for exploratory activity (hereinafter in this section referred to as "exploration plans") to the Secretary for approval. An exploration plan must set forth such information as the Secretary may require in order to determine whether the plan is consistent with the guidelines, including, but not limited to -

(A)a description and schedule of the exploratory activity proposed to be undertaken;
(B)a description of the equipment, facilities, and related manpower that would be used in carrying out the activity;
(C)the area in which the activity will be undertaken; and
(D)a statement of the anticipated effects that the activity may have on fish and wildlife, their habitats and the environment.

(2)Upon receiving any exploration plan for approval, the Secretary shall promptly publish notice of the application and the text of the plan in the Federal Register and newspapers of general circulation in the State. The Secretary shall determine, within one hundred and twenty days after any plan is submitted for approval, if the plan is consistent with the guidelines established under subsecton (d). If the Secretary determines that the plan is so consistent, he shall approve the plan: except that no plan shall be approved during the two-year period following the date of enactment of this ACt. Before making the determination, the Secretary shall hold at least one public hearing in the State for purposes of receiving the comments and views of the public on the plan. The Secretary shall not approve of any plan submitted by the United State Geological Survey unless he determines that (1) no other person has submitted a plan for the area involved which meets established guidelines and (2) the information which would be obtained is needed to make an adequate report under subsection (h). The Secretary, as a condition of approval of any plan under this section -

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(A)may require that such modifications be made to the plan as he considers necessary and appropriate to make it consistent with the guidelines;
(B)shall require that all data and information (including processed, analyzed and interpreted information) obtained as a result of carrying out the plan shall be submitted to the Secretary; and
(C)shall make such data and information available to the public except that any processed, analyzed and interpreted data of information shall be held confidential by the Secretary for a period of not less than two years following any lease sale including the area from which the information was obtained.

(f)MODIFICATION TO EXPLORATION PLANS - If at any time while exploratory activity is being carried out under an exploration plan approved under subsection (e), the Secretary, on the basis of information available to him, determines that continuation of further activities under the plan or permit will significanlty adversely affect fish and wildlife, their habitat, or the environment, the Secretary may suspend the carrying out of activities under the plan or permit for such time, make such modifications to the plan or to the terms and conditions of the permit (or both suspend and so modify) as he determines necessary and appropriate.

(g)CIVIL PENALTIES - (1) Any person who is found by the Secretary, after notice and an opportunity for a hearing in accordance with section 554 of title 5, United States Code, to have violated any provision of a plan approved under subsection (e) or any term of condition of a permit issued under subsection (f), or to have committed any act prohibited under subsection (d) shall be liable to the United State for a civil penalty. The amount of the civil penalty shall not exceed $10,000 for each violation. Each day of a continuing violation shall constitute a separate offence. The amount of such civil penalty shall be assessed by the Secretary by written notice. In determining the amount of such penalty, the Secretary shall take into account the nature, circumstances, extent, and gravity of the prohibited act committed, and, with respect to the violator, the history of any prior offenses, his demonstrated good faith in attempting to achieve timely compliance after being cited for the violation, and such other matters as justice may require.

(2)Any person against whom a civil penalty is assessed under paragraph (1) may obtain review thereof in the appropriate district court of the United States by filing a notice of appeal in such court within thirty days from the date of such order and by simultaneoulsy sending a copy of such notice by certified mail to the Secretary. The Secretary shall promptly file in such court a certified copy of the record upon which such violation was found or such penalty imposed, as provided in section 2112 of title 28, United State Code. The findings and order of the Secretary shall be set aside by such court if they are not found to be supported by substantial evidence, as provided in section 706(2)(E) of title 5, United States Code.

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(3)If any person fails to pay an assessment of a civil penalty against him under paragraph (1) after it has become final, or after the appropriate court has entered final judgement in favor of the Secretary, the Secretary shall refer the matter to the Attorney General of the United States, who shall recover the amount assessed in any appropriate district court of the United States. In such action, the validity and appropriateness of the final order imposing the civil penalty shall not be subject to review.

(4)The Secretary may compromise, modify, or remit; with or without conditions, any civil penalty which is subject to imposition or which has been imposed under this subsection unless the matter is pending in court for judicial review or recovery of assessment.

(h)REPORT TO CONGRESS - Not earlier than five years after the enactment date of this Act and not later than five years and nine months after such date, the Secretary shall prepare and submit to Congress a report containing -

  (1)the identification by means other than drilling of exploratory wells of those areas within the coastal plain that have oil and gas production potential and estimate of the volume of the oil and gas concerned;
  (2)the description of the fish and wildlife, their habitats and other resources that are within the areas identified under paragraph (1);
  (3)an evaluation of the adverse effects that the carrying out of further exploration for, and the development and production of, oil and gas within such areas will have on the resources referred to in paragraph (2);
  (4)a description of how such oil and gas, if produced within such area, may be transported to processing facilities;
  (5)an evaluation of how such oil and gas relates to the national need for additional domestic sources of oil and gas; and
  (6)the recommendations of the Secretary with respect to whether further exploration for, and the development and production of, oil and gas within the coastal plain should be permitted and, if so, what additional legal authority is necessary to ensure that the adverse effects of such activities on fish and wildlife, their habitats, and other resources are avoided or minimized.

(i)EFFECT OF OTHER LAWS - Until otherwise provided for in law enacted after the enactment date of this Act, all public lands within the coastal plain are withdrawn from all forms of entry or appropriation under the mining laws, and from operation of the mineral leasing laws, of the United States.