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PREFACE

This bibliography continues to find a useful place on library shelves if recent requests for volume 6 (this volume) are any indication that the publication serves a useful purpose. We have been slow to get this volume 6 in press for all the natural reasons and excuses that can be fabricated. But here it is. It includes 314 items mainly published in the period 1981 to 1983. Volume 7 has already been started; we hope to have it ready for distribution in about a year.

May 1, 1985

Cette bibliographie continue à recevoir une place très utile sur les rayons de nos bibliothèques, si les récentes demandes sont une indication de la popularité de cette bibliographie. Nous avons pris du retard à publier ce volume numéro 6, pour toutes les raisons naturelles et les excuses qui peuvent être fabriquées, mais, enfin, la voici. Elle comprends 314 items qui ont été publiés principalement durant la période de 1981 à 1983. Volume 7 est déja commencé; nous espérons qu'il sera desponible pour distribution l'année prochaine.

le 1 mai, 1985

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ARCHAEOLOGY

2224 ARNOLD, C.D. - 1981
The Lagoon site (OjRl-3): implications for Paleoeskimo interactions; National Museum of Man Mercury Series; *Archaeological Surv. Can.* Paper No. 107, 223 p.

Excavations at the Lagoon site (OjRl-3) on the southern coast of Banks Island, N.W.T., have provided a data base with which to formulate hypotheses concerning the Paleoeskimo culture history of the western periphery of the Canadian Arctic at ca. 500 B.C. In the several centuries previous to that date, Dorset culture is believed to have evolved in the Foxe Basin - Hudson Strait region of the Eastern Arctic, and from there spread by immigration into areas formerly occupied by Pre-Dorset people. At about the same time, Choris and Norton complexes were expanding from Alaska into northwestern Canada. The artifact assemblage obtained from the Lagoon site incorporates traits which are characteristic of several of these Paleoeskimo complexes. Since it appears that no more than one occupational episode is represented at the site, diffusion resulting from cross-cultural interactions is hypothesized to account for the nature of the data. In order to develop this postulate, aspects of models devised for historical, biological and anthropological explanations are drawn upon.

2225 ARNOLD, C.D. - 1981
Demographic process and culture change: an example from the western Canadian Arctic; *in* Proc. Twelfth Annual Chacmool Conference, Networks of the Past, 1981, pp. 311-317.

The discovery of several previously unknown or unreported styles and kinds of tools, as well as new associations of other artifact types, at the Lagoon site (OjRl-3) on Banks Island, N.W.T. has raised questions about the processes of regional diversification and cultural interaction during part of the Paleoeskimo period in arctic prehistory. To date, there has been scant evidence to counter the prevailing assumption that Paleoeskimo cultures in the Canadian Arctic developed along separate lines from those in Alaska following their divergence from a common Arctic Small Tool tradition base at ca. 2000 B.C. In fact, it seems that for much of prehistoric time the western and central/eastern regions of arctic North America constituted separate culture areas, each of which periodically differentiated into a number of cultural provinces. However, the eclectic nature of the Lagoon assemblage indicates that circumstances fostered cross-cultural, or at any rate inter-regional, interactions within this mosaic, instigating a new trajectory of cultural development.

In searching for agents of prehistoric culture change, archaeologists have frequently turned their attention to the effects of population pressure. In most situations that have been discussed in the literature, the cultural changes in question have been regarded as responses to stress imposed by an overtaxing of the available resources due either to an increase in population density, a lowering of the environmental carrying capacity, or both. These population pressure models may constitute useful interpretive tools; however, they deal only with a narrow sector of the broad range of casual relationships that can exist between demography and cultural configuration. Since social interrelationships depend to a large extent upon demographic structure, any shifts in that structure--regardless of kind or reason --may induce corresponding changes in social interrelationships and thus in the culture as a whole. This paper accounts for the atypical nature of the Paleoeskimo complex represented at the Lagoon site by outlining how a drop in population which seems to have occurred over parts of the western Canadian Arctic between 1000 and 500 B.C. could have fostered new social interrelationships, which are manifest in the form of new traits and trait clusters in the artifact assemblage.

2226 ARNOLD, C.D. - 1982
Banks Island Archaeological Research Project - Interim Report - Excavations in the Nelson River area, 1981; *Prince of Wales Northern Heritage Centre*, internal report, 15 p.

The Banks Island Archaeological Research Project was initiated in 1980 with a three-man survey along the coast of southeastern Banks Island, N.W.T. The intent of the survey was to delineate a study area with sufficient archaeological resources to answer outstanding questions about the culture history of, and prehistoric cultural dynamics in, the western Canadian Arctic.

The area under investigation was divided into two parts: De Salis Bay in the north, and Nelson River in the south. Both regions are rich in avian, terrestrial and marine fauna. Both are lowlying coastal areas bounded by terrain of higher elevation. As well, in both areas depositional and erosional agents are actively modifying the landscape so that many archaeological sites have likely been destroyed or hidden by overburden. However, those sites that were found suggest differences in the prior utilization of each area. No substantiated prehistoric sites were found at De Salis Bay, although protohistoric and historic occupations were abundant. On the other hand, there were few indications of recent activity at Nelson River, although at least five sites pertaining to the Thule stage of Inuit prehistory were encountered. Several of those sites were tested and judged to warrant further investigation. Consequently, a six-man crew returned to the Nelson River area in 1981 to carry out more detailed investigations.

2227 BEATTIE, O.B., and SAVELLE, J.M. - Discovery of Human Remains From Sir John Franklin's Last Expedition; *Historical Archaeology*, vol. 17, no. 2, pp. 100-105.

A survey of the south coast of King William Island in the south-central Arctic has revealed new information on the last Sir John Franklin

expedition (1845-1848) in search of a Northwest Passage. The undisturbed skeletal remains of an expedition member were discovered and are here described. In addition, two graves previously related to the Franklin expedition in the same area are shown to be of 19th century Inuit origin.

2228 BERTULLI, M.M. - 1983
Northern Cultural Heritage Project, 1983 - Annual Report of the Northern Heritage Society, *Northern Heritage Society*, internal report 49 p.

2229 BIELAWSKI, E. - 1980
Space and season: a study of the spatial behavior of prehistoric arctic hunters; unpub. Ph.D. thesis, Univ. Calgary, 163 p.

The theory of cultural ecology provides the framework for this study at the explanatory level. The methodology involves a regional approach to analysis of the spatial behavior of prehistoric Arctic hunters. The model is one of seasonal mobility for subsistence, and the degree and nature of such behavior, as it differs among these cultural groups are subjected to analysis here.

Four study hypotheses about spatial patterns in the archaeological site distribution on Aston Bay, Somerset Island, NWT are developed. These identify variables assumed to have affected the choice of site location made by Early Arctic Small Tool tradition, Dorset Culture and Thule Culture groups. The prehistory of Aston Bay is summarized on the basis of information collected through systematic, intensive survey and probabilistic sampling. Quantitative methods for spatial analysis (nearest neighbor, contingency table analysis, multiple regression and probability surface mapping) are used to identify and describe spatial patterning in the site distribution.

The study yields the conclusions that spatial behavior in the Aston Bay region differed between Early ASTt, Dorset and Thule groups; that a regional approach coupled with systematic data collection and analysis holds high potential for revealing subtle variability in archaeological data, and that anthropology provides the explanatory theory for interpretation of prehistoric spatial behavior.

2230 BIELAWSKI, E. - 1982
Northern Cultural Heritage Project - 1982 Archaeological Research; *Northern Heritage Society*, internal report, 45 p.

The Northern Cultural Heritage Project (NCHP) began research at Stanwell-Fletcher Lake in 1979. The presence of a large Paleoeskimo site, PfJv-2, drew us to the area. This site is significant because it is inland, located in a valley filled with lakes and streams. In contrast, much archaeological evidence recovered from the Arctic Islands has come from coastal sites.

At PfJv-2, all but the earliest components have now been sampled. Additionally, nine smaller sites have been located through survey around PfJv-2. During the 1982 season, we excavated one of these, PeJv-3. Interpretation of this site, and the bearing of its evidence on research problems under study at the large site, are the subject of this report.

2231 BOCKSTOCE, J. - 1983
Arctic Odyssey; *Nat. Geographic*, vol. 164, no. 1, July, pp. 100-127.

2232 COLE, S.C., and BIELAWSKI, E. - 1981
Beyond the field school: developing the Northern Cultural Heritage Project; *Northern Heritage Society*, internal report, 47 p.

The Northern Cultural Heritage Project (NCHP) seeks to integrate scientific research in the Northwest Territories with an education and employment program for young northerners. The program began operation in 1979 as an archaeological field school at Stanwell-Fletcher Lake on Somerset Island. In the summers 1979 to 1981, 20 young people from different communities throughout the Territories were employed and trained as scientific field assistants through their participation in an innovative heritage education program for four weeks in the field.

The present report describes the current status of the NCHP program and outlines some of the subsequent developments from the actual field school operation. The education and training component is described in Section I and the progress of the archaeological research is discussed in Section II. Section III outlines some of the ways in which the project has had impact beyond the field school and Section IV proposes possible directions for the future along with problems to be resolved.

2233 GODDARD, J. - 1982-83
Digging up the facts; *Northwest Explorer*, vol. 2, no. 1, Winter 1982-83, pp. 39-43.

2234 GODDARD, J. - 1983
Young Inuit learn, earn at archaeological sites; *Can. Geographic*, Feb/March, pp. 30-35.

At a dig on Somerset Island in the High Arctic Inuit students learn the basic methods of archeology. With trowels and dustpans they sift through gravel that overlies an ancient campsite, searching for stone tools left behind by a succession of four Eskimo cultures which flourished between 1,000 and 4,000 years ago.

2235 HELMER, J.W. - 1982
The archaeological resources of the Sparbo/Hardy and Truelove Lowland regions, north Devon Island, N.W.T.: a report of the 1982 Devon Island Archaeology Project; *Arctic Inst. N. Amer.* internal report, 123 p.

In August 1982, a programme of archaeological site survey was undertaken in the Sparbo/Hardy and Truelove Lowland regions of Northern Devon Island, N.W.T. The immediate objective of the 1982 survey was to assess the nature of the

archaeological resources present in the study area. The principal goal of this study, however, was to provide quantitative and qualitative data for use in evaluating the feasibility of implementing a long term study of changing seasonal subsistence/settlement strategies amongst the indigenous prehistoric populations of the central Arctic Archipelago. The following paper outlines the major research objectives, methodological approaches and quantitative results of the 1982 Devon Island Archaeology Project. This report concludes with recommendations for further field research in the Sparbo/Hardy and Truelove Lowland regions.

2236 JANES, R.R. - 1982
The Preservation and Ethnohistory of a Frozen Historic Site in the Canadian Arctic; *Arctic*, vol. 35, no. 3, pp. 358-385.

In 1853 a British Naval Expedition, involved in the search for the missing British Naval Northwest Passage Expedition under the command of Sir John Franklin, constructed a stone storehouse on Dealy Island off the coast of Melville Island, Northwest Territories. This storehouse was stocked with a complete inventory of supplies used in mid-19th century arctic exploration.

Excellent documentary sources pertaining to the origin and the abandonment history of the site indicate that it underwent a series of diverse alterations since its abandonment. Many of these alterations were found to be archaeologically invisible. The extant remains would have resulted in a crippling misinterpretation of the facts had written records not been available.

Because of the conservation problems posed by this extraordinarily large and rich collection of frozen material, traditional archaeological approaches were rejected. Instead, the structure and its contents were preserved *in situ* by a multidisciplinary team of archaeologists, conservators and architects. It is hoped that the underlying philosophy of this approach and some of the techniques used are applicable to other frozen sites.

Examination of the historical record and available archaeological data indicates that the Dealy Island site played an insignificant role as an agent of culture change among the historic Inuit. Several factors are considered in arriving at this conclusion, including British ethnocentrism, the logistical requirements of naval exploration and the abandonment of the High Arctic by indigenous peoples during the Neo-Boreal climatic episode.

2237 McCULLOUGH, K.M. - 1983
The Skraeling Island Research Project - Report on the 1982 Field Season; *Polar Cont. Shelf Proj.*; internal report, 67 p.

Definition of this culture phase and clarification of its chronological position within the Thule culture continuum are only the initial stages of a broader study which will seek to clarify the cultural relationships of the Ruin Island phase with the Alaska/Bering Strait region, assess its role in Thule cultural developments in the central and eastern Arctic, and delineate cultural changes throughout the phase itself.

2238 McGHEE, R. - 1981
The Prehistory and Prehistoric Art of the Canadian Inuit; *The Beaver*, summer 1981, pp. 23-30.

OVER THE PAST THREE DECADES there has been a growing interest in the art forms being produced by the Inuit of Arctic Canada. In the early days of this phenomenon there were many naive statements made by collectors, and claims made by dealers, that Inuit soapstone carving was the culmination of an artistic tradition which had gradually developed over the centuries, or even over millennia of prehistoric time. Another view, and one which is more fashionable today, treats Inuit art as an entirely new art form, rapidly evolving, changing as it grows, developing its own traditions, and which can be appreciated without reference to its origins or to the past.

Neither of these views is entirely satisfactory. We do not find soapstone carvings, nor the remains of any other modern art forms, on archaeological sites of the later prehistoric period; these developments belong to the mid-twentieth century. Nevertheless, although there is little resemblance between modern art forms and those of the prehistoric past, art has been produced in Arctic Canada for the last 4,000 years. Over this period the art took many forms. There was no simple development over time, either in Inuit culture or in its arts; yet perhaps some of these arts may have expressed concepts similar to those of modern Inuit art. A brief sketch of the history of the Canadian Inuit and of their art may serve as a useful background in appreciating the artistic productions of the Inuit today.

2239 McGHEE, R. - 1983
Arktisk Kontakt; *Skalk*, Nr. 3, pp. 12-15.

Det er kendt fra skriftlige kilder, at nordbokolonisterne på Grønland opdagede Amerika og foretog rejser dertil, men først de senere år har bragt den afgørende arkaeologiske bekraeftelse. Fra to canadiske arkaeologer har vi modtaget nedenstående rapport.

2240 PHILLIPS, C.J. - 1982
Report of the Surveys of the Sixth Season (1981) of the Arctic Historical Project; *Parks Can.*, Env. Can., Nat. Historic Parks and Sites Br., internal report, 42 p. *RESTRICTED*.

A limited field season was planned for the Arctic Historical Archaeology Project in August 1981 involving helicopter surveys of coastlines on Devon, Bathurst, Melville, Russell, Prince of Wales and Cornwallis Islands in order to locate and record sites left by: W.E. Parry; the Franklin search era expeditions of Austin, Penny, Kennedy and Belcher; and J.E. Bernier's Canadian sovereignty expeditions. Poor weather limited the search severely so that only sites below the 400 ft. level could be recorded and

the plans to travel along the northern Bathurst Island coast and on to Melville Island had to be cancelled. In all, three survey flights were made from Resolute covering: the southern Cornwallis Island coast west of Resolute; northwestern Bathurst Island and the Northumberland Sound area of Devon Island; and the coasts of Russell Island, northeastern Prince of Wales Island and the small islands in Barrow Strait. One historic period depot, ten cairns and several prehistoric sites were located.

2241 SCHLEDERMANN, P. - 1981
Eskimo and Viking Finds in the High Arctic; *Nat. Geographic*, vol. 159, no. 5, May 1981, pp. 575-601.

Survivors of time, toy dolls more than 500 years old - one in a bearskin skirt - recall an Eskimo people whose predecessors reached Canada's Arctic some 4,300 years ago. Searching the ruins of a 14th-century winter house near Ellesmere Island, the author discovered links of medieval chain mail and other Norse artifacts suggesting that early Viking voyages ranged 500 miles farther north than previously thought.

2242 THORSON, J. - 1983
Archeology digs key to the past; *news/north*, vol. 38, 2nd issue, Friday, June 24, 1983, pp. A11 and A13.

BATHYMETRY

2243 DAVIES, P.V. - 1981
Final Field Report, P.C.S.P. Survey M'Clintock Channel, Proj. File No. 5452-7324, February-April 1981; *Fisheries and Oceans*, Canadian Hydrographic Serv., Central Region, internal report, 34 p.

The two-year project to survey M'Clintock Channel, Larsen Sound and Franklin Strait was completed this year. The survey started on February 20, 1981 and ended on April 27, 1981, for a total of 67 days in the field.

2244 MacDOUGALL, J.R. - 1982
Final Field Report, P.C.S.P. Survey Prince of Wales Strait, Proj. File No. 5452-7324; *Fisheries and Oceans*, Canadian Hydrographic Serv., Central Region, internal report, 27 p.

This report covers the 1982 Polar Continental Shelf Project survey of Prince of Wales Strait. Four Bell 206B helicopters flew a total of 1200.2 hours between March 4 and April 24 supporting bathymetric and gravity operations. A total of 12877 spot depths were collected on a 1000 metre grid and 287 gravity observations obtained on a six kilometre grid. These observations were collected over the entire strait.

2245 SOBCZAK, L.W. - 1979
Bathymetry of the Arctic Ocean north of 85°N latitude - reply; *Tectonophysics*, vol. 60, pp. 297-302.

The purpose of my original letter was to compare a portion of the bathymetric map published by Heezen and Tharp with a newly compiled and updated bathymetric chart and to point out *significant* differences in morphology and positioning, and not merely minor variations in contours. Figure 1 has been modified to take into account Monahan's comments regarding missing and mislabelled contours, a submarine track, and a sounding location. Additional modifications have been made to Fig. 1 based on ice island T3 and British submarine Sovereign data.

This modified chart is one of 22 charts used to compile an Arctic Ocean bathymetric map at a scale of 1:7,500,000. The latter has been compiled from nearly 1/4 million digitized water depths, about 7 million values in analog form and several thousand values taken from plotting sheets.

2246 WEBER, J.R. - 1983
Maps of the Arctic Basin Sea Floor: A History of Bathymetry and its Interpretation; *Arctic*, vol. 36, no. 2, pp. 121-142. *LOREX CONTR. NO. 13.*

The history of oceanographic exploration of the Arctic Ocean basin from the beginning of this century to the present is summarized. Soviet, U.S. and Canadian contributions after World War II are described in some detail including sounding methods and navigational techniques. The major bathymetric charts of the Arctic Ocean basin from 1954 on are discussed. Comparison of the LOREX bathymetric map with other maps reveals that the Lomonosov Ridge is accurately positioned on early Soviet maps but is grossly in error on later U.S. and Canadian maps. It is shown that map makers relied too much on early U.S. submarine data (the only such data that were declassified) and that the latest General Bathymetric Map of the Oceans (GEBCO) is therefore suspect of being inaccurate in areas where publicly available sounding data are scant.

BIOLOGY

2247 ALLEN, L. - 1982
Bird migration and nesting observations, western Victoria Island, N.W.T., June 1980; *Govt. N.W.T.*, Can. Wildl. Serv. internal report, 61 p.

In 1979, Polar Gas Ltd. announced that they were considering construction of a gas pipeline from the High Arctic to southern markets. The pipeline would cross western Victoria Island, an area of the Arctic where there was practically no published information on birds. In 1980, the Canadian Wildlife Service initiated a study to obtain preliminary data on spring migrating and nesting birds on western Victoria

Island. The study was intended to help identify what further bird studies would be needed if a specific application for a gas pipeline was filed in the future. The project was funded by the Canadian Wildlife Service with logistical support from Polar Continental Shelf Project of Energy, Mines and Resources.

The study consisted of a spring migration watch and a set of aerial surveys for nesting birds. The migration watch was conducted at Cape Lambert in Dolphin and Union Strait from 6 to 9 June 1980 to record the migration of birds through the strait and their use of the nearby polynia. The aerial surveys for nesting birds were conducted from 23 to 29 June on western Victoria Island along the proposed Polar Gas pipeline route and along much of the adjacent coastline, cliffs and river valleys.

About 98% of the birds observed during the migration watch at Dolphin and Union Strait were ducks, most of which were Common Eiders, King Eiders and Oldsquaws. Geese accounted for about 1% of the sightings, while the remaining 1% consisted primarily of loons, jaegers, gulls and terns. The highest count occurred on 10 June when we observed over 20,000 birds. Approximately 18,400 of these birds were Common Eiders, and nearly all were feeding or resting on the polynia, rather than in flight.

Most of the birds migrating through Dolphin and Union Strait flew parallel to the coast in either a southeasterly or northwesterly direction. Species moving primarily southeast were the Brant, Common Eider, Oldsquaw, Rough-legged Hawk, Short-eared Owl, Pomerine Jaeger and Sabine's Gull. The majority of Whistling Swans and Parasitic Jaegers migrated towards the northwest. Nearly all flocks of migrants in flight, regardless of species, contained less than 10 birds. Where there were sufficient data and a definite trend, the timing of migration for each species was estimated. Early migrants which weremore abundant prior to mid-June included geese, jaegers, shorebirds and Short-eared Owls. Late migrants more common after 10 June, were loons, Arctic Terns and King Eiders.

The aerial surveys confirmed the importance of the polynia at Dolphin and Union Strait as a staging area for sea ducks during spring migration (64.8 ducks/km^2). The lead off Cape Baring at the mouth of Prince Albert Sound also harboured a large concentration of staging sea ducks (46.2 ducks/km^2). In addition, the Kagloryuak River mouth and several other stream mouths in Prince Albert Sound had small flocks of staging ducks.

The aerial survey of cliffs between Holman and Minto Inlet indicated that this area is important.

The highest overall density of nesting birds generally occurred in lowland areas where there was continuous vegetative cover and numerous ponds. More specifically, these were the lowlands adjacent Dolphin and Union Strait (5.9 birds/km^2), Prince Albert sound (6.4 birds/km^2) and Richard Collinson Inlet (4.8 birds/km^2), as well as the Kagloryuak River valley (3.8 birds/km^2) and the islands at the mouth of the river (10.0 birds/km^2). The most common species of waterfowl and their preferred nesting habitat were as follows: the Whistling Swan and Canada Goose which nested in relatively high densities wherever there were well-vegetated lowlands on the southern half of western Victoria Island; the Brant and Common Eider which nested on the islands in Dolphin and Union Strait and on the islands at the mouth of the Kagloryuak River; the King Eider which nested on inland lakes throughout western Victoria Island, and particularly in the Kagloryuak River Valley; and the Oldsquaw which was most abundant in well-vegetated coastal areas, but also nested in moderate numbers on the inland lakes of Diamond Jenness Peninsula. Several colonies of Arctic Terns, Glaucous Gulls, Thayers/Herring Gulls and Sabine's Gulls were noted as well during the aerial surveys.

The densities obtained for birds nesting on western Victoria Island were compared to those recorded during a similar study conducted in the Keewatin District in 1976 and 1977. Generally, western Victoria Island had lower densities of nesting birds than the District of Keewatin. Victoria Island had high concentrations of spring staging sea ducks in the polynia at Dolphin and Union Strait and in the lead off Cape Baring.

2248 BARRY, S.J., and BARRY, T.W. - 1982
Sea-bird surveys in the Beaufort Sea, Amundsen Gulf, and Prince of Wales Strait, 1981 season; *Env. Can.*, Can. Wildl. Serv. internal report, 52 p.

Nine surveys of sea-birds were flown along the water's edge of the Beaufort Sea, Amundsen Gulf, and Prince of Wales Strait during late May through September 1981 to compare with similar flights in 1980 and to locate the major nesting and brood-rearing areas of common eiders. The Beaufort Sea in 1981 had areas with less open water for spring migrants than in 1980, although Amundsen Gulf was nearly ice-free. Densities of sea-birds in spring migration were higher in the restricted open leads; later, however, the densities of molting sea-ducks were generally lower. Nevertheless, the areas of bird concentration remained the same as the year before. The 1981 surveys allowed important habitat for sea and coastal birds to be evaluated.

2249 BIRKHEAD, T.R., and NETTLESHIP, D.N. - 1980
Reproductive strategies in Brunnich's Guillemot *uria lomvia* L.: the effect of egg size and laying date on reproductive success; *Can. Wildl. Serv.*, Bed. Inst. Ocean., Report No. 88, 28 p.

(1) The effect of egg size and laying date on the fledging weight of Brunnich's Guillemot chicks was examined at Cape Hay, Bylot Island and Coburg Island, N.W.T., Canada.

(2) Three sets of data showed that there was a seasonal decline in egg volume.

(3) Egg volume was correlated with weight and size (wing length) of chicks soon after hatching. Partial correlations indicated that larger eggs give rise to heavier, but not larger chicks.

(4) Chicks hatched early in the season fledged at heavier weights than late hatched chicks. Hatching weight contributed significantly to this effect, but other factors (e.g. calorific intake) were probably also important.

(5) A model, based on a multiple regression of the effects of hatching weight and hatching date on fledging weight, shows the possible combinations of egg size and timing of breeding while maintaining a constant fledging weight.

(6) Data on the replacement interval and size of replacement eggs suggests that females which are unable to lay on time may do better (in terms of fledging weight of their chick) to minimize the delay in laying by producing a small egg early, rather than delay laying in order to produce a larger egg. This is because they are unable to lay down nutrients in the ovarian follicle at a fast enough rate to make a delay worthwhile. This suggests that the seasonal decline in egg size is an adaptive response to a seasonal deterioration in environmental conditions.

2250 BOND, W.A. - 1982
A study of the fish resources of Tuktoyaktuk Harbour, southern Beaufort Sea coast, with special reference to life histories of anadromous coregonids; *Fish. and Oceans*, Fish. Aquat. Sci. Can. Tech. Rep. No. 1119, 97 p.

The fish fauna of Tuktoyaktuk Harbour and the adjacent waters of Kugmallit Bay was sampled between July 1979 and March 1981, to document seasonal movement patterns in the vicinity of Tuktoyaktuk, to define the purpose of these migrations, and to acquire baseline data on the age and growth characteristics, sex ratio and maturity, and food habits of the various fish species.

Fifteen fish species, representing eight families, were identified from gillnet and seine catches. Seines produced the most fish, accounting for 63.8% of the total catch. Overall, samples were dominated by six anadromous species which accounted for 71.4% of all fish taken. Among the anadromous forms least cisco predominated (43.8%), followed by Arctic cisco (26.8%), broad whitefish (13.7%), lake whitefish (7.6%), rainbow smelt (5.2%), and inconnu (2.7%). Fourhorn sculpin was the most abundant (49.5%) of the six species considered to be brackish water or marine forms. Other species in this group included starry flounder (19.1%), Pacific herring (16.1%), Arctic flounder (12.8%), saffron cod (2.4%) and eelpout (0.1%).

Results of the present study suggest that the anadromous coregonids occurring in the vicinity of Tuktoyaktuk are primarily non-spawning members of the migratory populations whose spawning sites are located in the Mackenzie River and its tributaries. Few sexually mature coregonids were captured.

Broad whitefish, lake whitefish, and least cisco were seldom captured during the winter but were common in nearshore areas throughout the summer. The abundance of all three species increased greatly in early September, suggesting a movement from summer feeding areas to overwintering locations at that time.

Tuktoyaktuk Harbour is a major overwintering area for Arctic cisco. A large migration of non-spawning cisco entered the bay in September and this species was abundant below the halocline throughout the winter. A migration out of the bay took place around the time of break-up. Some of the Arctic cisco leaving the bay at this time had matured sexually over the winter.

The bay also appears to be an important overwintering area for inconnu which leave shortly after break-up for coastal feeding locations.

The other anadromous species, rainbow smelt, appears inside Tuktoyaktuk Harbour in mid-summer but does not overwinter there.

Pacific herring enter Tuktoyaktuk Harbour in large numbers during the autumn. Herring overwinter in the bay, spawn in June, and appear to leave the bay immediately after spawning. Fourhorn sculpin (January), Arctic flounder (March), saffron cod (March), and starry flounder (June-July) are also believed to spawn inside Tuktoyaktuk Harbour.

Large numbers of young-of-the-year least cisco and Arctic cisco entered Tuktoyaktuk Harbour during July but their abundance decreased during August.

2251 BOND, W.A., and ERICKSON, R.N. - 1982
Preliminary results of a fisheries study of two freshwater lake systems on the Tuktoyaktuk Peninsula, Northwest Territories; *Fish. and Oceans*, Can. Data Rep. Fish. Aquat. Sci. No. 348, 68 p.

In 1981, the Department of Fisheries and Oceans commenced a two-year study of two lake systems draining into Tuktoyaktuk Harbour on the southern Beaufort Sea coast. The purpose of the study was to determine the significance of these lake systems as fish habitat, especially for anadromous coregonids. This report presents preliminary data gathered during summer, 1981. A final report is to be produced following completion of the study in 1982.

Migrations of anadromous broad whitefish, *Coregonus nasus* (Pallas), lake whitefish, *C. clupeaformis* (Mitchill), and least cisco, *C. sardinella* (Valenciennes) were documented in both streams. Fish movements within the streams were monitored using two-way counting fences. The fence on Mayogiak Creek was operated from 14 June to 13 August while that on Freshwater Creek was run between 16 June and 1 September. At the fence sites data were collected describing the numbers of migrant fish, diurnal and seasonal timing of migrations, length-frequency distribution, age and growth, sex and maturity, and food habits.

Brief surveys were conducted on three lakes in each watershed to gather information on lake morphometry, water chemistry, benthic inverte-

brates, zooplankton and to assess the importance of these waterbodies as fish habitat.

2252 BOOTHROYD, P.N. - 1983
Preliminary assessment of potential environmental effects of the borealis iron ore development proposal on birds of Melville Peninsula, N.W.T.; *Env. Can.*, Can. Wildl. Serv. Wpg., internal report, 132 p.

Vegetation communities in the Parry Bay area of Melville Peninsula, N.W.T. were segregated into 10 classes through a combined biophysical and automatic computer classification approach using LANDSAT imagery. The colour-coded, 1:70 000 scale maps produced from the classification were used to prepare a derivative map showing the distribution of habitat most attractive to water-oriented birds in the Parry Bay area.

Aerial surveys were conducted of the shore-fast ice edge in Parry Bay, along the shoreline from Hall Beach to Cape Jermain and along transects established in terrestrial areas of the Parry Bay region to determine the significance of the area to birds. A reconnaissance survey of the Ajaqutalik River was also flown. Results of the survey are discussed and areas within the study area which appear to be most important to loon, waterfowl and other bird species are described and mapped.

A technique of environmental impact assessment, referred to as the Biophysical LANDSAT Technique, is described and used to assess the environmental implications of developing the iron ore bodies near Roche Bay as proposed by Borealis Exploration Limited. The most significant potential impacts would result from: oil spills occurring in Roche and Parry bays, and especially south Foxe Basin and Hudson Strait; construction of a road from the mine development to Hall Beach; aircraft traffic; and hydroelectric development of the Ajaqutalik River. Studies are recommended to provide the data necessary for evaluation of these impacts and for minimizing the adverse effects of the project on birds.

2253 BRUEMMER, F. - 1981
Two Weeks in a Polar Bear Prison; *Audubon*, November 1981, pp. 28-37.

A forty-five-foot tower stands on the esker, topped by a tiny hut, our home for the next two weeks. While we haul our provisions up, a polar bear shambles along the esker toward us. He walks slowly, ponderously. He stops, raises his elegant, triangular head; sniffs, weaving slightly from side to side; then shuffles on. He is a young male, high-rumped and low-shouldered, his long fur deep yellow in the gloomy evening light. He seems neither afraid nor aggressive, just intensely curious.

2254 BRUEMMER, F. - 1984
Nature's laboratory in a High Arctic oasis; *Can. Geographic*, Feb/March 1984, pp. 34-40.

MUCH OF THE High Arctic is a desert, as dry or drier than the Sahara, a harsh, cold and nearly barren land. Yet within this austere polar desert there are oases where plants grow in profusion and animals abound, islands of colour and life surrounded by desolation. These oases are rare and usually small. In the far North they cover less than 1% of the land surface.

Perhaps the best known and most intensively studied of these High Arctic oases is the Truelove Lowland.

2255 CORNISH, B.J., and ALLEN, D.L. - 1983
Waterbird surveys of McKinley Bay, Northwest Territories, 1982; *Govt. N.W.T.*, Can. Wildl. Serv., Report prepared for Can. Wildl. Serv., Ind. Affairs & North. Dev., Dome Petroleum Ltd., & Gulf Canada Resources Inc., January 1983, 105 p.

In anticipation of development of a medium draft harbour in McKinley Bay to support future oil and gas production in the Beaufort Sea, a study to monitor the abundance and distribution of birds in McKinley Bay was initiated in 1981. In order to obtain information on the natural year to year fluctuations in the number of birds that use McKinley Bay, the three aerial surveys that were done in 1981 were repeated in 1982. Hutchison Bay was added to the study as a control. Additional surveys by helicopter, boat and foot were done in 1982 to facilitate interpretation of the results of the aerial surveys. More specifically, these additional surveys were intended to determine the species composition of birds in McKinley Bay, the timing of the moult of diving ducks in the bay, and the effect of tides, wind or time of day on the distribution of ducks in the bay.

The fixed-wing aerial surveys conducted in 1982 at both McKinley and Hutchison bays occurred on July 20, July 30 and August 10. The population of diving ducks at McKinley Bay on the marine component was estimated to be 6697 ± 2058 (standard error) on July 20, 6621 ± 1036 on July 30 and 12 433 ± 1639 on August 10. At Hutchison Bay the population estimates for these dates were 6311 ± 1658, 3944 ± 871 and 13 465 ± 3075 diving ducks respectively. When a statistical comparison was carried out for the August 10 surveys there was no significant difference in the number of diving ducks using McKinley Bay in 1982 compared to 1981 ($p<0.05$), with the exception of scaup which were less common in 1982.

Oldsquaw and scoter were the most common species of diving duck observed in both bays in 1982. During most aerial and boat surveys, they accounted for more than 85 percent of the diving ducks. Numbers of Oldsquaw increased by a factor of eight between July 20 and August 10 at McKinley Bay and doubled at Hutchison Bay. This influx of Oldsquaw, which occurred primarily in early August, probably represented failed nesting females. During the same period scoters showed only a slight increase in number in McKinley Bay, although numbers doubled at Hutchison Bay.

At McKinley Bay, most eider were seen in the Atkinson Point area between July 24 and August

10. A peak number of 370 eider was observed on August 4. Most of the eider at McKinley Bay were females, and both King and Common eiders were identified. These eider were likely staging or resting while in migration westward to the Chukchi Sea to moult.

Large numbers of Greater Scaup moved into McKinley Bay after August 14. The highest count (238) occurred on August 24, the last day of surveys. The scaup were mostly male and it was speculated that they had already completed their wing-moult.

Brant and White-fronted Geese were identified at both bays, with Brant being the more common species. A density of 5.12 geese/km^2 was observed on the terrestrial component on August 10 at McKinley Bay. Fewer geese were observed at Hutchison Bay (2.33 geese/km^2). Increasing numbers of Brant (flocks of up to 250) moved into McKinley Bay after August 10 to rest and feed on the tide flats. Migrant flocks of Brant flying west were first noticed August 15, while similar flocks of Snow Geese were not seen until August 22. About 30 Whistling Swans were seen in the lagoon south of McKinley Bay throughout the summer.

No consistent trends were found to relate the distribution of diving ducks in McKinley Bay to tidal phase. However, it was noted during surveys that Oldsquaw tended to form larger flocks in the evening. It was also noted that there were more diving ducks on the south side of the Atkinson Point spit when the winds were from the northwest and northeast than from the southeast.

Flocks of scoter were consistently found at the south end of McKinley Bay on aerial surveys. Concentrations of ducks, mainly Oldsquaw, were also observed south of the spit at Atkinson Point.

The peak period of wing-moult for Oldsquaw was from the last week in July to the third week in August. Scoter moulted later, for many were still apparently flightless when the study ended on August 24.

The effect of factors such as the weather, sea state and flock size on the detectability of ducks during aerial surveys is discussed.

2256 CORNISH, B.J., and DICKSON, D.L. - 1984
Waterbird surveys of McKinley Bay, Northwest Territories, 1983; *Env. Can.*, Can. Wildl. Serv. Report prepared for Can. Wildl. Serv., Dome Petroleum Ltd., and Ind. Affairs & North. Dev. January 1984, 64 p.

In anticipation of development of a medium draft harbour in McKinley Bay to support future oil and gas production in the Beaufort Sea, a study to monitor the abundance and distribution of birds in McKinley Bay was initiated in 1981 and continued in 1982 and 1983. Emphasis was placed on determining the natural annual fluctuation in numbers of moulting diving ducks. In 1982 and 1983, Hutchison Bay was also surveyed as a control.

The aerial surveys in 1983 were conducted on August 5, 6 and 8. On August 5, the day when survey conditions were best, the number of diving ducks at McKinley Bay was estimated to be 12 799 ± 2299, while at Hutchison Bay on the same day the estimated number was 13 635 ± 2488 diving ducks. Scoter and Oldsquaw, in that order of abundance, were the two most common species observed at both bays.

No significant change in the total number of diving ducks at either bay was detected ($p>0.05$) between the years 1981, 1982 and 1983. However, significantly more scaup were present in McKinley Bay on August 10, 1981 than on August 10, 1982 or August 5, 1983 ($p<0.05$), and there were significantly more scoter on August 5, 1983 than on August 10, 1981 ($p<0.05$). The variation in the number of moulting scoter and scaup seen in McKinley Bay between the three years may be related to the timing and success of breeding each year.

In 1983, as in previous studies at McKinley Bay, concentrations of diving ducks were consistently seen in the area south of the spit at Atkinson Point. The highest concentrations of scoter were seen at the south end of the bay. Unlike other years, concentrations of diving ducks were also seen just south of the artificial island in 1983.

Brant, Greater White-fronted Geese, and Tundra Swans were observed at both bays, primarily on the terrestrial component. At McKinley Bay, geese occurred especially in the small embayments near Atkinson Point and on the lagoon system south of the bay, whereas swans were widely scattered on lakes and ponds as well as on the lagoon.

2257 DICKMAN, M., and OUELLET, M. - 1982
Limnological characteristics and origin of a hypersaline meromictic, high arctic lake; *Polar Cont. Shelf Proj.*, internal report, 42 p.

The main characteristic of a meromictic lake is its incomplete circulation during isothermal periods. This results in a permanent anoxic condition in its monimolimnion. Walker and Likens have recently reviewed the typology of meromixis, principally as a function of their water circulation patterns. The permanent stratification of the water column generally tends to get stronger with time and the constant accumulation of electrolytes in the monimolimnion results in a build up of a chemical gradient which has a profound effect on the biotic communities. The continuous loss of nutrients from the uppermost layers (mixolimnion) results in the low productivity (oligotrophy) of many meromictic lakes.

The absence of benthic organisms below the bottom of the chemocline eliminates the possibility of sediment bioturbation making meromictic lakes attractive for paleolimnological research.

The main objectives of the present study were to broaden our knowledge of the chemical and biological nature and origin of this unusual lacustrine environment and to determine the

impact of subsurface (25m) discharge of lead and zinc mine tailings on the lake's biota and water chemistry.

2258 ENGLAND, J., KERSHAW, L., LaFARGE-ENGLAND C, and BEDNARSKI, J. - 1981
Northern Ellesmere Island: a natural resource inventory; *Univ. Alta.*, Report to Parks Can., 237 p.

Northern Ellesmere Island has a very diversified physiography and ecology, much of which typifies the entire range of environments found in the Canadian High Arctic. In addition, some of the natural themes in this area are unique such as the ice shelves of the northernmost coast and the rich ecology surrounding the interior thermal oasis of Lake Hazen. The landscape itself varies from coastal lowlands and spectacular fiords to the expansive Hazen Plateau which borders the abrupt fault scarp of the Grant Land Mountains which in turn supports extensive icefields and outlet glaciers. The area can be described as a true polar desert whose aridity concentrates its rich and essential ecological sites into small and widely dispersed pockets on the landscape. Hence, although it has many aspects which would attract visitors it remains extremely vulnerable to a wide range of disturbances which visitors would ironically produce. Consequently, there is a serious dilemma between a park for people and a park for the preservation of this very sensitive and unique environment. Innovative, and perhaps by 'southern' standards extreme measures of protection, would likely be mandatory. The Executive Summary, which follows this introduction, discusses these issues in greater detail.

Due to the many noteable aspects found in this area it has long been recognized that it is deserving of special status and protection. Such recommendations have come from private individuals, the Canadian Wildlife Service and the International Biological Project. During 1979/80 Parks Canada designated northern Ellesmere Island as an area of interest within Natural Region 38 and requested that a natural resource inventory be undertaken, concentrating on the area surrounding Lake Hazen.

As a result, this report is aimed at fulfilling the following objectives: 1) To describe the geology, physical geography, flora, fauna and human history of the study area; 2) To map and classify the vegetation types and ecological units of the study area; 3) To identify outstanding features and areas that might be critical to the management of a national park that includes all or a part of the study area; 4) To identify and propose boundaries for a preserve that might operate effectively under National Park policy.

2259 FALLIS, B.W. - 1982
Trace metals in sediments and biota from Strathcona Sound, NWT; Nanisivik Marine Monitoring Programme, 1974-1979; *Fish. and Oceans* Wpg., Can. Tech. Rep. Fish. Aquat. Sci. No. 1082, 39 p.

The development of the Nanisivik Mine resulted in the federal government initiating a programme to monitor changes in trace metal concentrations in sediments and biota in Strathcona Sound, NWT. The first set of post-operational samples since commencement of production at the mine in October, 1976 were collected in August, 1979. Analytical results indicate that concentrations of lead, zinc, cadmium and arsenic in sediments, seaweed (*Fucus vesiculosus*) and molluscs (*Mya truncata*) in the vicinity of the marine terminal (station 3) have increased relative to pre-operational concentrations. Concentrations of lead, zinc and arsenic in sea urchins, (*Strongylocentrotus droebachiensis*) at station 3 have also increased; however, the postoperational cadmium concentration in sea urchins was slightly less than that recorded prior to production. Increases relative to preoperational concentrations at station 3 were as follows: mean lead concentrations in sediments, *Fucus* and *Mya* rose by 56.0, 57.4 and 1.09 µg/g, respectively, representing 3.8, 28.3 and 1.92 times pre-operational values, while the concentration in sea urchins rose from below the limit of detection to 23.9 µg/g. Mean zinc concentrations in sediments, *Fucus*, *Strongylocentrotus* and *Mya* rose by 595, 405, 213 and 283 µg/g respectively, equivalent to elevations of 4.8, 5.6, 4.3 and 3.7 times pre-operational values. Arsenic concentrations rose 5.4, 10.1, and 0.2 µg/g respectively in sediments, *Fucus* and *Strongylocentrotus*, equivalent to 2.4, 1.4 and 1.1 times pre-operational values, respectively.

Concentrations of lead, zinc, cadmium, arsenic and mercury in *Serripes groenlandicus* from station 3 increased 2.99, 97.4, 0.92, 4.32 and 0.11 µg/g, (19.7, 2.3, 1.9, 1.7 and 4.7 times) respectively, between 1975 and 1979. Metal concentrations in *Cardium ciliatum* also showed an increase at station 3 during the same time period with lead, zinc, cadmium, arsenic and mercury elevations of 0.37, 33.8, 218, 3.37 and 0.11 µg/g, equivalent to increases of 1.4, 1.7, 2.4, 1.7 and 2.2 times pre-operational levels, respectively.

Comparison of 1979 *Fucus* metal concentrations at stations 1 and 2 to Bohn's (1979) 1975 pre-operational concentrations at comparable stations, indicated highly significant differences ($P \leq 0.01$) in cadmium and zinc concentrations at station 1 and a significant difference ($p \leq 0.05$) in the concentration of zinc at station 2. Lack of pre-operational data from other stations in the Sound prevented assessing the extent to which trace metals in biota at other stations have changed. Analytical results from samples collected in subsequent years should provide an indication of the zone of influence resulting from trace metal inputs to Strathcona Sound.

Concentrations of lead and zinc in *Strongylocentrotus* and zinc concentrations in *Mya* in the vicinity of the marine terminal (station 3) currently exceed the maximum recommended levels (1.0 µg/g Pb, 100 µg/g Zn) for marine animal products established by the Canadian Food and Drug Directorate. Correlations between dry weight of soft tissues, shell height, width, and length and metal concentration in

Mya truncata and dry weight, test height, width, and metal concentration in *Strongylocentrotus droebachiensis*, showed no consistent pattern with respect to the various stations sampled and thus prevented predictions of future concentrations which may be attained in these species. Continued inputs of trace metals to Strathcona Sound may result in elevation of biota concentrations to threshold levels at station 3 (and possibly other stations), beyond which further elevations will be less likely. The toxicological and physiological consequences of such threshold trace metal levels on biota in Strathcona Sound are unknown.

2260 FALLIS, B.W., KLENNER, W.E., and KEMPER, J.B. - 1983
Narwhal surveys and associated marine mammal observations in Admiralty Inlet, Navy Board Inlet, and Eclipse Sound, Baffin Island, N.W.T., during 1974-1976; *Fish. and Oceans*, Wpg., Can. Tech. Rep. Fish. Aquat. Sci. No. 1211, 24 p.

Reconnaissance and systematic surveys were flown in Admiralty Inlet and adjacent waters during the open water season from 1974 to 1976 to determine marine mammal utilization patterns. An estimate of 9 683 narwhal (*Monodon monoceros*) in central Admiralty Inlet was recorded on 28 July 1975 with a subsequent decline in numbers in August. In 1976, narwhal utilization was less than the level observed in 1975 with an estimated 1 614 whales present on 14 August. Aerial surveys indicated substantial variations in the timing of narwhal movement into Admiralty Inlet between 1975 and 1976. Fluctuations in the number of narwhal utilizing Admiralty Inlet between and within seasons were also recorded. Beluga *(Delphinapterus leucas)* were uncommon in the study area during both years. On 28 July 1975, three bowhead whales *(Balaena mysticetus)* were observed in central Admiralty Inlet. Narwhal utilized bays and inlets on the east side of Admiralty Inlet infrequently during both 1975 and 1976 but were observed in the central portion of Strathcona and Adams sound on occasion. Harp seals *(Phoca groenlandica)* were very abundant in 1975 but a decrease in size of groups and frequency of occurrence of groups indicated lower utilization of central Admiralty Inlet by harp seals in 1976.

2261 FREEDMAN, B., and SVOBODA, J. - 1982
Populations of Breeding Birds at Alexandra Fjord, Ellesmere Island, Northwest Territories, Compared with Other Arctic Localities; *Can. Field-Naturalist*, vol. 96, no. 1, pp. 56-60.

Populations of breeding birds of a 1200 ha high Arctic oasis at Alexandra Fjord, Ellesmere Island, N.W.T. (78°53'N, 75°55'W) were 153 pairs (12.8 pr/100 ha) in 1980, and 164 pairs (13.7 pr/100 ha) in 1981. An average of 77% of the breeding birds were Snow Buntings (*Plectrophenax nivalis*),Baird's Sandpipers *(Calcarius lapponicus)*, Hoary Redpolls *(Carduelis hornemanni)*, Lapland Longspurs *(Calcarius lapponicus)*, and Arctic Terns *(Sterna paradisaea)*; smaller numbers of five other species made up the rest. The total breeding bird density was similar to those reported for other high Arctic oases, but much lower than for most low Arctic localities, where productivity is higher.

2262 FRISCH, T. - 1983
Ivory Gull Colonies on the Devon Island Ice Cap, Arctic Canada; *Arctic*, vol. 36, no. 4, pp. 370-371.

Four small Ivory Gull colonies have been found on nunataks on the ice cap of eastern Devon Island. Mainly on the basis of their similarity to known breeding places of the Ivory Gull on Ellesmere Island, all four sites are believed to be those of nesting colonies - the first to be reported from Devon Island.

2263 GASTON, A.J. - 1982
Migration of Juvenile Thick-billed Murres through Hudson Strait in 1980; *Can. Field-Naturalist*, vol. 96, no. 1, pp. 30-34.

Aerial surveys carried out in September 1980 suggested that, after leaving the large colonies at Digges Sound (62°35'N, 77°40'W), Thick-billed Murre *Uria lomvia* chicks, each with a parent, dispersed slowly during the first 1-2 weeks, but then migrated through Hudson Strait at a rate in excess of 40 km/day^{-1}, passing the eastern entrance to the Strait within a month of leaving the colony.

2264 GASTON, A.J. - 1982
On the seabirds of northern Hudson Bay; *Naturaliste can.*, vol. 109, pp. 895-903. Can. Wildl. Serv. Contribution No. 112, Studies on northern seabirds.

The area of northern Hudson Bay and west Hudson Strait supports the third largest seabird community in the Canadian Arctic, dominated by the thick-billed murre. The northern fulmar and the black-legged kittiwake, common elsewhere in arctic Canada, are absent here. Comparisons of the ecology of these three species elsewhere suggest that lack of suitable concentrations of food in west Hudson Strait and Hudson Bay accounts for the absence of fulmars and kittiwakes.

Evidence from foraging ranges and the weight of chicks at fledging suggests that the population of thick-billed murres at Digges Sound is close to the limit of its food sources. Absence of competitors may enable density-dependent population regulation to respond more quickly to periodic density-independent mortality, hence allowing the population to respond rapidly to variations in the level of its food supplies.

2265 GASTON, A.J., and NETTLESHIP, D.N. - 1981
The Thick-billed Murres of Prince Leopold Island; *Env. Can.*, Can. Wildl. Serv. Monograph Series No. 6, 350 p.

The search on Prince Leopold Island was designed and initiated as part of a major study program undertaken by the CWS on the distribution and ecology of seabirds in eastern Canada. The field study was to cover 5 years, beginning in 1975 and ending in 1979, but it became necessary due to financial constraints to limit the project to 3 years, 1975-77. Our objective was to gather as much information as possible on the reproductive biology and ecological requirements of Thick-billed Murres breeding at a single location in Lancaster Sound, the gateway to the Northwest Passage. We were concerned principally with aspects of ecology and behaviour which might allow us to predict the effects of environmental changes, particularly those associated with human activities, and we also paid considerable attention to the evaluation of methods in the hope of formulating guidelines for future investigators. The study led us to speculate on the adaptive significance of many aspects of the species' ecology and we hope that these hypotheses will be useful in the generation of new ideas which can be tested in the field.

In Chapter I, we identify the general features of the study area and our approach to the investigation. Chapter II describes the pattern of attendance at the colony and associated behaviours displayed by the various age cohorts; we also outline the methods used to determine the size of the breeding population. In Chapter III, we analyse the timing of breeding and the levels and determinants of reproductive success both within and between years. Chapter IV describes egg size and colour, and features of chick growth and diet. Chapter V reviews the morphology and diet of adults, and outlines foraging and food-finding characteristics of the population. In Chapter VI, we integrate and synthesize the information given in the preceding chapters and review more generally our views of the biological properties of Thick-billed Murres in Lancaster Sound and the selective forces that shape and limit their specialization and prospects for the future.

The appendices include details of critical parts of the study (e.g., study plot photos) and much of the raw data (daily counts, breeding performance, climatic conditions, etc.) gathered over the 3 years of study. These are intended to provide: (1) a comprehensive baseline for accurately monitoring population levels (size, status, and productivity) of murres over both the short and long terms in a way that enables biologists and wildlife managers to identify species' problems and responsible factors (natural and man-induced), and (2) an opportunity for making direct comparisons with populations examined elsewhere, as well as using the data to re-examine, test or develop new ideas.

2266 GASTON, A.J., and NETTLESHIP, D.N. - 1982
Factors determining seasonal changes in attendance at colonies of the Thick-billed Murre *Uria Lomvia*; *The Auk*, vol. 99, no. 3, pp. 468-473.

A comparison of the interyear variation in attendance patterns of Thick-billed Murres *(Uria lomvia)* with the variation in egg size and chick growth rates suggests that the number of birds in attendance at a murre colony at any time during the breeding season is determined principally by the availability of food in surrounding waters. This effect operates mainly through the behavior of a large floating population of prospectors. When food is abundant, numbers on the cliffs will be high because birds have plenty of time to spare. Conversely, when food is scarce, numbers will be low because birds must devote most of their time to feeding. Implicit in the hypothesis is the assumption that birds strive to maximize the amount of time that they spend at the breeding colony in order to improve their chances of acquiring and retaining a breeding site.

2267 GUNN, A. - 1982
Muskox *Ovibos moschatus*; *in* Wild Mammals of North America: Biology, Management, and Economics, eds. J.A. Chapman and G.A. Feldhamer, The John Hopkins Univ. Press, Baltimore, 1147 p., Chapter 51, pp. 1021-1035.

The earliest names given by northern explorers to the muskox (musk or polar cattle, musk or arctic bison) emphasize its superficial resemblance to members of the genus *Bos*. Although the generic name also refers to sheeplike as well as cattlelike traits, the muskox is now classified in the tribe Ovibosini, of the subfamily Caprinae. The closest living relative is the golden takin *(Burdorcas taxicolor)*, a goatlike mammal of the Himalayas.

2268 GUNN, A., and MILLER, F.L. - 1982
Muskox Bull Killed by a Barren-Ground Grizzly Bear, Thelon Game Sanctuary, N.W.T.; *Arctic*, vol. 35, no. 4, pp. 545-546.

The carcass of an adult muskox bull *(Ovibos moschatus)* killed by a barren-ground grizzly bear *(Ursus arctos richardsoni)* was found in the Thelon Game Sanctuary. It is suggested that adult muskox bulls along the Thelon River system have become prey for at least some grizzly bears that have learned to ambush them in dense vegetation.

2269 GUNN, A., GLAHOLT, R., MILLER, F.L., and JINGFORS, K. - 1983
Caribou behaviour, range use patterns and short term responses to helicopter landings on the Beverly calving ground, N.W.T., 1982; *Govt. N.W.T.*, Wildl. Serv. File Report No. 30, 126 p.

The exploration for minerals on the tundra ranges of migratory barren-ground caribou *(Rangifer tarandus groenlandicus)* raised concerns about the potential effects of these activities on the well-being of caribou, especially on cows and calves. As a result, the Department of Indian Affairs and Northern Development implemented the Caribou Protection Measures which limit land-use activities just before and during the calving and post-calving periods

of the Beverly and Kaminuriak herds (15 May - 31 July). As an initial step to evaluating the Caribou Protection Measures and to develop appropriate methodology for measuring some behavioural responses to man's activities, we field-tested a sampling design for recording undisturbed behaviour of cow-calf pairs on the Beverly calving ground in 1981 and 1982. Additionally, we recorded the responses of cow-calf pairs to 16 helicopter landings. We landed 950 ± 650 m, SD from the caribou, and shut down the helicopter for about 20 min before flying away. Observations of the same caribou after the helicopter landings indicated greater proportions of cows and calves were walking, trotting or galloping during post-disturbance than pre-disturbance. The frequency and duration of nursing was slightly less during the landing than before and after, but sample sizes were small as seven groups were totally and six groups were partially out of sight during the landing. We cannot evaluate the consequences of displacing all or some of the caribou during 13 of the 16 landings. Any measurement of the short-term consequences to the population exposed to human activities is beyond the objectives and scope of this study.

2270 HAIGH, J.C., LEE, L.J., and SCHWEINSBURG, R.E. - 1983
Immobilization of polar bears with carfentanil; *J. Wildl. Diseases*, vol. 19, no. 2, pp. 140-144.

Sixty-four free-ranging polar bears *(Ursus maritimus)* were immobilized using carfentanil at doses ranging from 1.0-38.0 µg/kg (mean 20 ± 8 µg/kg). Induction was rapid (5.0 min)(n = 46) and the bears showed good muscle relaxation. Respiratory rate was depressed (mean 3.8 bpm). The mean arousal after the administration of narcotic antagonists was longer than 5 min. Recurrence of narcotic effects - so called recycling - was seen in some bears and in a separate black bear trial was consistently observed in animals given doses of 10 µg/kg or more of carfentanil. The rapid induction, low drug volume and excellent muscle relaxation related to carfentanil immobilization make this a potentially useful drug for polar bear immobilization.

2271 HAVAS, M., and HUTCHINSON, T.C. - 1982
Aquatic Invertebrates from the Smoking Hills, N.W.T.: Effect of pH and Metals on Mortality; *Can. J. Fish. Aquat. Sci.*, vol. 39, no. 6, pp. 890-903.

Experiments were conducted on planktonic crustaceans and insect larvae from acidic and alkaline tundra ponds at the Smoking Hills, N.W.T. to determine their tolerance to low pH and elevated levels of potentially toxic elements, including Al. The crustaceans *(Daphnia middendorffiana, Diaptomus arcticus, Lepidurus arcticus, Branchinecta paludosa)*, which are found only in alkaline ponds, died rapidly below pH 4.5. The insect larvae *(Orthocladius consobrinus* and *Limnephilus pallens)* from the same alkaline ponds were able to survive for extended periods at pH 3.5, though they do not occur in acidic waters at the Smoking Hills. The red chironomid *(Chironomus riparius)* is restricted to acidic ponds although it was able to survive not only at pH 2.8, but also in pond water of pH 8.2.

Water from an acidic pond (pH 2.8) was markedly more toxic to crustaceans than water from an alkaline pond (pH 8.2) when both were adjusted to pH 4.5. Elevated concentrations of aluminum may account for this additional toxicity of the acidic pond water. Levels reached 20 mg/L Al, and in experiments with Al, additions to the alkaline waters and to the acidic pond waters, after metal removal, caused toxicity to the crustaceans.

The absence of crustaceans from acidic ponds at the Smoking Hills may be due to their extreme sensitivity to low pH. The similarly restricted distribution of certain of the insect larvae, in contrast, cannot be explained this simply. Metal concentrations in acidic ponds impose an added stress. Aluminum was found to be the key additional factor to that of H^+ ion concentration.

2272 HAVAS, M., and HUTCHINSON, T.C. - 1983
The Smoking Hills: natural acidification of an aquatic ecosystem; *Nature*, vol. 301, Jan. 6, 1983, pp. 23-27.

Spontaneous burning of bituminous shales at the Smoking Hills in the Canadian Arctic has produced intense acidic fumigations and strongly influenced the local tundra. The burns are of great antiquity. In an area of typically alkaline ponds with pH above 8.0, ponds within the fumigation zone have been acidified below pH 2.0. Elevated concentrations of metals (aluminium, iron, zinc, nickel, manganese and cadmium) occur in these acidic ponds. Soils and sediments have also been chemically altered. The biota in the acidic ponds are characteristic of acidic environments worldwide, in contrast to the typically Arctic biota in adjacent alkaline ponds.

2273 HOBBS, L.J., and GOEBEL, M.E. - 1982
Bowhead Whale Radio Tagging Feasibility Study and Review of Large Cetacean Tagging; *U.S. Dept. Commerce*, NOAA Tech. Memo. NMFS F/NWC-21, 68 p.

This report reviews marking and tagging techniques, their feasibility, success, and history of employment on large cetaceans. Static tags, freeze branding, paint marking, natural marks, and sonic tags are discussed. Emphasis is placed on radio tags. Three radio tracking systems and four types of radio transmitter attachments currently available for large cetaceans are evaluated and discussed.

Results of a feasibility study using a VHF radio tracking system on bowhead whales are presented. On 20 and 21 August 1981 radio tags were deployed on two bowhead whales *(Balaena mysticetus)* in the eastern Beaufort Sea (69°54'N x 132°12'W). From one whale,

signals were received intermittently for 10 min, the other, for one and one-half hours. Reliable dive-surface profiles of tagged whales from these transmissions were not possible. However, dive-surface profiles are reported for a bowhead whale identifiable by natural marks. Efforts to relocate tagged whales from ship and three aerial receiving stations were unsuccessful.

Aerial surveys were flown from 20 July through 12 September, initially to locate whales but ultimately to relocate and track tagged animals. Efforts to relocate tagged whales continued from 16 September through 13 October in collaboration with a Bureau of Land Management bowhead survey team working in Outer Continental Shelf lease-sale areas. A brief radio transmission was received during one of these surveys but the presence of a tagged whale was unconfirmed by either further transmission or visual relocation. A record of all species of marine mammals sighted on surveys is presented.

The development of a satellite-linked transmitter and requirements for a successful satellite tracking program are discussed.

2274 HOPKY, G.E., and RATYNSKI, R.A. - 1983
Relative Abundance, Spatial and Temporal Distribution, Age and Growth of Fishes in Tuktoyaktuk Harbour, N.W.T., 28 June to 5 September 1981; *Fish. and Oceans*, Wpg., Can. Manuscr. Rep. Fish. Aquat. Sci. No. 1713, 76 p.

A study of the fishes in Tuktoyaktuk Harbour, N.W.T., was conducted from 28 June to 5 September, 1981. The objective was to provide additional baseline data prior to anticipated increases in industrial development within the harbour. Offshore areas were sampled with otter trawls and experimental gillnets at various depths. Inshore areas were sampled with experimental gillnets and trapnets.

Twenty fish species were captured and included freshwater, marine and anadromous forms. Total numbers caught inshore, in both trapnets and gillnets, consisted predominately of coregonids, particularly least cisco *(Coregonus sardinella)* and lake whitefish *(C. clupeaformis)*. In offshore gillnet catches, Pacific herring *(Clupea harengus pallasi)* and rainbow smelt *(Osmerus mordax)* were predominant. Otter trawl catches were dominated by rainbow smelt, least cisco and Arctic cisco *(C. autumnalis)*. Bottom otter trawls also captured large numbers of zoarcids (eelpouts) and lumpenids (blennies).

Total catch-per-unit-effort (CPUE) for all species combined was greatest in the north harbour area for all gear types. In offshore gillnets, total CPUE was higher at midwater than at the surface or bottom This was largely the result of a midwater concentration of Pacific herring and rainbow smelt. Seasonally, total trapnet CPUE in the north harbour declined from mid-July to September, while in the south harbour it was relatively more constant. Highest in- and offshore gillnet, and otter trawl CPUE was observed in early July and late August.

Species specific length-frequency distributions are indicated by gear and season, with results suggesting that for certain species, particularly the coregonids, there was gear-specific size selection. Length at age data, by sex, is presented for the major species captured. Samples of Pacific herring were dominated by the four and eleven year old age groups. The blackline prickleback *(Acatholumpenus mackayi)* population was dominated by three, six and thirteen year olds. Weight-length relationships are also provided.

2275 HSIAO, S.I.C. - 1979
Sea Ice Microalgal Data from the Eskimo Lakes, 1972 to 1974; *Fish. and Oceans*, Arctic Biological Station, Fish. Mar. Serv. Data Rep. No. 146, 47 p.

Sea ice microalgal collections, made during the late winter and spring of the years 1972 to 1974 in the Eskimo Lakes, are tabulated quantitatively. Thirty-one genera and 104 species were identified; ice diatoms comprised the largest group with 27 genera and 103 species. The sea ice microalgae were most abundant in late spring on the bottom of the sea ice.

2276 HSIAO, S.I.C. - 1980
Quantitative Composition, Distribution, Community Structure and Standing Stock of Sea Ice Microalgae in the Canadian Arctic; *Arctic*, vol. 33, no. 4, pp. 768-793.

One hundred and ninety-six (196) species of microalgae were identified from the annual shorefast sea ice samples collected from the Canadian Arctic between November and June in the years 1971 to 1978. The diatoms were represented by 189 species (21 centric and 168 pennate), the flagellates by three species, the dinoflagellates and chrysophytes by two species each. There were no blue-green algae. Species composition and distribution are tabulated. The dominant species of the microalgal communities in the bottom of the ice different from those found elsewhere in the ice.

The sea ice microalgal communities and standing stock started to develop in late fall at the time of ice formation. They grew very slowly through the winter months, exponentially increased in early spring, reached a peak just prior to the thaw period in late spring or early summer, and declined rapidly in summer as ice melting occurred. Standing stock was greatest at the bottom of the sea ice, where it was one to two orders of magnitude larger than in other parts of the ice column, and 50 to 500 times greater than in the phytoplankton in the underlying waters. The ice communities consisted mainly of diatoms with a great majority of pennate forms. Large numbers of species and cells of diatoms were found at the bottom of the sea ice. Dinoflagellates, flagellates and chrysophytes occurred in relatively low numbers except in a few cases when ice blooms were observed. During May most of the sea ice microalgal blooms occurred in the bottom of the ice except for *Phaeocystis pouchetii*, which occurred elsewhere in the ice.

Environmental factors controlling standing stock, growth and distribution of sea ice microalgae are discussed.

2277 JINGFORS, K., GUNN, A., and MILLER, F.L. - 1982
Behaviour and range use patterns of caribou on the Beverly Calving Ground, N.W.T.; *Govt. N.W.T.*, Wildl. Serv. File Rep. No. 22, 118 p.

The exploration for minerals on the tundra ranges of migratory barren-ground caribou *(Rangifer tarandus groenlandicus)* raised concerns about the potential effects of these activities on the well-being of caribou, especially on cows and calves. As a result, the Department of Indian Affairs and Northern Development implemented the Caribou Protection Measures in 1978. These measures limited the activities of mining companies exploring for minerals just before and during the calving and post-calving periods of the Beverly and Kaminuriak herds (15 May - 31 July). As an initial step to evaluating the Caribou Protection Measures and to develop appropriate methodology for measuring some behavioural responses to man-induced disturbance, we field-tested a sampling design for recording undisturbed behaviour of cow-calf pairs on the Beverly calving ground in 1981. Activity budgets and the frequency of events that reflect the strength of the cow-calf bond and that may be influenced by or indicative of disturbance, such as nursing and aggressive acts were recorded between 2-23 June. Patterns of range use in relation to snow melt and plant phenology were recorded. We emphasized rigorous definitions of behaviour categories and readily detectable classifications of range types under field conditions to reduce observer errors and to ensure repeatability. To be able to recognize behavioural responses to disturbance and to evaluate some of the short-term effects of human activities on cows and calves on the calving grounds, it is necessary to use the same study design during sampling periods involving exposure to foreign stimuli (helicopter landings and human activity on the ground). Findings and interpretations are preliminary and subject to change upon further analyses and evaluations.

2278 KARASIUK, D.J., and BOOTHROYD, P.N. - 1982
Preliminary environmental assessment of proposed harbour sites at McKinley Bay and Baillie Islands, Northwest Territories, Volume 1: Migratory bird habitat and bird use, 1980; *Govt. N.W.T.*, Can. Wildl. Serv., 91 p.

Aerial and ground observations of migratory bird use of McKinley Bay and Baillie Islands, N.W.T., were made during the summer of 1980. Vegetation and ecological land classifications were developed for the two areas through aerial photo interpretation, ground reconnaissance and consideration of classifications assembled by other researchers.

2279 KARASIUK, D.J., and BOOTHROYD, P.N. - 1982
Preliminary environmental assessment of proposed harbour sites at McKinley Bay and Baillie Islands, Northwest Territories, Volume II: Potential effects of harbour and associated development on wildlife; *Govt. N.W.T.*, Can. Wildl. Serv., 46 p.

Possible implications to wildlife of the development of harbour and marine terminal facilities at McKinley Bay and Baillie Islands, N.W.T. in conjunction with Beaufort Sea oil and gas production, are evaluated. Potential impacts are rated numerically assuming single company use (Dome Petroleum Limited) of each site. Measures for minimizing adverse environmental effects are recommended.

2280 KERBES, R.H. - 1983
Lesser snow goose colonies in the western Canadian Arctic; *J. Wildl. Manage.*, vol. 47, no. 2, pp. 523-526.

Lesser snow geese *(Chen caerulescens caerulescens)* nest in colonies in Arctic Canada and on Wrangel Island, U.S.S.R. Because they are large, conspicuous birds, snow geese are well suited to census by aerial photography, especially while they are concentrated on their nesting grounds. In 1973, I photographed the colonies of the eastern Canadian Arctic and estimated a total of over 1 million nesting birds. In June 1976, I photographed the western Canadian Arctic colonies using similar methods. The purpose of this paper is to provide baseline data on the colonies that can be used in managing the population and its breeding habitat.

2281 KERBES, R.H., McLANDRESS, M.R., SMITH, G.E.J., BEYERSBERGEN, G.W., and GODWIN, B. - 1983
Ross' Goose and Lesser Snow Goose colonies in the central Canadian Arctic; *Can. J. Zool.*, vol. 61, no. 1, pp. 168-173.

A total of 133 700 nesting Ross' Geese and Lesser Snow Geese *(Anser rossii* and *Anser c. caerulescens)*, in 30 colonies, were photographed in the central Canadian Arctic, Queen Maud Gulf, N.W.T., in June 1976. Estimated species totals were 77 300 Ross' Geese and 56 400 Lesser Snow Geese (of which 15% were blue phase). Species totals were calculated from a photographic census of all Ross' Geese and white phase Snow Geese combined with assumptions based on the estimated proportion of blue phase Snow Geese in each of the 10 largest colonies and the estimated proportion of Ross' Geese in the largest colony. Comparison with a previous visual nesting inventory suggested that from 1967 to 1976 Ross' Geese doubled in number while Lesser Snow Geese increased fivefold. Nesting resources do not appear to be limited.

2282 KINGSLEY, M.C.S., STIRLING, I., and CALVERT, W. - 1982
The distribution and abundance of seals in the High Arctic, 1980-1981; *Env. Can.*, Can. Wildl.

Serv., Rep. for Arctic Islands Operating Advis. Com., DIANA, and Fish. and Oceans, 68 p.

An extensive aerial survey was flown in 1980 and repeated in 1981 to obtain information on the distribution of seals in Jones Sound, the Sverdrup Basin, the channels between the Parry Islands, the Parry Channel, Prince of Wales Strait, and northern Amundsen Gulf. The survey was flown at 152 m over north-south strip transects 800 m wide spaced every 40' of longitude, and between 21 June and 10 July, covering the peak period of seal haul-out.

Hauled-out ringed seals, bearded seals and walruses were recorded; so were observations of polar bears, white whales and narwhals as well as records of weather, ice cover, and ice type.

Investigation by multiple regression of the habitat associations of ringed seals showed preferences for annual ice, high ice cover and fast or cracking ice, and avoidance of deep water. Bearded seals appeared to prefer floe and rotten ice of moderate or low cover. Only one group of walruses was seen.

The density of ringed seals was highest in Barrow Strait and Wellington Channel, and decreased westward and northward; high densities were also recorded in northern Amundsen Gulf. In Jones Sound, the density was low. The two years of survey gave very similar distributions of density.

Bearded seals were sparsely distributed over the earliest-opening annual ice areas in the east of the study area, with an apparent centre of abundance in the Belcher Channel-Penny Strait area.

2283 KINGSLEY, M., CALVERT, W., and STIRLING, I. - 1982
The abundance of seals in the eastern Beaufort Sea, northern Amundsen Gulf, and Prince Albert Sound, 1981; *Env. Can.*, Can. Wildl. Serv., Rep. for Dome Petroleum, Esso Resources Can., and Gulf Canada Resources, 19 p.

Densities of ringed and bearded seals were determined by aerial survey of an area extending 160 km, more or less, north from the coastline of the Mackenzie Delta and the Tuktoyaktuk Peninsula. This survey was the first of a series to monitor the effects of oil and gas exploration and development in the Beaufort Sea, and also covered control areas in northern Amundsen Gulf and Prince Albert Sound.

When the survey was flown, the Beaufort Sea survey area had broken up to floe ice, and Amundsen Gulf was almost ice-free; however, the ice in Prince Albert Sound was still fast.

Ringed seals were evenly distributed at low densities (0.15 seals/km^2) over the Beaufort Sea floe ice, and were much more numerous (3.28 seals/km^2) on the fast ice of Prince Albert Sound and northern Amundsen Gulf.

Regression analyses of the factors affecting ringed seal density in the Beaufort Sea confirmed previously found preferences for high ice cover and moderate water depth. No relationship was found between density and distance to the nearest artificial island.

Bearded seals were evenly distributed at moderately low densities (2.05 seals/100 km^2 ice) throughout the floe ice of the Beaufort Sea, while few were seen in Prince Albert Sound and southern Prince of Wales Strait.

2284 KINGSLEY, M.C.S., and LUNN, N.J. - 1982
The abundance of seals in Jones Sound and in the waters round Cornwallis Island, 1982; *Env. Can.*, Can. Wildl. Serv., Rep. for DIANA, Dome Petroleum, Gulf Canada Resources, and Fish. and Oceans, 21 p.

Part of the high Arctic seal survey area was resurveyed in July 1982 to confirm the densities of seals found there in the previous two years. The areas resurveyed were Jones Sound, and Barrow Strait, Wellington Channel and other waters round Cornwallis Island. Breakup was late, and Barrow Strait was covered with fast ice; all strata had higher ice cover than in the previous two years.

Densities of ringed seals in all parts of the resurvey area were similar to those of previous years: high in Barrow Strait, Wellington Channel and McDougall Sound, and low to the north and northwest of Cornwallis Island and in Jones Sound. The systematic recording of seal holes, and analysis of their densities, led to the conclusion that large portions of Barrow Strait, in spite of high densities of seals, may, in some years, not be important breeding habitat for ringed seals.

No bearded seals were seen in the resurvey area.

2285 KINOSITA, S. - 1981
Joint Studies on Physical and Biological Environments in the Permafrost, North Canada, July to August 1980 and February to March 1981; ed. S. Kinosita, Inst. Low Temp. Sci., Hokkaido Univ., Japan, 121 p.

The soil of the active layer of permafrost retains and stores thawing water and precipitation. The retained water feeds both soil fauna and vegetation during the summer. Moreover, during the winter frost heaving is the cause of a change in ground feature, associating itself with thermal cracks due to a large temperature gradient in the active layer. Our expedition pursued the purpose of clarifying the physical and chemical properties of the active layer from the behaviour of the retained water as well as their relations to environmental aspects such as ground morphology, fauna and vegetation.

Subjected to research were a tundra area around Tuktoyaktuk and a forest area around Inuvik, both in Mackenzie Delta, N.W.T., Canada. The period of research was divided into two: from July to August, 1980; February to March, 1981. The following are specific subjects in each period. July-August, 1980 ... 1. Detailed mapping of particular ground features; 2. Observation of stratified structures in the active layer; 3. Collection and analysis of

ground ice samples; 4. Observation of changes in water content in the active layer with a lapse of time; 5. Setting of long-term recorders for measuring meteorological factors; 6. Setting of standard points for mapping; 7. Collection of fauna samples in the active layer; 8. Collection of insects using traps; 9. Observation of distribution patterns of vegetation; 10. Pollen analysis; 11. Analysis of physical properties of soil samples; 12. ^{14}C, ^{18}O analysis; 13. Collection of soil-inhabiting invertebrates; 14. Collection of vegetation samples. February-March, 1981 ... 1. Recovering of long-term recorders; 2. Measurements of frost heaving; 3. Snow survey; 4. Collection and analysis of exposed ground ice samples; 5. Collection of ice samples for ^{18}O analysis.

The results are presented in this report. The field expedition and the publication of this report have been supported financially by the Japanese Ministry of Education.

2286 KORCZYNSKI, R.E. - 1983
Comparison of freshwater and saltwater populations of the isopod *Mesidotea entomon* from Dolomite Lake, Northwest Territories, and Pauline Cove Yukon Territory; unpub. Ph.D. thesis, McGill Univ., 223 p.

Mesidotea entomon inhabiting Pauline Cove YT, is larger in total body length at sexual maturity than *M. entomon* inhabiting Dolomite Lake, NWT. The sex ratio, diet, habitat distributions, size frequency distributions, and fecundity in the two populations are compared. Total carbohydrate, protein, lipid, chitin, and ash contents of both isopods' life stages are compared. Isopods in the cove show reduced carbohydrate and elevated lipid levels. In the 1975, 1978, and 1979 summers, isopods in the cove were internally infected with an extracellular protozoan parasite; those in the lake were uninfected. The infection is systemic. The prevalence of the protozoan infection increases with increasing host size. The host response involved phagocytosis and encapsulation. Transmission may be transovarially and/or by ingestion of the infective stage. The protozoan also infected *Mesidotea sibirica*. The infection is related to growth, habitat, abundance, reproduction, and biochemical variables.

2287 LGL ECOLOGICAL RESEARCH ASSOCIATES, INC. - 1982
Behavior, disturbance responses and feeding of bowhead whales *Balaena mysticetus* in the Beaufort Sea, 1980-81; Rep. to Contract No. AA-851-CTO-44, US Dept. of Interior, ed. W.J. Richardson, 456 p.

The imminence of offshore exploration for oil and gas in the Alaskan part of the Beaufort Sea has raised concerns about the potential for disturbance of bowhead whales. The bowhead, *Balaena mysticetus*, is a baleen whale inhabiting cold northern waters. Historically, five substantial populations existed: Western Arctic, Davis Strait, Hudson Bay, Okhotsk Sea, and Spitsbergen. The western Arctic stock inhabits the Bering, Chukchi and Beaufort Seas off the shores of Alaska, the U.S.S.R., and Canada. All five populations were heavily exploited by commercial whalers, and all are now seriously reduced. Only the western arctic population continues to be of substantial size, yet even it is considered to be rare and endangered under U.S. legislation, in Canada, and by the International Whaling Commission. Until very recently, the size of the western arctic stock was believed to be in the range 2264-2865 individuals, but the latest estimates are somewhat higher.

2288 LGL ECOLOGICAL RESEARCH ASSOCIATES, INC. - 1983
Behavior, disturbance responses and distribution of bowhead whales *Balaena mysticetus* in the eastern Beaufort Sea, 1982; Rep. for U.S. Minerals Mgt. Serv., ed. W.J. Richardson, 357 p.

The bowhead whale, *Balaena mysticetus*, inhabits cold northern waters. All populations were exploited heavily by commercial whalers in the 18th or 19th centuries, and all were seriously reduced. The Western Arctic stock now contains more bowheads than the others, but even it is considered endangered. The International Whaling Commission's current 'best estimate'of the population size is 3857.

The Western Arctic bowheads winter in the Bering Sea and summer in the eastern Beaufort Sea. Their spring and autumn migrations are around the western and northern coasts of Alaska. The spring migration is close to shore in the Chukchi Sea, but well offshore in the Alaskan Beaufort Sea. Thus, the eastward spring migration through the Alaskan Beaufort Sea is well north of the area of imminent oil exploration near the coast. However, during the westward autumn migration many bowheads occur close to the Alaskan north coast and within or near some offshore oil leases.

Bowheads move eastward through the Alaskan Beaufort Sea from April to early June and return westward through that area in September and October. From May to September, the great majority of the population is in Canadian waters. Intensive offshore oil exploration from drillships and artificial islands has been underway in the central part of the summering area since about 1976; seismic exploration and nearshore drilling began there earlier and still continue. The main area of offshore drilling is north of the Mackenzie Delta and the western Tuktoyaktuk Peninsula. Summering bowheads are sometimes common in that area.

2289 MALLORY, F.F., and BOOTS, B.N. - 1983
Spatial distribution of lemming mats in the Canadian High Arctic; *Can. J. Zool.*, vol. 61, no. 1, pp. 99-107.

Spatial distributions of lemming mats on exposed beach ridges on Bathurst and Devon islands, N.W.T., in the Canadian High Arctic were recorded by triangulation. The collared lemming

Dicrostonyx groenlandicus is the only microtine in this region, which eliminates interspecific influences. In addition, vegetation is sparse, making centres of activity easy to identify. Mats were relatively permanent structures with a mean diameter of 3.88 m and an average of 13.0 burrows. The mean nearest neighbour distance ranged from 40 to 45 m and the average mat polygon area (interpreted as territory or home range) was 0.34 ha. Individual mat polygons were contiguous with an average of 5.3 other polygons and the distribution of the mats over the environment was nonrandom. The data support the conclusion that lemming mats represent core areas within lemming territories or home ranges which are distributed regularly over the environment because of social processes which influence social interaction. The data are discussed as they apply to current theories on microtine demography and population dynamics.

2290 MILLER, F.L. - 1982
Caribou *Rangifer tarandus*; *in* Wild Mammals of North America: Biology, Management, and Economics, eds. J.A. Chapman and G.A. Feldhamer, The John Hopkins Univ. Press, Baltimore, 1147 p., Chapter 47, pp. 923-959.

The Queen Charlotte Island's caribou (*R.t. dawsoni)* probably became extinct shortly after 1910. The causes for its extinction are unknown, but it is suggested that habitat deterioration through amelioration of the climate and loss of genetic plasticity through isolation were more important than hunting or other human interference.

2291 MILLER, F.L., EDMONDS, E.J., and GUNN, A. - 1982
Foraging behaviour of Peary caribou in response to springtime snow and ice conditions; *Env. Can.*, Can. Wildl. Serv. Occasional Paper No. 48, 41 p.

Studies of snow and ice conditions on Prince of Wales and Somerset Islands; of inter-island movements of Peary caribou *(Rangifer tarandus pearyi)* between those two islands and the Boothia Peninsula; and of springtime foraging behaviour of Peary caribou were carried out during 1979 and 1980 in the Northwest Territories of Canada. Caribou in the Prince of Wales Island - Somerset Island - Boothia Peninsula complex function as an inter-island population with Prince of Wales serving as the major summering area for most of the caribou that winter on Somerset Island and the northern Boothia Peninsula. Comparison of spring snow and ice conditions suggests that there should be more snow-free caribou range available sooner on eastern Prince of Wales Island than on western Somerset Island. However, snow-covered ranges on either island would be iced over and unavailable to caribou at that time of the year. Peary caribou select poorly vegetated, windblown snow-free patches or cratering areas with shallow snow at the edge of snow-free sites or shallow fresh snow areas for springtime foraging sites because of the relative availability of forage. Inter-island movements, special springtime foraging behaviour, and late calving are some of the adaptive strategies that Peary caribou have evolved in response to restricted forage availability. The complex ecological relation of Peary caribou with their environment in the spring of the year warrants further study for a more detailed understanding of the key to caribou survival in the Canadian High Arctic.

2292 NAMS, M.L.N. - 1982
Ecology of *Cassiope tetragona* at a High Arctic Lowland, Alexandra Fjord, Ellesmere Island, N.W.T.; unpub. M.Sc. thesis, Dalhousie Univ., 139 p.

Cassiope tetragona (L.) D. Don (Ericaceae) is an evergreen, dwarf, heath shrub that has a circumpolar distribution in the arctic, and also occurs in some alpine regions. Throughout much of its range, it is an important component of low shrub - heath, dwarf shrub - heath, and mixed heath communities. However, *Cassiope*-dominated heaths are relatively rare, and tend to be restricted to snowbed sites, particularly in the far north. Although the occurrence of *Cassiope*-heaths has been documented for arctic localities in North America, few studies have detailed the synecology of these heaths. Studies of community composition and structure have generally been limited to species lists and relative abundances, except for those of Böcher in West Greenland, and that of Bliss et al on Devon Island, Canada. As well, Muc reported preliminary data on the composition of *Cassiope*-heaths at Alexandra Fjord, Ellesmere Island. The standing crop and production of arctic *Cassiope*-heaths have rarely been estimated. I encountered only two reports concerning these topics in the literature, that of Vassiljevskaja et al for a *Cassiope*-dominated lichen - moss tundra in the West Taimyr of the Soviet Union, and that of Bliss for a *Cassiope*-dominated dwarf shrub - heath - moss community on Devon Island, Canada.

Thus, the first objective of my study is to investigate the synecology of *Cassiope*-heaths in a variety of habitats at a high arctic lowland adjacent to Alexandra Fjord, Ellesmere Island. Community composition and structure are quantitatively described, and an attempt is made to relate compositional differences among communities in different habitats to environmental factors. As well, the standing crop and production of a representative *Cassiope*-heath are estimated.

The second objective of my study is to document aspects of the autecology of *Cassiope tetragona* in order to gain insight into the overall growth and reproductive strategy of this species. Seasonal patterns of growth, phenology, and resource allocation are described. Although earlier studies done in the arctic have described aspects of the growth and phenology of *Cassiope*, none have given detailed seasonal results or discussed seasonal resource allocation.

2293 RATYNSKI, R.A. - 1983
Mid-summer ichthyoplankton populations of Tuktoyaktuk Harbour, N.W.T.; *Fish. and Oceans*, Wpg., Can. Tech. Rep. Fish. Aquat. Sci. No. 1218, 25 p.

The ichthyoplankton of Tuktoyaktuk Harbour, N.W.T. and adjacent waters of Kugmallit Bay was sampled by plankton net (mesh size 750 µm), during 11 July to 16 August, 1982, to determine species composition, abundance, distribution, and growth. There was also limited sampling by epibenthic sled and seine. Rainbow smelt *(Osmerus mordax)* was the most abundant larva in plankton net catches from the harbour (8.1· 100 m^{-3}) followed by Pacific herring *(Clupea harengus pallasi)* (0.6· 100 m^{-3}) and saffron cod *(Eleginus gracilis)* (0.3· 100 m^{-3}). Larval starry flounder *(Platichthys stellatus)*, lumpenids-blackline prickleback *(Acantholumpenus mackayi)* and/or slender eelblenny *(Lumpenus fabricii)*, fourhorn sculpin *(Myoxocephalus quadricornis)*, and Arctic cod *(Boreogadus saida)*, were also captured within the harbour. Only rainbow smelt, Pacific herring, fourhorn sculpin, and Arctic cod were obtained outside the harbour in Kugmallit Bay and smelt and herring were far less abundant than in the harbour. A partial temporal separation of larvae in the harbour occurs as a result of different spawning times. Lumpenids, fourhorn sculpin, and gadids would appear first in the ichthyoplankton under the ice followed by rainbow smelt and Pacific herring at breakup and starry flounder in August. There was also spatial separation of larvae vertically. Most rainbow smelt, Pacific herring, and fourhorn sculpin larvae were obtained from the harbour near the surface at the higher temperatures and lower salinities found above the halocline. Saffron cod, starry flounder, and lumpenids were found in the colder, more saline waters of the upper halocline. The size of smelt, herring, and sculpin at the end of August was similar to that reported for other areas in the southern Beaufort Sea. Saffron cod grew very slowly, reaching a mean total length of only 7.5 mm by mid-August. Mean total length of starry flounder in early August was 4.2 mm.

2294 RING, R.A. - 1981
The physiology and biochemistry of cold tolerance in Arctic insects; *J. therm. Biol.*, vol. 6, pp. 219-229.

Nine species of insects from three different geographical regions of Canada were examined for freezing tolerance, supercooling capacity, water content and changes in biochemical characteristics during acclimation to subzero temperatures. Six species proved to be freezing tolerant, the remaining three freezing susceptible. The majority of species in each category conformed to the generally recognized profiles of overwintering response. There were enough specific variations within each category, however, to indicate that cold tolerance mechanisms have evolved independently on a number of different occasions. Specific physiological and biochemical anomalies in these insects were discussed.

2295 RING, R.A. - 1982
Freezing-tolerant insects with low supercooling points; *Comp. Biochem. Physiol.*, vol. 73A, no. 4, pp. 605-612.

1. *Pytho deplanatus* {Coleoptera: Pythidae (Salpingidae)} is an alpine species that overwinters as a larva under the bark of fallen spruce in the Rocky Mountains. It belongs to a small group of insects which not only is tolerant of freezing but also develops the capacity to supercool to low sub-zero temperatures (-54°C), indeed in this case the lowest ever recorded for this category.

2. The freezing tolerance profile of *P. deplanatus* is similar to that of many other insects in that glycerol is accumulated to moderately high levels during low temperature acclimation, while water content and glycogen concentrations are considerably reduced. Blood sugar levels, mainly trehalose, also accumulate during this period.

3. The most feasible explanation for the co-existence of freezing tolerance and low supercooling points is that *P. deplanatus* is physiologically incapable of synthesizing haemolymph nucleating agents and that nucleators in the gut and other fluid compartments are absent in the overwintering larvae. The adaptive advantage of this strategy is that larvae would normally overwinter in a supercooled state, but if freezing did occur (e.g. by inoculation from contact water in the hibernaculum) then the antifreeze function of glycerol and blood sugars would assume a cryoprotective role.

4. The freezing tolerance mechanisms of *P. deplanatus* larvae are compared and contrasted with those of (a) the congeneric *P. americanus* which also overwinters under the bark of fallen trees but has both an alpine and arctic distribution, and (b) *Xylophagus* sp. (Diptera: Xylophagidae) which has a different phylogenetic background but occupies a similar niche in the Arctic.

2296 RING, R.A. - 1983
Cold tolerance in Canadian Arctic insects; *in* Plant, Animal, and Microbial Adaptations to Terrestrial Environment, eds. N.S. Margaris, M. Arianoutsou-Faraggitaki, and R.J. Reiter, Plenum Pub. Corp., pp. 17-29.

Canada is ideally located for the comparative study of insect cold tolerance mechanisms due to its wide range in latitudes, altitudes and climatic zones. Although the high altitude insects have not been enumerated the arctic insect fauna is rich and varied, the current estimate being 1640 identified species, including Collembola and Protura. This includes representatives from about 16 different orders, thus the diversity of taxa makes the arctic region also suitable for phylogenetic studies. Table 1 is a compilation of the available data on identified species in various comparable regions of the world where low winter temperatures and short growing seasons prevail.

2297 SCHWEINSBURG, R.E., LEE, L.J., and LATOUR, P.B. - 1982
Distribution, Movement and Abundance of Polar Bears in Lancaster Sound, Northwest Territories; *Arctic*, vol. 35, no. 1, pp. 159-169.

Mark-recapture studies show that polar bears are distributed at varying densities throughout Lancaster Sound during winter and spring. Major concentrations occur along the north and south coasts and the transverse floe edge at the mouth of the sound. As the ice melts, some bears move west whereas others move to nearby land areas. There is some evidence that as the ice forms, polar bears return from their summer locations to eastern Lancaster Sound. Polar bears of Lancaster Sound are part of the larger population whose western range extends to Barrow Strait, Prince Regent Inlet, Wellington Channel and Jones Sound. The southern and eastern range limits are unknown although this population may extend at least to Clyde River on northeastern Baffin Island and probably to Greenland. Maternity denning appears to be widespread over the study area probably because of the abundance of suitable habitat. We estimated a population of 1031 $\pm$ 236 polar bears in Lancaster Sound during 1979; however, more estimates are needed to determine if this relatively high number is normal for the area.

2298 SCHWEINSBURG, R.E., and LEE, L.J. - 1982
Movement of Four Satellite-Monitored Polar Bears in Lancaster Sound, Northwest Territories; *Arctic*, vol. 35, no. 4, pp. 504-511.

Four female polar bears, fitted with satellite-monitored transmitters at Lancaster Sound, N.W.T. during May 1979, were tracked to determine seasonal distribution, movements relative to ice conditions, and home range. Most locations (68.7%, n = 46) of satellite-tracked bears were on landfast ice, 13.4% (n = 9) on old pack ice, 13.4% (n = 9) on land, 3.0% (n = 2) on bergy water, and 1.5% (n = 1) on young pack ice. These observations support the conclusions of mark-recapture studies in the area, that landfast ice is favored until breakup when bears move onto land. Data from the satellite-tracked bears indicate that they had home ranges.

2299 SCOTT-BROWN, M., ALLEN, L., and ROE, N.A. - 1981
1981 waterbird surveys McKinley Bay, Northwest Territories; internal report, prepared for Can. Wildl. Serv., Env. Can.; DIAND, and Dome Petroleum, 42 p.

Aerial surveys were conducted on July 21, July 31, and August 10, 1981 at McKinley Bay, Northwest Territories to determine waterfowl distribution, species composition and abundance. Each survey consisted of two parts: a series of ten east-west transects across McKinley Bay and adjacent terrain, and an aerial survey of the shoreline or "shoreline cruise". The 305 km^2 study area was further divided into marine and terrestrial components, and total bird numbers in each component were extrapolated from the results of aerial transects.

A total of 19,136, 7,949 and 13,180 birds were estimated in the marine component on July 21, July 31 and August 10, 1981 respectively. Diving ducks were the most abundant group recorded, with Oldsquaw and scotters accounting for over 80 percent of the species total observed in the marine component. The observed distribution of diving ducks differed within McKinley Bay from one survey to the next. Compared to earlier surveys, many more birds were observed away from the shoreline in McKinley Bay on August 10. Large concentrations of diving ducks were observed off Atkinson Point during all three aerial surveys.

Total estimated numbers of birds were lower in the terrestrial component, numbering 3,797, 2,498 and 5,517 on the three respective survey dates. Diving ducks were again the most abundant group recorded, but numbers were substantially lower than in the marine component. Swans were common in the lagoon system at the southeast end of McKinley Bay, with an estimated 269 birds present on July 21. Numbers of Brant and White-fronted Geese increased over the study period, and these species were most commonly observed in small embayments adjacent to Atkinson Point and in the lagoon system. An estimated 784 geese were present in McKinley Bay on August 10, 1981.

Compared to similar surveys in 1980, considerably more birds were observed in both components of McKinley Bay during 1981.

2300 SHAW, G.G., and GUNN, A. - 1981
Element Concentrations in High Arctic Vegetation and some Caribou and Lemmings; Can. Wildl. Serv. internal report, 28 p.

Concern about heavy metals in northern food chains has been narrowly focused on the harmful effects of mercury in fresh water and marine food chains. In terrestrial food chains of the north few data exist for heavy metals in either soils and sediments, or plants and none exist for animals. Moreover and henceforth, survey and effects assessment in both types of food chains should consider several elements at the same time. Heavy metals and other elements have many biogeochemical and nutritional interactions, some of which are definitely counter-indicative of toxicity.

More data on heavy metal dynamics in the north are needed to evaluate and modify existing health standards of industrially-employed native people. There is also a need to ensure the well being of wildlife which are still an integral part of northern native diets and our northern Canadian heritage.

High concentrations of metals and other elements occur naturally in soils and sediments from the weathering of ore bodies and mineral-containing rocks. Elements can be taken up by plant roots or absorbed from atmospheric contamination of leaves and stems. Data on element concentrations in lichens, mosses, grasses, shrubs and some animals are reported here as a first step

to better understanding elemental dynamics in high arctic, terrestrial food chains. We attempted to collect materials for analysis from areas of known mineral bodies being developed now and in geologically similar areas without mineral bodies.

2301 SHEATH, R.G., HAVAS, M., HELLEBUST, J.A., and HUTCHINSON, T.C. - 1982
Effects of long-term natural acidification on the algal communities of tundra ponds at the Smoking Hills, N.W.T., Canada; *Can. J. Bot.*, vol. 60, no. 1, pp. 58-72.

Epipelic and planktonic algal communities have been examined periodically for 3 years from four tundra ponds which have very low pH values (1.8-3.6) and high heavy metal concentrations due to long-term fumigation by sulphur dioxide and sulphuric acid aerosols from nearby lignite burns. These communities have been compared with those of control ponds which are situated further from the burns and have alkaline waters (pH 8) due to calcareous marl soils. The 90 species identified from the control ponds are members of nine classes of algae. In contrast, 14 species have been observed in the fumigated ponds which are representatives of four classes the Chlorophyceae, Euglenophyceae, Bacillariophyceae, and Cryptophyceae. The plankton of the control ponds is typical of tundra ponds in that it is dominated by small flagellates, particularly the cryptomonad *Chroomonas minuta*. Diatoms such as *Amphora, Navicula* and *Surirella* species, are the major components of the epipelic periphyton of these ponds, accounting for 67 to 90% of the biomass. Most of the primary productivity and biomass of the algae in the acidified ponds is benthic (3.7 versus 0.17 mg C $m^{-2}h^{-1}$ for epipelon and plankton, respectively). The dominant species in the fumigated ponds include *Chlamydomonas acidophila, Euglena mutabilis, Nitzschia communis, Eunotia arcus,* and *Eunotia glacialis*. Fine structural examination of *Euglena* and *Nitzschia* indicates that these species are healthy under conditions of pH 1.8 and high heavy metals. These results show that the flora of the fumigated ponds is atypical of tundra ponds but rather is similar to that of very acidic temperate waters such as those draining coal-mined areas or volcanic lakes.

2302 SIMS, R.A. - 1983
Ground-truth and large-scale 70 mm aerial photographs in the study of reindeer winter rangeland, Tuktoyaktuk Peninsula area, N.W.T.; unpub. Ph.D. thesis, Univ. British Columbia, 178 p.

Reindeer (*Rangifer tarandus tarandus* L.) winter rangeland in the Tuktoyaktuk Peninsula area, N.W.T., was studied using a ground-truth/large-scale (1:1,400 - 1:3,400) remote sensing program.

Ground-truth of vegetation, soils and general environment was conducted at 112 representative sites located throughout the study area. Two-way indicator species analysis (TWINSPAN) of vegetation cover by 420 plant taxa assigned sites among four broadly-defined 'vegetation groups'. The vegetation groups could be considered as ecosystemic units since they are also differentiated by a range of site parameters, including slope position classes, general cover features measured in 10 m x 10 m plots, mineral soil texture classes, the occurrence of organic soils and ice-wedge polygons, and certain soil physical and chemical parameters. Lichens are of particular importance as the winter diet mainstay for the reindeer, and differences among vegetation groups are reflected by dominant lichen taxa, and lichen ground cover, biomass and standing crop estimates. Lichen cover at sites ranged up to 89.3% and, for sites where lichen cover $\geq$ 20%, standing crop ranged from 194.4 to 6,337.6 $kg.ha^{-1}$.

Large-scale colour-infrared (CIR) 70 mm stereo photographs were acquired throughout the study area along 44 flightlines, and a total of 1,469 photoframes were interpreted and inventoried. Data were summarized according to 7 reindeer management zones defined within the study area.

Ice-wedge polygons are common terrain features in poorly-drained locations and are estimated to cover 23.4% of the land surface. Terrain disturbance by vehicles was observed in 19.0% of the photo-frames, but accounted for generally low cover which ranged from 0.5% to 2.0% for different reindeer management zones.

Lichen Types were recognized as the air-photo interpreted equivalents of three of the four vegetation groups. Within Lichen Types identified on photoframes, microdensitometric measurements were made of lichen patches. Quantitative study of the measurements helped confirm separability of the Lichen Types; Linear Discriminant Function analysis provided an 81.1% correct reassignment of 296 sets of measurements among Lichen Types.

Percent lichen cover and lichen standing crop were summarized according to the reindeer management zones. Measured on the photo-frames, lichen cover varied among zones from 1.48% to 14.24% of land area. Using lichen biomass measurements from ground-truth studies, lichen standing crop ranged from 39.6 $kg.ha^{-1}$ to 572.0 $kg.ha^{-1}$ for different zones. These estimates allowed the study area's winter carrying capacity to be tentatively determined at 20,373 reindeer.

The study concludes that ground-truth and large-scale CIR 70 mm photographs can play an important and integrative role in the study of *Rangifer* winter rangeland. Use of large-scale 70 mm photographs is especially advocated; there are numerous advantages for using large-scale remote sensing systems to study northern rangelands, including particularly a provision of baseline information that permits future monitoring.

2303 SMITH, T.G. - 1981
Seal hunters; *Oceans*, vol. 14, no. 3, May-June 1981, pp. 16-17.

Our northern peoples have been subjected to great changes in their way of life in a rela-

tively short time. But to this, as with all things, the Inuit have shown a remarkable resilience and adaptability. The arrival of a cash-revenue economy has created many problems for the hunters now dependent on expensive equipment for their livelihood, yet they remain the main providers for their growing population. They are "the people", descendants of a seal society, and protectors of an old way of life, still necessary in a modern era.

2304 SMOL, J.P. - 1983
Paleophycology of a high arctic lake near Cape Herschel, Ellesmere Island; *Can. J. Bot.*, vol. 61, no. 8, pp. 2195-2204.

Fifty-five diatom taxa, representing mostly acidophilous and benthic species (e.g. *Pinnularia biceps, Nitzschia bryophila, Navicula variostriata)*, were identified in a 56 cm long core from a small, deep lake (78°29.5'N, 76° 44.3'W) in innermost Baird Inlet, Ellesmere Island, Arctic Canada. The size and composition of past algal populations appears to have been controlled by fluctuations in the extent of icefree conditions in the littoral zone. The development of planktonic diatoms may have been precluded by extended ice cover in the pelagic region, although planktonic chrysophytes (exclusive of the Synuraceae) were abundant throughout the lake's 9000 year history. Crysophycean success in this harsh environment is attributed to their versatile nutritional strategies, their motility, and their ability to form a good resting stage. Four fossil zones were delineated. Following the onset of organic sedimentation (~9000 years before present (BP)), the diatom flora was dominated by small *Fragilaria* species (zone 1), comparable to early postglacial communities from temperate lakes. A contemporary analog of this early assemblage was recorded in the surficial sediments of Proteus Lake (78°41.7'N, 74°23.0' W), on Pim Island, suggesting that these diatoms reflect slightly alkaline conditions and extended ice cover. As the climate warmed, the assemblage shifted to one dominated by *Nitzschia bryophila* and *Pinnularia biceps* (zone 2), followed by an increase in *Navicula variostriata* (zone 3), indicating that ice cover was at a minimum and that bryophytes were abundant. Climatic deterioration (~4000 years BP) coincided with a shift to a diverse assemblage of shallow water diatoms and a marked decline in chrysophyte and diatom populations (zone 4). These data suggest that, in arctic regions, diatoms may provide indirect information of past climates, since temperature is closely associated with habitat availability.

2305 STEWART, D.B., and MacDONALD, G. - 1981
An Aquatic Resource Survey of Devon, Cornwallis, Somerset and Northern Baffin Islands, District of Franklin, Northwest Territories, 1980; *Ind. & Northern Affairs*, Environmental Studies No. 20, 84 p.

This report documents the results of survey work conducted in the summer of 1980 for the Northern Land Use Information mapping program. This fisheries survey encompasses Devon, Cornwallis, Somerset and northern Baffin Island in the District of Franklin, Northwest Territories. These islands border Lancaster Sound which is an area of interest for potential resource and transportation development.

The Land Use Information Series is an environmental research and information mapping program for northern Canada, which provides a convenient reconnaissance-level information base to facilitate regional planning and application of the Territorial Land Use Regulations. This report provides a detailed description of the fisheries information in the study area, and the main observations and results are portrayed on the individual Land Use Information Series maps.

During the survey, data were collected on freshwater fish, zooplankton, water chemistry, and domestic and commercial fisheries. This report summarizes the data collected and briefly discusses freshwater and marine fish research in the area.

2306 STEWART, D.B., and BERNIER, L.M.J. - 1982
An aquatic resource survey of islands bordering Viscount Melville Sound, District of Franklin, Northwest Territories; *Env. Can. & Ind. & Northern Affairs Can.*, Land Use Infor. Series Background Rep. No. 2, 110 p.

This report documents the results of survey work conducted in the summer of 1981 for the Northern Land Use Information Series mapping program. This fisheries survey encompasses Bathurst, Melville, Prince of Wales and northern Victoria islands in the District of Franklin, Northwest Territories. These islands border Viscount Melville Sound which is an area of interest for potential resource and transportation development.

The Northern Land Use Information Series is an environmental research and information mapping program for northern Canada, which provides a reconnaissance-level information base to facilitate regional planning and application of the Territorial Land Use Regulations. This report provides detailed information on the biology and utilization of fish species inhabiting the study area. The information has also been summarized in comments included on the individual land use maps.

During the survey, data were collected on freshwater and marine fish, planktonic and benthic invertebrates, water chemistry, and domestic and commercial fisheries. This report summarizes that information and briefly discusses previous freshwater and marine research in the area. Wildlife and botanical observations are included in appendices along with a list of other reports in the Northern Land Use Information Series.

2307 STIRLING, I. - 1980
The Biological Importance of Polynyas in the Canadian Arctic; *Arctic*, vol. 33, no. 2, pp. 305-315.

Polynyas are areas of open water surrounded by ice. In the Canadian Arctic, the largest and best known polynya is the North Water. There are also several similar, but smaller, recurring polynyas and shore lead systems. Polynyas appear to be of critical importance to arctic marine birds and mammals for feeding, reproduction and migration. Despite their obvious biological importance, most polynya areas are threatened by extensive disturbance and possible pollution as a result of proposed offshore petrochemical exploration and year-round shipping with ice-breaking capability. However, we cannot evaluate what the effects of such disruptions might be because to date we have conducted insufficient research to enable us to have a quantitative understanding of the critical ecological processes and balances that may be unique to polynya areas. It is essential that we rectify the situation because the survival of viable populations or subpopulations of several species of arctic marine birds and mammals may depend on polynyas.

2308 STIRLING, I., KINGSLEY, M., and CALVERT, W. - 1982
The distribution and abundance of seals in the eastern Beaufort Sea, 1974-79; *Env. Can.*, Can. Wildl. Serv. Occasional Paper No. 47, 25 p.

Between 1974 and 1975, there was a drop of about 50% in the numbers of ringed and bearded seals in the eastern Beaufort Sea, followed by a further 2 years of low numbers after which, in 1978, the population more than doubled. The decline in numbers appeared to be associated with particularly heavy ice conditions in the winter of 1973-74, which may have reduced the food available to seals. The resulting heavy winter mortality, combined with reduced productivity and large-scale emigration, could be responsible for the drop in numbers. Immigration appears to be responsible for the large increase in 1978.

Ringed seals prefer water with high ice cover and moderate depth. Bearded seals prefer broken-ice areas over shallow water. The greatest densities of ringed seals were recorded in the fast ice along the Yukon coast, around Cape Parry, and along the southwest coast of Banks Island. The greatest densities of bearded seals were found in the shallow water areas off the Tuktoyaktuk Peninsula.

Ecological conditions in the eastern Beaufort Sea are highly variable and cause changes in the distribution and abundance of ringed and bearded seals. Thus, management of these species as well as assessment of the possible consequences of man-made detrimental effects must be flexible, depending on the status of the populations at the time.

2309 STIRLING, I., and CALVERT, W. - 1983
Environmental threats to marine mammals in the Canadian Arctic; *Polar Record*, vol. 21, no. 134, pp. 433-449.

The Arctic Ocean is the home of three major groups of mammals that depend on the sea for survival and show varying degrees of adaptation for maritime life. Most fully adapted are the whales (Cetacea), which never leave the water, and the seals and walruses (Pinnipedia) that feed entirely at sea but emerge onto land or ice for pupping and basking. Less exclusively marine are two species of the order Carnivora - Polar Bears *(Ursus maritimus)*, that seldom live far from the sea because they feed almost entirely upon seals, and Arctic Foxes *(Alopex lagopus)*, some of which move out onto the sea ice during the winter, mainly to scavenge on the remains of seals killed by Polar Bears.

This article reviews the general biology and ecological requirements of Arctic Ocean mammals, comments on some specific threats, and where possible indicates both remedies and questions for future research.

2310 STIRLING, I., CALVERT, W., and CLEATOR, H. - 1983
Underwater Vocalizations as a Tool for Studying the Distribution and Relative Abundance of Wintering Pinnipeds in the High Arctic; *Arctic*, vol. 36, no. 3, pp. 262-274.

Recordings of the underwater vocalizations of ringed seals, bearded seals and walruses were made in the High Arctic between late March and late June 1980 and 1981, to evaluate the potential for using sub-ice vocalizations to study the distribution and relative abundance of wintering pinnipeds. Most of the calls made by these three species are identified and an initial lexicon is presented. Ringed seal vocalizations were more frequent in late April than earlier in the season or in late June, whereas the highest vocalization rates recorded for bearded seals were in late June. Vocalization rates of all three species were indicative of their distribution and relative abundance in different areas and sea ice habitat types. We conclude that underwater vocalizations have the potential for giving more precise information on the relative abundance of wintering pinnipeds than techniques previously used. It may be possible, provided the necessary information on the vocal behaviour of these species is acquired, to use this technique for censusing.

2311 SUTHERLAND, I. - 1982
A collection of zooplankton from Tuktoyaktuk Harbour, Northwest Territories; *Can. J. Zool.*, vol. 60, no. 3, pp. 477-480.

Forty-seven taxa of zooplankton were identified from collections taken during larval fish tows in the Tuktoyaktuk region. The zooplankton fauna consists of three components: a small number of common species characteristic of brackish water and a large number of rare species of either freshwater or marine affinities. *Eurytemora gracilicauda* Akatova 1949, *E. raboti* Richard 1897, and *E. richingsi* Heron and Damkaer 1976 are newly recorded from Canada.

2312 TAKADA, H., and TODA, M.J. - 1981
Notes on Arctic Canadian Diastatidae and Drosohilidae (Diptera), with the Description of a New Species; *in* Joint Studies on Physical and Biological Environments in the Permafrost, North Canada, July to August 1980 and February to March 1981, Inst. Low Temp. Sci., Hokkaido Univ., Japan, p. 113.

The list of three species of Diastatidae and thirteen species of Drosophilidae collected in the Arctic Canada is reported, together with collection records and the description of a new species, *Amiota quadrata* sp. nov.

2313 THOMAS, D.C. - 1981
At the crossroads of caribou management in northern Canada; *Can. Nature Fed.*, Special Pub. No. 10, 21 p.

Several major populations of caribou in Canada and Alaska have declined sharply in this decade with overharvest a common denominator. A review of what is known about the causes of these declines, of past attempts to manage populations, and of demographic characteristics of the user groups leads to the conclusion that hunting must be curtailed soon or some populations in northern Canada will be reduced to an insignificant resource or extirpated.

Action must be taken quickly to curb these caribou declines because recovery from population lows can take 1 to 3 decades. Meanwhile the population of the hunting villages is doubling every 16 to 20 years and land claims may delay implementation of restrictions.

Solutions will be extremely difficult to achieve until all land claims are settled, but interim action is needed to save the Kaminuriak caribou population and to maintain adequate numbers in some of the others. Wolf control is needed to speed the recovery of the Kaminuriak and Beverly populations but without harvest quotas it will not save them. One approach to curbing the kill by hunters is an educational program with a goal of voluntary self-restraint (essentially self-management) by the user group. A second solution is some form of restriction imposed on the people by the management agencies with the involvement and support of hunter associations. My view is that the first approach will not work in the short term and possibly not in the long run; but, in the present political climate, it is a prerequisite to attempted deployment of the second.

2314 THOMAS, D.C., and KROEGER, P. - 1981
Digestibility of Plants in Ruminal Fluids of Barren-Ground Caribou; *Arctic*, vol. 34, no. 4, pp. 321-324.

The comparative digestibilities of plants and their rates of digestion *in vitro* were assessed by fermentation with ruminal fluids obtained from barren-ground caribou *(Rangifer tarandus groenlandicus)* shot on their winter range in the southern Northwest Territories. There was a near-linear increase in the *in vitro*, dry-matter disappearance (IVDMD) with fermentation time (30-120 h) for all eight lichen species that we tested. In contrast, IVDMD was essentially maximal after 60 h fermentation for 10 of 11 non-lichen species. The green leaves of *Carex rostrata* and *Equisetum variegatum* were the only species with IVDMDs higher than 50% after a 60-63 h fermentation period. The two species of mosses and a liverwort were poorly digested (15-27%). The addition of 63 mg of urea to each tube markedly increased the digestibilities of both species of lichens tested, and that of *Vaccinium vitis-idaea,* but it lowered the IVDMD of *Salix* and *Betula* stems and the green and cured parts of *Carex rostrata*. The IVDMDs of four lichen species collected on the Canadian Arctic Islands were higher than those of eight terricolous species obtained from the mainland winter range of *R. t. groenlandicus*.

2315 THOMAS, D.C. - 1982
The relationship between fertility and fat reserves of Peary caribou; *Can. J. Zool.*, vol. 60, no. 4, pp. 597-602.

There was a close association between pregnancy rates and levels of fat reserves and body weights in Peary caribou *(Rangifer tarandus pearyi)* collected in the late winters of 1974 through 1977 on several islands in the Canadian Arctic. Pregnancy rates were <8% in adult (>2 years) females weighing <53 kg in March and April, >75% in those weighing >57 kg, and 100% in those >67 kg in weight. Pregnancy rates increased progressively from 7 to 100% as the percentage marrow fat increased from 43 to 79% and the kidney-fat index increased from 24 to 41%. Only heavy (>46 kg) yearling (21 month) females with high fat reserves were pregnant. Reproduction virtually ceased from 1973-1974 to 1975-1976 in Peary caribou on the western Queen Elizabeth Islands because their physical condition was poor. Pregnancy rates were as high as 100% in females in a second population located on Somerset and Prince of Wales islands, and in 1974-1975 four of five yearling females were pregnant. The adjustment of fertility to energy reserves is viewed as an adaptation to conserve energy. It is well developed in Peary caribou whose environment is characterized by a highly variable and often harsh climate in which negative energy balances probably prevail for 8 to 10 months of the year.

2316 THOMAS, D.C., and EVERSON, P. - 1982
Geographic variation in caribou on the Canadian arctic islands; *Can. J. Zool.*, vol. 60, no. 10, pp. 2442-2454.

Analyses of body, leg bone, skull, and pelage data indicated a cline in the characters of caribou *(Rangifer tarandus)* from central Boothia Peninsula to the western Queen Elizabeth Islands. The main difference between the skulls of barren-ground caribou *(R. t. groenlandicus)* on central Boothia Peninsula and the more northerly Peary caribou *(R.t. pearyi)* was a shorter muzzle in the latter. Pelage

tone was markedly lighter in Peary caribou and they were smaller in most body measurements, most notably in the length of long bones. Two major populations of Peary caribou were identified: one on the western Queen Elizabeth Islands (Parry Islands), the other on Somerset and Prince of Wales islands. Differences in skull size and form suggest that each population was composed of two or more subpopulations. The larger and darker *R. t. groenlandicus* occurred on north-central Boothia Peninsula and the two subspecies and apparent intergrades were present in winter on northern regions of the peninsula. The morphological similarity of Peary caribou on Somerset and Prince of Wales islands is explained by interisland movements resulting in genetic mixing. The same is true for caribou on the western Queen Elizabeth Islands and that population apparently has little genetic interchange with the other.

2317 THOMAS, D.C., and EDMONDS, J. - 1983
Rumen contents and habitat selection of Peary caribou in winter, Canadian Arctic Archipelago; *Arctic and Alpine Res.*, vol. 15, no. 1, pp. 97-105.

We obtained data on geographical variation in the rumen contents of Peary caribou *(Rangifer tarandus pearyi)* by visual estimation of the proportionate composition of plants in 188 rumen samples obtained in March and April from five regions (eight islands). The floral composition of the samples obtained in 1974 through 1977 were highly variable among sites on some of the islands and among some of the regions. Among-year differences were slight despite highly variable snowfalls. Only a few species dominated the rumen samples from all regions but the apparent winter diets were more diverse and there was more variability among sites on Somerset and Prince of Wales islands than on the more northerly islands. Monocotyledons (predominantly *Luzula* spp.) and mosses each comprised 13 to 58% and together 33 to 97% ($\bar{x}$ 70%) of the rumen contents of caribou in the five regions. They and lichens (2 to 15%) were the only plant groups common to the samples from all regions. High proportions of mosses (34 to 58%) characterized the rumen samples from caribou on Bathurst, Melville, and Eglinton/Prince Patrick islands. Mosses comprised >50% of the rumen contents of caribou sampled on Bathurst and Melville islands in March 1974 when foraging was extremely difficult and malnutrition widespread.

2318 TODA, M.J., and KIKUCHI, Y. - 1981
Collections of Soil Mesofauna in Arctic Canada; *in* Joint Studies on Physical and Biological Environments in the Permafrost, North Canada, July to August 1980 and February to March 1981 Inst. Low Temp. Sci., ed. S. Kinosita, Hokkaido Univ., Japan, pp. 61-72.

In order to investigate the habitat structure of a soil animal community, soil mesofaunal samples were taken from various places different in microtopographic feature and vegetation at two localities, Tuktoyaktuk and Inuvik, within the Arctic Circle of the Mackenzie Delta area, northern Canada, in July-August, 1980. Tuktoyaktuk (69°26'N, 133°03'W) is situated in the tundra zone, while Inuvik (68°22'N, 133°45'W) in the subarctic forest zone immediately south of the timber line. This difference will make it possible to compare habitat structures between the two vegetational zones.

A part of the samples were entrusted to Prof. H. Tamura, of Department of Biology, Faculty of Science, Ibaraki University, Mito, Japan, so that preparations were made and the collembolan species identified. The methods and the original sample data are presented in this report to facilitate further utilization by any other specialists who wish to study the samples from respective viewpoints.

2319 TODA, M.J. - 1981
Daily Activity of Drosophilid Flies in the Arctic Summer; *in* Joint Studies on Physical and Biological Environments in the Permafrost, North Canada, July to August 1980 and Februarv to March 1981; Inst. Low Temp. Sci., ed. S. Kinosita, Hokkaido Univ., Japan, p. 115.

A preliminary record on the daily activity of drosophilid flies in the arctic summer is reported. Two different patterns of daily periodicity are observed, bimodal in *Drosophila athabasca* and unimodel in *D. rellima* and *D. subquinaria*. The former results from inactivity under the bright light condition early in the afternoon, while the latter from the coincidence of the active peak with the daily thermal maximum. The dim light condition around midnight suppresses the activity of all flies. Species-specific requirements for physical environment are deduced from meteorological records at the time of collection.

2320 WILLIAMS, S. -
The report of the Joint Services Expedition to Princess Marie Bay, Ellesmere Island, 1980; *Polar Cont. Shelf Proj.*, internal report, 390 p.

This is the report of the Joint Services Expedition to Princess Marie Bay, Ellesmere Island, 1980.

The aims of the expedition were to make a scientific survey of a remote Arctic region, with an emphasis on biology. Summaries of scientific work form the major part of this report, but some are incomplete as data are still being analysed. The final results of major projects will eventually be submitted for publication in appropriate journals. Planning procedures and activities in the field are given in some detail to assist future expeditions.

This report has been written and produced in sections. Each section has separate pagination, with figures at the end.

Geographical measurements are given in metric units, with the exception of heights which are shown in feet to conform to the Canadian map to be found inside the back of the report.

2321 YAMANE, S., MAKINO, S., and TODA, M.J. - 1981
Nests of *Dolichovespula albida* from the Arctic Canada; *in* Joint Studies on Physical and Biological Environments in the Permafrost, North Canada, July to August 1980 and February to March 1981, Inst. Low Temp. Sci., Hokkaido Univ., Japan, p. 111.

Two thriving nests of *Dolichovespula albida* were collected from the Arctic Canada in the summer of 1980. They were found each in "supraterrestrial" nest sites. The envelope paper was loose in texture, showing a close resemblance to that of *D. norwegica*. Both nests had only two (one worker and one reproductive) combs and about 170 cells, much smaller than in other *Dolichovespula* species in temperate regions. Adult productivity was also considerably low, but the colonies did have a good number of workers.

2322 ZOLTAI, S.C., BOOTHROYD, P.N., and SCOTTER, G.W. - 1981
A natural resource survey of eastern Axel Heiberg Island, Northwest Territories; *Parks Can.* internal report, 156 p.

Portions of northeastern Ellesmere Island and eastern Axel Heiberg Island were designated by Parks Canada as natural areas of Canadian significance that merit protection under the national parks system. In the original concept, the Ellesmere Island portion was to represent the glacier-covered highlands and the Axel Heiberg Island portion would represent the biologically more productive lowlands. In May 1980, Parks Canada requested the Canadian Wildlife Service and the Canadian Forestry Service to evaluate the natural resources of eastern Axel Heiberg Island.

The study area covers some 5400 km^2 on the east side of Axel Heiberg Island. It lies east of the Princess Margaret Range, the glacier-clad high mountain chain that forms the backbone of the island. The study area is within Natural Region 39, Eastern High Arctic Glacier Region, but it is located within a large depression surrounded by high mountains. The area, therefore, is representative of the lowland portions of the region.

The objectives of this study are: 1. To describe the geology, physical geography, flora, fauna, and human history of the study area. 2. To map and classify the vegetation types and ecological units of the study area. 3. To identify outstanding features that might be critical to the management of a national park that includes all or part of the study area. 4. To determine whether the study area would complement the main potential national park on northeastern Ellesmere Island. 5. To suggest alternative solutions to having a national park in two widely separated sections.

2323 ZOLTAI, S.C., McCORMICK, K.J., and SCOTTER, G.W. - 1983
A natural resource survey of Bylot Island and adjacent Baffin Island, Northwest Territories; *Parks Can.*, internal report, 176 p.

This study was carried out, at the request of Parks Canada, to briefly summarize the existing knowledge of the natural resources of Bylot Island and the adjacent portion of Baffin Island. This area is being considered as a potential national park by Parks Canada as an area representing glacier-covered highlands and associated lowlands, with a significant marine component. In February 1982, Parks Canada requested the Canadian Wildlife Service and the Canadian Forestry Service to carry out an overview study of this region.

The study area covers approximately 10 750 km^2 on Bylot Island, and some 13 000 km^2 of adjacent Baffin Island. Most of the study area lies within Natural Region 26, Northern Davis Region of the Canadian Shield (Parks Canada 1972) and a small part of the northwestern portion of the study area is in Natural Region 37, Eastern Arctic Lowlands.

The specific objectives of this study were: 1. To describe the geology, physical geography, flora, fauna, and human history of the study area. 2. To map and classify the vegetation types and ecological units of the study area. 3. To identify outstanding features that might be critical to the management of a national park that includes all or part of the study area.

BOTANY

2252 BOOTHROYD, P.N. - 1983
Preliminary assessment of potential environmental effects of the borealis iron ore development proposal on birds of Melville Peninsula, N.W.T.; *Env. Can.*, Can. Wildl. Serv., Wpg, internal report, 132 p.

2254 BRUEMMER, F. - 1984
Nature's laboratory in a High Arctic oasis; *Can. Geographic*, Feb/March 1984, pp. 34-40.

2324 EDLUND, S.A. - 1980
Vegetation of Lougheed Island, District of Franklin; *in* Current Research, Part A, Geol. Surv. Can., Paper 80-1A, pp. 329-333.

The nature of the flora and the relationships between plant communities and the surficial materials on Lougheed Island were studied. Thirty-three vascular species were identified. Most communities are dominated by monocotyledons. Several *Luzula*-based communities occur on sandy materials; grass-based communities, primarily dominated by *Alopecurus alpinus* and *Puccinellia* species occur on fine grained materials. *Saxifraga oppositifolia*-based communities are restricted to materials with significant calcareous components. For each type of material, moisture content determines which type of community is present.

2325 EDLUND, S.A. - 1982
Vegetation of Melville Island, District of Franklin: Eastern Melville Island and Dundas Peninsula; *Geol. Surv. Can.*, Open File No. 852.

Two unedited maps at 1:250 000 scale of eastern Melville Island and Dundas Peninsula show the types and distribution of major plant communities and their relationships to the surficial geology.

The area is subdivided into four bioclimatic zones based on species diversity and plant community composition, especially the presence and significance of dwarf shrubs in the communities. From this zonation a "mini forest-line" and "mini treeline" is established for this part of the High Arctic.

2326 EDLUND, S.A. - 1982
Vegetation of Cornwallis, Little Cornwallis, and associated islands, District of Franklin; *Geol. Surv. Can.*, Open File No. 857.

One unedited map, at a scale of 1:250 000, of the Cornwallis Island area shows the distribution of major plant communities and their relationships to surficial geology and moisture regimes. This area is largely unvegetated, probably due to the strongly alkaline surficial materials, which cover most of the area, and to the purity of these carbonates and evaporites, which are severely deficient in plant nutrients.

This area is also subdivided into three bioclimatic zones, based on species diversity and plant communities and the significance of dwarf shrubs in the communities. The zonation establishes a "mini treeline" and a "mini forest-line" in this part of the south-central Queen Elizabeth Islands.

2327 EDLUND, S.A. - 1982
Vegetation of Polar Bear Pass, Bathurst Island, Northwest Territories; *Geol. Surv. Can.*, Open File No. 884.

The unedited map, at a scale of 1:125 000, shows the distribution of High Arctic plant communities on the various surficial materials of the Polar Bear Pass Wildlife Area, central Bathurst Island. In addition, inset maps show surficial materials and watersheds of the Polar Bear Pass area as well as the general physiography of Bathurst Island.

The Polar Bear Pass lowland area has the largest concentration of sedge meadows on Bathurst Island and in the central High Arctic. Dwarf shrub communities also occur in abundance. This High Arctic oasis occurs in this area due to a combination of factors. The surficial materials-moderately calcareous gravels of local and foreign lithologies - provide a variety of plant nutrients: whereas areas surrounding the lowland, particularly the pure limestone and dolomite of the uplands north and south of Polar Bear Pass, are extremely low in plant nutrients. Moisture is available throughout the growing season due to the storage of spring meltwater in numerous lakes and ponds on the lowland and to the slow, continuous melting of snowbeds on the north and south slopes of the pass. Polar Bear Pass is an unusual inland-lowland, where coastal fog does not always penetrate, and thus the climate is locally milder than the adjacent coastal areas.

2328 EDLUND, S.A. - 1983
Vegetation of north-central Queen Elizabeth Islands, Northwest Territories; *Geol. Surv. Can.* Open File No. 887.

Two unedited maps at 1:250 000 scale of Amund Ringnes, Cornwall, Table, Lougheed, Graham and adjacent islands show the types and distribution of major plant communities and their relationships to the surficial geology.

The area is subdivided into three bioclimatic zones based on species diversity and plant community composition, especially the presence and significance of dwarf shrubs in the communities. From this zonation a "mini forest-line" and "mini treeline" are established for this part of the High Arctic.

2329 EDLUND, S.A. - 1983
Vegetation of the Bathurst Island Area, Northwest Territories; *Geol. Surv. Can.*, Open File No. 888.

The unedited map at 1:250 000 scale of Bathurst, Alexander, Massey, Vanier, Cameron, Helena, Loney, Byam Martin, Marc, and Pauline Islands shows the types and distribution of major plant communities and their relationships to the surficial geology.

The area is subdivided into three bioclimatic zones based on species diversity and plant community composition, especially the presence and significance of dwarf shrubs in the communities. From this zonation a "mini-forest line" and "mini treeline" is established for this part of the High Arctic.

2330 EDLUND, S.A. - 1983
Bioclimatic zonation in a high Arctic Region: Central Queen Elizabeth Islands; *in* Current Research, Part A, Geol. Surv. Can., Paper 83-1A, pp. 381-390.

The central Queen Elizabeth Islands in the High Arctic are subdivided into four bioclimatic zones based on plant community life-forms, species diversity within plant communities, total number of species, and the presence and abundance of a variety of indicator species such as woody plants, marsh emergents, sedges, vascular cryptogams, legumes, and Compositae. These zones, which cross lithologic boundaries, establish a 'mini-treeline' north of which no woody species occur (prostrate dwarf shrubs such as arctic willow and mountain avens) and a 'mini-forest zone' in which dwarf shrubs are the major vascular plant component. This bioclimatic zonation occurs on latitudinal, altitudinal, and local scales. It appears likely that the mean daily July temperature for the limit of vascular plants is a little

above 2.5°C, for woody plants ('mini-treeline') is between 3° and 3.5°C and for the 'mini-forest zone', is between 3.5° and 4°C.

2331 EDLUND, S.A. - 1983
Reconnaissance vegetation studies on western Victoria Island, Canadian Arctic Archipelago; *in* Current Research, Part B, Geol. Surv. Can., Paper 83-1B, pp. 75-81.

Reconnaissance observations of the flora and plant communities of western Victoria Island suggest that surficial materials strongly influence the flora. The widespread calcareous glacial deposits support a variety of calciphilous plant communities and flora. All three broad arctic ecosystems (Low, Mid, and High Arctic) occur on western Victoria Island. The Low Arctic ecosystem is the most extensive, occurring along the southwest coast of Prince Albert Peninsula, coastal areas of Diamond Jenness Peninsula and up Kuujjua River valley, and most of Wollaston Peninsula; dwarf shrubs dominate most plant communities and vegetation cover is nearly continuous. The High Arctic ecosystem is restricted to northern Victoria Island and to areas above 500 m in Shaler Mountains and parts of Diamond Jenness Peninsula. The Mid Arctic ecosystem occurs mainly in central Prince Albert and Diamond Jenness peninsulas. Around Minto Inlet rare tree-sized (2 to 5 m-high) thickets of willow occur in some sheltered valleys and along river terraces. The vegetation of western Victoria Island is compared with calciphilous vegetation of the southern Queen Elizabeth Islands, Banks, Somerset, and Prince of Wales islands, and with vegetation on noncalcareous surficial materials of north-central District of Keewatin. Several bioclimatic zones are suggested, including an extension of the 'mini-forest zone' from the Queen Elizabeth Islands and an erect shrub limit and an erect shrub-forest limit in wetlands.

2258 ENGLAND, J., KERSHAW, L., LaFARGE-ENGLAND, C., and BEDNARSKI, J. - 1981
Northern Ellesmere Island: a natural resource inventory; *Univ. Alta.*, Report to Parks Can., 237 p.

2332 FREEDMAN, B., HILL, N., SVOBODA, J., and HENRY, G. - 1982
Seed banks and seedling occurrence in a high Arctic oasis at Alexandra Fjord, Ellesmere Island, Canada; *Can. J. Bot.*, vol. 60, no. 10, pp. 2112-2118.

The sizes and floras of the seed banks and seedling communities are described for a variety of habitats in a high Arctic lowland oasis on Ellesmere Island, located at 79°N latitude. Four disturbed habitats had larger seed banks than did four undisturbed habitats (averaging 3070/m^2vs. 63/m^2). The seedling densities measured in the disturbed habitats were also larger (1780/m^2vs. 180/m^2). The data indicate that sexual reproduction is important to the herbaceous, short-lived, ruderal species which colonize disturbed sites in the high Arctic. This contrasts with the more conservative strategy of stress-tolerant species that occur in relatively closed and undisturbed habitats, which tend to propagate by vegetative mechanisms.

2333 GRAINGER, E.H., and EVANS, M.S. - 1982
Seasonal Variations in Chlorophyll and Nutrients in a Canadian Arctic Estuary; *Estuaries*, vol. 5, no. 4, pp. 294-301.

The Eskimo Lakes and Liverpool Bay constitute a series of estuarine waters to the Beaufort Sea in arctic Canada. Salinity ranges in summer from 20 $^{o}/_{oo}$ at the mouth to less than 1 $^{o}/_{oo}$ at the head of the system. Arctic features include an ice cover lasting for about 8 months annually and water temperatures which fluctuate from -1°C in winter to as high as 12°C in late summer. Subsurface light is severely attenuated. Reactive phosphate varies from a spring high of 0.3 µg-at P per l to undetectable levels during summer. Nitrate is more abundant, and silicate is consistently plentiful. Chlorophyll *a* reaches a maximum only occasionally higher than 3 mg per m^3 in June and July, rising from undetectable levels in winter. Photosynthetic rates are low by all standards, and have not been measured at greater than 6.4 mg C per m^2 per hour in summer. Low levels of subsurface light and reactive phosphate and nitrate characterize this exceptionally oligotrophic arctic estuary.

2334 GRULKE, N.E., and BLISS, L.C. - 1983
A note on winter seed rain in the High Arctic; *Arctic and Alpine Res.*, vol. 15, no. 2, pp. 261-265.

Vascular plant cover is low (~ 5 to 25%) in semidesert communities in the High Arctic. Snow was cored over two plant communities for winter seed rain. Seeds were found roughly in proportion to plant cover in the immediate area. In snow cores sampled over a moss-herb community, 63 diaspores m^{-2} were found versus 20 diaspores m^{-2} over a graminoid barrens community. No exotic diaspores were found, but seeds of species typical of communities 1 km distant were sampled. Winter seed rain is only a fraction of reported summer values from an alpine site.

2272 HAVAS, M., and HUTCHINSON, T.C. - 1983
The Smoking Hills: natural acidification of an aquatic ecosystem; *Nature*, vol. 301, Jan. 6, 1983, pp. 23-27.

2285 KINOSITA, S. - 1981
Joint Studies on Physical and Biological Environments in the Permafrost, North Canada, July to August 1980 and February to March 1981; ed. S. Kinosita, Inst. Low Temp. Sci., Hokkaido Univ., Japan, 121 p.

2335 MAESSEN, O., FREEDMAN, B., NAMS, M.L.N., and SVOBODA, J. - 1983

Resource allocation in high-arctic vascular plants of differing growth form; *Can. J. Bot.*, vol. 61, no. 6, pp. 1680-1691.

Resource allocation strategies are described for a range of vascular plant species of a high-arctic lowland oasis, located adjacent to Alexandra Fjord, Ellesmere Island, N.W.T. The patterns of allocation of biomass and major nutrients (N, P, K, Ca, and Mg) differed greatly among the 16 species, which represented six growth forms (biennial herbs, perennial herbs, graminoids, cushion plants, deciduous dwarf shrubs, and evergreen dwarf shrubs). The dominant growth strategy was that of the stress tolerator, well adapted to cold, dry, and exposed situations. This strategy is characterized by low annual net production, a small proportion of resources allocated belowground, a large proportion of resources allocated to the attached litter compartment, and internal nutrient cycling. Ruderal growth strategies were evident in such species as *Cochlearia fenestrata* and *Draba groenlandica*, which occupied disturbed habitats. These species had a large proportion of resources allocated to sexual reproductive tissues. Perennial herbs exhibited intermediate strategies, and they occupied a wide range of habitats.

2336 MILLER, N.G., and HOWE AMBROSE, L.J. - 1976
Growth in Culture of Wind-blown Bryophyte Gametophyte Fragments from Arctic Canada; *The Bryologist*, vol. 79, no. 1, pp. 55-63.

Samples collected during the summer from a lingering snowbed on Bathurst Island in the Canadian high arctic contained large numbers of moss and liverwort gametophyte fragments. For the most part, species represented occur on ridges and slopes immediately adjacent to the sampling site. Accumulation of the fragments and associated plant debris presumably took place during the preceding winter through the action of surface winds. In laboratory culture trials 12% of the fragment sample showed evidence of viability by generating protonemata, new shoots or rhizoids or by otherwise resuming growth. Leaf-bearing gametophore tips of mosses showed the greatest response. No detached moss leaves generated new growth and only one leafy liverwort fragment proved to be viable. Based on the number of fragments in subsample volumes, it is estimated that over 4000 viable propagules occurred per cubic meter of granular snow at the sampling site. These data indicate that some gametophyte fragments are able to function as propagules in nature and that wind dispersal and establishment of bryophytes by vegetative means may be routine in arctic latitudes.

2300 SHAW, G.G., and GUNN, A. - 1981
Element Concentrations in High Arctic Vegetation and some Caribou and Lemmings; Can. Wildl. Serv., internal report, 28 p.

2301 SHEATH, R.G., HAVAS, M., HELLEBUST, J.A., and HUTCHINSON, T.C. - 1982
Effects of long-term natural acidification on the algal communities of tundra ponds at the Smoking Hills, N.W.T., Canada; *Can. J. Bot.*, vol. 60, no. 1, pp. 58-72.

2306 STEWART, D.B., and BERNIER, L.M.J. - 1982
An aquatic resource survey of island bordering Viscount Melville Sound, District of Franklin, Northwest Territories; *Env. Can. & Ind. & Northern Affairs Can.*, Land Use Infor. Series Background Rep. No. 2, 110 p.

2337 SVOBODA, J., and FREEDMAN, B. - 1981
Ecology of a High Arctic Lowland oasis, Alexandra Fiord (78°53'N, 75°55'W) Ellesmere Island, N.W.T., Canada; *Univ. Toronto & Dalhousie Univ.* 1981 Progress Rep. of Alexandra Fiord Lowland Ecosystem Study, 245 p.

This second volume represents a summary of 1980 and 1981 full field seasons of research at Alexandra Fiord (78°53'N), Ellesmere Island, N.W.T., Canada. It was prepared as a "papers report" two months after the researchers returned from the North and much of the 1981 data are therefore preliminary. However, in projects which went through their second field season an attempt for more substantial contribution is clearly visible. All research described is ongoing. It is anticipated that most of the graduate student projects will be completed during the summer of 1982. Several studies, however, will continue part of 1982, climatology, plant and soil nutrient study, ecophysiology of certain species, invertebrate and breeding birds being among them.

Very few intensive studies in Ecosystem ecology have been conducted in the Canadian High Arctic. The only comprehensive study which has been completed to date was located at Truelove Lowland, on Devon Island. This dearth of information relevant to the ecology of the high arctic archipelago is significant, in view of the tremendous geography of this region, the sensitivity of the systems, and the scope of disturbance that could arise from northern resource development.

Most of the Arctic Archipelago north of Lancaster Sound is classified as polar desert or semi-desert, or is covered by ice fields. These are xeric, barren, and highly unproductive regions. However, certain localities generally infrequent in occurrence and small in size, have developed into relatively lush and productive ecosystems. These are usually uplifted lowlands, having favourable microclimates and moisture regimes, and are termed high arctic lowland oases. Virtually all of the resident and migratory terrestrial arctic wildlife depends on the primary production of these infrequent sites for their survival.

In order to contribute further information on the ecology of these rare Bio-enclaves we initiated in 1979, an intensive study of a lowland adjacent to Alexandra Fiord on Ellesmere Island. This site, in addition to being an exceptional

example of a lowland oasis, also has the great logistic advantage of accessibility and accommodation in an abandoned RCMP post.

The overall objectives of this project are to determine the environmental factors which influence plant diversity and primary production in the lowland, anomalously located in a region otherwise surrounded by barren polar desert and glaciers. Within the scope of these objectives we are carrying out studies of meso- and microclimate, soils, decomposition, distribution and production of plant communities, and the autecology of certain plant species.

The Alexandra Fiord lowland is a flat, roughly triangular, peri-glacial outwash lowland, approximately 12 km^2 in area. This lowland oasis is discrete and well-developed, being bordered on the southern apex by two glacial tongues, on the west and east side by steep talus slopes and cliffs, and on the north side by the oceanic waters of the fiord. The plant communities respond to the varying topography, drainage, soil substrates, and microclimate conditions within the lowland, and are modified accordingly. The western part of the lowland is well moistened by numerous seepages of meltwater from the upland plateaus for most of the growing season, and extensive and lush sedge-cottongrass meadows have developed here. These are dominated by *Carex stans, C. membranacea,* and *Eriophorum triste.* Also extensive are mesic white heather *(Cassiope tetragona)* fields. Associated species include *Carex misandra, Salix arctica, Dryas integrifolia,* and *Vaccinium uliginosum.* Another significant community type, but having lower cover and productivity, are rock outcrops and talus slopes, dominated by such species as *Papaver radicatum, Draba spp. Poa arctica,* and various species of crustose lichens. Also occurring are certain microsites having vigorous and phenologically advanced plant communities. These are located adjacent to the glacier, where they may be positively influenced by light reflected from the ice, and along the fiord coast, where light reflected from the sea ice may be of similar significance. Also large erratic boulders obviously influence the thermal regime of the biotic community surrounding the rocks. Other favourable situations, include disturbed areas around a fox denning site and near the buildings. Studies of these exceptional situations will yield information as to the environmental factors which have allowed their high production, (albeit on a very restricted scale) to occur. These same factors, operating at more moderate rates, are believed to be of significance in influencing the lushness of the lowland itself, compared with the surrounding barrens.

2338 YOSHIE, F., and FUJINO, K. - 1981
Vegetational Changes in Relation to Topography and Soil Environments in Arctic Tundra; *in* Joint Studies on Physical and Biological Environments in the Permafrost, North Canada, July to August 1980 and February to March 1981, Inst. Low Temp. Sci., ed. S. Kinosita, Hokkaido Univ., Japan, pp. 73-93.

Correspondence between the plant community and climate and topography is a well-established ecological concept. Although vegetational differences associated with differences in topography and soils in Arctic Coastal Plain have been studied by a large number of investigators, the relation between them using some simple indicators has not been attempted.

The water content in soil of the active layer is one of the good indicators of topography of a site at which it is located. The acidity pH of soil solution is also one of the typical physico-chemical properties of the site. Horiguchi reported that the pH value of soil solution decreased with increasing organic content and water content in the arctic tundra. Thus, the acidity pH of soil is one of the good indicators of the organic content of the soil in the active layer.

In this expedition we investigated the vegetational changes associated with the topography of a site as well as the relation between them through water content and acidity pH as simple indicators of soil, whereby we discussed interaction between vegetation and soil.

A vegetational pattern can be detected within an area of a few square kilometers and a few square meters in the arctic tundra. So, in our study we examined a vegetational pattern in a small-scale area. Vegetation was analyzed and soil was sampled at two experimental sites, one 2 km south of Tuktoyaktuk and the other around Ibyuk pingo, 4.4 km south-southwest of Tuktoyaktuk. The first site was mainly divided into three parts from their topographic features, that is, flat place, small hill, and high-center polygon. The elevation of this site was 1 to 8 m above sea level. Vegetation was dominated by *Eriophorum vaginatum* ssp.*vaginatum* (1st part), *Salix alaxensis* ssp. *alaxensis* and *Betula glandulosa* (2nd part) and *Betula glandulosa* (3rd part). Meanwhile, the second site was marsh, 0 to 0.6 m above sea level, and dominated by sedges and grasses.

2339 YOSHIE, F., FUKUDA, M., and TSUKADA, M. - 1981
Pollen Stratigraphy of Polygon Sediment at Tuktoyaktuk, N.W.T., Canada; *in* Joint Studies on Physical and Biological Environments in the Permafrost, North Canada, July to August 1980 and February to March 1981, Inst. Low Temp. Sci. Hokkaido Univ., Japan, pp. 117-121.

The ice-wedge polygon is one of the most striking features of land forms in the continuous permafrost regions. The process by which polygons are formed is complex and not thoroughly understood, but there is a sufficient body of facts known to permit a relatively simple outline of their origin, growth and decay. Contraction cracks into permafrost are formed in winter. Ice wedges are formed when contraction cracks become filled with snow and refrozen meltwater. A polygonal pattern is formed by cracks and then an ice wedge increases in width 0.5 to 2.0 mm per year. The pressure of the growing ice wedge eventually results in the formation of a low-center polygon.

Low-center and high-center polygons were observed in our study site. Black pointed out the existence of gradational formes of polygons. Black also stated that a polygon goes through a cycle that can be described as youth maturity and old-age - from a flat surface with cracks to a low-center polygon and finally to a high-center polygon. Britton stated that polygons occur in a developmental series, stem from the same origin, have the same potential future, and each form is simply the current representative of a stage reached. Britton hypothesized the 'thaw lake cycle' that includes these geomorphic changes through time. His main hypothesis follows: a thaw lake comes to existence as the sediment rises above the sea; the lake grows to maturity by thermokarst erosion of the shoreline and central basin; it is then captured and drained by small streams; the drained flat basin slowly changes to a low-center polygon with a ponded center; and finally an assembly of low-center polygons coalesce into thaw-pond which grew by marginal into a thaw lake similar to the original. Billings and Peterson examined and modified the Britton's hypothesis on the thaw lake cycle from a viewpoint on new observations on ice wedges and revegetation following drainage of lakes in the wet coastal tundra of arctic Alaska. But, all these results are based on examinations conducted for relatively short time and no determination was made concerning a time scale about the completion of one thaw lake cycle.

The objective of this study was to determine pollen stratigraphy from the sediment of high-center and low-center polygons at Tuktoyaktuk, N.W.T., Canada, and to understand the developmental process of ice-wedge polygons and their time scales.

2340 YOSHIE, F., and SAKAI, A. - 1981
Water status and Freezing Resistance of Arctic Plants; *in* Joint Studies in Physical and Biological Environments in the Permafrost, North Canada, July to August 1980 and February to March 1981; ed. S. Kinosita, Inst. Low Temp. Sci., Hokkaido Univ., Japan, pp. 95-110.

A study was made of water status and freezing resistance of plants in N.W.T., Canada, in an arctic tundra area 2 km south of Tuktoyaktuk and in area around the northern limit of boreal coniferous forest regions near Inuvik Scientific Research Center, Inuvik, the areas being called Tuktoyaktuk and Inuvik, respectively, in this paper.

2322 ZOLTAI, S.C., BOOTHROYD, P.N., and SCOTTER, G.W. - 1981
A natural resource survey of eastern Axel Heiberg Island, Northwest Territories; *Parks Can.* internal report, 156 p.

2323 ZOLTAI, S.C., McCORMICK, K.J., and SCOTTER, G.W. - 1983
A natural resource survey of Bylot Island and adjacent Baffin Island, Northwest Territories; *Parks Can.*, internal report, 176 p.

CESAR

2341 BEAUDOIN, A. - 1983
CESAR 83: La fin d'une énigme?; *GEOS*, EM&R, vol. 12, no. 2, pp. 18 and 20.

2342 MUNGALL, C. - 1983
CESAR - 60 days on the ice - an exercise in inventiveness and cooperation; *GEOS*, EM&R, vol. 12, no. 2, pp. 17, 19 and 21.

2343 OHLENDORF, P., and VAN DUSEN, J. - 1983
Staking an arctic claim; *Maclean's*; vol. 96, no. 14, p. 48.

2344 WEBER, J.R., SWEENEY, J.F., and JUDGE, A.S. - 1981
CESAR 83, Canadian Expedition to Study the Alpha Ridge; *Energy, Mines & Res. Can.*, Earth Phys. Br. internal report, 81 p.

CLIMATOLOGY

2345 ABURAKAWA, H. - 1981
Microclimatic Investigations of the Arctic Tundra; *in* Joint Studies on Physical and Biological Environments in the Permafrost, North Canada, July to August 1980 and February to March 1981; ed. S. Kinosita, Inst. Low Temp. Sci., Hokkaido Univ., Japan, pp. 1-11.

As part of the permafrost expedition in North Canada, the microclimatic regimes of this region were investigated.

The study site, situated on the open tundra area near Tuktoyaktuk, Mackenzie Delta, is characterized by the low-polygonal patterned ground. Micrometeorological observations were carried out at this site.

The present paper summarizes results of analyses of the data, part of which were supplied by the meteorological station of Tuktoyaktuk.

2346 ALT, B.T. - 1983
Synoptic analogs: a technique for studying climatic change in the Canadian High Arctic; *in* Climate Change in Canada 3, Syllogeus, no. 49, ed. C.R. Harington, Nat. Museums Can., pp. 70-107.

Considerable emphasis has been placed, recently, on the study of climatic change through analysis of trends in temperature on both hemispheric and regional scales. In the Queen Elizabeth Islands mass balance measurements are available beginning in 1960, whereas meteorological records begin in the late 1940s. This brief period of record provides only a glimpse of the climate of the QEI and allows discussion of only short-term trends. Even on a hemispheric scale, "The range of year-to-year variability in most data sets is several times larger than the departure due to long-term trends.". In

the QEI where Maxwell indicates a 0.5°C decrease of temperature during the period of record, standard deviations of monthly mean temperature range from 1 to 4°C. The impact of these year-to-year variations is magnified by the sensitivity of the Arctic environment to small changes in temperature-particularly during spring and summer. These season-to-season variabilities can, however, be exploited as a means of examining the degree to which paleoclimate changes, of the order of magnitude of the Climatic Optimum and Little Ice Age, can be accounted for by changes in the frequency of occurrence of present synoptic weather patterns.

2347 FISHER, D.A. - 1982
Carbon-14 production compared to oxygen isotope records from Camp Century, Greenland and Devon Island, Canada; *Climatic Change*, vol. 4, pp. 419-426.

Carbon-14 production rate variations that are not explainable by geomagnetic changes are thought to be antiphase with solar activity and as such should be in antiphase with paleotemperature records or proxy temperature histories such as those obtainable from oxygen isotope analyses of ice cores. Oxygen isotope records from Camp Century, Greenland and Devon Island Ice Cap are in phase with each other over thousands of years and in antiphase to the ^{14}C production rate residuals.

2348 FISHER, D.A., and KOERNER, R.M. - 1983
Ice-core study: a climatic link between the past, present and future; *in* Climate Change in Canada 3, Syllogeus, no. 49, ed. C.R. Harington, Nat. Museums Can., pp. 50-69.

Research over the past 20 years has substantiated the pioneer work of Manley and Lamb in emphasizing the variable nature of climate at almost all wavelengths. However, ideas concerning the nature of future climatic changes, unfortunately, seem to follow the trends of fashion. Experts in one decade consider we are entering an ice age, whereas those in the next believe we are due for a dramatic warming. What we, as scientists, should emphasize in this period of academic flux is that climate has changed in the past and will change in future. We must, therefore, generate our best estimates of the *degree* of climatic change that is likely to occur in the future in order to allow and encourage the development of contingency plans to accommodate all possible changes. The northern boundary of cultivable land crosses Canada from east to west. So the country is peculiarly sensitive to climatic change - especially in terms of the length of the growing season. This in turn has profound political implications, Canada being the world's second largest grain exporter.

In this paper we will outline the way climate has changed in the High Arctic over the past few thousand years, giving particular attention to the last few hundred years. Based on knowledge of the past, we will attempt to evaluate the magnitude of climatic change, extrapolate our climatic record a few decades into the future, and indicate how this might affect human development and extractive industries in the North. We consider only the natural climatic record, essentially disregarding various effects produced by people. The magnitude of these effects, termed anthropogenic, are disputed and we will mention them briefly later.

2349 FISHER, D.A., KOERNER, R.M., PATERSON, W.S.B., DANSGAARD, W., GUNDESTRUP, N., and REEH, N. - 1983
Effect of wind scouring on climatic records from ice-core oxygen-isotope profiles; *Nature*, vol. 301, no. 5897, pp. 205-209.

Removal of winter snow by wind explains why the annual mean oxygen-isotope ratio at an ice divide is 2.5 ‰ less negative than it is 1.2 km downslope. Cores from two sites on an ice cap, Ellesmere Island, Canada, show past variations in the difference, depending on where the ice originated relative to the scoured zone. Some ice-core climatic records may need correction for scouring.

2350 KOERNER, R.M., FISHER, D., and ALT, B. - 1981
Glacier Studies - Arctic - Queen Elizabeth Islands; *Ice*, no. 65, 1st issue, p. 2.

2351 KOERNER, R.M., FISHER, D., ALT, B., PARNANDI, M., and BOURGEOIS, J. - 1982
Glacier Studies - Arctic - Queen Elizabeth Islands; *Ice*, no. 68, 1st issue, p. 2.

2352 MAXWELL, J.B. - 1981
Climatic Regions of the Canadian Arctic Islands; *Arctic*, vol. 34, no. 3, pp. 225-240.

As a result of a comprehensive assessment of the climate of the Canadian Arctic Islands and adjacent waters, five climatic regions were identified. The regional boundaries were delineated by an analysis of the influence of the major climatic controls while further regional subdivisions were arrived at through consideration of the fields of the standard observed meteorological elements. Short discussions of the climatic characteristics of each sub-region are given and tables outlining values of selected climatic elements are presented. A brief discussion of climatic change across the entire area is included.

2353 OHMURA, A. - 1982
Evaporation From the Surface of the Arctic Tundra on Axel Heiberg Island; *Water Resources Res.*, vol. 18, no. 2, pp. 291-300.

Hourly and daily evaporation rates were measured at the base camp (79°25'N, 90°45'W, 200 m above mean sea level) as part of the energy balance program during the Axel Heibergy Island Expedition in spring and summer of 1969, 1970,

and 1972. The study period covered about 50 days of the dry snow period, 15 days of the melt period, and 2 months of the postmelt period in each year. The measuring and analysis methods are described, in that the aerodynamic profile method is examined, objective criteria are developed to accept or reject the profile data for the Bowen ratio energy balance method, and the problems of the snow lysimeter and the ordinary weighing lysimeter are described. Systematic differences among these methods are presented, and the causes for the differences are examined. Seasonal and diurnal variations of the evaporation rate are discussed. A unique effect of the föhn on evaporation is found and the cause investigated. Each season, characterized by different surface conditions, is found to possess a rather distinctive evaporation rate and ratio of latent heat flux to net radiation. The annual total evaporation is estimated at 140 mm, which is equivalent to 80% of the annual total precipitation, the remaining 20% being annual total runoff. The runoff occurs mostly during and immediately after the melt of the snow cover.

2354 OHMURA, A. - 1982
Regional Water Balance on the Arctic Tundra in Summer; *Water Resources Res.*, vol. 18, no. 2, pp. 301-305.

The regional distributions of evaporation and precipitation were investigated on the arctic tundra on Axel Heiberg Island, Northwest Territory, Canada, during the summers of 1969 and 1970. The measurements were made using small weighing lysimeters and Canadian standard rain gauges installed at eight locations ranging in altitude from the sea level to 800 m above mean sea level. The mean evaporation rate for the snow-free period increases slightly with altitude. The total evaporation for the snow-free period at high altitudes, however, is cut short due to the longer duration of the snow cover. Consequently, the total summer evaporation shows a maximum value in the altitude zone between 100 and 600 m. Summer total precipitation increases steadily with altitude, exceeding evaporation at about 500 m. Below this altitude, most of the annual runoff takes place during and immediately after the melt of the winter snow cover. At higher altitudes, runoff is observed throughout summer.

2355 OHMURA, A. - 1982
Climate and energy balance on the Arctic tundra; *J. Climatology*, vol. 2, pp. 65-84.

Energy balance measurement on the arctic tundra on the midwest coast of Axel Heiberg Island, N.W.T., Canada, is summarized. The methods and the instruments as well as their difficulties in the arctic field conditions are described. The seasonal characteristics of the energy balance are presented for the dry snow, the melt and the postmelt periods. The diurnal variations of the energy balance for each of these periods are also presented.

The climatic differences for the regions of the tundra, glaciers and the arctic seas become prominent during the three summer months of June, July and August. The energy balance at the present site is compared with that of Barrow, Alaska, revealing a high degree of similarity. The slight differences between them are more net radiation, more sensible and latent heat fluxes, larger Bowen ratio and less soil heat flux at Barrow. These differences are considered to be due to the larger distance of the present station from the coast.

The energy balance on and in the dry snow cover is investigated. The stability of the snow cover is attributed to the high reflectivity as well as to the large absorptivity of its surface with respect to solar radiation. The absorption occurs mainly at the surface of the snow cover rather than its interior. This condition facilitates the efficient removal of the absorbed energy from the surface by the atmosphere.

The energy balance on the tundra is compared with those on the Central Arctic Ocean, the ablation area of the polar glaciers, the accumulation area of the glaciers and the boreal forests. The surfaces of the tundra, ablation area of the glaciers and the Central Arctic Ocean are found to receive similar net radiation, despite the albedo differences. The fundamental difference among these surfaces is the magnitude of the latent heat of melt. This component on the ablation area of the glaciers and the Central Arctic Ocean is four to six times larger than on the tundra, which results in differential heating and evaporation in these regions. This difference is considered to be the basis of the milder climate in the tundra region in the Arctic.

More substantial differences are found between these low altitude arctic surfaces and the accumulation areas of the glaciers and the boreal forests. The differences are due to the large variation in albedo for the former and to the difference in global radiation for the latter. These differences ultimately regulate the regional variations in net radiation, sensible and latent heat fluxes.

2356 OHMURA, A. - 1982
Review Paper - a historical review of studies on the energy balance of Arctic tundra; *J. Climatology*, vol. 2, pp. 185-195.

The main field experiments and climatological calculations of the surface energy balance on the arctic tundra are reviewed, following the historical development of theories and instruments. The scientific significance and problem areas of individual studies are discussed and the present status of understanding the energy balance on the arctic tundra is described.

2357 OHMURA, A., and STAUFFER, B. - 1982
North Water - Oase im Eismeer; *in* Forschung und Technik, Neue Bürcher Beitung, Mittwoch, September 29, 1982, Nr. 226, pp. 61-64.

2358 RITCHIE, J.C., CWYNAR, L.C., and SPEAR, R.W. - 1983

Evidence from north-west Canada for an early Holocene Milankovitch thermal maximum; *Nature*, vol. 305, no. 5930, pp. 126-128.

According to Milankovitch theory of global climatic change, maximum summer solar radiation at high latitudes of the Northern Hemisphere occurred at 10,000 yr BP. In particular, it predicts summer solstice radiation greater by 9-10%. Preliminary climate simulation experiments with these increased values of radiation confirm that high-latitude land surfaces received maximal insolation at ~10,000 yr. Paradoxically, however, the large volume of fossil pollen and other evidence from North America indicates a maximum of Holocene warmth at 7,000-6,000 yr, and a recent review of the evidence from New England suggests that the warming began at 9,000 and ended at 5,000 yr, but also stresses the difficulties of interpretation in terms of climate change. We summarize here data from sites in the northwest corner of mainland Canada that directly support the Milankovitch hypothesis.

EQUIPMENT

2359 EATON, R.M., McALONEY, M., MORTIMER, A., SCHENING, E., and WALDOCK, B. - 1982
Beaufort Sea Loran-C Tests; *Can. Aeronautics & Space J.*, vol. 28, no. 1, pp. 9-17.

Hydrocarbon and mineral extraction from the Canadian Arctic is becoming both attractive and practical as prices rise and the technical problems of operating in the Arctic are solved. Exploration is now in full swing, some mines are already operating, and there are strong prospects of oil production later this decade.

Much of the oil and gas production will be offshore and this will demand reliable navigation, both to service the production rigs with safety and to ship out the oil in an environment that is very vulnerable to spills. The Beaufort Sea has some of the most promising prospects, but it also has hazards to tankers in the shape of underwater pingos (ice-cored mounds rising to within 9 m of the sea surface) coupled with a combination of shallow coastal waters and a low coastline that make navigation by radar of limited use.

Clearly, some form of radio navaid will eventually be required in the Beaufort Sea, and in other parts of the Arctic. This test of Loran-C as one such navaid arose out of the shared interests of the Canadian Coast Guard (CCG) as operators of all Canadian public-use navaids, of Dome Petroleum Limited as potential users in the Arctic, and of the Canadian Hydrographic Service (CHS) who have experience in Loran-C and use it for offshore survey work.

Loran-C is an LF radio aid, which has been adopted by the USA and Canada as a standard marine navaid. It is described in most texts on electronic navigation. Loran-C has been used widely for a decade in ice-free waters, and it operates at much the same frequency as Decca, which has been used for surveying in the Canadian Arctic since 1960 by the Canadian Government's Polar Continental Shelf Project (PCSP).

In spite of this experience, there was a need to find out how well Loran-C performs under Arctic conditions.

2360 MORTIMER, A., and MILNER, P. - 1980
Loran-C and Omega navigation system tests in the Beaufort Sea; *Fish. & Oceans*, Inst. Ocean Sci., Sidney, Pacific Marine Sci. Rep. No. 80-4, 84 p.

This report describes Loran-C skywave reception in the Beaufort Sea. The accuracy of Loran-C positions using this mode of reception is evaluated. Omega reception was also monitored in the Beaufort Sea and the accuracy of positions obtained with an MX1105 Satnav/Omega receiver are given.

2361 NEAL, C.S. - 1982
High resolution radio echo sounding on Ellesmere Island, Northwest Territories; *Polar Record*, vol. 21, no. 130, pp. 61-64.

In May 1981 a four-man team visited the Aggassiz Ice Cap in northern Ellesmere Island. Their aim was to use a new high resolution radio echo sounder to investigate the link between radio echo layers and ice core stratigraphy, in particular between the radio echo layers and density fluctuations in the firn layer.

GENERAL

2362 ANONYMOUS - 1983
Polar Shelf work gets break; *news north*, vol. 38, issue 17, p. A5.

2363 BLAKE, Jr., W. - 1980
Glacial Sculpture; *GEOS*, Spring 1980, pp. 10-13.

2364 BLISS, L.C. - 1978
Opinion Paper - The Role of Science in the North; *in* Northern Transitions, Sec. Nat. Workshop on People, Resources and the Environment North of 60°, eds. R.F. Keith and J.B. Wright, Can. Arctic Resources Com., Ottawa, 470 p.

When reviewing the material of the last ten years, the most frequently heard plea is for an increased concentration on northern research. Either we speak from a broken record or those that listen are hard of hearing. Why are we being relatively unsuccessful in our urgings?

What can be done to change this pattern and image? I do not pretend to have the answers to these difficult questions; however, I do have some thoughts on the subject.

2365 CHANTER COLBY, J. - 1983
Snow blindness, polar bears part of Arctic experience; *The Brighton Independent*, Wed., August 24, p. 5.

2366 COCHRAN, G.V.B. - 1982
Report of the Polar Mountains Expedition; *Polar Cont. Shelf Proj.*, internal report, 23 p.

2367 DYSON, J. - 1983
Amarok's Endless Arctic Odyssey; *Reader's Digest*, May 1983, pp. 164-170.

On his long, arduous journeys, Fred Bruemmer captures the great light of the Arctic in the click of his shutter. You may never want to go to the deep-frozen lands and seas at the top of the map, but he makes you glad they're there.

2258 ENGLAND, J., KERSHAW, L., LaFARGE-ENGLAND C., and BEDNARSKI, J. - 1981
Northern Ellesmere Island: a natural resource inventory; *Univ. Alta.*, Report to Parks Can., 237 p.

2368 ENGLAND, J. - 1983
Ellesmere Island needs special attention; *Can. Geographic*, vol. 103, no. 3, pp. 8-17.

2369 ITO, H. - 1982
Wind Through a Channel - Surface Wind Measurements in Smith Sound and Jones Sound in Northern Baffin Bay; *J. Applied Meteorology*, vol. 21, no. 8, pp. 1053-1062.

Surface wind was measured in Smith Sound and Jones Sound in northern Baffin Bay in conjunction with an investigation of the North Water. The influence of local topography on the surface wind was found to be especially strong where the sea narrows to form a channel. Surface wind through a channel seems to be confined within the channel; the wind direction is adjusted to run parallel to the channel orientation.

2370 JONKEL, C., and HOBSON, G. - 1983
The Eighth Continent; *Western Wildlands*, vol. 9, no. 2, pp. 33-36.

The Polar Sea is not an ordinary sea: It is covered either seasonally or for the entire year with from three to sixteen feet of sound, resilient ice. Whether broken or solid, the ice is a very stable platform, and vast areas can be used for travel or temporary living. Long unused by man, except by the native arctic peoples and the occasional arctic explorer or research team, ice should be viewed not as a foe, but as both a seasonal extension of "land" and as a renewable resource.

2279 KARASIUK, D.J., and BOOTHROYD, P.N. - 1982
Preliminary environmental assessment of proposed harbour sites at McKinley Bay and Baillie Islands, Northwest Territories, Volume II: Potential effects of harbour and associated development on wildlife; *Govt. N.W.T.*, Can. Wildl. Serv., 46 p.

2371 KING, L. - 1981
Gebiet der Heidelberg - Ellesmere Island Expedition 1978, Northwest Territories, Canada, Orthophotokarte 1:25000, Oobloyah Bay.

2285 KINOSITA, S. - 1981
Joint Studies on Physical and Biological Environments in the Permafrost, North Canada, July to August 1980 and February to March 1981; ed. S. Kinosita, Inst. Low Temp. Sci., Hokkaido Univ., Japan, 121 p.

2372 LEHN, W.H., and GERMAN, B.A. - 1981
Novaya Zemlya effect: analysis of an observation; *APPLIED OPTICS*, vol. 20, no. 12, pp. 2043-2047.

The Novaya Zemlya effect, historically identified with the premature rebirth of the sun during the polar night, is a long range optical ducting phenomenon in the lower atmosphere. An occurrence of the effect was observed at Tuktoyaktuk, Canada (69°26'N, 133°02'W) on 16 May 1979, when the minimum solar altitude was -1°34'. The sun's image remained above the horizon, within a gray horizontal band, and assumed the various expected shapes, ranging from a bright rectangle filling the band, to three flat suns stacked one over the other, to several thin vertically separated strips. A model for the corresponding atmospheric conditions was identified by matching the observations with images calculated from a computer simulation study.

2373 MacINNIS, J. - 1982
The Breadalbane Adventure; published by Optimum Publishing International Inc., Montreal, Can., 171 p.

There are those today who decry the lack of opportunity for adventure in a world of exploding population, the consequent development of once virgin lands, and the transportation and communication networks that put every corner of our globe in instant touch with every other.

To a large extent they are right - when they speak of the surface of our globe. But there are still two great, almost limitless areas, where exploration has only begun - the outer space beyond our atmosphere, and the inner space below our oceans.

There, adventure still is to be had, and there are adventurers eager to assault these hostile environments.

They are our 20th century pioneers, pushing our frontiers into the reaches where our future may lie. Our astronauts have begun the utilization of outer space with the U.S. space shuttle program. Our aquanauts are pushing ever deeper into the oceans probing the vast reaches which some day may be the principal source of our foods, minerals and, perhaps even, domicile.

Along with our future, under the oceans we may also find some clues to our past. Such is the nature of the Breadalbane expedition.

But out of the two should come invaluable experience in tapping the vital resources that well may lie below the forbidding Arctic ice cap.

As this is written, only the preliminary work has been done on that incredible challenge, but already it comprises a fascinating, gripping story of man's daring and ingenuity and his heroic willingness to take personal risk to further man's knowledge.

2374 MacINNIS, J.B. - 1982
The Breadalbane project: a progress report; *Can. Geographic*, June/July 1982, pp. 68-71.

2375 MacINNIS, J.B. - 1983
Exploring a 140-year-old Ship Under Arctic Ice; *Nat. Geographic*, vol. 164, no. 1, pp. 104A-104D.

Exploration of *Breadalbane* was conducted from our camp on the sea ice a mile south of Beechey Island. Cutting through six feet of ice at two separate points, we erected tents over the holes to protect the operators and equipment of WASP and RPV. To establish the camp we brought supplies in by air and by tractor train across the sea ice from the outpost of Resolute on Cornwallis Island, some 60 miles to the west. Hampered by a steady temperature of minus 20° Celsius but aided by clear skies and 24-hour daylight, we managed six man-hours of diving on *Breadalbane* and more than twice that time exploring with the RPV, all within the space of 18 days. Finally we broke camp and on May 9, 1983, set out for Resolute and home.

2376 MacKAY, G. - 1983
Into the tomb of HMS Breadalbane; *Maclean's*, June 6, 1983, pp. 42-44.

2377 McNEELY, R. - 1982
Ambient pH levels in environmental samples from the High Arctic; *in* Current Res., Part C; Geol. Surv. Can., Paper 82-1C, pp. 111-114.

2378 MORROW, C.J. - 1983
Impressions of Bylot Island; *Carnegie Magazine* Vol. LVI, no. 12, pp. 30-31.

2379 PAYNE, D. - 1983
H.M.S.Breadalbane; *Northwest Explorer*, vol. 2, no. 2, pp. 6-9.

2380 SIGVALDASON, J. - 1982
Fostering an explosion in Arctic research; *news/north*, Friday, April 30, 1982, pp. A-8 & A-9.

2381 SIGVALDASON, J. - 1982
Informing people in settlements a priority; *news/north*, Friday, May 7, 1982, p. B1.

2303 SMITH, T.G. - 1981
Sea hunters; *Oceans*, vol. 14, no. 3, May-June 1981, pp. 16-17.

2306 STEWART, D.B., and BERNIER, L.M.J. - 1982
An aquatic resource survey of islands bordering Viscount Melville Sound, District of Franklin, Northwest Territories; *Env. Can. & Ind. & Northern Affairs Can.*, Land Use Infor. Series Background Rep. No. 2, 110 p.

2382 WAINWRIGHT, P., and FENTON, W. - 1983
Beaufort Sea 1983 Shoreline Drift Plastic Survey; *Polar Cont. Shelf Proj.*, internal report, 12 p.

While carrying out field programs based out of the Polar Continental Shelf Project base in Tuktoyaktuk, EPS staff received various reports from other researchers and helicopter pilots of quantities of plastic wastes washed up along the shores of Tuktoyaktuk Peninsula. In response to these reports it was decided to carry out a helicopter survey of the shoreline on July 10, 1983 to investigate the occurrence of such wastes. This report documents the results of that survey.

2383 WASHBURN, A.L., and EASTERBROOK, D.J. - 1982
Presentation of the Kirk Bryan Award to John Ross Mackay - Citation and Response; *Bull. Geol. Soc. Amer.*, vol. 93, no. 4, pp. 361-362.

2320 WILLIAMS, S. -
The report of the Joint Services Expedition to Princess Marie Bay, Ellesmere Island, 1980; *Polar Cont. Shelf Proj.*, internal report, 390 p.

2322 ZOLTAI, S.C., BOOTHROYD, P.N., and SCOTTER, G.W. - 1981
A natural resource survey of Eastern Axel Heiberg Island, Northwest Territories; *Parks Can.*, internal report, 156 p.

2323 ZOLTAI, S.C., McCORMICK, K.J., and SCOTTER, G.W. - 1983
A natural resource survey of Bylot Island and adjacent Baffin Island, Northwest Territories; *Parks Can.*, internal report, 176 p.

2384 BALKWILL, H.R., HOPKINS, Jr., W.S., and WALL, J.H. - 1982
Geology of Lougheed Island and nearby small islands District of Franklin (Parts of 69C, 79D); *Geol. Surv. Can.*, Memoir 395, 22 p., 3 maps.

A succession of Lower and Upper Cretaceous terrigenous clastic rocks, about 1540 m thick, is exposed on Lougheed Island and nearby small islands; the exposed rock units are the Isachsen, Christopher, Hassel, Kanguk, and Eureka Sound formations. Two exploratory wells drilled on Lougheed Island penetrated Mesozoic rocks to the level of the Lower Triassic Bjorne Formation. The Mesozoic succession at Lougheed Island is significantly thinner than it is eastward toward the central part of the Sverdrup Basin.

A syncline with gently dipping limbs plunges southward toward central Lougheed Island. Small flexural-flow folds, with enigmatic origins, are present on Edmund Walker Island.

Regional studies indicate that favourable prospects for hydrocarbons should exist in the environs of Lougheed Island: the island is about midway between proven large natural gas fields at King Christian Island and at Sabine Peninsula (Melville Island); and the subsurface rocks should have general levels of organic maturation, reservoir quality, and geological structure comparable with those fields.

2385 BARAGAR, W.R.A., and LOVERIDGE, W.D. - 1982
A Rb-Sr study of the Natkusiak Basalts, Victoria Island, District of Franklin; *in* Rb-Sr and U-Pb Isotopic Age Studies, Report 5; *in* Current Research, Part C, Geol. Surv. Can., Paper 82-1C, pp. 167-168.

The age of the Natkusiak Formation of basaltic flows, Victoria Island, is of interest because of its paleomagnetic correlation with the Franklin Magnetic Interval. Rb-Sr results on six dolerites and eight flow basalt samples show linear trends suggesting ages of 2200 and 384 Ma, both of which are unacceptable in terms of a primary age for these rocks. The older age suggests that the dolerites are, contrary to previous belief, contaminated with crustal material, whereas the 384 Ma alignment is unexplained, but may also be due to contamination, or to late or post Devonian uplift.

2386 BARSCH, D., and STABLEIN, G. - 1980
Geomorphologische karte 1:25 000 Oobloyah Bay, Ellesmere Island, N.W.T., Canada.

2363 BLAKE, Jr., W. - 1980
Glacial Sculpture; *GEOS*, Spring 1980, pp. 10-13.

2387 BLAKE, Jr., W. - 1982
Coring of frozen pond sediments, east-central Ellesmere Island: a progress report; *in* current Research, Part C, Geol. Surv. Can., Paper 82-1C, pp. 104-110.

The program of coring frozen pond sediments, initiated in 1978, has been continued in succeeding field seasons. The aim at first was to sample shallow ponds below the limit of Holocene marine submergence in order to obtain chronological and paleoecological information. The region is characterized by steep and rough terrain and, unlike other parts of Ellesmere Island, the few pockets of raised beaches are generally lacking in driftwood, hence dating the basal organic pond sediment was one way of studying the pattern of emergence. The work has been expanded, in 1981 and 1982, to include ponds at higher elevations. These ponds also freeze to the bottom each winter, and they cannot be sampled with conventional lake coring equipment because the basal organic sediments never thaw. This note summarizes highlights of field results obtained since 1978, when a preliminary report was issued. Laboratory work is under way on various facets of a number of cores, but this is not expected to be completed for several years.

2388 BLAKE, Jr., W. - 1982
Terrestrial interstadial deposits, Ellesmere Island, N.W.T., Canada; *Abstract in* Amer. Quaternary Assoc., 7th Biennial Meeting, June 28-30, 1982, Seattle, Wash., p. 73.

Wood with finite ages in the 30,000 to 40,000 year-range has been recovered recently from two sites in Ellesmere Island, N.W.T. Terrestrial organic deposits examined previously in the Queen Elizabeth Islands have yielded ages beyond the limit of the ^{14}C method; e.g., a massive peat near the head of Makinson Inlet, Ellesmere Island is >52,000 years old.

The first collection was made in 1977 on the west side of the central Ellesmere Island ice cap, 16 km north of the Makinson Inlet peat locality cited above. Three twigs, extracted from frozen silt in a gully adjacent to Glacier 7A-45 (77°49.8'N; 130-140 m a.s.l.), gave an age of 32,500 ± 1580 years. The wood was probably Salix sp., and the enclosing silt was interpreted as being of lacustrine origin.

More extensive collections were made on a revisit to the site in 1981. Fine twigs (all <4mm in diameter) contained in a 5 cm-thick band of organic debris, beneath till, gave an age of 31,100 ± 480 years. Although the organic band was not an in situ buried tundra surface, the well preserved nature of the fragile twigs and of the accompanying seeds and mosses suggests deposition in a pond with minimum transport. Fossils present include fragments of a ground-beetle, *Amara alpina*, and seeds of either *Arctostaphylos alpina* or *A. rubra*, none of which live at this latitude today. The deposit also contains a rich assemblage of luxurious mosses, in which the dominant species is *Tomenthypnum nitens*.

The overlying till is a compact unit, forming miniature cliffs; it is distinct from the loose bouldery till deposited on top of Holocene peat nearer Glacier 7A-45 by a readvance within the

last century. Additional work will be required, however, to unravel the complex sequence of events at this site. Well developed ice wedges and buried ice masses of unknown origin are present, other organic layers occur, and much of the ground surface has a veneer of Shield erratics (the rocks underlying the unconsolidated Quaternary deposits are steeply-dipping Tertiary sediments).

The second locality, northeast of Oobloyah Bay on the north side of Nansen Sound, is 340 km due north of the site described above. A variety of organic materials were collected in 1978 by members of the Heidelberg Ellesmere Island Expedition. Perhaps the most interesting age determination is one on wood, presumably also willow, which was thawing out of the basal ice of Webber Glacier (80°53'N; 175 m a.s.l.). The age of this sample was 37,550 ± 1420 years.

These two groups of age determinations demonstrate the existence of significant ice-free enclaves in the High Arctic at the same time that widespread recession of the Laurentide and Cordilleran ice in southern Canada occurred.

2252 BOOTHROYD, P.N. - 1983
Preliminary assessment of potential environmental effects of the borealis iron ore development proposal on birds of Melville Peninsula, N.W.T.; *Env. Can.*, Can. Wildl. Serv., Wpg., internal report, 132 p.

2389 CECILE, M.P., HUTCHEON, I.F., and GARDNER, V. - 1982
Geology of the northern Richardson Anticlinorium (Map areas 106L/12, 13, 116 1/9, 16); *Geol. Surv. Can.*, Open File No. 875.

This Open File consists of a geological map at a scale of 1:125 000 based on field work in 1982 showing detailed stratigraphy of Lower Paleozoic basin facies and occurrences of barite veins and strata that react to field tests for zinc.

2390 CLARK, D.L., MORRIS, T.H., and BLASCO, S.M. - 1983
Pleistocene sedimentation patterns for the Lomonosov Ridge and Amerasian Basin, Central Arctic Ocean; *Abstract in* Proc. Geol. Soc. Amer., *LOREX Contr. No. 18.*

Sixteen short sediment cores taken as part of the Lomonosov Ridge Experiment (LOREX) include most of the same stratigraphic units as those described from the Alpha-Chukchi areas, some 300 km distant. The LOREX cores include at least 12 sedimentary units differentiated by texture, color and carbonate content. The units are silty and arenaceous lutites and are principally glacial-marine. Benthic and planktonic foraminifera, degree of bioturbation and Fe-Mn micronodule abundance generally are positively correlated. Foraminifera in core B-8, from 3956 m in the Makarov Basin, have been affected by CCD fluctuations that did not affect core B-24, from 1600 m on the crest of the Lomonosov Ridge.

The 12 stratigraphic units were deposited during the late Pleistocene and represent the same major sedimentary events as those of stratigraphic units K, L and M of the Amerasian Basin. This correlation is excellent evidence for the remarkable and widespread uniform depositional style of glacial marine sediment. Times of major glacial ice transport reflect deglaciation events in the Central Arctic Ocean. Surface currents during deglaciation transport glacial ice in a more or less uniform pattern over at least 50% of the Arctic Ocean. Even thin sedimentary units deposited during relatively long time intervals are correlated over more than 500,000 km^2.

2391 DANKERS, P. - 1982
Implications of Early Devonian poles from the Canadian Arctic Archipelago for the North American apparent polar wander path; *Can. J. Earth Sci.*, vol. 19, no. 9, pp. 1802-1809.

Lower Devonian red beds from the upper member of the Peel Sound Formation at Prince of Wales Island (Canadian arctic) yield two different paleopoles at 25N 099E and at 01N 091E, the first one being older than the second one. The magnetic directions from which the poles are calculated are derived from vector analysis of thermal, chemical, and alternating magnetic field demagnetization results. Normal and reversed polarities are recorded for the northerly pole, whereas the pole at the equator reveals mainly a normal polarity. The position of the pole close to the equator has significant implications for the early Paleozoic apparent polar wander path of the North American craton. It appears that from the Late Cambrian to Early Devonian the craton moved continuously in a counter-clockwise direction that ended abruptly in the Early Devonian when the direction of the motion of the continent was reversed in a very similar manner to what occurred in Late Cambrian times.

2392 DAWES, P.R., FRISCH, T., and CHRISTIE, R.L. - 1982
The Proterozoic Thule Basin of Greenland and Ellesmere Island: importance to the Nares Strait debate; *Meddr Grønland, Geosci.*, vol. 8, pp. 89-104.

Onshore geological investigations in the Smith Sound region are now so advanced as to allow correlation between Canada and Greenland to be made with confidence.

The Precambrian Shield is unconformably overlain by unmetamorphosed Proterozoic strata (Thule group) that are best preserved in Greenland, where they attain a thickness of at least 4.5 km. Less than 1100 m are present in southeastern Ellesmere Island, but the succession is so similar to the lower part of the Greenland succession that unit to unit correlation of both sedimentary and volcanic rocks is possible. This correlation strongly supports the concept of a single intracratonic basin (Thule Basin) spanning the southernmost part of Nares Strait. In Greenland the basin is well defined and its northern margin is at about 78°15'N. In Elles-

mere Island paucity of outcrop provides less definition but the northern margin lies between Baird Inlet (78°30'N) and Bache Peninsula (79°N).

The lithological and thickness correlation of the Proterozoic successions on the opposite shores of the Smith Sound region strongly suggests that any tectonic movement along the Nares Strait lineament has not resulted in major net transcurrent displacement of Greenland and Ellesmere Island.

2393 DAWSON, M.R., and WEST, R.M. - 1982
Cenozoic Vertebrates and Floras in the Arctic; *Nat. Geographic Soc. Res. Reps.*, vol. 14, pp. 143-148.

The lake sediments in Haughton Astrobleme, Devon Island, produced a peculiar assemblage of vertebrates dominated by fish and a very large pika (family Ochotonidae). The only other well-represented mammal is a peculiar artiodactyl. The age of this fauna is probably late Miocene.

Fossil leaves and wood are abundant in the Eureka Sound Formation. In the first year of the project, some specimens were collected but this was not done systematically until 1977, when palynological samples were made from two localities in the Eureka Sound Formation. A more extensive paleobotanical project was undertaken in 1979, when fossil leaves, wood, and pollen were collected from one area on Axel Heiberg Island and four areas on Ellesmere Island.

Collecting invertebrate fossils has not been a primary object of our work, but samples of marine and nonmarine invertebrates have been collected.

2394 DIXON, O.A., and PARKINS, W.G. - 1982
Coral distribution in a Silurian marine limestone sequence in the Canadian Arctic; Third North Amer. Paleontological Convention, Montreal, Aug. 5-7, 1982; *Abstract in* J. Paleontology, vol. 56, Suppl. no. 2, p. 8.

Corals flourished during deposition of the Upper Silurian Douro Formation on Somerset and Cornwallis Islands. Although this subtidal shelf limestone sequence is largely monotonous lithologically, it shows marked variations in coral abundance and diversity with stratigraphic level. This apparently reflects subtle variations in environments of deposition. Diverse coral faunas occur in and around lithistid sponge bioherms in two main intervals of the Douro Formation. Favositid and syringoporid tabulate corals, cerioid, fasciculate and solitary rugose corals and heliolitid corals all occur with greatest diversity in bioclastic haloes around the bioherms. The bioherms and their bioclastic haloes evidently provided plentiful attachment sites for the benthic coral fauna. Coral faunas of much lower diversity occur outside the biohermal intervals and typically include unattached ballasted solitary rugosans and discoid to hemispherical favositid and syringoporid corals. Corals are typically absent from strongly argillaceous parts of the Douro Formation. Bowl- and saucer-shaped solitary rugosans of the genera *Mucophyllum* and *Schlotheimophyllum*, the cerioid rugosan *Mazaphyllum* and the heliolitid genera *Heliolites, Squameolites* and *Stelliporella* appear to be restricted to biohermal intervals. These fossils and associated peaks of coral diversity characterize the two stratigraphic intervals of the bioherms and collectively provide evidence for physical correlation within this widespread formation.

2395 DYKE, A.S., DREDGE, L.A., and VINCENT, J-S. - 1982
Configuration and dynamics of the Laurentide Ice Sheet during the Late Wisconsin Maximum; *Géographie physique et Quaternaire*, vol. XXXVI nos. 1-2, pp. 5-14, 5 fig.

Prior to 1943 the Laurentide Ice Sheet was considered to have three major domes centered in Keewatin, Labrador, and Patricia (TYRRELL, 1898 a, b;1913). FLINT (1943) argued that these centres were of only local and temporary importance and favoured a single-domed ice sheet. Despite the lack of supporting geological evidence, and despite the proposition of a Foxe Dome in the interim, the single-dome concept was not seriously challenged until the late 1970's and, in fact, is still strenuously supported. This paper extends and modifies recent conclusions that the Laurentide Ice Sheet had more than one dome at the Late Wisconsin maximum. We propose a model incorporating five domes (M'Clintock, Foxe, Labrador, Hudson, and (?) Caribou) based on the position of ice divides, ice flow patterns, drift composition, late-glacial features, post-glacial isostatic recovery and free-air gravity anomalies. Our Labrador and Hudson domes closely correspond to Tyrrell's Labradorean and Patrician ice sheets; our Caribou and M'Clintock domes together with the Franklin Ice Complex over the Queen Elizabeth Islands north of the Laurentide Ice Sheet, correspond to Tyrrell's original Keewatin Ice Sheet. The style of glaciation of the Foxe Basin region was not known to Tyrrell, but our reconstruction of the Foxe Dome is in close agreement with the original proposal of Ives and Andrews. Like Tyrrell, our reconstruction is based on field evidence obtained through extensive mapping; the single dome model continues to be unsupported by geological data.

2258 ENGLAND, J., KERSHAW, L., LaFARGE-ENGLAND C., and BEDNARSKI, J. - 1981
Northern Ellesmere Island: a natural resource inventory; *Univ. Alta.*, Report to Parks Can., 237 p.

2396 ENGLAND, J., BRADLEY, R.S., and STUCKENRATH, R. - 1981
Multiple glaciations and marine transgressions, western Kennedy Channel, Northwest Territories, Canada; *Boreas*, vol. 10, pp. 71-89.

Along a 70 km section of western Kennedy Channel three prominent weathering zones are iden-

tified and serve to differentiate major events in the Quaternary landscape. The oldest zone (Zone IIIb) is characterized by a deeply weathered, erratic-free terrain which extends from the mountain summits down to ca. 470 m above sea level. This zone shows no evidence of former glacierization. Zone IIIa extends from ca. 470 to 370 m above sea level and is characterized by sparse granite, gneiss and quartzite erratics amongst weathered bedrock and extensive, oxidized colluvium. The Precambrian provenance and uppermost profile of these erratics reflect the maximum advance of the northwest Greenland Ice Sheet onto northeastern Ellesmere Island. These uppermost erratics along western Kennedy Channel decrease in elevation southward and suggest that the former Greenland ice was thickest in the direction of the major outlet of Petermann Fiord. No evidence of a former ice ridge in Nares Strait was observed. Zone II is marked by the moraines of the outermost Ellesmere Island ice advance which form a prominent morpho-stratigraphic boundary where they crosscut the zone of Greenland erratics at ca. 250-350 m above sea level. These moraines show advanced surface weathering and ice recession from them is associated with a pre-Holocene shoreline at 162 m above sea level. Late Wisconsin/Würm glacial deposits, equivalent to Zone I, were not observed in the lower valleys bordering Kennedy Channel. The outermost Ellesmere Island ice advance (Zone II) is radiometrically bracketed by ^{14}C dates on *in situ* shells from subtill and supratill marine units which are 40,350 ± 750 and >39,000 B.P., respectively. Amino acid age estimates on the same shell samples and others from similar stratigraphic positions all suggest ages of >35,000 B.P. Stratigraphically and chronologically this ice advance is correlated with the outermost Ellesmere Island ice advance 20-40 km to the north which formed small ice shelves when the relative sea level was ca. 175 m above sea level. The Holocene marine transgression along western Kennedy Channel occurred in an ice-free corridor maintained between the separated margins of the northwest Greenland and northeast Ellesmere Island ice sheets during the last glaciation. Initial emergence may have begun ca. 12,300 B.P., however, sea level had dropped only 15 m by ca. 8000 B.P. after which glacio-isostatic unloading of the corridor was rapid. The implications of these data are discussed in the context of existing models on high latitude glaciation and paleoclimatic change.

2397 ENGLAND, J. - 1982
Postglacial emergence along northern Nares Strait; *Meddr om Grønland, Geosci.*, vol. 8, pp. 65-75.

During the last glaciation much of northern Nares Strait remained an ice-free corridor separating the northeast Ellesmere Island and northwest Greenland ice sheets. The disproportionate size of these ice sheets resulted in the lithosphere being differentially loaded on either side of this prominent rift valley. Postglacial emergence in this area is analyzed in order to determine whether glacio-isostatic unloading engendered any abnormal displacement along the Nares Strait fault zone. Present data suggest that synchronous shorelines dated 6000, 7000 and 8000 BP rise from north to south across northeast Ellesmere Island and northern Nares Strait towards the Greenland ice sheet. This is considered to represent the glacio-isostatic dominance of the Greenland ice sheet during the last glaciation together with earlier postglacial emergence towards northernmost Ellesmere Island which lay beyond the influence of the Greenland ice sheet. This Greenland dominance indicates that northeast Ellesmere Island lay in the depression marginal to the Greenland ice sheet. This, in turn, requires a lithospheric flexural parameter extending in an undisrupted manner across the Nares Strait rift valley. Hence, on a regional scale, it appears that the lithosphere in this area has integrated the depressions from these separated ice sheets without any observable unconformities along Nares Strait. Although postglacial faulting has followed initial glacio-isostatic unloading in other areas the present data base does not have the resolution to document similar events along Nares Strait.

2398 FRENCH, H.M. - 1981
Western Arctic; *Ice*, no. 65, p. 10.

2399 FRENCH, H.M., HARRY, D.G., and CLARK, M.J. - 1982
Ground ice stratigraphy and late-Quaternary events, south-west Banks Island, Canadian Arctic; *in* Proc. 4th Can. Permafrost Conf., March 2-6, 1981, Calgary, Alta., Nat. Res. Council, The Roger J.E. Brown Memorial Volume, pp. 81-90.

The stratigraphic study of pingos and ice wedges on south-west Banks Island indicates a period of continuous permafrost aggradation in late Quaternary times interrupted by a temporary period of deeper seasonal thaw in the mid-Holocene. Both epigenetic and small syngenetic ice wedges are exposed in coastal bluffs southeast of Sachs Harbour. Within the Sachs and Kellett River catchments, radiocarbon dating suggests that a number of collapsed and partially eroded pingos are relict features related to a period of climatic deterioration which commenced approximately 4000 years B.P. The stratigraphic study of ground ice is thought to be a useful method of geomorphological and paleoenvironmental reconstruction, especially in areas which have experienced extended histories of cold, non-glacial conditions.

2400 FRISCH, T., and CHRISTIE, R.L. - 1982
Stratigraphy of the Proterozoic Thule Group, southeastern Ellesmere Island, Arctic Archipelago; *Geol. Surv. Can.*, Paper No. 81-19, 13 p.

The Thule Group comprises unmetamorphosed, gently dipping sedimentary and basaltic rocks unconformably overlying crystalline basement in chiefly two coastal areas of southeastern Ellesmere Island, namely Clarence Head-Cape

Combermere and Goding Bay-Gale Point. The group is subdivided into six units, from bottom to top as follows: unit I - sandstone and stromatolitic dolomite; unit II - tholeiitic basalt sills and lavas and minor pyroclastics interbedded with red sandstone, siltstone and shale; unit III - variegated sandstone, siltstone and shale, underlain by stromatolitic dolomite; unit IV - white orthoquartzite; unit V - variegated sandstone, siltstone and shale; unit VI - mainly light weathering orthoquartzite. The sediments were deposited in a shallow marine to terrestrial environment; the extrusive igneous rocks are terrestrial. The Thule Group is thickest at Goding Bay, where 1000 m of strata were measured in a section whose lower contact is not exposed and whose top is an erosion surface. The northern limit of Thule deposition lies between 78°32'N and 79°N. Whole-rock ^{40}K-^{40}Ar ages of basalt from unit II indicate that the Thule Group is 1.0-1.2 Ga old.

2401 FRISCH, T. - 1982
Reconnaissance geology of the Precambrian Shield of Ellesmere, Devon and Coburg Islands, Arctic Archipelago: a preliminary account; *Geol. Surv. Can.*, Paper 82-10, 11 p.

The extensively ice- and snow-covered upland areas of southeastern Ellesmere Island, eastern Devon Island and Coburg Island are underlain by granulite facies rocks of the northernmost Canadian Shield. Rocks of supracrustal origin abound and include migmatitic garnet-cordierite-sillimanite-biotite gneisses, marble with diopside, forsterite and wollastonite sillimanite quartzite, clinopyroxene-orthopyroxene amphibolite, and orthopyroxene-bearing gneisses. Other orthopyroxene-bearing quartzofeldspathic gneisses are probably deformed intrusive rocks, which are also represented by massive to crudely gneissic, orthopyroxene-bearing granite and tonalite. The orthopyroxene-bearing rocks carry primary biotite invariably and primary hornblende commonly. Various kinds of granite have intruded all these rocks. Granite with biotitic pseudomorphs after orthopyroxene and locally with garnet is commonly intruded into fresh orthopyroxene-bearing granitoid rocks. A similarly retrograded orthopyroxene granite with prominent perthite porphyroblasts forms large bodies at the northern edge of the Shield. Peraluminous granite with garnet, cordierite and/or sillimanite and locally rich in aluminous metasedimentary inclusions is particularly widespread in Ellesmere Island. These granites are thought to have formed by anatexis of aluminous metasediments under granulite facies conditions. Amphibolite facies rocks are of minor importance in the area and were produced by retrogression from the granulite facies. The granulite facies metamorphism is provisionally envisaged to have taken place at moderate to low pressure and high temperature. The rare presence of the assemblage orthopyroxene + sillimanite + quartz, however, indicates that higher pressures may have prevailed locally. Limited radiometric data suggest a late Archean age for the main granulite facies metamorphism and possibly a major Hudsonian deformation. The basement rocks are overlain on the east coast of Ellesmere Island by unmetamorphosed clastic sediments and basalt of the Neohelikian Thule Group and are bordered on the west and north by lower Paleozoic strata of the Arctic Platform.

2402 FRISCH, T., and DAWES, P.R. - 1982
The Precambrian Shield of northernmost Baffin Bay: correlation across Nares Strait; *Meddr om Grønland, Geoscience*, vol. 8, pp. 79-88.

The northern rim of the North American craton outcrops in the Baffin Bay - Nares Strait region where it forms large parts of southeastern Ellesmere Island and northwestern Greenland. Between 76°N and 78°N the Precambrian Shield comprises high-grade gneiss and metasediments which show a comparable chronological history in Ellesmere Island and Greenland. Two major features that emphasize the close relationship between the Shield on either side of Nares Strait are the presence of marble-rich metasedimentary tracts and a distinctive suite of late Archaean granitic to basic plutonic rocks which have locally been transformed by intense Proterozoic (probably Hudsonian) deformation into complexly folded orthogneisses.

Marble-rich tracts are common throughout southeastern Ellesmere Island: in northwestern Greenland they are restricted to Inglefield Land north of 78°N. The regional structure suggests that the marble-rich tracts constitute a single marble province and that those on opposite sides of Smith Sound at Cape Isabella (Canada) and Sunrise Pynt (Greenland) may well represent on-strike parts of the same belt of supracrustal rocks.

Correlation of the distinctive features of the Shield in southeastern Ellesmere Island and northwestern Greenland is entirely consistent with there having been no major strike-slip movement along Nares Strait.

2403 FUKUDA, M. - 1981
Observations of Pingo Growth near Tuktoyaktuk, N.W.T., Canada; *in* Joint Studies on Physical and Biological Environments in the Permafrost, North Canada, July to August 1980 and February to March 1981, Inst. Low Temp. Sci., ed. S. Kinosita, Hokkaido Univ., Japan, pp. 37-44.

The pingo is the ice-cored hill developed in a continuous permafrost region. Usually it has a conical shape. Its development is closely related with changes in physical environment in the permafrost region. Continuous intensive field investigations have been made by Mackay, whereupon proposals have been made by him concerning the process and mechanism of pingo growth in the Mackenzie delta area. The number of pingos occurring in the western Arctic Coast totals 1450. Some of them are still in the evolutionary stage at the present climatic condition, while others are now in the stage of termination of evolution.

The dynamics of pingo growth is established upon a comparison of a variety of pingos in various evolutionary stages, and also upon the

geophysical information of permafrost. The author investigated a small pingo located near Tuktoyaktuk, N.W.T., Canada and carried out field observations of growth of the pingo. This is a preliminary report about the field observations from August 1980 to March 1981.

2404 FUKUDA, M. - 1981
Field Observations of Ice Wedge Cracking in the Permafrost Area near Tuktoyaktuk, N.W.T., Canada; *in* Joint Studies on Physical and Biological Environments in the Permafrost, North Canada, July to August 1980 and February to March 1981, Inst. Low Temp. Sci., ed. S. Kinosita, Hokkaido Univ., Japan, pp. 45-60.

Large-scale ice wedge polygons constitute the most common topography in continutus permafrost regions. Bounded by troughs, they form patterns rectangular, or hexagonal, or both. An ice wedge lies below an ice trough tapering down toward an apex. Typical ice wedge polygons, commonly called tundra polygons, are shown by an aerophoto of Fig. 1, which was taken near Tuktoyaktuk, district of Mackenzie, N.W.T., Canada. Meanwhile, fossile ice wedge polygons and ice wedge casts are observed in Hokkaido, Japan, which indicate that permafrost occurred in the past in a cold climatic environment. Thus, it is important to investigate the ice wedge polygons, especially concerning physical conditions for formation of them, which may indicate permafrost temperature and air temperature necessary for it.

2405 GIBBINS, W. - 1981
Mineral deposits and exploration activity Arctic Islands, Canada; *Abstract in* Proc. Third Inter. Sym. Arctic Geology, June 28 - July 1, 1981, Calgary, Alta., sponsor Can. Soc. Pet. Geol.

The first mining operation in the Canadian Arctic was conducted by Sir Martin Frobisher in 1577-1578, when he mined and shipped some 2000 tons of worthless rock. Almost four centuries later mining was resumed at Strathcona Sound, Northern Baffin Island.

Proven ore reserves include: 25 million tons grading 4.3 percent lead and 14.1 percent zinc at the Polaris Mine on Little Cornwallis Island in the central arctic: and 3.6 million tons grading 11.9 percent zinc and 1.2 percent lead (January 31, 1980) at the Nanisivik Mine on northern Baffin Island. The world's most northerly metal mine, Polaris, will be the eleventh largest zinc-lead producer in the western world when brought into production in 1982.

Known marginal and submarginal resources include large iron deposits at Mary River and Eqe Bay, Baffin Island and the Melville Peninsula as well as additional lead-zinc mineralization in the Cornwallis Fold Belt and the Nanisivik area. Major coal resources occur within the Upper Cretaceous and lower Tertiary Eureka Sound Formation on Ellesmere and Axel Heiberg Islands. Oil sands occur on Melville Island, oil shale on Southampton Island, uranium near Cape Dorset, southwestern Baffin Island, copper on Victoria Island and diamonds have been reported from Somerset Island.

Political, logistical, environmental and economic factors related to conventional mining and mineral exploration are magnified in the arctic.

2406 GIBBINS, W.A. - 1982
Mining developments, mineral inventory and metallogenic models: Arctic regions, Northwest Territories, Canada; *in* Arctic Geology and Geophysics, eds. A.F. Embry and H.R. Balkwill, Can. Soc. Pet. Geologists Memoir 8, pp. 113-133.

Native people collected, traded and used native copper, pyrite, galena, chert, quartz and various kinds of soapstone, carving stone or pipestone long before contact with Europeans. Today, many Inuit quarry and carve various kinds of "soapstone". Their sculpture represents the only mineral commodity which undergoes a high degree of processing in the north and has a significant economic impact on their society.

The first European mining operation in the Canadian Arctic took place more than four centuries ago, when Sir Martin Frobisher mined and shipped some 2000 tons of worthless rock back to England (1577-1578). Former producing mines in the Arctic include the Eldorado Mine at Port Radium, Great Bear Lake, the nickel-copper mine at Rankin Inlet on the western shore of Hudson Bay, the Tundra Gold Mine at Matthews Lake and the Hope Bay Silver Mine on Melville Sound.

At present, there is one lead-zinc mine in production at Nanisivik on northern Baffin Island. A second lead-zinc mine, Polaris on Little Cornwallis Island, and two gold mines at Contwoyto Lake and Cullaton Lake on the mainland, are just beginning production. Mineral exploration continues at high levels for several commodities and deposit types. A number of deposits and a substantial tonnage of mineral inventory have been discovered and the list continues to grow. Favoured metallogenic models include volcanogenic massive sulphide deposits, Mississippi Valley type lead-zinc deposits, unconformity-related uranium deposits, gold associated with iron formation, and gold with quartz veins. The latter type is found mainly in rocks of the Yellowknife Supergroup, often with complex quartz-carbonate-sericite shear zones.

Major coal resources within the Upper Cretaceous and Lower Tertiary Eureka Sound Formation of Ellesmere and Axel Heiberg islands are currently being explored.

2407 HARPER, J.R., and PENLAND, S. - 1982
Beaufort Sea Sediment Dynamics; *Geol. Surv. Can.*, Atlantic Geosci. Centre internal report, 214 p.

Numerous scientific studies have been conducted in the Beaufort Sea since the original Beaufort Sea Project of 1974 and 1975, but, to date, these studies have not been synthesized

with respect to sediment dispersal. This report provides a state-of-the-art interpretation of information related to sediment dynamics and outlines a revised sediment dispersal model for the Beaufort Sea.

Analysis of the sediment budget indicates that the Mackenzie River is the major contributor of sediment to the southern Beaufort Sea system, contributing over 95 percent of the total. Analysis of mud volumes and sedimentation rates on the shelf indicates that the major portion of the sediment contributed by the Mackenzie River is deposited in shallow water near the delta. This observation is supported by analysis of suspended sediment concentrations (SSC), which were derived from LANDSAT imagery enhancement. The processed images often show very high SSC values (>100 mg/l) inside the 10-m contour and low SSC values (<10 mg/l) seaward of the 10-m contour with a strong SSC gradient in the 5-m to 10-m water depths. These analyses indicate that the proximal delta area serves as the primary sediment sink for river sediment. The enhanced LANDSAT imagery also shows that the turbid water of the Mackenzie River plume is frequently deflected to the north and east from the delta and serves as a sediment source to these areas of the shelf, although sedimentation rates (<0.2 mm/yr) are nearly one order of magnitude less than those near the delta (>2 mm/yr).

Wave climate data and current meter data were analysed for potential transport frequency and potential transport directions. The results show that the shelf seaward of the 20-m contour is dormant in terms of transport potential except on the western shelf where slightly stronger currents occur. Landward of the 20-m contour sediments can be transported by combined wave and current action; transport is most active inside the 5-m contour where waves may suspend material over 50 percent of the time. On the central and eastern part of the shelf net transport is directed to the northeast; longshore transport at the coast is controlled by the dominant northwest storm wave approach and is directed to the east or south, depending on shoreline orientation. Shelf transport on the western shelf may be directed to either the northwest or southeast.

Geologically recent changes in sea level and supply patterns have affected shelf sediment dispersal. Areas of the shelf with little or no ongoing sedimentation (the eastern-most and western-most parts of the shelf) have coarse surficial sediments, which are thought to be relict and deposited under different hydrodynamic conditions than exist at present. As such, the shelf morphology and sediment character is a product of both present and past (early to mid-Holocene) sedimentary process.

2408 HARRY, D.G. - 1982
Aspects of the permafrost geomorphology of southwest Banks Island, Western Canadian Arctic; unpub. Ph.D. thesis, Univ. Ottawa, 230 p.

This thesis explores the relationship between permafrost conditions and landscape evolution on southwest Banks Island, Western Canadian Arctic. Particular attention is focused upon the history of permafrost and ground ice aggradation, the development of thaw lake terrain, and the influence of permafrost on rates and processes of coastal change.

Stratigraphic analysis of coastal sections suggests that permafrost aggradation has been continuous in late-Quaternary times, with the exception of a short period of deeper seasonal thaw during the Holocene climatic optimum. Both epigenetic and small syngenetic ice wedges are recognized, and their development is interpreted within a framework of paleoenvironmental reconstruction. Additional evidence of permafrost aggradation is provided by the existance of pingos. The distribution of sediments and ice bodies within sections excavated through the rampart of one feature is interpreted with respect to a model of pingo growth. There is broad synchroneity between the age of a second pingo examined and that of other pingos on Banks Island, suggesting that growth may have been triggered by regional climatic deterioration in late-Holocene times.

Thaw lakes on southwest Banks Island appear to be quasi-equilibrium landforms, and cannot be interpreted within the traditional thaw lake 'cycle'. In the Sachs River lowlands, basins at least 3 m in depth probably formed by thaw subsidence, initiated during the Holocene climatic optimum. Geothermal analysis indicates that, under equilibrium conditions, lakes greater than 700-800 m in diameter are underlain by throughgoing taliks. A majority of lakes are oriented perpendicular to prevailing summer wind direction, and possess a D-shaped outline which is in equilibrium with wind-generated geomorphic processes. Lake drainage occurs primarily by catastrophic outflow, following basin capture or truncation by coastal retreat.

Rates and processes of coastal change are controlled by the nature of perennially frozen shoreline materials. In particular, patterns of cliff failure are frequently related to ice wedge distribution. During the period 1972-1979, ice-rich cliffs west of Sachs Harbour receded by up to 35 m. The high rate of sediment supply has contributed to the growth of two sand spits in the vicinity of Sachs Harbour which have prograded by 400-600 m since 1950.

The results of this study suggest that a knowledge of permafrost conditions forms an integrating factor in the analysis of arctic terrain. Moreover, a stratigraphic approach to permafrost may be used to reconstruct the evolution of present geomorphological conditions.

2409 HAYES, P.G. - 1982
Canadian fossils forge link to Europe; *The Milwaukee Journal*, Thurs., September 9, p. 2.

2410 HODGSON, D.A. - 1982
Surficial materials and geomorphological processes, Western Sverdrup and adjacent islands, District of Franklin (including Amund Ringnes, southern Ellef Ringnes, Cornwall, Graham and King Christian Islands); *Geol. Surv. Can.*, Paper 81-9, 44 p.

Amund Ringnes, Ellef Ringnes, Cornwall, Graham, King Christian, and adjacent islands are part of north-central Queen Elizabeth Islands, the northern group of the Canadian Arctic Archipelago. The islands are dominantly lowland or low dissected plateau (rarely greater than 200 m elevation), but relief is locally rugged. The Islands and surrounding marine channels and basins are underlain by poorly indurated Mesozoic sandstone alternating with soft shale and siltstone, whereas areas of high relief are underlain by evaporite diapirs and igneous intrusions. Residual weathered rock and marine-reworked rock, chiefly sand to clay sized and unconsolidated, are the most widespread surficial materials.

Late Tertiary and Quaternary fluvial planation and dissection developed the present gross morphology; scattered high-level deposits remain from this episode. Quaternary glacial deposits are a minor element of the landscape. Dominant Quaternary events appear to replicate those of the Mesozoic: alternating marine and subaerial episodes over much of the present land area. Sea levels repeatedly rising to near 100 m have planed the margins of most islands. This coastal lowland and the interior fluvial landscape are the two most significant components of the physiography. A wedge of marine and deltaic sediments of Holocene and in part older age overlies the coastal lowland; sediment composition is controlled by underlying and upstream source materials, particularly rock.

Fluvial processes, ranging from rilling to lateral river channel corrasion, are presently the dominant subaerial processes, despite the sparse precipitation, short summer, and underlying permafrost. Mass wasting appears less significant, but rapid mass movement is locally highly active on fine grained materials.

Terrain sensitivity, hazards, and trafficability, assessed on the basis of materials, processes, and relief, vary greatly seasonally and between and within surficial materials units.

2411 HODGSON, D.A., and VINCENT, J-S. - 1982
Surficial geology of Central Melville Island, NWT; *Geol. Surv. Can.*, Open File No. 874.

The unedited map at 1:125 000 scale shows the distribution of Quaternary deposits and of weathering products of pre-Quaternary outcrop on central Melville Island, NWT.

2412 HUGON, H., and SCHWERDTNER, W.M. - 1982
Discovery of halite in a small evaporite diapir on southeastern Axel Heiberg Island, Canadian Arctic Archipelago; *Bull. Can. Pet. Geol.* vol. 30, no. 4, pp. 303-305.

Surficial NaCl deposits and talus rich in rock salt occur in a major valley cut through the Stolz Diapir. This occurrence suggests that anhydrite of the Pennsylvanian Otto Fiord Formation was underlain by rock salt on southeastern Axel Heiberg Island. The Stolz Diapir may have risen halokinetically in the Mesozoic before it was deformed during the Tertiary Eurekan orogeny.

2413 HYVÄRINEN, H., and BLAKE, Jr., W. - 1981
Lake sediments from Baird Inlet, east-central Ellesmere Island, Arctic Canada; radiocarbon and pollen data; *Abstract in*, Third Inter. Sym. Paleolimnology, Joensuu, Finland, September 1981, p. 35.

A 56-cm long core covering ~9000 yrs. was obtained from an unnamed lake (78°29.5'N, 76°46.8' W) at 295 m elevation, innermost Baird Inlet. The lake is ca. 250 by 150 m and occupies a deep, closed basin excavated in a rock "island" surrounded by valley glaciers. The bedrock is granulite gneiss and the local vegetation is relatively lush, with areas of *Empetrum nigrum - Vaccinium uliginosum - Cassiope tetragona* heath on south-facing slopes above the lake. Cores were taken from near the lake centre through 14.6 m of water under 101 cm of ice. Basal sandy-silt is overlain by 51 cm of laminated silty gyttja and fine detritus gyttja grading upwards into loose algal gyttja. Three ^{14}C age determinations are available from Core 3: 20-25 cm 4080 ± 210 years (GSC-3192) $\delta^{13}C = -36.6\ ^{o}/_{oo}$; 30-35 cm 6780 ± 220 years (GSC-3184) $\delta^{13}C = -37.2\ ^{o}/_{oo}$; and 46-51 cm 8970 ± 160 years (GSC-3051) $\delta^{13}C = -31.2\ ^{o}/_{oo}$. Rates of sedimentation vary from 0.07 to 0.04 mm/yr. Pollen concentration in samples analysed at 2.5 cm intervals varies from 1500-2000 per cm^3 in the lower part of the core to 100-200 in the upper part; calculated pollen influx is between 17 and 0.8 grains per cm^2 per yr. The basic total of ca. 100 grains/sample includes exotic/derived pollen (tree pollen and indeterminables) and excludes spores. The amount of exotic/derived pollen is low (2-10%) through most of the core, with some rise towards the top. The basal sandy-silt is devoid of local pollen but does contain some obviously derived pollen, mainly degraded betuloid and coniferous types. Four local pollen zones reflect an early pioneer phase (grass-sedge-*Oxyria/Rumex*) in the lowermost organic sediment, followed by a spread of *Salix* and then, some 7000 to 6560 years ago, a rise in Ericales. The topmost zone shows some increase in indicators of bare ground and fell-field vegetation (*Saxifraga*, Ranunculaceae, Caryophyllaceae, *Dryas*), hence deterioration of local conditions during the last 4000 years.

2414 JAGO, B.C. - 1982
Mineralogy and petrology of the Ham Kimberlite, Somerset Island, N.W.T., Canada; unpub. M.Sc. thesis, Lakehead Univ., 235 p.

The Ham diatreme and dyke are post-late Silurian intrusions located in north-central Somerset Island and are the most northerly known

kimberlites in the Somerset Island kimberlite province. The Ham diatreme, which consists of three petrographically distinct varieties of kimberlite, formed as a series of fluidized intrusions at the intersection of several regional fracture sets. Type 1A kimberlite is petrographically similar to the Ham dyke (a single intrusion located 1.5 km to the east) and forms the flanks of the Ham diatreme. This dark, massive rock contains phenocrysts and xenocrysts of garnet, olivine, chrome-diopside, phlogopite, spinel and carbonate in a serpentine-carbonate groundmass containing carbonate and serpentine emulsion textures. Type 1B kimberlite, which occupies the central portion of the Ham diatreme, is a highly altered, light green, serpentine-carbonate-rich rock formed by the prograde serpentinization and carbonatization of Type 1A kimberlite. This alteration occurred during the degassing of structurally lower portions of the Ham diatreme. Type 2 kimberlite is a carbonate-rich mineralogical equivalent of Type 1A kimberlite and formed as a late stage dyke within the Ham diatreme.

Pre-fluidization phenocrysts include Mg-rich olivine (Fo_{89-93}), low Cr, (<3.5 wt.% Cr_2O_3), high Ti (>0.3 wt.% TiO_2) pyrope-garnet, Al-rich, Ti-poor (<2.00 wt.% TiO_2) aluminous-magnesium chromite (Cr/Cr+Al=0.18-0.85) and Ti-rich phlogopite (1.0-4.6 wt.% TiO_2). Post-fluidization microphenocrysts include Mg-rich olivine (Fo_{89-93}), Ti-rich phlogopite (2.5-4.0 wt.% TiO_2) and spinel which evolved from Ti-bearing (2.00 wt.% TiO_2), titan-magnesium-aluminous-chromite to Fe^{3+} - and Ti-rich (max. 17.0 wt. % TiO_2) magnesium-ulvöspinel- ulvöspinel-magnetite. Atoll spinels, formed prior to the complete crystallization of the kimberlite groundmass are present in the Ham dyke but extensive resorption of magnesium-ulvöspinel-ulvöspinel-magnetite and titan-magnesium-aluminous-chromite in the Ham diatreme has precluded their persistence.

Xenocrysts formed by the disaggregation of garnet and spinel lherzolites include Cr-rich (3.5-10.0 wt. % Cr_2O_3), Ti-poor (<0.30 wt. % TiO_2) pyrope-garnet, Mg-rich olivine and chrome-diopside. Pressure temperature estimates from garnet lherzolite xenoliths range from 36 to 37 kb and 1031 to 1146°C corresponding to a depth of origin of 110 to 120 km.

Multiple discriminant analysis demonstrates that cluster analysis can only distinguish between garnets of grossly different chemistry and paragenesis and that major and minor element variation diagrams are required to separate statistically, chemically similar garnets within a paragenesis.

Geophysical studies may be used to delineate kimberlite subcrop patterns and structural elements which may have controlled the intrusion of the kimberlite.

2415 JONES, B. - 1982
Paleobiology of the Upper Silurian Brachiopod *Atrypoidea*; *J. Paleontology*, vol. 56, no. 4, pp. 912-923, 2 pls., 1 text-fig.

Atrypoidea, the dominant brachiopod in the Read Bay Formation of Arctic Canada, lived with its umbo buried in the sediment and its commissure subperpendicular to the sediment/water interface. Study of these brachiopods suggests that their filtering system, which increased in capacity during ontogeny, operated with a medial inhalant current and lateral exhalant current. Many *Atrypoidea*, *Protathyris* and *Atrypa* in the Read Bay Formation have extensive shell malformation which may have resulted from damage to the epithelial cells due to the incursion of lithic detritus into the shell or some type of biological disturbance(s) such as disease, crowding or predation.

2416 JONES, B. - 1982
Upper Silurian brachiopod faunas from the Douro Formation of Arctic Canada; *in* Proc. Third North American Paleontological Conv., August 1982, vol. 1, pp. 269-274.

A collection of nearly 10,000 brachiopods from 92 stratigraphic localities in the Douro Formation on Somerset, Prince of Wales, Cornwallis and Ellesmere Islands encompasses only 13 species, namely: *Atrypoidea phoca, A. foxi, A. erebus, A. n.sp., Protathyris praecursor, Nanukidium arctica, N. cunninghamensis, Tannuspirifer dixoni, Howellella pseudogibbosa, Gypidula galeata, Stegerhynchus borealis, Atrypa sp.* and *Morinorhynchus sp. Atrypoidea* (4 species) and *Protathyris* account for 80% and 10% respectively of the brachiopod fauna. The remaining 10% of the brachiopod fauna is represented by the other 8 species. *A. foxi* is the most common species accounting for over 50% of the total brachipod fauna. Paleomagnetic evidence suggests that the carbonates of the Douro Formation accumulated in equatorial regions. Despite this, the brachipods have a geographically and stratigraphically uneven distribution. This fact along with the relatively low-diversity of the brachiopods and the dominance by *Atrypoidea* suggests that the fauna was adapted to environments that were in some sense restricted: factors such as poor food or high salinity may have been responsible.

The distribution of the various species of *Atrypoidea* seems to have been environmentally controlled. *A. phoca* apparently lived close to shore; *A foxi* lived farther off shore in inter-reefal areas whereas *A. n.sp.* only lived in direct association with reefs.

2417 JONES, B. - 1982
Lower Devonian brachiopods from the "Bird Fiord" Formation of the Vendom Fiord area, Ellesmere Island, Arctic Canada; *J. Paleontology*, vol. 56, no. 6, pp. 1375-1396, 3 pls., 13 text-figs.

The "Bird Fiord" Formation in the area west of Vendom Fiord, southwest Ellesmere Island, contains a rich, Lower Devonian brachiopod fauna comprising 12 species: *Cortezorthis*? sp., *Cymostrophia*?sp., *Brachyprion*?sp., *Carinagypa (Aseptagypa) maclareni* Brice, 1982, *Athyrhynchus vendomensis* n.sp., *Athyrhynchus sverdrupi*

(Meyer, 1913), *Fimbrispirifer? scheii* (Meyer, 1913), *Najadospirifer* sp., *Nucleospira* sp., *Howellella*? sp., *Atrypa* sp. *A* and *Spinatrypa* sp. This fauna is dominated by *Atrypa* (53.0%) and *Carinagypa* (35.4%);the remaining ten species accounting for the other 11.6% of the fauna.

The brachiopods suggest correlation with the lower part of the *pinyonensis* Zone of Nevada; a correlation that is corroborated by the available conodont evidence. On Ellesmere Island, this fauna correlates with that in the top part of the Eids Formation in the area south of Baumann Fiord.

2418 JONES, B. - 1982
Devonian brachiopods from the Bird Fiord Formation of the Goose Fiord area, southern Ellesmere Island, Arctic Canada; *J. Paleontology* vol. 56, no. 6, pp. 1397-1409, 2 pls. 7 text-figs.

The brachiopod fauna in the Bird Fiord Formation at Goose Fiord, southwest Ellesmere Island comprises 8 species, namely, *Megastrophia (Megastrophiella) frami* n.sp., *Atrypa* sp.B, *Atrypa* sp.C, *"Elythyna" sverdrupi, "Fimbrispirifer" scheii, Nucleospira*?sp. *Schizophoria*?cf.*S. sulcata, Spinulicosta*? sp. and *Phragmostrophia? latior. M. (M.) frami, "E." sverdrupi* and *Atrypa* dominate the faunas which occur in sandy limestone and sandstone.

The brachiopod fauna, which is thought to be of late Emsian age (probably *serotinus* Conodont Zone), is different from the brachiopod fauna found in the Bird Fiord Formation elsewhere on Ellesmere Island and Bathurst Island.

2419 JONES, B., and JIA-YU, R. - 1982
Comparison of the Upper Silurian *Atrypoidea* faunas of Arctic Canada and Southern China; *J. Paleontology*, vol. 56, no. 4, pp. 924-937.

Comparison of topotype specimens of *Atrypoidea dorsoconvexa* Wang, Rong and Yang, 1980 and *A. qujingensis* Wang, Rong and Yang, 1980 from southern China with the type material of *A. foxi* (Jones, 1974) from Arctic Canada suggests that they should be included under the senior name, *A. foxi*.

The Upper Silurian brachiopod faunas associated with *Atrypoidea foxi* in southern China and Arctic Canada, share similar genera and display similar community characteristics and sedimentological setting. In both regions, two types of *Atrypoidea* Community are present, namely, 1) a low-diversity *Atrypoidea* Community that probably inhabited a near-shore environment and 2) a high-diversity *Atrypoidea* Community that probably inhabited a more offshore habitat compared to the former.

The paleogeographic position of China relative to Arctic Canada remains somewhat of an enigma. However, the common occurrence of *Atrypoidea foxi* as well as the overall similarity of the brachiopod faunas suggests that the two areas may have been connected in some manner.

2420 JUDGE, A.S. - 1980
Natural gas hydrates in northern Canada: a review; *in* Proc. Sym. Permafrost Geophysics (No. 5), Nov. 13-14, 1978, eds. W.J. Scott and R.J. E. Brown, NRC Tech. Memo. No. 128, pp. 139-158.

Most of the symposium has focussed on permafrost and problems of its detection and properties. This session will concern itself not with water-ice but with ice-like compounds known as gas hydrates; specifically with hydrates as they occur naturally in subsurface formations rather than hydrate formation in flowing wells or pipelines. Generally, natural gas hydrates have been found in two distinctly different environments, associated with areas of relatively thick permafrost where many aspects of their behaviour and geophysical response are similar to those of water-ice, (i.e. to ice bonded permafrost), and in the sediments of the deep oceans. The recognition of hydrates in nature is relatively recent resulting primarily from Soviet research by Makogan in the onshore environment and by the Lamont-Columbia group in the deep ocean. In this symposium we would like to introduce the subject to those unfamiliar with it and thus perhaps stimulate some interest and physical research on hydrates and their properties in Canada. Most of the research to date has been conducted by chemists and chemical engineers concerned with fundamental structure and behaviour. The enclosed bibliography lists a selection of important papers relating to hydrates; their thermodynamics, kinetics, physical and chemical properties, occurrence and extent in nature.

Due to large changes that occur in the physical properties of hydrates during dissociation into gas and water, they present many geotechnical problems similar to those of the change of state from ice to water in permafrost terrains. The very rapid release and expansion of the entrapped gas during dissociation leads to additional problems during drilling and production through such naturally occurring zones.

Such naturally occurring zones however are a "concentrated" form of gas storage and as such may prove to hold very important reserves of natural gas. The difficulties associated with releasing the gas in commercially recoverable quantities and disposing of the associated volumes of water make gas hydrates at present an unconventional and possibly uneconomic source of natural gas.

2421 KING, Von L. - 1981
Typen von Torfhügeln im Gebiet der Oobloyah Bay, N-Ellesmere Island, N.W.T., Kanada; *Polarforschung*, vol. 51, no. 2, pp. 201-211.

North of Neil Peninsula, Ellesmere Island, at roughly 81°N/83°W peat mounds with a height between 30 cm and 2 m occur. Systematic diggings in the frozen mounds of similar appearance show that they must have different origins.

Some conspicious mounds are located on terraces and raised deltas at places that are strongly exposed to the wind. Their thick peat cover is crossed by ice veins that formed after contraction. A few small ice lenses may occur.

The core always consists of sandy gravel or even boulders. Droppings, bones and retched wool of snowy owls indicate that these places, that remain free of snow even in winter, are used as observation points by many animals. The formation of these „bird perches" is due to fast peat growth favoured by manure.

Mainly shield-shaped mounds occur very frequently in some peat bogs and show lenses of segregation ice that must be responsible for their upheavel. A dissection of the peat bog by contraction polygons and formation of ice wedges, seems to be an initial and necessary condition. The mounds themselves have similarities with some palsa forms of the subarctic.

In badly drained and shallow depressions a few dome-shaped mounds show a core of pure ice. The formation of these mounds is due to cryostatic pressure of freezing water in a closed system. There may be some genetic similarity with closed-system pingos. Despite wind exposure, there is a rich vegetation on all mounds. Some rare mosses could be found here regularly; *Polytrichum strictum* has been found here for the first time in northern Ellesmere Island. *Dicranum angustum* and *Calliergon trifarium* are known only from one more place and *Dicranum fuscescens, Drepanocladus badius* and *Calliergon sarmentosum* are rare elsewhere in northern Ellesmere Island.

2285 KINOSITA, S. - 1981
Joint Studies on Physical and Biological Environments in the Permafrost, North Canada, July to August 1980 and February to March 1981; ed. S. Kinosita, Inst. Low Temp. Sci., Hokkaido Univ., Japan, 121 p.

2422 MACKAY, J.R. - 1981
Western Arctic; *Ice*, no. 65, p. 10.

2423 MACKAY, J.R. - 1982
Active layer growth, Illisarvik experimental drained lake site, Richards Island, Northwest Territories; *in* Current Research, Part A, Geol. Surv. Can., Paper 82-1A, pp. 123-126.

On 13 August, 1978 a lake (600 by 300 m) located 60 km due west of Tuktoyaktuk, Northwest Territories was artificially drained for experimental research in a region of thick continuous permafrost. Permafrost commenced to grow downwards in the first winter on the exposed lake bottom. Active layer depths have been measured in June and August for the first three summers, viz. 1979, 1980, and 1981. The measurements show no trend towards a thinning of summer thaw depths accompanying downward permafrost growth. The absence of a thinning trend is attributed to the warm subjacent permafrost temperatures whose August minimums are in the -1.5 to -3.0°C range for most of the drained lake bottom. The relatively warm permafrost results from two heat sources - the active layer above and the former sublake-bottom talik, whether frozen or unfrozen, beneath.

2424 MAIR, J.A., and FORSYTH, D.A. - 1982
Crustal structures of the Canada Basin near Alaska, the Lomonosov Ridge and adjoining basins near the North Pole; *Tectonophysics*, vol. 89, pp. 239-253. *LOREX Contr. No. 10.*

Seismic refraction surveys conducted in 1976 and 1979 over the broken ice surface of the Arctic Ocean, reveal distinctly different crustal structures for the Fram, Makarov and Canada basins. The Canada Basin, characterized by a 2-4 km thick sedimentary layer and a distinct oceanic layer 3B of 7.5 km/s velocity has the thickest crust and is undoubtedly the oldest of the three. The crust of the Makarov Basin has a thin sedimentary layer of less than 1 km and is about 9 km in total thickness. The Fram Basin has a similarly thin sedimentary layer but is 3-4 km thicker than the Makarov as it approaches the Lomonosov Ridge near the North Pole. The ridge itself is cored by material with a velocity of 6.6 km/s and may be a metagabbro similar to oceanic layer 3A. This ridge root material extends to a depth of about 27 km, where a change occurs to upper-mantle material with a velocity of 8.3 km/s. The core is overlain by up to 6 km of material with a velocity of about 4.7 km/s which could be oceanic layer 2A basalts or continental crystalline rocks with some sedimentary material.

The Fram Basin probably began to open contemporaneously with the North Atlantic about 70 m.y. ago, by spreading along the Nansen-Gakkel Ridge. Although not yet dated, the Makarov Basin is probably no older than the initiation of the Fram Basin and may be much younger. The Alpha Ridge may once have been part of the Lomonosov Ridge, splitting off to form the Makarov Basin between 70 and 25 m.y. ago, and possibly contributing to the Eurekan Orogeny of 25 m.y. ago, evident on Ellesmere Island. In contrast, the likely age of the Canada Basin lies in the 125-190 m.y. range and may have been formed by the counter-clockwise rotation of Alaska and the Northwind Ridge away from the Canadian Arctic Islands. The Lomonosov Ridge emerges from this scenario as a block resulting from a strike-slip shear zone on the European continental shelf, related to the opening of the Canada Basin (180-120 my) and then becomes an entity broken from this shelf by the opening of the Eurasia Basin (70-0 m.y.).

2425 MAYR, U., TRETTIN, H.P., EMBRY, A.F., and CHRISTIE, R.L. - 1982
Preliminary geological map and notes, Clements Markham Inlet and Robeson Channel map areas, District of Franklin; *Geol. Surv. Can.*, Open File No. 833.

2426 MAYR, U., TRETTIN, H.P., and EMBRY, A.F. - 1982
Preliminary geological map and notes, part of Tanquary Fiord map area; *Geol. Surv. Can.*, Open File No. 835.

2427 MIALL, A.D. - 1981
Late Cretaceous and Paleogene sedimentation and tectonics in the Canadian Arctic Islands; Sedimentation & Tectonics in Alluvial Basins, ed. A.D. Miall, *Geol. Assoc. Can.* Special Paper 23, pp. 221-272.

The Eureka Sound Formation (Maastrichtian to Eocene or ?Oligocene) includes at least 3000 m of marine and nonmarine sandstone, siltstone, mudstone, conglomerate and coal. It forms thick wedges flanking the Arctic Ocean and Baffin Bay, and occupies seven major basins within the Arctic Islands (Banks, West Sverdrup, Meighen, Remus, Eclipse, Lake Hazen and Judge Daly).

The formation comprises ten major facies assemblages, estuarine, shallow marine-prodeltaic, marine shoreline, distal delta front, proximal delta front-delta plain, high sinuosity, fluvial, low sinuosity (perennial?) fluvial, ephemeral stream, gravelly alluvial fan and lacustrine. There are two main styles of basin fill, deltaic-marine (Banks, Meighen, Remus, Eclipse Basins are typical) and fluvial-lacustrine (Judge Daly, Lake Hazen Basins).

The detritus of which the formation is composed was all locally derived from source areas flanking each basin. These expose a wide variety of igneous, metamorphic and sedimentary rocks, most of which can be specifically identified from the derived fragments, indicating rapid sedimentation and burial with little weathering or winnowing.

The Eureka Sound Formation was deposited during the early phases of the Eurekan Orogeny. The first phase, during the Maastrichtian, elevated Storkerson Uplift, Sverdrup Basin Rim, Cornwall Arch, Princess Margaret Arch and the Craton south of Sverdrup Basin, and separated distinct depocentres between these arches. Sedimentation encroached on the uplifts during the Paleocene and Eocene and there the formation rests unconformably on Mesozoic or Paleozoic rocks. Judge Daly Basin formed by rift faulting in the Paleocene and sedimentation ceased there during a thrust faulting episode later in the Paleocene. Lake Hazen Basin probably is entirely Eocene.Eureka Sound sedimentation was terminated by the compressive phase of the Eurekan Orogeny (Eocene-early Miocene).

The development of the formation can be correlated in part with seafloor spreading events in Baffin Bay-Labrador Sea. The basin and uplift phase (Maastrichtian) resulted from anticlockwise rotation of Greenland about a pole in northern Baffin Island, causing rotation and compression in the northeast Arctic islands and, probably, sinistral strike-slip movement along Parry Channel. Judge Daly Basin formed during a short interval of plate divergence, and sedimentation there was terminated when Greenland commenced northward transpressional movement. This mid-Paleocene to Eocene phase caused extensive thrust faulting in eastern Ellesmere Island and, probably, extensive strike slip movement along Nares Strait. Sedimentation was terminated by folding and faulting in the late Eocene or Oligocene during convergence between the Atlantic and Arctic oceanic plates.

2428 MORRIS, T.H. - 1983
The stratigraphy and late pleistocene sedimentological history of the Lomonosov Ridge-Makarov Basin, Central Arctic Ocean; unpub. M.Sc. thesis, Univ. Wisconsin-Madison, 100 p., *LOREX Contr. No. 17.*

As part of LOREX (Lomonosov Ridge Experiment), 42 Benthos gravity cores were collected during a two month drift from the Makarov Basin across the Lomonosov Ridge into the Fram Basin. Coarse (greater than 63 microns) weight percent, planktonic foraminifera abundance, benthonic foraminifera diversity and abundance, estimated ferromanganese micronodule percent, and bulk carbonate analysis were selected as sedimentary parameters to define. This study permitted recognition of a stratigraphy for Late Pleistocene sediment of the Makarov Basin and Lomonosov Ridge. The Makarov Basin Formation is proposed for twelve lithologic units that are defined as Members Alpha through Nu. This Makarov Basin Formation cannot be correlated with the sediments of the Fram Basin but can be correlated with the stratigraphy of the Alpha Cordillera-Chukchi Rise area, some 300 kilometers distant.

Fluctuations in current velocity have occurred over the Lomonosov Ridge during the Late Pleistocene and variation in ridge crest and basin stratigraphic units is attributed largely to these currents. The Makarov Basin is the depositional sink for silt- and clay-sized particles swept off of the Lomonosov Ridge. Ferromanganese micronodules are correlated to silty lutite and bioturbated silty lutite. Paleo CCD levels are interpreted to be between 3956 meters and 1600 meters for much of the Late Pleistocene as evidenced by calcareous foraminifera abundance differences between the Lomonosov Ridge crest and the Makarov Basin.

2429 SADLER, H.E., and SERSON, H.V. - 1981
A survey of some Arctic beach zones in southwest Cornwallis Island, N.W.T.; *Defence Res. Est. Pacific*, Nat. Defence, DREP Rep. 81-1, 84 p.

This was a preliminary investigation into the physical processes in the beach zone along an arctic coast with emphasis on the possible damage to scientific equipment by ice action on gravel beaches. Detailed profiles are given of the spring ice on a number of beaches in the area and of the bathymetry and ice morphology at three stations where test cable arrays were laid. The results indicate that a comparatively shallow trench into the frost table below the beach will provide good protection for cables laid across gravel beaches, and that most of the breaks to be expected are probably due to the freezing of the cable onto the bottom surface of the sea ice during tidal changes in level. Additional investigations were made into methods of accelerating the melting of sea ice, on a simple method of obtaining stereophotographs and on the properties

of a belt of fresh-water anchor ice which was found along the beaches.

2430 SWEENEY, J.F., WEBER, J.R., and BLASCO, S.M. - 1982
Continental ridges in the Arctic Ocean: LOREX constraints; *Tectonophysics*, vol. 89, pp. 217-237, *LOREX Contr. No. 9.*

Recent multidisciplinary geophysical measurements over the Lomonosov Ridge close to the North Pole support the widely held belief that it was formerly part of Eurasia. The known lithologies, ages, P-wave velocity structure and thickness of the crust along the outer Barents and Kara continental shelves are similar to permitted or measured values of these parameters newly acquired over the Lomonosov Ridge. Seismic, gravity and magnetic data in particular show that the ridge basement is most likely formed of early Mesozoic or older sedimentary or low-grade metasedimentary rocks over a crystalline core that is intermediate to basic in composition. Short-wavelength magnetic anomaly highs along the upper ridge flanks and crest may denote the presence of shallow igneous rocks. Because of the uncertain component of ice-rafted material, seafloor sediments recovered from the ridge by shallow sampling techniques cannot be clearly related to ridge basement lithology without further detailed analysis. The ridge is cut at the surface and at depth by normal faults that appear related to the development of the Makarov Basin. This and other data are consistent with the idea that the Makarov Basin was formed by continental stretching rather than simple seafloor spreading. Hence the flanking Alpha and Lomonosov ridges may originally have been part of the same continental block. It is suggested that in Late Cretaceous time this block was sheared from Eurasia along a trans-Arctic left-lateral offset that may have been associated with the opening of Baffin Bay. The continental block was later separated from Eurasia when the North Atlantic rift extended into the Arctic region in the Early Tertiary. The data suggest that the Makarov Basin did not form before the onset of rifting in the Arctic.

2431 WEST, R.M., and DAWSON, M.R. - 1980
Paleogene paleontology, stratigraphy and environments, northern Arctic Canada; *Abstract in* Geol. Assoc. Can., Program with Abstracts, vol. 5, p. 87.

Fossil plants, invertebrates and vertebrates have been collected from many levels through the 4000 meter thickness of the Eureka Sound Formation on Axel Heiberg and Ellesmere Islands. The lowermost of the four informal members contains Santonian-Campanian molluscs and was deposited as the base of a transgressive clastic wedge succeeding the Kanguk Formation. The second member, deposited under fluvial conditions, has produced numerous plant remains indicative of a humid, equable climate. The third member, containing abundant marine to brackish-water organisms, represents aquatic deposition, probably fully marine in the middle part. Oxygen isotope studies of scaphopod shells indicate shallow water temperatures of about 15° during the marine interval. The upper member, of fluvial origin, has produced diverse continental vertebrates as well as plants. It is late early to middle Eocene in age and the paleontologic data strongly indicate a warm, equable climate.

The Eureka Sound Formation vertebrate assemblage correlates reasonably well with early and middle Eocene faunas from the Rocky Mountains of Wyoming, and also suggests paleobiological affinities with western Europe and eastern Asia. It thus is important in dealing with the evolution of Holarctic Paleogene organisms.

2322 ZOLTAI, S.C., BOOTHROYD, P.N., and SCOTTER, G.W. - 1981
A natural resource survey of eastern Axel Heiberg Island, Northwest Territories; *Parks Can.*, internal report, 156 p.

2323 ZOLTAI, S.C., McCORMICK, K.J., and SCOTTER, G.W. - 1983
A natural resource survey of Bylot Island and adjacent Baffin Island, Northwest Territories; *Parks Can.*, internal report, 176 p.

GEOPHYSICS

2432 BURGESS, M., JUDGE, A., TAYLOR, A., and ALLEN, V. - 1982
Ground temperature studies of permafrost growth at a drained lake site, Mackenzie Delta; *in* Proc. 4th Can. Permafrost Conf., March 2-6, 1981, Calgary, Alta., Nat. Res. Council, The Roger J.E. Brown Memorial Volume, pp. 3-11.

Illisarvik lake on Richards Island, Mackenzie Delta, Canada, was artificially drained in order to investigate the growth of permafrost. Twenty-four boreholes were hydraulically drilled to depths ranging from 15 to 92 m below lake level and were instrumented with temperature cables. Monitoring of ground temperatures beneath the lake and surrounding shore-lines prior to drainage delineated a bow-shaped talik extending up to 32 m below lake bottom. Characteristics of the predrainage temperature profiles in the central lake holes were i) an upper unfrozen horizon in which temperatures reached a maximum of 2.5°C at roughly 5 m below lake bottom, ii) a permafrost table at depths of 20 to 32 m in the central part of the lake with consistently negative temperatures below, and iii) negative temperature gradients below the 5 m maximum temperature, averaging 50 mk/m in the permafrost section. Two years of post-drainage temperature monitoring revealed iv) that the former talik had completely frozen at nearshore sites (10 m thick or less), whereas, v) only 5 to 6 m of new permafrost had formed at central sites, and vi) in the unfrozen sections temperatures were close

to 0°C. A two-dimensional finite element computer simulation of the formation and growth of Illisarvik suggests a minimum lake age of 900 to 1000 years. Post-drainage conditions in the first year after drainage were modelled by studying the microclimatic regime together with the ground thermal regime. Although predicted profiles agreed well with measured temperatures, geotechnical and year-round weather gathering programmes are necessary before further post-drainage modelling is warranted.

2433 CAULFIELD, D.D., and YIM, Y - C. - 1983
Prediction of shallow sub-bottom sediment acoustic impedance while estimating absorption and other losses; *J. Can. Soc. Explor. Geophysicists*, vol. 19, no. 1, pp. 44-50.

A model is developed for estimating the acoustic absorption in marine sediments. The model correlates to Hamilton's (1972) *in situ* measurement in marine sediments. It is used to correct for losses in the bottom sediment so that the reflection coefficients and acoustic impedance of the sediments can be calculated as if they were surficial sediments. Results are given to show agreement with actual core data.

2391 DANKERS, P. - 1982
Implications of Early Devonian poles from the Canadian Arctic Archipelago for the North American apparent polar wander path; *Can. J. Earth Sci.*, vol. 19, no. 9, pp. 1802-1809.

2434 FORSYTH, D.A., and MAIR, J.A. - 1984
Crustal structure of the Lomonosov Ridge and the Fram and Makarov Basins near the North Pole; *J. Geophys. Res.*, vol. 89, pp. 473-481, *LOREX Contr. No. 15.*

Reversed refraction surveys were conducted along and across the Lomonosov Ridge as part of the 1979 Lomonosov Ridge Experiment (LOREX).

Interpretation of the strike profiles indicates a 5 km thick upper crustal layer with a velocity of 4.7 km/s overlying a 15 to 20 km thick layer of 6.6 km/s material. An upper mantle velocity of 8.3 km/s is indicated by a few p_n arrivals. High amplitude reflection events recorded from this boundary can be successfully modelled by a transition zone of rapidly changing velocity over a depth interval of 5 km.

Ray-trace modelling of the dip profiles suggests a root structure extending to about 28 km depth flanked by crust thinning to a depth near 13 km beneath the Makarov Basin and a more gradual thinning to near 16 km beneath the Fram Basin. The similarity between the crust of the Lomonosov Ridge and that beneath the Barents and Kara Seas supports the suggestion that the Ridge is a slice rifted from the Baltic Shelf.

2435 FRANSHAM, P.B., UNRAU, J.D., and REESOR, S.N. - 1982
Field and laboratory acoustic testing of frozen soils; *in* Proc. 4th Can. Permafrost Conf., March 2-6, 1981, Calgary, Alta., Nat. Res. Council, The Roger J.E. Brown Memorial Volume, pp. 274-282.

Research was undertaken to investigate the compressional wave velocities in frozen soils. Samples were obtained during two consecutive field seasons from Illisarvik lake, N.W.T. Compressional wave velocities were measured on cores in the field using portable ultrasonic testing equipment. Velocity measurements were made at a single temperature and, hence, yielded a single point on a velocity *versus* temperature curve. Grain-size and moisture content tests serve as a base for interpreting wave velocities. Velocities obtained from field surveys show a strong correlation with those obtained from laboratory measurements. This suggests that one should be able to differentiate ice-rich from ice-poor zones, and, hence, obtain an impression of the spatial distribution of the ground ice.

Compressional wave velocities have also been measured on a series of kaolinite and sand mixtures. Kaolinite to silica sand mixtures were made in the following ratios;1.0, .75, .50, .25, and 0. Water contents ranged from 3 to 45 per cent. The samples were compacted using the modified Proctor method. The results show a strong dependence of velocity on moisture content, the proportion of sand to clay, and the bulk density.

2436 FUJINO, K. - 1981
Thermal Regime of the Uppermost Layer of Tundra and Its Effect on Microtopography; *in* Joint Studies on Physical and Biological Environments in the Permafrost, North Canada, July to August 1980 and February to March 1981, Inst. Low Temp. Sci., Hokkaido Univ., Japan, pp. 21-36.

The thermal regime of the uppermost layer of the tundra area is closely related to the behavior of soil water in that layer; that is, soil water is retained in that layer owing to the freeze-thaw cycle in the previous season.

In the former joint research expedition Inoue et al measured thawing depths and temperature profiles in the field and found that both depended on surface conditions such as vegetation and soil type. They also carried out measurements of thermal conductivity of several soil samples in the laboratory and found an increase in thermal conductivity in the frozen state, which amounted to values several times as large as those in the unfrozen state.

In this expedition the serial records of temperature at different depths in soil were measured together with those of water content. Using the records obtained, thermal diffusivity at each depth was calculated. From these results discussions were made of the formation mechanism of a particular ground feature such as the earth hummock in relation to the thermal regime of the uppermost layer in the tundra area.

2437 GOOD, R.L., and HUNTER, J.A. - 1982
Mapping sub-seabottom permafrost in the Tuktoyaktuk area, Northwest Territories; *in* Current Research, Part B; Geol. Surv. Can., Paper 82-1B, pp. 285-286.

From 1972 to 1978 the offshore area near Tuktoyaktuk, Northwest Territories, was used by the Geological Survey of Canada as a test site for marine shallow refraction systems used in the offshore Mackenzie Delta area in sub-seabottom permafrost mapping. Over the years a number of traverse lines were run with differing types of seismic refraction equipment as "shake-down" cruises prior to deployment of these systems in other areas.

Sufficient information has been acquired in the Tuktoyaktuk area to enable us to determine, in a reconnaissance manner, the general structure of the upper surface of sub-seabottom ice-bonded permafrost.

2438 HUNTER, J.A., and MacAULAY, H.A. - 1982
Some observations of up-hole seismic velocities and permafrost temperatures in Mackenzie Delta sediments; *in* Current Research, Part B; Geol. Surv. Can., Paper 82-1B, pp. 287-290.

During the 1978 and 1979 field seasons, a series of shallow holes were drilled in sediments of the modern Mackenzie River delta. Many of these holes presented an excellent opportunity to obtain comparisons of in situ velocities, sediment types and temperatures of permafrost materials.

2420 JUDGE, A.S. - 1980
Natural gas hydrates in northern Canada: a review; *in* Proc. Sym. Permafrost Geophysics (No. 5), Nov. 13-14, 1978, eds. W.J. Scott and R.J. E. Brown, NRC Tech. Memo. No. 128, pp. 139-158.

2439 JUDGE, A., TAYLOR, A., BURGESS, M., and ALLEN, V. - 1981
Permafrost and ground ice - permafrost thickness, Northwest Territories; *Ice*, vol. 65, p. 9.

2440 MacAULAY, H.A., and HUNTER, J.A. - 1982
Detailed seismic refraction analysis of ice-bonded permafrost layering in the Canadian Beaufort Sea; *in* Proc. 4th Can. Permafrost Conf., March 2-6, 1981, Calgary, Alta., Nat. Res. Council, The Roger J.E. Brown Memorial Volume, pp. 256-267.

The recent application of high-resolution, multi-channel, seismic reflection techniques in the Canadian Beaufort Sea has yielded better sources of data for refraction interpretation of ice-bonded sub-sea permafrost. This paper discusses some examples of this work which demonstrate the structural detail which can be obtained.

A seismic line transecting the Beaufort Sea shelf has been interpreted with data spacings of 125 m. The results confirm early results of Hunter *et al.* (1978) and show detailed structural and velocity variations of ice-bonded zones.

Detailed seismic results at two off-shore drill sites have been examined. Velocity variations indicate optimum zones where ice-content is low or absent suggesting that such detailed refraction surveying can be of use in geotechnical site evaluations.

2424 MAIR, J.A., and FORSYTH, D.A. - 1982
Crustal structures of the Canada Basin near Alaska, the Lomonosov Ridge and adjoining basins near the North Pole; *Tectonophysics*, vol. 89, pp. 239-253. *LOREX Contr. No. 10.*

2441 O'CONNOR, M.J. & ASSOCIATES LTD. - 1983
Distribution of shallow permafrost; *Geol. Surv. Can.*, Open File No. 953, p. 114.

This report describes the distribution of shallow subsea permafrost beneath the Beaufort continental shelf based on interpreted high resolution seismic data. The various types of acoustically defined permafrost encountered are described including representative seismic sections and a distribution map at a scale of 1:250 000.

2442 OVERTON, A. - 1982
Seismic reconnaissance profiles across the Sverdrup Basin, Canadian Arctic Islands; *in* Current Research, Part B, Geol. Surv. Can., Paper 82-1B, pp. 139-145.

Seismic data may be described as multifold reversed profile data, with multiplicities ranging from 300 to 700% in each direction of the reversed profile. The viewpoint that reversed refraction profiles are more determinate than unreversed profiles is stringently tested for these deep sedimentary basins, and results show that great quantities of data complicate rather than simplify interpretations. Attempts to use traditional reversed profile refraction analyses based on a layered model with dipping interfaces failed to reveal unique velocities, dips and structures for the layers which could be matched bidirectionally.

A different analytical approach, using a model with velocities gradually increasing with depth, so that seismic events may be treated as wide angle reflections near critical incidence, appears to be justified. This approach yielded delay time - velocity profiles which match perfectly for the two directions of the reversed profile and uses all the available seismic data without internal conflict. The delay time-velocity structures are also consistent with observed gravity anomalies.

2443 SCOTT, W.J., and MACKAY, J.R. - 1977
Reliability of permafrost thickness determination by DC resistivity soundings; *in* Proc. Sym. Permafrost Geophysics, Oct. 12, 1976, eds. W.J. Scott and R.J.E. Brown, NRC Tech. Mem. No. 119, pp. 25-38.

Between 1971 and 1975, about 30 resistivity soundings were made at various locations on the Tuktoyaktuk Peninsula in order to obtain estimates of permafrost thickness. Most of the soundings were made in lake basins which had been drained recently enough that permafrost is presently aggrading in them.

During interpretation of these soundings it became apparent that particularly for those taken over thin permafrost, unique resistivity-depth functions were not obtainable. This paper examines the problem of non-uniqueness in the context of permafrost thickness determination.

The soundings to be described in this paper were made with the Schlumberger technique (Companie Générale de Géophysique, 1963) in which either the current electrode spacing AB or the potential electrode spacing MN is increased by steps, but never both simultaneously. The result of such a sounding is shown schematically in Figure 2, which is a plot of apparent resistivity ρ_a against the distance from the centre of the array to one current electrode (AB/2). The dashed line in Figure 2 represents the curve which would be obtained with a vanishingly small value of MN. Measurements with a finite value of MN approximate this ideal curve within a few percent if MN < AB/5.

2430 SWEENEY, J.F., WEBER, J.R., and BLASCO, S.M. - 1982
Continental ridges in the Arctic Ocean: LOREX constraints; *Tectonophysics*, vol. 89, pp. 217-237, *LOREX Contr. No. 9.*

GLACIOLOGY

2444 ARNOLD, K.C. - 1981
Ice ablation measured by stakes and terrestrial photogrammetry - a comparison on the lower part of the White Glacier, Axel Heiberg Island, Canadian Arctic Archipelago; *McGill Univ. Axel Heiberg Island Research Reports*, Glaciology No. 2, NHRI Paper No. 19, 98 p. 3 maps.

On the lower part of the ablation area of the White Glacier standard terrestrial photogrammetric techniques were used to measure the height difference of the glacier surface (21 June 1969 to 5 August 1969, and 5 August 1969 to 4 August 1970) at 689 points spaced on a 50 m grid, covering an area of 1.7 km^2. Twenty-two ablation stakes served as control.

Photogrammetry is not necessarily considered a method of replacing stakes for measuring specific ice ablation, because a glacier's specific vertical velocity components, necessary for deducing ablation from height changes, can only be measured by stakes anchored in the ice.

In the White Glacier experiment the emergence velocity was deduced by comparing maps made in 1960 and 1970. The "long-term" ablation gradient was determined from measurements made during the years 1960-1962. Results comparable to those from ablation stakes were obtained.

Some specific problems inherent in the technique are discussed. In the High Arctic the specific roughness and accelerated glacier movement during the ablation season are the principal difficulties.

2395 DYKE, A.S., DREDGE, L.A., and VINCENT, J-S. - 1982.
Configuration and dynamics of the Laurentide Ice Sheet during the Late Wisconsin Maximum; *Géographie physique et Quaternaire*, vol. XXXVI nos. 1-2, pp. 5-14, 5 fig.

2396 ENGLAND, J., BRADLEY, R.S., and STUCKENRATH, R. - 1981
Multiple glaciations and marine transgressions, western Kennedy Channel, Northwest Territories, Canada; *Boreas*, vol. 10, pp. 71-89.

2397 ENGLAND, J. - 1982
Postglacial emergency along northern Nares Strait; *Meddr om Grønland, Geoscience*, vol. 8, pp. 65-75.

2347 FISHER, D.A. - 1982
Carbon-14 production compared to oxygen isotope records from Camp Century, Greenland and Devon Island, Canada; *Climatic Change*, vol. 4, pp. 419-426.

2348 FISHER, D.A., and KOERNER, R.M. - 1983
Ice-core study: a climatic link between the past, present and future; *in* Climate Change in Canada 3, Syllogeus, no. 49, ed. C.R. Harington, Nat. Museums Can., pp. 50-69.

2349 FISHER, D.A., KOERNER, R.M., PATERSON, W.S.B., DANSGAARD, W., GUNDESTRUP, N., and REEH, N. - 1983
Effect of wind scouring on climatic records from ice-core oxygen-isotope profiles; *Nature*, vol. 301, no. 5897, pp. 205-209.

2445 JEFFRIES, M. - 1982
The Ward Hunt Ice Shelf, Spring 1982; *Arctic*, vol. 35, no. 4, pp. 542-544.

In order to improve the understanding of arctic ice shelf evolution, ice coring and water sampling were undertaken and observations made on the Ward Hunt Ice Shelf and surrounding area during spring 1982. A total of 74 m of 7.6 cm diameter ice core was obtained from seven locations including Ward Hunt Ice Shelf, Ayles Fiord and Milne Ice Shelf. Water sampling of Lake "A" and Disraeli Fiord indicated that these water bodies remain stratified. Observations of ice conditions between Ward Hunt Is-

land and Cape Evans revealed the following accretion of multi-year ice along the front of Ward Hunt and Milne Ice Shelf; grounding and/or loss of approximately 40 km^2 of ice shelf near Cape Discovery; possible development of rolls in multi-year ice in Ayles Fiord; and evidence of former ice tongues in Milne Fiord.

2446 JEFFRIES, M.O. - 1983
Arctic ice shelf studies, spring 1983; *Polar Cont. Shelf Proj.*, internal report, 21 p.

A 31.79 m ice core from Ward Hunt Ice Shelf penetrated a brine layer which might be related to lateral brine infiltration induced by calving at the ice front. Strainmeter measurements revealed oscillating strains with cycles of 35 to 40 seconds and 20 minutes related to ocean swell and internal waves respectively. Ice cores obtained from Milne Ice Shelf are expected to reveal a more complex ice shelf structure and growth history. The ice in Milne Fiord can be divided into three parts, one of which is undoubtedly of glacier origin. The 4.25 km advance of Milne Glacier since 1959 is just one of a series of advances and retreats to affect the inner part of Milne Ice Shelf. Ice conditions along the north coast of Ellesmere Island continue to change, e.g. 40 km^2 of ice calved from the east end of Ward Hunt Ice Shelf. Whilst Disraeli Fiord, Lake "A" and Lake "B" remain stratified, stratified water has been discovered at the south end of Milne Fiord.

2447 JEFFRIES, M.O. - 1983
Preliminary isotope studies on Ward Hunt Ice Shelf; *Defence Res. Est. Pacific*, Nat. Defence DREP Contractors Rep. Series 83-26, 56 p.

In spring 1982 nearly 77m of ice core were obtained from the ice shelves of northern Ellesmere Island. The major part of this total came from the Ward Hunt Ice Shelf as part of a study of ice shelf evolution; structure, behaviour and origin.

Preliminary investigations of ^{18}O, pH and conductivity have drawn attention to the variations of, and the processes which have produced variations of these parameters. The $\delta^{18}O$ variations cannot be used for ice dating but variations between high and low δ values, and high and low SEC values, might provide a record of past summer warmth and sea ice conditions. Isotopic fractionation during melting and refreezing, and evaporation at open water surfaces, makes it possible to distinguish between low and high δ values of iced firn and lake ice respectively. Sea ice and "brackish" ice can also be identified according to $\delta^{18}O$ content. The stable isotope contents of snow and ice from this area compare well with other High Arctic stable isotope studies though differences do exist due to spatial and temporal effects.

Although the report is only a preliminary statement and further work is required the results suggest that stable isotope variations, together with other techniques, can be used to distinguish between the ice types within Arctic Ice Shelves. The ability to do this ought to make it easier to understand Arctic Ice Shelf evolution.

2350 KOERNER, R.M., FISHER, D., and ALT, B. - 1981
Glacier Studies - Arctic - Queen Elizabeth Islands; *Ice*, no. 65, 1st issue, p. 2.

2351 KOERNER, R.M., FISHER, D., ALT, B., PARNANDI, M., and BOURGEOIS, J. - 1982
Glacier Studies - Arctic - Queen Elizabeth Islands; *Ice*, no. 68, 1st issue, p. 2.

2448 MÜLLER, F. - 1978
Zu den temperaturverhältnissen arktischer gletscher; *in* Proc. Inter. Polartagung, Berlin, Oktober 4-7, 1978, Programm und Kurzfassungan.

2449 MÜLLER, F., and OMMANNEY, C.S.L. - 1971
The contribution of glacier ice to the world water balance; *Energy, Mines & Res.*, Inland Waters Br., Reprint Series No. 102, pp. 6-20.

This paper reviews the UNESCO/IASH guide for a world glacier inventory and the three pilot studies carried out on the basis of the guide's recommendations, and reports - on the example of Canada - on the problems and progress of one of the countries most advanced in its IHD glacier inventory work. After a brief and incomplete mentioning of some of the fine efforts being made to implement this guide in many other countries, some of the limitations, difficulties and also potentials are discussed. Plans for an International Technical Secretariat for global data compilation and analysis are mentioned.

2450 OHMURA, A. - 1981
Glacier Studies - Arctic - Queen Elizabeth Islands; *Ice*, no. 65, 1st issue, p. 2.

2355 OHMURA, A. - 1982
Climate and energy balance on the Arctic tundra; *J. Climatology*, vol. 2, pp. 65-84.

HISTORY

2236 JANES, R.R. - 1982
The Preservation and Ethnohistory of a Frozen Historic Site in the Canadian Arctic; *Arctic*, vol. 35, no. 3, pp. 358-385.

2373 MacINNIS, J. - 1982
The Breadalbane Adventure; published by Optimum Publishing International Inc., Montréal, Can., 171 p.

2374 MacINNIS, J.B. - 1982
The Breadalbane Project: a progress report; *Can. Geographic*, June/July 1982, pp. 68-71.

2375 MacINNIS, J.B. - 1983
Exploring a 140-year-old Ship Under Arctic Ice; *Nat. Geographic*, vol. 164, no. 1, pp. 104A-104D.

2376 MacKAY, G. - 1983
Into the tomb of HMS Breadalbane; *Maclean's*, June 6, 1983, pp. 42-44.

2379 PAYNE, D. - 1983
H.M.S. Breadalbane; *Northwest Explorer*, vol. 2, no. 2, pp. 6-9.

HYDROGRAPHY

2451 BAYNES, R. - 1984
Clearing the Way for Arctic Oil; *OFFSHORE RESOURCES*, vol. 2, no. 1, pp. 36-38.

Exploration may be on the back burner, but Canadian scientists are working overtime to take the mystery out of the Northwest Passage.

2452 BIRCH, J.R., FISSEL, D.B., LEMON, D.D., CORNFORD, A.B., LAKE, R.A., SMILEY, B.D. MacDONALD, R.W., and HERLINVEAUX, R.H. - 1983
Arctic Data Compilation and Appraisal, Volume 3. Northwest Passage: Physical Oceanography - Temperature, Salinity, Currents and Water Levels; *Fish & Oceans*, Can. Data Rep. Hydrogr. Ocean Sci 5, vol. 3, 262 p.

This volume is one of a group of catalogues designed to compile and appraise marine data sets for the Canadian Arctic. For user convenience, the group has been organized with its subject matter divided into three general disciplines: physics, chemistry and biology. The Arctic has been arbitrarily divided into seven geographical areas incorporating, where possible, major oceanographic regions. The format throughout has been structured to facilitate comparison among subjects and regions. With such a large undertaking it is not possible to provide all reports at once. Therefore catalogues which are presently available in the series are indicated on the inside back cover of each volume.

Data collection is a continuing process and further updates of the catalogues are planned. Readers are requested to submit corrections and additions by writing the issuing establishment. Such corrections will be incorporated in on-line computerized data set listings and will be continuously available upon request.

2453 BIRCH, J.R., FISSEL, D.B., LEMON, D.D., CORNFORD, A.B., HERLINVEAUX, R.H., LAKE, R.A., and SMILEY, B.D. - 1983
Arctic Data Compilation and Appraisal, Volume 5. Baffin Bay: Physical Oceanography - Temperature, Salinity, Currents and Water Levels; *Fish. & Oceans*, Can. Data Rep. Hydrogr. Ocean Sci. 5, vol. 5, 372 p.

2454 CORNFORD, A.B., LEMON, D.D., FISSEL, D.B., MELLING, H., SMILEY, B.D., HERLINVEAUX, R.H., and MacDONALD, R.W. - 1982
Arctic Data Compilation and Appraisal, Volume 1. Beaufort Sea: Physical Oceanography - Temperature, Salinity, Currents and Water Levels; *Fish. & Oceans*, Can. Data Rep. Hydrogr. Ocean Sci 5, vol. 1, 279 p.

2243 DAVIES, P.V. - 1981
Final Field Report, P.C.S.P. Survey M'Clintock Channel, Proj. File No. 5452-7324, February-April 1981; *Fish. & Oceans*, Canadian Hydrographic Serv., Central Region, internal report, 34 p.

2257 DICKMAN, M, and OUELLET, M. - 1982
Limnological characteristics and origin of a hypersaline meromictic, high arctic lake; *Polar Cont. Shelf Proj.*, internal report, 42 p.

2445 JEFFRIES, M. - 1982
The Ward Hunt Ice Shelf, Spring 1982; *Arctic*, vol. 35, no. 4, pp. 542-544.

2244 MacDOUGALL, J.R. - 1982
Final Field Report, P.C.S.P. Survey of Prince of Wales Strait, Proj. File No. 5452-7324; *Fish. & Oceans*, Canadian Hydrographic Serv., Central Region, internal report, 27 p.

2455 MELLING, H. - 1983
Oceanographic features of the Beaufort Sea in early winter; *Fish. & Oceans*, Can. Tech. Rep. Hydrogr. Ocean Sci., no. 20, 131 p.

Oceanographic data were acquired over an area of 150,000 km^2 in the southeastern Beaufort Sea during November 1979 in conjunction with the Beaufort Sea Winter Ice Experiment. Hydrographic profiling by CTD probe enabled delineation of the dynamic topography of the region and identification and tracing of the principal water masses. Baroclinic shear was directed southwestward along bathymetric contours, with a jet of 10 cm/s (0/300 db) overlying the continental slope. Outflow from Amundsen Gulf was evident. Measured flow at mid-depth on the shelf was easterly in the mean, while the baroclinic shear implied weaker surface flow. Observed intrusions of near freezing water over the slopes pointed to important exchanges of water between the shelf and the basin. The existence on the shelf of suitably saline water for these intrusions was confirmed and is indicative of the importance of freezing and ice-cover divergence in Arctic oceanography.

2456 MOORE, R.M. - 1983
The relationshi; between distributions of dissolved cadmium, iron and aluminium and hydrography in the central Arctic Ocean; *in* Proc. NATO Advance Res. Inst. Conf. on Trace Metals in Sea Water, eds. Wong, Boyle, Bruland, Burton and Goldberg, Plenum Pub. Corp., pp. 131-142. *LOREX Contr. No. 8.*

Over many years there has been considerable interest in the role of iron as a micronutrient element with attention focussing on its solubility, speciation, both inorganic and organic, its availability to plankton and modification of its speciation by organisms, and the possible ecological effects of its concentration and chemical form.

Studies of the biological roles, solubility and speciation of iron in seawater have not, however, been matched by studies giving a coherent picture of the distribution of this element in the world ocean. The reasons for this are probably related to the ubiquitous terrestrial distribution of the element and its very low solubility in seawater which combine to give contamination problems equalled by few other elements. Added to this, the distribution of the metal between dissolved and particulate forms, with the latter strongly favoured, results in some difficulty in comparing data sets which make different divisions of the total iron pool. These divisions result from the procedures used for storage, filtration and analysis.

This paper describes the vertical distribution of iron in the central Arctic Ocean and compares this with profiles of Cd and Al, relating each to the hydrography.

2457 MOORE, R.M., LOWINGS, M.G., and TAN, F.C. - 1983
Geochemical Profiles in the Central Arctic Ocean: Their Relation to Freezing and Shallow Circulation; *J. Geophys. Res.*, vol. 88, no. C4, pp. 2667-2674. *LOREX Contr. No. 12.*

Temperature, salinity, nutrient, tritium, and oxygen isotope data collected during the Lomonosov Ridge Experiment along a drift track between the Makarov and Fram Basins over the Lomonosov Ridge are presented. The relationship of these quantities to the processes that maintain the halocline, in particular to the production of more saline waters by addition of brines formed during the freezing of seawater, is described. The results support the idea that the wide continental shelves of the Arctic Ocean play an important role in maintaining the halocline.

2357 OHMURA, A., and STAUFFER, B. - 1982
North Water - Oase im Eismeer; *in* Forschung und Technik, Neue Bürcher Beitung, Mittwoch, September 29, 1982, Nr. 226, pp. 61-64.

2458 PRINSENBERG, S.J., and SOSNOSKI, D. - 1983
Arctic Oceanographic Data Report 1983, Barrow Strait, Volume 1; *Fish. & Oceans*, Ocean Sci. and Surveys, Bayfield Lab. Marine Sci. and Surveys, Data Rep. Series No. 83-6, 344 p. *UNPUBLISHED MANUSCRIPT.*

This report contains the profile data collected by Bayfield Laboratory, Ocean Science and Surveys, in the centre section of the Northwest Passage during the month of April, 1983. The conductivity and temperature data were obtained with a Guildline Mark IV CTD probe deployed from the ice surface using a small portable Arctic profiling winch. A helicopter (Bell 206B Jet Ranger), based at the Polar Continental Shelf Project camp at Resolute Bay, N.W.T., was used as the means of transportation and contained the recording electronics of the CTD system. The time-series current meter and time-series CTD data collected during this survey will be published separately in Volume II.

HYDROLOGY

2459 ANDERSON, J. - 1981
Lake and River Ice - Aufeis, N.W.T.; *Ice*, no. 65, 1st issue, p. 7.

2460 ANDERSON, J.C. - 1982
Permafrost and Ground Ice, Gas Hydrates - Aufeis, N.W.T.; *Ice*, no. 68, 1st issue, p. 11.

2461 ANDERSON, J.C. - 1982
Hydrologic studies in the Mackenzie Delta Region, N.W.T., 1980; *Nat. Hydro. Res. Inst.*, Env. Can. Rep. Northern Roads Env. Working Group, DIAND, 41 p.

Hydrologic investigations continued during the 1980 open water season at several watersheds in the taiga and tundra zones of the eastern Mackenzie Delta region, N.W.T. Data were gathered on snowpack water equivalent, river channel and culvert icings, precipitation, air temperature, and river discharge. Culvert icings to the south of Inuvik were of intermediate magnitude, while to the north, an icing recurred on Hans Creek, upstream of the proposed highway crossing. In both taiga and tundra, late winter snowpack water equivalents were high. Snowmelt produced the largest flood event of the season and peak flows were 23 to 92% of the 50-year design curve values in the taiga zone basins. Snow drifting was identified as a probable maintenance problem for any north-south highway in the tundra region, owing to the prevalence of easterly and northwesterly winds during the winter season.

2462 ANDERSON, J.C. - 1983
Hydrologic studies in the Mackenzie Delta Region, N.W.T., 1981; *Nat. Hydro. Res. Inst.*, Env. Can., internal report, 40 p.

Hydrologic investigations continued during 1981 at several watersheds in the taiga and tundra zones of the eastern Mackenzie Delta region, N.W.T. Data were gathered on snowpack water equivalent, river channel and culvert icings, precipitation, air temperature, river discharge, and suspended sediment. Culvert icings to the south of Inuvik were of intermediate magnitude, while in the north, an icing recurred on Hans Creek, upstream of the proposed highway crossing. A second, larger icing in the tundra zone was observed on Stanley Creek between Noell and Jimmy Lakes. Late winter snowpack water equivalents were slightly above normal at Inuvik airport, and of intermediate magnitude at the tundra sites. Due to warm weather in April and early May, snowmelt commenced relatively early, and caused the largest flows of the 1981 season, except at Caribou Creek. Though instantaneous flow maxima were not estimated, it appears from the daily maxima that significant flood peaks occurred at Km 1561 and Zed Creek, and possibly at Km 1535.9 as well. Suspended sediment concentrations measured during the snowmelt flood in the taiga zone were low to moderate in amount.

2463 DUBREUIL, M.A. - 1983
Dust at the surface of High Arctic snowpacks and its effects on snowmelt; unpub. M.Sc. Thesis, McMaster Univ., 115 p.

During the snowmelt season of 1981, the dust characteristics and surface energy balance of Arctic snowpacks were studied at and around Resolute Bay, N.W.T. A site near the airstrip was used to represent dusty snow conditions within the settlement while a second site with clean snow outside the settlement was typical of the uninhabited areas of the Arctic. The dust, which was concentrated mostly at the surface, strongly affected the snow albedo. The resulting difference in net radiation caused by the dust cover was primarily responsible for the difference in the rate of melt between the two experimental sites. In the study period, rain-on-snow melt was negligible because of low rainfall, and the turbulent fluxes over dirty snow were overshadowed by the radiation flux.

Values of mid-day albedo throughout the melt season can be predicted by their empirical relationship with the dust load. The decrease in albedo with time can also be described by a logistic curve. Using these empirical equations, the melting of snowpacks with varying amounts of surface dust can be simulated.

Results from this study indicate that a northern settlement such as Resolute significantly affects the local snowmelt conditions. Therefore, measurements taken at weather stations, particularly radiation, may not truly reflect the general conditions assumed for relatively dust-free Arctic snowpacks.

2436 FUJINO, K. - 1981
Thermal Regime of the Uppermost Layer of Tundra and Its Effect on Microtopography; *in* Joint Studies on Physical and Biological Environments in the Permafrost, North Canada, July to August 1980 and February to March 1981, Inst. Low Temp. Sci., Hokkaido Univ., Japan, pp. 21-36.

2464 HERON, R., and WOO, M-K. - 1981
Lake and River Ice - Cornwallis Island, N.W.T.; *Ice*, no. 65, 1st issue, p. 6.

2465 HERON, R., and WOO, M-K. - 1982
Lake and River Ice - Cornwallis Island, N.W.T.; *Ice*, no. 68, 1st issue, p. 7.

2466 KATO, K., and FUJINO, K. - 1981
Oxygen Isotopic Composition of Massive Ice at Tuktoyaktuk, North Canada; *in* Joint Studies on Physical and Biological Environments in the Permafrost, North Canada, July to August 1980 and February to March 1981, Inst. Low Temp. Sci., Hokkaido Univ., Japan, pp. 13-20.

Distinctive ground features such as polygons, pingos and involuted hills are commonly observed in the arctic region, especially around Tuktoyaktuk, N.W.T. of Northern Canada.

Their origins and formation processes still remain arguable, but the fact that large ice bodies are found underneath them suggests that water supply from various sources plays an important role in their formation processes.

Meanwhile, water in nature has a fairly uniform isotopic composition, which has a strong correlation with annual temperature.

These results have contributed to successful stratigraphic analyses of the antarctic continental ice sheet related to long and short-term climatic conditions. In case of ground ice of the arctic region, stratigraphic application of isotopes may make it possible to find a key to the formation mechanisms and characteristics of them. From these viewpoints, oxygen isotopic compositions of ground ice such as polygons, pingos and massive ices were investigated during the former joint research expedition of 1977. Results obtained showed very interesting characteristics.

A massive ice body at Tuktoyaktuk, Mackenzie Delta, N.W.T., Canada, was subjected in this expedition to a systematic study of the profile of oxygen isotopes of it and a crystallographic study of its ice texture so that the origin of water forming it as well as the formation mechanism of it was investigated.

2467 MARSH, P. - 1982
Ripening Processes and Meltwater Movement in Arctic Snowpacks; unpub. Ph.D. thesis, McMaster Univ., 179 p.

This is a study of the processes controlling snowpack ripening and the movement of meltwater through wet snowpacks. Measurements made in the Canadian High Arctic during the 1979, 1980, and 1981 snowmelt periods, included premelt stratigraphy, surface energy ba-

lance, physical changes in snowpack properties during melt, snow and soil temperatures, and water movement within the pack.

Field observations and computer modelling demonstrated an interdependence of finger flow at the wetting front and ice layer growth at premelt snow horizons. Ice layers grow rapidly in cold snowpacks, slowing the finger wetting front advance and releasing considerable latent heat which warms the underlying snow and soil. Since the ground is frozen when water reaches the ground surface, the meltwater refreezes at the snowpack base. The growth of this basal ice layer limits the amount of water available for daily runoff and extends the melt period, a phenomenon which is typical of cold arctic snowpacks.

A redistribution of flow within the snowpack, concentrating flow in certain areas and diminishing it in others, is due to variations in ice layer properties, and not flow instabilities or vertical flow channels. The result is a spread of the rising limb of the melt wave at depth and a decrease of the peak flow. Results from a multiple flow path model, suggest that flow variability is similar in snowpacks from different environments. This indicates that the model is applicable to snowpacks in a wide range of environments.

2377 McNEELY, R. - 1982
Ambient pH levels in environmental samples from the High Arctic; *in* Current Research, Part C; Geol. Surv. Can., Paper 82-1C, pp. 111-114.

2354 OHMURA, A. - 1982
Regional Water Balance on the Arctic Tundra in Summer; *Water Resources Res.*, vol. 18, no. 2, pp. 301-305.

2468 SHERSTONE, D.A. - 1981
Lake and River Ice - Freeze-up, Break-up and Ice Jams; *Ice*, no. 65, 1st issue, p. 7.

2469 STEER, P., and WOO, M-K. - 1981
Permafrost and Ground Ice - Cornwallis Island, N.W.T.; *Ice*, no. 65, 1st issue, p. 9.

2470 STEER, P., and WOO, M-K. - 1982
Permafrost and Ground Ice, Gas Hydrates - Active Layer Hydrology; *Ice*, no. 68, 1st issue, p. 11.

2471 STEER, P. - 1982
Hydrology of a slope in the High Arctic; unpub. M.Sc. thesis, McMaster Univ., 111 p.

Components of slope hydrology were studied between 1977 and 1981 near Resolute, N.W.T. Emphasis was placed on the relationship of surface and subsurface flows with snowmelt, rainfall and evaporation. During the thaw season, runoff responses to snowmelt and rainfall vary depending upon (1) the magnitude of the water input, (2) antecedent soil moisture conditions and (3) the type of slope material which affects storage capacity and the thickness of the thawed zone in the active layer. Results indicate that surface flow removes 2.5 times more water from the slope than does subsurface flow and that frost table configuration is an important variable affecting slope runoff responses.

2472 STEER, P., and WOO, M-K. - 1982
Measurement of slope runoff in a permafrost region; *Can. Geotech. J.*, vol. 20, no. 2, pp. 361-365.

Installations at a High Arctic experimental site that is underlain by continuous permafrost allowed the measurement of slope runoff. Surface flow was collected near the base of the slope and the water was led to a flume with a V-notch weir. The water level in the flume was recorded and subsequently converted to discharge measurements. Subsurface flow was intercepted by an impermeable flow barrier set in a trench dug down to the permafrost table and later backfilled by the excavated slope materials. Water draining from above the flow barrier was fed into another flume unit similar to that for surface runoff. During the operational period, regular inspection of the flumes was required to ensure the prevention of ice formation or evaporative losses from the water in the flumes.

2473 TERROUX, A.C.D., and SHERSTONE, D.A. - 1981
Lake and River Ice - Mackenzie Delta, N.W.T.; *Ice*, no. 65, 1st issue, pp. 6-7.

2474 WANKIEWICZ, A. - 1982
Permafrost and Ground Ice, Gas Hydrates - Permafrost Hydrology; *Ice*, no. 68, 1st issue, p. 11.

2475 WOO, M-K. - 1982
Snow - Arctic Snow Cover - Resolute, N.W.T.; *Ice*, no. 68, 1st issue, p. 5.

2476 WOO, M-K. - 1982
Determination of snow distribution in High Arctic Basins; *in* Proc. 4th Northern Res. Basin Sym. Workshop, Ullensvang, Norway, March 22-25, 1982, Effect of distribution of snow and ice on streamflow, pp. 21-31.

For nine months each year, snowfall is the major form of precipitation in the Canadian High Arctic. Without vegetation, snow drift is predominantly controlled by the local terrain. By establishing the snow characteristics for different terrain types, total basin snow storage can be obtained by areally weighting the snow cover for various terrain units in the basin.

Such a method has been successfully employed at McMaster River basin at Resolute to compute total snowfall for the winters of 1976 to 1981.

A major finding is that the official weather station data consistently underestimated basin snow storage. In 1981, similar snow surveys were extended to other basins in the High Arctic. Results confirm the feasibility of mapping snow distribution by terrain types.

2477 WOO, M-K. - 1982
Effects of valley snowpacks upon the break-up of steams in the High Arctic; *in* Proc. 4th Northern Res. Basin Sym. Workshop, Ullensvang, Norway, March 22-25, 1982, Effect of distribution of snow and ice on streamflow, pp. 103-116.

Prolonged winter snow drifting in the High Arctic results in snowpacks of high density and hardness. The distribution of snow cover is extremely uneven, with substantial amounts drifted into valleys, forming massive barriers to spring runoff.

Initial runoff occurs as slush flow, sheet flow over snow or subsurface flow in the snow. Subsequently streamflow follows channels carved through the snowpack or tunnels developed in the snow. In some valleys, large quantities of water may be impounded behind snow jams which rupture catastrophically to generate flash floods downstream.

Runoff in all High Arctic basins is often affected by the presence of snow jams, and this greatly complicates any simple snowmelt-runoff relationship. Further research on the formation and the break-up of snow jams will greatly improve our understanding of streamflow processes, hence the predictions of floods in the Arctic.

2478 WOO, M-K. - 1982
Snow hydrology of the High Arctic; presented Western Snow Conf., Reno, Nevada, April 20-23, 1982, Joint Western Snow Conf. - Eastern Snow Conf., 1982; McMaster Univ., pp. 63-74.

The High Arctic of Canada lies well within the Arctic circle. For about nine months each year, snow and ice constitute an integral part of the landscape, and snow plays a dominant role in the climatology, hydrology and the ecology of the region. Within this vast area, however, there are only four permanent weather stations which routinely record snowfall and carry out snow survey at half-monthly intervals. The extreme paucity and inaccuracy of precipitation data probably forced Lvovitch (1973) to ignore the Canadian Arctic archipelago in his global survey of water balance.

Scientific studies of snow in the High Arctic dated back to the last century. Detailed studies on various aspects of the Arctic snow cover were carried out mainly since the 1950's. Most of these works do not treat the subject comprehensively. This, together with a lack of adequate data base, has not dispelled some of the improper notions regarding the nival processes in a polar environment conceived through cursory observations of early travellers. In the 1970's, a growing interest in the Arctic accompanied mineral exploration and the transport of oil and gas, and a modest body of literature on Arctic snow and ice becomes available.

This paper will review aspects of snow hydrology of the High Arctic, mainly drawing upon works published after 1960, and from field experience of the author and his students in the past decade. Through a survey of the existing knowledge, some insight into future progress may be gained.

2479 WOO, M-K. - 1982
Upward flux of vapor from frozen materials in the High Arctic; *Cold Regions Sci. & Tech.*, vol. 5, pp. 269-274.

This study demonstrates the formation of depth hoar by upward vapor transport from frozen soils in the Canadian High Arctic. The saturated boggy site produced more hoar than the non-saturated gravelly site nearby but, compared with interior Alaska, the amount produced was one order of magnitude less. The difference is attributed mainly to the reduced soil temperature gradient in a cold, polar environment which is less favorable to vapor transfer.

2480 WOO, M-K. - 1983
Snow hydrology of the Canadian High Arctic; *Water Quality Bull.*, vol. 8, no. 1, pp. 19, 20, 21, and 52.

The Canadian High Arctic is a barren polar region where tundra vegetation occurs only in more favoured localities and where for over nine months each year, snow forms an integral part of the landscape. In this region, most rivers are short and their drainage basin area seldom exceeds 2000 km^2. All basins in this region are underlain by permafrost at a depth of about 0.5 m, which is maintained by cold winters with long hours of darkness. In the summer, a large proportion of the annual solar radiation which reaches the High Arctic between April and August is reflected because of the high reflectivity of snow (with albedo averaging 0.7 to 0.8). Figure 2 illustrates the radiation received at a station which is quite large compared with the net radiation.

The marked contribution of snowmelt to runoff has been recognized. Remoteness and high cost, however, have prohibited thorough hydrological investigations of the region. This paper provides a review of available literature on snow hydrology in a high arctic environment. The influence of glaciers, wetlands and lakes, though important in some northern basins, are excluded from the present discussion.

2481 WOO, M-K., HERON, R, and MARSH, P. - 1981
Basal ice layers of very cold arctic snowpacks; *in* Proc. Eastern Snow Conf., 38th Annual Meeting, Syracuse, N.Y., June 4-5, 1981, pp. 67-75.

In the Canadian High Arctic, both the snowpack and the ground temperatures are extremely low

throughout winter. During the melt period, meltwater percolating through the cold pack will refreeze as ice layers, thus releasing heat to the lower parts of the pack. When water reaches the bottom of the pack, the cold substrate again refreezes the meltwater to produce a basal ice layer. The growth of this layer will continue until meltwater supply is depleted or until the extreme coldness of the ground is removed. When the basal ice is exposed, its destruction is accomplished by surface melting or by rills eroding on the ice.

Basal ice formation is an efficient mechanism that transfers heat through the cold snowpacks and to the cold substrate. Hydrologically, multiple freezing and melting of water through ice formation and destruction complicate the snowmelt-runoff relationship. Where basal ice layers are abundant, basin storage is prolonged and they contribute to streamflow during the drier Arctic summers.

2482 WOO, M-K., HERON, R., and MARSH, P. - 1982
Basal ice in High Arctic snowpacks; *Arctic & Alpine Res.*, vol. 14, no. 3, pp. 251-260.

In late May or June, meltwater percolating through cold arctic snowpacks often refreezes as ice layers. In the presence of a cold substrate, such layers form at the base of the snowpack. This basal ice continues to grow so long as meltwater supply is sustained and the substrate remains below 0^{0}C. Upon exposure, the ice is destroyed by sublimation and surface melting or by thermal and mechanical erosion by water which runs on, in or under the ice. Multiyear ice is preserved when the incompletely melted basal ice is buried by subsequent snowfall or by a layer of earth materials.

Multiple freezing and melting of water in basal ice layers complicate the snowmelt-runoff relationship in three principal ways. Where basal ice is abundant, the melt is prolonged and contributes to streamflow during the drier summer months. During breakup, the basal ice in stream beds tends to increase flow velocity and, consequently, the capacity for sediment transport. However, a basal ice layer in the channel will reduce opportunities for erosion.

2483 WOO, M-K., HERON, R., MARSH, P., and STEER, P. - 1983
Comparison of Weather Station Snowfall With Winter Snow Accumulation in High Arctic Basins; *ATMOSPHERE-OCEAN*, vol. 21, no. 3, pp. 312-325.

Most water balance studies in the High Arctic indicate that the weather stations underestimate annual precipitation, but the magnitude of such error is unknown. Based on up to seven years of field measurements, this study provides a comparison of snowfall at weather stations with the winter snow accumulation in their nearby drainage basins.

Snowfall is the major form of precipitation in the polar region for nine months every year. Without vegetation, snowdrift is controlled by the local terrain. By establishing the snow characteristics for different terrain types, total basin snow storage can be obtained by areally weighting the snow cover for various terrain units in the basin. Such a method was successfully employed to compute total winter snowfall in the drainage basins near Resolute, Eureka and Mould Bay. Results show that the basins had 130 to 300 per cent more snow than the weather stations recorded. Using revised snowfall values that are reinforced by Koerner's snow core measurements from ice-caps, it is hoped that a more realistic precipitation map can be provided for the High Arctic.

2484 WOO, M-K., MARSH, P., and HERON, R. - 1981
Snow and Avalanches - Snow Metamorphism and Melt, N.W.T.; *Ice*, no. 65, 1st issue, p. 5.

2485 WOO, M-K., and STEER, P. - 1982
Occurrence of surface flow on arctic slopes, southwestern Cornwallis Island; *Can. J. Earth Sci.*, vol. 19, no. 12, pp. 2368-2377.

Surface flow on arctic slopes is due to a rise of the suprapermafrost water table above the ground surface. The active layer therefore has to be saturated, or surface flow will be lost to infiltration.

In spring, snowmelt supplies abundant water to the slopes, but a shallow frost table restricts the active layer storage capacity. This produces extensive surface flow, delivering considerable volumes of water downslope as overland flow or rill runoff. As the snowpacks are reduced and ground thaw increases the subsurface storage capacity, surface flow declines in magnitude and in areal coverage. During most summers, subsurface flow dominates, except when occasional rainstorms of high intensity raise the water table above the ground to rejuvenate surface runoff.

The occurrence of surface flow is controlled by slope material, slope profile, and the water balance. Spatial and temporal changes in these controlling variables always result in a highly dynamic pattern of surface flow on arctic slopes.

2486 WOO, M-K., MARSH, P., and STEER, P. - 1983
Basin water balance in a continuous permafrost environment; *in* Proc. Permafrost: Fourth International Conf., Nat. Academy Press, Washington, D.C., ISBN 0-309-03435-3, pp. 1407-1411.

The hydrology of a basin in the continuous permafrost region of Canada was studied for 6 years to establish seasonal and annual water balances. Emphases were placed upon the spatial and temporal variations of snowmelt, rainfall, evaporation, streamflow and active layer storage capacity. Spring melt released consi-

derable meltwater which could not be accommodated by a thinly thawed active layer. High runoff resulted. Evaporation was active concurrently but from the snow-free portion of the basin. Summer rainfall was often of low intensity. Storage capacity increased as the frost table receded and much of the rain could be held in the active layer to maintain evaporation and base-flow. Over the years, snowfall constituted about three-quarters of annual precipitation, about 80% of which was consistently removed by runoff. Annual evaporation was small and net change in storage for the 6 year period was also of low magnitude.

2487 WOO, M-K., and STEER, P. - 1983
Slope hydrology as influenced by thawing of the active layer, Resolute, N.W.T.; *Can. J. Earth Sci.*, vol. 20, no. 6, pp. 978-986.

High arctic slopes have a shallow active layer that thaws unevenly during summer. The result is often a lack of agreement between the configuration of the frost table and the surface topography, and this has effects on the slope hydrology. (1) Areas with a shallow frost table favour surface runoff but areas with a deeper frost table require a thick zone of saturation to generate surface flow. Uneven thaw depths then cause alternating seepage and re-emergence of water down a slope. (2) The configuration of the frost table is highly dynamic, causing day to day changes in water storage capacity in the active layer. (3) A frost table with local depressions can pond up groundwater, which may be rapidly released when part of the frozen sill is breached by continual thawing. (4) The topographical drainage divide may not correspond with the subsurface drainage divide as defined by the frost table, thus allowing groundwater to drain laterally across topographical boundaries. These findings show that a knowledge of the frost table behaviour, both spatially and temporally, is essential to the study of slope hydrology in continuous permafrost terrains.

ICE ISLAND

2445 JEFFRIES, M. - 1982
The Ward Hunt Ice Shelf, Spring 1982; *Arctic*, vol. 35, no. 4, pp. 542-544.

2446 JEFFRIES, M.O. - 1983
Arctic ice shelf studies, spring 1983; *Polar Cont. Shelf Proj.*, internal report, 21 p.

2447 JEFFRIES, M.O. - 1983
Preliminary isotope studies on Ward Hunt Ice Shelf; *Defence Res. Est. Pacific*, Nat. Defence DREP Contractors Rep. Series 83-26, 56 p.

2488 JEFFRIES, M.O., and SERSON, H. - 1983
Recent Changes at the Front of Ward Hunt Ice Shelf, Ellesmere Island, N.W.T.; *Arctic*, vol. 36, no. 3, pp. 289-290.

LOREX

2390 CLARK, D.L., MORRIS, T.H., and BLASCO, S.M. - 1983
Pleistocene sedimentation patterns for the Lomonosov Ridge and Amerasian Basin, Central Arctic Ocean; *Abstract in* Proc. Geol. Soc. Amer., *LOREX Contr. No. 18.*

2434 FORSYTH, D.A., and MAIR, J.A. - 1984
Crustal structure of the Lomonosov Ridge and the Fram and Makarov Basins near the North Pole; *J. Geophys. Res.*, vol. 89, pp. 473-481. *LOREX Contr. No. 15.*

2489 LOWINGS, M.G. - 1981
Carbonate Chemistry in the Central Arctic Ocean; unpub. M.Sc. thesis, Dalhousie Univ., *LOREX Contr. No. 7.*

A comprehensive survey of the carbonate system in the central Arctic Ocean was conducted during the Lomonosov Ridge Experiment (LOREX) in April and May 1979. From measured distributions of pH and total alkalinity, calculated values of carbonate alkalinity, total carbon dioxide, partial pressure of carbon dioxide and calcite percent saturation were determined. These data indicate the presence of strongly-advective structure in the central Arctic Ocean, the isolation of bottom waters by the Lomonosov Ridge and the dominant role of shelf processes in the carbonate chemistry of surface and near surface waters.

High pH and high (normalised) total alkalinity were found in the Arctic Surface Layer at the LOREX site. Calculated partial pressures of carbon dioxide exceeded 450 x 10^{-6} atm. In waters identified as the Bering Winter Layer, pronounced total carbon dioxide and (normalised) total alkalinity maxima, and pH and calcite percent saturation minima, were observed through a narrow range of depths. Calculated partial pressures of carbon dioxide were greater than 900 x 10^{-6} atm. Carbonate characteristics of the Atlantic Intermediate Layer showed generally conservative behaviour. Core properties were not altered or modified by mixing with adjacent water masses. In the Arctic Bottom Layer at depths of roughly 1500 m and below, total alkalinity and total carbon dioxide are consistently lower, and pH consistency higher, on the Eurasian side of the Lomonosov Ridge.

A qualitative model for the carbonate system of the Arctic Ocean and marginal seas was formulated from the LOREX observations and other Arctic data. Speculative in nature, the model

suggests that shelf processes control the carbonate chemistry of surface and near surface waters in central basin regions. The transition from polar day to polar night and different degrees of ice cover are important factors in this respect. The absence of primary production in winter, versus the presence of oxidation 12 months of the year, is also significant.

2424 MAIR, J.A., and FORSYTH, D.A. - 1982
Crustal structures of the Canada Basin near Alaska, the Lomonosov Ridge and adjoining basins near the North Pole; *Tectonophysics*, vol. 89, pp. 239-253. *LOREX Contr. No. 10.*

2490 MOORE, R.M. - 1981
Oceanographic distributions of zinc, cadmium, copper and aluminium in waters of the central Arctic; *Geochimica et Cosmochimica Acta* vol. 45, pp. 2475-2482. *LOREX Contr. No. 6.*

Vertical profiles are presented of dissolved cadmium, zinc, copper and aluminium at the LOREX 79 site in the central Arctic Ocean. Cd, Zn and Cu show unusually high surface concentrations of 0.3, 3 and 5 nmol l^{-1} respectively; these levels are related to contributions from surface run-off and from the underlying nutrient-rich Bering Sea winter water. Al has lower surface concentrations than observed elsewhere and shows no correlation with the nutrients; the importance of aeolian supply is questioned and the results point to a major role for inorganic removal of Al at least in the Arctic Ocean.

2457 MOORE, R.M., LOWINGS, M.G., and TAN, F.C. - 1983
Geochemical Profiles in the Central Arctic Ocean: Their Relation to Freezing and Shallow Circulation; *J. Geophys. Res.*, vol. 88, no. C4, pp. 2667-2674. *LOREX Contr. No. 12.*

2428 MORRIS, T.H. - 1983
The stratigraphy and late pleistocene sedimentological history of the Lomonosov Ridge-Makarov Basin, Central Arctic Ocean; unpub. M.Sc. thesis, Univ. Wisconsin-Madison, 100 p. *LOREX Contr. No. 17.*

2491 POPELAR, J., and KOUBA, J. - 1983
Satellite Doppler Determination of Differential Sea Ice Motion in the Vicinity of the North Pole; *Marine Geodesy*, vol. 7, no. 1-4, pp. 171-198. *LOREX Contr. No. 14.*

During April and May 1979 multidisciplinary observations were conducted in the central Arctic Ocean from three manned ice stations to explore the nature of the submarine Lomonosov Ridge. Positions of the LOREX (Lomonosov Ridge Experiment) ice camps were monitored continuously using geodetic satellite doppler receivers and the U.S. Navy Navigation Satellite System. Near real-time doppler data reduction on the ice using broadcast satellite ephemeris provided operational horizontal positions with accuracies of about ± 250 m. A precise geodetic satellite doppler reduction program has been adapted to accommodate linear station motion in a simultaneous multistation, three-dimensional adjustment in phases using postfitted precise satellite ephemeris, if available. Complete reprocessing of the LOREX doppler data set has produced average errors of ± 48 m for single pass solution and ± 24 m for mean three-four horizontal station positions. The station ellipsoidal heights show strongly correlated variations in excess of 5 m, with the average error of ± 0.45 m. Station velocities are also strongly correlated, with the mean of about 225 m/h and the maximum of 1,240 m/h. Total strain and hourly strain rate components of sea ice have been evaluated for a homogeneous two-dimensional strain model. The configuration of the ice camps provides a unique solution for mesoscale strain, indicating a major change in the pattern of pack ice deformation over the Lomonosov Ridge. The total strain reflects plastic deformation, which takes place mainly in episodic events. The strain rate also indicates nearly diurnal oscillations, with amplitudes an order of magnitude smaller than those corresponding to the major deformation events.

2492 POPELAR, J., KOUBA, J., and WELLS, D. - 1981
LOREX 79 Satellite Positioning; *Dept. Energy, Mines & Res.*, Gravity & Geodynamic Div., Earth Phys. Br., internal rpt. no. 81-2, 129 p.

Positions of three LOREX 79 ice stations used to explore the submarine Lomonosov ridge in the vicinity of the geographic North Pole were continuously monitored using the Navy Navigation Satellite System. Near real-time satellite data reduction was performed on the ice providing operational positions with accuracies of about ± 250 m. Precise geodetic satellite software has been adapted to accommodate station drift. The new dynamic Doppler reduction program facilities simultaneous multi-station, three-dimensional adjustment in phases using precise satellite ephemeris and comprehensive instrumental and environmental error modelling. Complete reprocessing of the LOREX Doppler data set has produced average errors of ± 50 m for single pass solution and ± 25 m for mean three-hour horizontal station positions. The station ellipsoidal heights show strongly correlated variations in excess of 5 m with the average error of ± 0.45 m. Station velocities are also strongly correlated with the mean of about 225 m/h and the maximum of 1240 m/h. Total strain and hourly strain rate components have been evaluated for a homogeneous two-dimensional strain model. The configuration of the ice camps provides a unique solution for meso-scale strain indicating major change in the pack ice deformation pattern over the Lomonosov ridge. The total strain reflects plastic deformation which takes place mainly in episodic events. The strain rate indicates nearly diurnal oscillations with amplitudes an order of magnitude smaller than those corresponding to the major deformation events.

2493 QUEK, S.H. - 1983
LOREX (1979) - Ice Station Positions and Velocities Using Two-Dimensional Cubic Spline Approximation; *Univ. New Brunswick*, Dept. Surveying Engineering Tech. Rep. no. 97, 159 p. *LOREX Contr. No. 20.*

During the summer of 1979, an expedition to the North Pole was made to investigate the nature and origin of the Lomonosov Ridge running across the Arctic Ocean. Three ice camps were established and positioned using Transit satellites. The positioning data series from the three ice camps, for the duration of the expedition, were processed using the cubic spline algorithm developed in Quek (1983). Plots of raw and smoothed positions are given. Smoothed positions and velocities from the three ice camps are compared with those produced by other techniques.

2430 SWEENEY, J.F., WEBER, J.R., and BLASCO, S.M. - 1982
Continental ridges in the Arctic Ocean: LOREX constraints; *Tectonophysics*, vol. 89, pp. 217-237. *LOREX Contr. No. 9.*

2246 WEBER, J.R. - 1983
Maps of the Arctic Basin Sea Floor: A History of Bathymetry and its Interpretation; *Arctic*, vol. 36, no. 2, pp. 121-142. *LOREX Contr. No. 13.*

OCEANOGRAPHY

2452 BIRCH, J.R., FISSEL, D.B., LEMON, D.D., CORNFORD, A.B., LAKE, R.A., SMILEY, B.D. MacDONALD, R.W., and HERLINVEAUX, R.H. - 1983
Arctic Data Compilation and Appraisal, Volume 3. Northwest Passage: Physical Oceanography - Temperature, Salinity, Currents and Water Levels; *Fish. & Oceans*, Can. Data Rep. Hydrogr. Ocean Sci 5, vol. 3, 262 p.

2453 BIRCH, J.R., FISSEL, D.B., LEMON, D.D., CORNFORD, A.B., HERLINVEAUX, R.H., LAKE, R.A., and SMILEY, B.D. - 1983
Arctic Data Compilation and Appraisal, Volume 5. Baffin Bay: Physical Oceanography - Temperature, Salinity, Currents and Water Levels; *Fish. & Oceans*, Can. Data Rep. Hydrogr. Ocean Sci. 5, vol. 5, 372 p.

2494 BROOKS, D.J. - 1982
Arctic Oceanographic Survey, Barrow Strait, 1982 Field Report; *Fish. & Oceans*, internal report, Ocean Sci. & Surveys, Bayfield Lab., Burlington, Field Report Series No. 82-1, 87 p. *UNPUBLISHED MANUSCRIPT.*

This report describes second-year field activities for the Barrow Strait project which were carried out in the period February to May, 1982. Long-term monitoring of ocean properties and transport in Barrow Strait was initiated in March, 1981 by the Oceanographic Division of Bayfield Laboratory for Marine Science and Surveys (Burlington, Ontario). This study is being carried out to fill, in part, an information gap that was identified by the Division in 1979, and it is an activity associated with the Working Group on Northwest Passage Oceanography, Subcommittee on Arctic Oceanography (SCAO), of the Canadian Committee on Oceanography. Because year-round shipping through the Northwest Passage seems likely in a few years, both government and industry require development of an oceanographic knowledge base for the region, not only for judging the design and operation of the proposed transport systems, but also for addressing safety, environmental protection, and regulatory concerns.

The general aim of the field work described here is to collect information on the magnitude of short- and long-term variations in the physical, chemical, and biological properties of the water in a section of the Northwest Passage. The selected study area, Barrow Strait, is shown in relation to the Canadian Arctic Archipelago in Figure 1, and in detail in Figure 4. The study area includes the entrances to the contiguous waters of McDougall Sound, Peel Sound, and Wellington Channel. The field work utilizes the stable ice cover, and accordingly is scheduled for the late March - early May period. Rotary and fixed-wing aircraft are used to transport equipment and personnel to on-ice observation sites from the main logistics base at Resolute.

The field work is a combination of regional surveys of water structure and properties, intended to delimit spatial variations, and, at selected sites, of repeated/continuous measurements to identify variability in water structure, chemical and biological properties, and water movements.

Since the CTD and G-UMPS data are processed in the field, preliminary results of observations are readily available, and comparisons to the data of the previous year (spring 1981) can be made. The surface mixed layer this year (1982) was 20 to 30 metres deeper than observed at same locations in 1981. In McDougall Sound, water was homogeneous to the bottom (200 metres). The G-UMPS data also reflected this change as the maximum current usually associated with the bottom of the surface mixed layer was observed deeper this year than last year. This indicates that the vertical current distribution is closely correlated to the density structure (as predicted by theory).

The eastward flow along the south shore of Barrow Strait was again observed and caused upwelling, bringing up water to the under surface of the ice (causing thinner ice in the area). The CTD regional survey also indicates that the different water masses (Peel Sound, McDougall Sound, etc.) were found in different areas, as these mixed and flowed out via Barrow Strait.

The biological data can not be processed in the field and thus it is not readily available

for preliminary results. What can be observed visually indicates that zooplankton species composition is different for various water masses. This will enable water mass identification by means other than physical parameters.

The onset of spring production of ice biota was observed. In March, there was little production and little biomass. By late April, however, a 2 to 3 cm mat covered the underside of the ice, and was probably being actively grazed by fish larvae and other biota.

2454 CORNFORD, A.B., LEMON, D.D., FISSEL, D.B., MELLING, H., SMILEY, B.D., HERLINVEAUX, R.H., and MacDONALD, R.W. - 1982
Arctic Data Compilation and Appraisal, Volume 1. Beaufort Sea: Physical Oceanography - Temperature, Salinity, Currents and Water Levels; *Fish. & Oceans*, Can. Data Rep. Hydrogr. Ocean Sci 5, vol. 1, 279 p.

2407 HARPER, J.R., and PENLAND, S. - 1982
Beaufort Sea Sediment Dynamics; *Geol. Surv. Can.*, Atlantic Geosci. Centre internal report, 214 p.

2495 LANGLEBEN, M.P. - 1983
Water stress on pack ice in the vicinity of the North Pole; *in* Proc. Seventh Inter. Conf. Port & Ocean Engineering under Arctic Conditions, Vol. 1, Helsinki, Finland, April 5-9, 1983, Tech. Res. Centre of Finland, pp. 128-137.

A series of water stress measurements in the turbulent boundary layer under a multiyear ice floe were made near the North Pole in the spring of 1979. The data were obtained from a station on the ice during the Lomonosov Ridge Experiment (LOREX 79). Observations of the instantaneous current, measured with a three-component ultrasonic current meter, were recorded as half-hour time series. Twenty-seven of the data runs were of good quality and were used to calculate the water stress or the square of the friction velocity from the cross-correlation between the downstream and vertical components of the fluctuations in current. The values of water stress ranged from about 0.04 dyne cm^{-2} to 0.9 dyne cm^{-2} for currents at 1-m depth of 3.9 cm s^{-1} and 16.8 cm s^{-1} respectively. As predicted by theory, the water stress was found to be highly linearly correlated to the square of the current, and the least-squares analysis yielded a value for the 1-m water drag coefficient of $(3.09 \pm 0.16) \times 10^{-3}$. The standard deviation between the observed values of water stress and those predicted on the basis of the fitting equation was 0.09 dyne cm^{-2}.

No thermal or density stratification of the water column was evident within the mixed layer. Conditions of neutral stability within that layer persisted throughout the period of observations although its depth which was about 35 m until 5 May decreased thereafter to about 20 m on 8 May and to 10 m on 11 May as a result of passage of an oceanic front. The accompanying change in temperature of the water mass was from -1.64C to -1.55C, of salinity from 29.9 $^{0}/_{00}$ to 28.6 $^{0}/_{00}$, and of density anomaly from 24.1 kg m^{-3} to 23.1 kg m^{-3}.

2455 MELLING, H. - 1983
Oceanographic features of the Beaufort Sea in early winter; *Fish. & Oceans*, Can. Tech. Rep. Hydrogr. Ocean Sci., no. 20, 131 p.

2496 MELLING, H., and LEWIS, E.L. - 1982
Shelf drainage flows in the Beaufort Sea and their effect on the Arctic Ocean pycnocline; *Deep Sea Res.*, vol. 29, no. 8A, pp. 967-985.

Wintertime hydrographic observations in the Canadian Beaufort Sea illustrate both the formation on the continental shelf of water which has the T-S characteristics of the Arctic subsurface layer, and the interleaving of such water at various depths within the subsurface layer in the adjacent Canadian Basin. The flow over the sea floor of this cold saline water from the shelf, where it is produced by freezing, to the depth of interleaving, is modelled as a gravity current using available observations. Its residence time on the shelf is long and the entrainment rate small.

The existence of such water in early winter in an area of low summertime salinity is discussed in terms of regional ice-cover deformation which, in the area studied, enables large increases in ice growth and surface-water salinity over predictions of these quantities based on climatology alone. Because the estimated increases are insufficient to account for the observed salinity changes, ice-cover deformation, while important, cannot alone provide their explanation.

2457 MOORE, R.M., LOWINGS, M.G., and TAN, F.C. - 1983
Geochemical Profiles in the Central Arctic Ocean: Their Relation to Freezing and Shallow Circulation; *J. Geophys. Res.*, vol. 88, no. C4, pp. 2667-2674. *LOREX Contr. No. 12.*

2458 PRINSENBERG, S.J., and SOSNOSKI, D. - 1983
Arctic Oceanographic Data Report 1983, Barrow Strait, Volume 1; *Fish. & Oceans*, internal report, Ocean Sci. and Surveys, Bayfield Lab. Marine Sci. and Surveys, Data Rep. Series No. 83-6, 344 p. *UNPUBLISHED MANUSCRIPT.*

2307 STIRLING, I. - 1980
The Biological Importance of Polynyas in the Canadian Arctic; *Arctic*, vol. 33, no. 2, pp. 305-315.

2497 THOMAS, D.J., MacDONALD, R.W., and CORNFORD, A.B. - 1982
Arctic Data Compilation and Appraisal, Volume 2. Beaufort Sea: Chemical Oceanography; *Fish.*

& Oceans, Can. Data Rep. Hydrogr. Ocean Sci. No. 5, Inst. Ocean Sci., Sidney, B.C., 243 p.

This volume is one of a group of catalogues designed to compile and appraise marine data sets for the Canadian Arctic. For each reference, the group has been organized with its subject matter divided into three disciplines: physics, chemistry and biology. The Arctic has been arbitrarily divided into seven geographical areas to include, where possible, major oceanographic regions. The format has been structured to facilitate comparison between subjects and regions. With such a large undertaking it is not possible to provide all reports at once. Therefore catalogues which are presently available in the series are indicated on the inside back cover of each volume.

Data collection is a continuing process and further updates of the catalogues are planned. Readers are invited to submit corrections and additions by writing the issuing establishment. These corrections will be incorporated in on-line computerized data set listings; they will be continuously available upon request.

2498 TODOROFF, S.W. - 1983
Circulation characteristics of Barrow Strait in the Northwest Passage; *Fish. & Oceans*, internal report, Ocean Sci. & Surveys, Bayfield Lab., Manuscript Rep. Series No. 16, 104 p. *UNPUBLISHED MANUSCRIPT.* (M.A.Sc. Civ. Eng., Univ. Waterloo)

The objective of this thesis has been to determine the circulation characteristics of Barrow Strait in the Northwest Passage. To this end a four-layer finite difference numerical model has been employed to simulate flow patterns in the region under a variety of conditions. As the region is ice covered for much of the year, the modifying effect of the ice is investigated. It has been found that ice cover exerts a significant drag on the flow in the top layer. The subsurface flow appears insensitive to ice conditions and is controlled more by the depth contours.

Verification of simulation results is provided through available observations and satellite imagery. The flows are characterized by jets conforming to the coastline of land masses while in mid-channel irregular motions occur. Persistent eddy-like features appear, usually at the intersection of channels.

An instability analysis was also carried out in order to propose an explanation as to the physical mechanisms affecting the flow field. Baroclinic instability can be generated when vertical shear velocities on the order of 17.6 cm/sec are realized. At the intersection of channels the component or horizontal velocity shear may lead to barotropic instabilities as well.

The topographic complexity of the Barrow Strait results in a corresponding complicated flow system.

SEA ICE RESEARCH

2499 de LANGE BOOM, B.R., MacNEILL, M.R., and BUCKLEY, J.R. - 1982
Iceberg Motion in Lancaster Sound and Northwest Baffin Bay, Summer 1978; *Arctic*, vol. 35, no. 1, pp. 219-233.

A radar station on Hope Monument, Devon Island, N.W.T., was operated from 7 July 1978 to 24 September 1978 to track the movement of icebergs in eastern Lancaster Sound and northwestern Baffin Bay. Data were recorded by photographing the radar screen every 20 minutes. Meteorological measurements were also made. The data were processed by computer to provide a statistical picture of the iceberg motions as well as tracks of individual bergs.

2500 DRAKE, J.J., and McCANN, S.B. - 1982
Sea Ice - Dynamics of Sea Ice Transported Boulders; *Ice*, no. 68, 1st issue, p. 7.

2501 FREDERKING, R. - 1982
Macro-scale cracking in sea ice, Nanisivik; *Ice*, no. 68, 1st issue, p. 8.

2502 FREDERKING, R., SANDERSON, T., WESSELS, E., and INOUE, M. - 1983
Ice behaviour around a small Arctic island; *in* Proc. VTT Sym. 28, Seventh Inter. Conf. on Port and Ocean Eng. under Arctic Conditions, Helsinki, Finland, April 5-9, 1983, vol. 2, pp. 875-887. NRCC Pub. No. 22804.

Adams Island, 200 m in diameter and about 3 km offshore in Lancaster Sound, has been established as a site for studying ice interaction processes. Preliminary surveys of ice and environmental conditions over the winter 1981/82 showed ice features reflecting a short-term pile-up as well as long-term thrust on the island. Associated ice pressures were in the range 40-400 kPa. Information on first-year ice cover, icebergs and multi-year floes was also collected.

2503 FREDERKING, R., and TIMCO, G.W. - 1983
Uniaxial compressive strength and deformation of Beaufort sea Ice; *in* Proc. VTT Sym. 27, Seventh Inter. Conf. on Port and Ocean Eng. under Arctic Conditions, Helsinki, Finland, April 5-9, 1983, vol. 1, pp. 89-98. NRCC Pub. No. 22805.

Strength and deformation behaviour of horizontally oriented specimens of granular and columnar-grained ice were measured in the field. Cylindrical specimens were loaded on compliant platens and prismoidal specimens on steel platens to provide a range of loading system stiffness. Loading system stiffness proved to have a significant effect on strength when

the results were interpreted in terms of nominal strain rate, but in terms of stress rate it was largely eliminated. The strength of the granular ice (2.5 - 4 MPa) was substantially higher than that of columnar-grained ice (1 - 2.5 MPa). Regardless of grain structure, the specimens all failed by yielding at a strain of about 3×10^{-3}.

2504 HAINES, S.A. - 1980
Plotting through the pack Radar resistant ice; *Science Dimension*, vol. 12, no. 3, Nat. Res. Council, pp. 16 & 18.

NRC's Division of Electrical Engineering is developing new techniques for measuring sea ice as part of the continuing search for ways of extending the Arctic shipping season.

2505 HANSON, A.M. - 1980
The snow cover of sea ice during the Arctic Ice Dynamics Joint Experiment, 1975 to 1976; *Arctic and Alpine Res.*, vol. 12, no. 2, pp. 215-226.

Data were obtained on snow depth during the Arctic Ice Dynamics Joint Experiment. In May 1975, the mean snow depth on similar multiyear floes varied across a 150-km wide area from 0.20 m in the northeast to 0.28 m in the southwest. A weighted mean snowfall for the year 1974/75 (freezeup to freezeup) was calculated to be 1.5 m, of which about 40% fell during the summer. As the snow cover melted ice was progressively exposed: $\cong$5% by 21 June, $\cong$ 50% by 2 July, and $\cong$ 90% by 13 July 1975. Summer snowfall prolonged the melting of the initial snow cover and later intermittently covered the ice. The snow cover of the winter 1975/76 began on 30 August and reached at least 67% of its depth by the end of October. Snow depths measured on a 10-m grid spacing over an area 510 by 410 m, containing small floes, ridges, rubble, and first-year ice, showed a net movement of snow by the wind from the floes to the rough ice. Despite a shorter period of accumulation, the mean snow depth was about 50% greater in a band of rough ice which formed the borders of the small floes. Twenty to thirty meters into the rough ice surrounding the small floes, the mean depth decreased to that of the floes. A minimum mean depth of snow cover is hypothesized to occur on a small floe in the size range 1000 to 3000 m^2 where the surrounding ridges and piles of ice are similar to those reported, i.e., 1.5 to 3.5 m high. The mean snow depth would be greater both on larger floes and on smaller floes or cakes.

2506 HAWKINS, R.K., LIVINGSTONE, C.E., GRAY, A.L., OKAMOTO, K., ARSENAULT, L.D., PEARSON, D., and WILKINSON, T.L. - 1981
Single and multiple parameter microwave signatures of sea ice; *in* Proc. Final SURSAT Ice Workshop, Atmos. Env. Serv., Toronto, June 23-27, 1980, eds. R.O. Ramseier and David J. Lapp, Section 5.1, 22 p.

Simultaneous 13.3 GHz dual-polarized fanbeam scatterometer data, 19.35 GHz horizontally polarized profiling radiometer data and nadir looking aerial photography with corresponding X- and L-band SAR (Synthetic Aperture Radar) imagery were collected with the CCRS Convair-580 in March 1979 in the Beaufort Sea and in the Eastern Arctic in April 1979. This data set was analysed to compile statistics on 11 WMO (World Meteorological Organisation) classes of sea ice, ranging from calm open water to multi-year ice and ice island.

The microwave signatures of each sea-ice class are presented in terms of the dependence on incidence angle and polarization of the backscattering coefficient as well as their emissivity and brightness temperature, at an incidence angle of 45^0. Some class signatures were obtained at several temperatures which included the early stages of melting. These effects distort the microwave signatures, as is discussed for four ice classes.

The problem of sea-ice classification using quantitative microwave measurements is examined and it is shown that simultaneous emissivity and backscattering coefficient measurements using a fixed incidence angle can yield a unique sea-ice classification for certain instrument parameters.

2507 HENGEVELD, H.G. - 1981
SURSAT Ice Experiment, Project #4, Qualitative comparison of SLAR & SAR data sets; *in* Proc. Final SURSAT Ice Workshop, Atmos. Env. Serv., Toronto, June 23-27, 1980, eds. R.O. Ramseier and David J. Lapp, Section 5.8, 8 p.

Data reliability, accuracy and timeliness, are essential elements in the effective ice information support of marine activities in northern waters. Hence, active microwave sensors, particularly side looking radars, have become vital tools in operational ice reconnaissance programs. However, despite several years of operational use of these sensors as well as extensive investigation into their usage by the research community, many unresolved questions still remain with respect to radar parameters required for an optimized operational sensor package for ice reconnaissance platforms. Radar variables which must be considered in such a design include spatial resolution, incidence angles, number of looks, tendencies of data availability, and extent of spatial coverage.

During the SURSAT ice experiments held in the Beaufort Sea in March, 1979, extensive active microwave data sets were collected over winter Beaufort Sea ice pack in conjunction with surface ice measurements. The microwave data sets include near-coincident coverage of the experiment area with both the multi-channel Synthetic Aperture Radar (SAR), mounted on the CCRS Convair-580 aircraft, and the X-band Motorola APS-94D Side Looking Airborne Radar (SLAR) on the NASA C-131 aircraft. These data proved useful for a qualitative evaluation of the effect of incidence angle and spatial resolution on the nature and quality of microwave imagery.

2508 INKSTER, D.R., and LOWRY, R.T. - 1981
Ridge height measurement with SAR; *in* Proc. Final SURSAT Ice Workshop, Atmos. Env. Serv., Toronto, June 23-27, 1980, eds. R.O. Ramseier and David J. Lapp, Section 5.11, 15 p.

Forty ice ridges in the vicinity of T3 were identified on XHH SAR imagery, and on low altitude photography. Ridge heights were estimated, using the lengths of shadows cast on the photography, and were compared to the widths of the ridges as seen in steep- and shallow-angle radar imagery. The results indicate that both multi-year and first year ridges are more detectable at shallow depression angles (from 6^0 to 20^0), than at steep angles (from 40^0 to nadir). For a given height, a multi-year ridge is more detectable than a first year ridge. For instance, viewed at shallow angles, a 1-m-high, first year ridge typically had an apparent width of about 10 m on the SAR imagery, while a comparable multi-year ridge had an apparent width of 16 m. Finally, more directional dependence of ridge signatures was seen for first year ridges than for multi-year ridges. Young ridges, viewed broadside, had wider signatures than similar ridges viewed "end-on". The widths of multi-year ridge signatures were less dependent on viewing angle.

A simple scattering model for ridges was developed to explain the results. Ridges were assumed to be triangular in cross-section, with ridges of different heights being geometrically similar. When reasonable angles of repose for ridges were assumed, the model predictions of ridge heights were consistent with the observed heights.

These results suggest that ridge heights can be estimated rather rapidly to within a factor of 2 to 3 , over large areas, using high-resolution SAR. More work is planned, using a larger data set, including laser profiles, to relate SAR ridge height distributions to heights obtained using conventional techniques.

2509 ITO, H. - 1981
On the Mechanics of the Fast Ice in the North Water Area; *Geographisches Institut Eidg. Technische Hochschule*, Zürich, Heft 2, 93 p.

A study was made of the mechanics of fast ice in the North Water area. An attempt was made to contribute to the elucidation of the cause of the North Water. Wind and sea current were assumed to be the main external forces and the fast ice was assumed to deform under the influence of those external forces. Wind, sea current and the resulting displacement and strain were, therefore, measured *in situ* together with some physical characteristics of the fast ice such as thickness, temperature and salinity, as well as sea water temperature. The results showed that the displacement of the fast ice was determined by the external forces but the influence of the boundary conditions was also important. It is concluded that the postulated purely mechanical causes of the North Water are insufficient to create such a large polynya and that of thermal contributions must also be taken into account.

2510 ITO, H. - 1982
Sea Ice Atlas of Northern Baffin Bay; *Zürcher Geographische Schriften*, Zurich, No. 7, Swiss Fed. Inst. Tech., 142 p.

The sea ice conditions in the northern part of Baffin Bay and its adjacent area were investigated using the data obtained by Landsat, and the results are presented in graphic form in this atlas.

2511 ITO, H., and MULLER, F. - 1982
Ice movement through Smith Sound in northern Baffin Bay, Canada, observed in satellite imagery; *J. Glaciology*, vol. 28, no. 98, pp. 129-143.

Movement of pack ice in Smith Sound in northern Baffin Bay was observed for April 1975 using the satellite imagery obtained by Landsat. Mean velocity was found to be directed to the south with a magnitude of 4 km d^{-1}. The influence of the wind is discussed and the amount of ice transported from Smith Sound evaluated. The findings show that on a daily average 600 km^2 of pack ice was carried out of the area.

2370 JONKEL, C., and HOBSON, G. - 1983
The Eighth Continent; *Western Wildlands*, vol. 9, no. 2, pp. 33-36.

2512 LAPP, D., and PRASHKER, S. - 1982
Sea ice salinity and temperature data, Pond Inlet, Northwest Territories; volume 1, December 1974 to May 1976, volume 2, October 1976 to May 1978, volume 3, October 1978 to June 1979, volume 4, October 1979 to June 1981; *Polar Res. & Eng.* report to R.O. Ramseier, Atmos. Env. Serv., 623 p., 434 p., 528 p., and 300 p.

The Arctic Research Establishment (ARE) was established in 1972 at Pond Inlet, N.W.T., and has been operational since April 1974. Since the latter time, the station has collected on a year round basis data on Arctic oceanography, snow and sea ice physics as well as related climatology and meteorological data. These data continue to be collected today, and the hope is that this program will continue, for the data collected here is one of the very few long term data sets available to study annual variations and investigate the interrelationships between these various parameters.

The sea ice data collection program has varied considerably over the years in the frequency of collection and the number of stations. As well, limitations on funding have limited the availability of data for certain years. In 1975-76 the data collection effort was largely funded through the resources of the A.R.E. itself and as such some data is not publicly available. A full documentation of existing

and available data collected at Pond Inlet by the A.R.E. since 1972 is expected to be available by April, 1982.

The frequency of collection has ranged from daily to semi-monthly. Up to four offshore stations have been established extending northward from the town of Pond Inlet across Eclipse Sound. The base station, or station number 1 is generally located within 1 km of Pond Inlet but outside of the shore ice ridges.

The sea ice data collected at these sites includes snow and sea ice depths and salinities as well as sea ice temperatures. The former are obtained from cores drilled on site and subdivided into equal segments for analysis. Ice temperatures were measured initially using thermister chains and beginning in late 1976 with thermocouples.

The purpose of this document is to gather together and publish in graphical and tabular format sea ice data collected at this station since 1974. The data set begins in late December 1974 and continues at varying levels of intensity until the end of April 1981. Data covering the last two months of the 1980-81 ice season had not been delivered by the time of this report and hence could not be included in this submission.

2513 LEAVITT, E. - 1980
Surface-based Air Stress Measurements Made during AIDJEX; *in* Sea Ice Processes and Models; Proc. Arctic Ice Dynamics Joint Experiment, Intern. Comm. Snow & Ice Sym., ed. R.S. Pritchard, Univ. Wash. Press, Seattle, pp. 419-429.

Mean profiles of wind speed and temperature were recorded at AIDJEX camps in 1975 and 1976 using a 25 m high tower. Measurements were also made of the wind speed variance in the frequency range between 0.2 and 1.0 Hz at 3 m, 10 m, and 22 m heights above the ice. These data were used to compute surface air stresses and drag coefficients. The contribution of the nearby pressure ridges caused the effective 10 m drag coefficient to approximately double when calculated from the upper height as compared to the lowest height. The resultant $C_{10} \simeq 2 \times 10^{-3}$ is probably still underestimated because the tower sites were located on very smooth floes.

2514 LEWIS, E. - 1981
Ice radar experiment Borden Peninsula March, 1981; *Fish. & Oceans*, internal report, Ocean Sci. and Surveys, Bayfield Lab. Marine Sci. and Surveys, Field Rep. Series No. 81-2, 34 p. *UNPUBLISHED MANUSCRIPT.*

This report describes a field experiment carried out at a site near the entrance to Navy Board Inlet, N.W.T., during March and April, 1981 by the Department of Fisheries and Oceans to evaluate the effect of various radar parameters on classifying sea ice features. The program investigated radars operating at X (9400 MHz) and S (3040 MHz) Band, as well as effects of various pulse lengths, antenna beam widths, elevation above sea level and changes in polarization. Data was recorded photographically from the radar Plan Position Indicator (PPI), on an oscilloscope (A-Scope) and on a wide-band video recorder. The data collected was extensively groundtruthed by detailed surface observations and aerial photography.

2515 LINDSAY, D.G. - 1977
Sea Ice Atlas of Arctic Canada, 1969-1974; *Polar Cont. Shelf Proj.*, Infor. Can. Cat. No. M78-4/1977, 219 p.

The results of aerial sea-ice observations made by the Polar Continental Shelf Project, Department of Energy, Mines & Resources, at various intervals between March and November, from 1969 through 1974, are shown in this atlas. Most of the observations were made in the general region of the Queen Elizabeth Islands and adjacent Arctic Ocean and in Parry Channel, with additional less complete data from more southerly waters of the arctic archipelago. A previous atlas published in 1976 describes sea-ice conditions from 1961 through 1968.

This atlas, like its predecessor, shows the geographical distribution and extent of the various types of sea-ice, and their characteristic features at different specific and identified times throughout the years. The observations recorded on each map were made over as short a period as operationally feasible - usually three to eight days - in order to give a more or less simultaneous overall view of the state and extent of sea-icer over the Canadian arctic at selected intervals. The atlas is thus an historical record of the sea-ice; it also provides sequential observations on the dynamic and constantly changing phenomena which dominate the marine areas of arctic Canada.

The basic purpose of the atlas is to make available, in comprehensive cartographic form, the reliable information available about the sea-ice in the areas covered, for the periods indicated. The information on the maps is supplemented by written descriptions which emphasize special features of the sea-ice cover at the times portrayed and describe the geographical and chronological changes throughout each season; the progression of break-up, the process of ablation, the pattern of movement and the sequence of freeze-up. It is hoped that these descriptions will increase the usefulness of the information shown on the maps and add to the understanding of the significance of changes or similarities between successive maps or between different years. This atlas includes maps which show the routes taken and the visibilities encountered during each track, so that the reliability and extensiveness of the observations can be assessed if necessary, and information from other sources can be compared or amalgamated with that given here.

The maps comprising the atlas have been arranged in sequence from 1969 to 1974. A seasonal summary is used to introduce each year and the

written description for each map faces the map to which it refers. The various types of sea-ice information are shown by a combination of colours, line patterns, symbols and numerical expressions.

It is intended that this atlas will be followed by others showing sea-ice information obtained since 1974.

2516 LINDSAY, D.G. - 1981
Sea Ice Atlas of Arctic Canada, 1975-1978; *Polar Cont. Shelf Proj.*, Infor. Can. Cat. No. M78-4/1978E, 139 p.

Systematic aerial surveys of sea ice in the Canadian Arctic Archipelago and adjacent waters were started by the Polar Continental Shelf Project in 1961 and were concluded at the end of 1978. During these years, at various intervals between March and November, successive sets of observations have been made of distributions of sea-ice types and features, progression of break-up, advance of ablation, patterns of movement and the sequence of freeze-up. These observations, for 1974 to 1978, are presented on 64 coloured maps, 28 x 38 cm, accompanied by written descriptions, selected satellite imagery and seasonal summaries.

This atlas is the last of a set of three. The first, entitled *Sea Ice Atlas of Arctic Canada 1961-1968* was published in 1976. The second volume *Sea Ice Atlas of Arctic Canada 1969-1974* was published in 1977.

2517 LIVINGSTONE, C.E., HAWKINS, R.K., GRAY, A.L., OKAMOTO, K., WILKINSON, T.L., YOUNG, S., ARSENAULT, L., and PEARSON, D. - 1981
Classification of Beaufort sea-ice using active and passive microwave sensors; *in* Proc. Final SURSAT Ice Workshop, Atmos. Env. Serv., Toronto, June 23-27, 1980, eds. R.O. Ramseier and David J. Lapp, Section 5.5, 8 p.

Results obtained by the Canada Centre for Remote Sensing (CCRS) show that simultaneous dual-polarized 13.3 GHz airborne scatterometer and 19.4 GHz H-polarized radiometer data may be used to uniquely classify sea-ice data into 11 WMO sea-ice classes under a variety of ambient temperature conditions found in the Beaufort Sea (March 1979), Frobisher Bay (April 1979) and Davis Strait (April 1979).

Two distinct feature spaces have been constructed for sea-ice classification: $\sigma^0_{hh}(\theta)$, $\sigma^0_{hv}(\theta)$, θ discriminates sea-ice classes in terms of the incidence angle variation of the backscattering coefficients; while $\sigma^0_{hh}(\theta_o)$, $\sigma^0_{hv}(\theta_o)$, $\varepsilon_h(\theta_o)$ relies on the complementary nature of emissivity and backscattering coefficients at fixed incidence angle.

In this paper, both feature spaces are assembled from data collected in the Beaufort Sea in March 1979 and are evaluated for ice type discrimination. A sea-ice classification algorithm is presented for the fixed incidence angle space, and a requirement for generalization of the feature spaces to four dimensions by the inclusion of ambient temperature is indicated.

The total CCRS results suggest that generalized feature spaces $\sigma^0_{hh}(\theta)$, $\sigma^0_{hv}(\theta)$ θ, T and $\sigma^0_{hh}(\theta_o)$, $\sigma^0_{hv}(\theta_o)$, $\varepsilon_h(\theta_o)$, T are valid for sea-ice classification over a very wide range of ambient temperature and ice surface conditions.

2518 LOWRY, R.T., and HENGEVELD, H.G. - 1981
Optimizing imaging radar parameters for ice reconnaissance; *in* Proc. Final SURSAT Ice Workshop, Atmos. Env. Serv., Toronto, June 23-27, 1980, eds. R.O. Ramseier and David J. Lapp, Section 5.17, 11 p.

Imaging radar systems are fast becoming the mainstay of all Arctic sea ice reconnaissance systems. This is true in spite of all available radars having been designed for rather different purposes and fabricated before the impact of modern digital hardware. Synthetic Aperture Radar (SAR), once considered too complicated for operational use, has been transformed by digital processor into a practical and reliable tool. In preparation for the development of future radars, the authors undertook a study aimed at defining the parameters needed for an ice reconnaissance radar. Using imagery generated under the SURSAT project, the authors have investigated the effects of resolution and incoherent averaging on image interpretability.

The investigations reported here included a study of the relationship between the utility of the image as a function of the data rate as well as the optimum way of presenting a given data rate the relationship between non-square pixels and interpretability was studied along with the relationship between incoherent averaging and image interpretability. It was found that product of range and azimuth resolution is the best measure of image quality up to distortions of 4:1. Incoherent averaging, and thereby reducing resolution, was found to have a small positive effect on image utility, for 3 or 4 looks. This result is very dependent on the means by which the incoherent averaging is implemented.

The study of image utility indicates that an equivalent to an 8m x 8m 1 look radar is the minimum acceptable system. Further work is needed to more precisely delineate the tradeoffs for other ice types and other displays. In particular, much more work is needed to specify exactly the effect of display limits.

2519 LUTHER, C.A., and SHUCHMAN, R. - 1981
Sea ice detectability as a function of resolution and mixed integration; *in* Proc. Final SURSAT Ice Workshop, Atmos. Env. Serv., Toronto, June 23-27, 1980, eds. R.O. Ramseier and David J. Lapp, Section 5.16, 12 p.

Numerous attempts have been made to define an appropriate resolution for Synthetic Aperture Radar (SAR) operations in polar regions. SEA-

SAT SAR provided 25 m resolution believed adequate for both operational and research purposes, but high data rates and inordinate processing times rendered the SEASAT SAR less than an optimum tool for providing near real-time data for Arctic use. In an attempt to arrive at a resolution which would meet perhaps the minimum requirements of the operational and research communities, while permitting a wide ($\sim$ 300 Km) swathwidth and a reasonably low systems data rate, a resolution of 100 m was speculated within the scientific community as being sufficient. This parameter was based mostly on intuition, with no scientific study to verify the adequacy of the poorer resolution to satisfy both operational and research requirements. In this paper, SAR imagery at various resolutions is analyzed in an attempt to determine the most appropriate SAR system resolution for meeting the requirements of both the operational and research communities in the Arctic. SAR data collected on Fletcher's Ice Island and other Beaufort Sea ice types was progressively degraded, starting with a nominal 3 m x 3 m resolution and continuing through several coarser resolutions down to a 100 m 4-look sample. The results provide an interesting and informative visual representation of sea ice characteristics at various resolutions from which decisions regarding resolution adequacy can be made.

2520 MARKO, J.R., and THOMSON, R.E. - 1977
Rectilinear Leads and Internal Motions in the Ice Pack of the Western Arctic Ocean; *J. Geophys. Res.*, vol. 82, no. 6, pp. 979-987.

Large-scale (100 km) rectilinear lead patterns are a common feature of the Arctic Ocean ice cover. We show that many of the characteristics of these patterns can be explained by analogy with rock mechanics. In particular, the existence of two intersecting lead sets, the typical intersection angles of 28^0, and the observed relative shearing motions are consistent with faulting associated with a semibrittle failure. Further support for this explanation has been obtained by using NOAA and Landsat satellite imagery, over an approximately 100-km-square area of the Beaufort Sea. These provide coverage of 2 days of ice deformation prior to the formation of a lead at 14^0 to the axis of compression. Strains of 4% over the 2-day period are within the range attributed to rock distortion preceding semibrittle failure. Finally, we suggest that the range from brittle to plastic type behavior is feasible within the Arctic Ocean sea ice, depending upon the applied rate of strain and/or the ambient confining pressures.

2521 McPHEE, M.G. - 1981
An Analysis of Pack Ice Drift in Summer; *in* Sea Ice Processes and Models; Proc. Arctic Ice Dynamics Joint Experiment, Intern. Comm. Snow & Ice Sym., ed. R.S. Pritchard, Univ. Wash. Press, Seattle, pp. 62-75.

Periods of *free drift*, when the internal stress divergence in pack ice is minimal, are identified during the melt season of 1975 by considering inertial oscillations, ice-wind-current statistics, and direct simulations of ice drift at the AIDJEX stations. Working from a simple balance of wind stress, water drag, and Coriolis force, it is shown that the water stress magnitude is well described by the relationship $|\tau_\omega| = c_\omega |V|^2$, where V is the ice velocity relative to the ocean; that the oceanic boundary-layer turning angle is probably in the range $21^0 < \beta < 26^0$; and that the ratio c_ω/c_{10}, where c_{10} is the 10 m wind drag coefficient, is about 2. Times are also shown when simulations of velocity gradients using a uniform free-drift model across the manned ice station array agree reasonably well with observations. Similar calculations with geostrophic winds show many of the same features, but are not as close quantitatively.

2522 MILLER, J.D. - 1979
An equilibrium surface temperature climate model applied to first year sea ice growth; unpub. M.Sc. thesis, Carleton Univ., Ottawa, 182 p.

The problem of sea ice growth is approached using an energy conservation methodology. A climate simulation is developed which utilizes information about the state of the atmosphere, snow/ice surface, snow/ice medium and underlying ocean and establishes an explicit relationship between the surface temperature and each component of the energy balance. In this manner sea ice growth is treated as a function of the dynamic interaction of atmosphere, ice and ocean.

The model furnishes daily estimates of the individual components of the radiation balance and the turbulent, conductive and melt induced energy fluxes. The surface temperature and temperature at the snow-ice interface are determined and the average ice salinity and ice thickness predicted. Thermal properties are internally modified as a response to changes in snow and ice properties. Also included is the transient occurrence and thermodynamic behaviour of a snowpack.

A comparison of sea ice growth observations at three Arctic locations with model predictions indicates a successful reproduction of real world conditions by the computer simulation.

2523 NAKAWO, M., and SINHA, N.K. - 1981
Growth rate and salinity profile of first-year sea ice in the High Arctic; *J. Glaciology*, vol. 27, no. 96, pp. 315-330.

This paper describes the growth of sea ice and the salinity profiles observed in Eclipse Sound near Pond Inlet, Baffin Island, Canada, during the winter of 1977-78. A numerical method of calculation has been developed to incorporate the variations in snow conditions and physical properties of ice and snow during the growth season. It is shown that the growth rate can be predicted reasonably well. It is also shown that the vertical salinity profile

in the ice towards the end of the season, provides a record of previous climatological conditions. A dependence has been shown between the predicted growth rate and the measured salinity.

2524 NERALLA, V.R., GABISON, R., JESSUP, R.G., VENKATESH, S., FALKINGHAM, J., and JARVIS, E.C. - 1981
Regional scale dynamical thermodynamical model for unconsolidated sea ice; *Fish. & Oceans*, Meteorological Serv. Res. Br. internal report 81-5, 193 p.

The objective of this study is to develop a regional scale sea ice dynamics model for obtaining short range, real time or near-real time predictions of ice conditions for operational use. Hibler's (1979) dynamic - thermodynamic formulation is modified to suit this objective. The regional-scale model consists of (1) a momentum equation which includes air to ice stress, water to ice stress, Coriolis force, ocean tilt and internal ice resistance, (2) a constitutive law which relates the ice stress to the strain rate and the ice strength and (3) continuity equations for ice thickness and concentration. The continuity equations consider a simple ice thickness distribution which is the same as the one used in Hibler's (1979) model. An improved thermodynamic formulation for use in the ice thickness distribution is being developed and will be incorporated later into this model. A plastic viscous rheology is used for modelling the ice-ice interaction. Other stresses are parameterized using standard methods. A finite difference numerical procedure is used for solving the equations.

The regional ice model is run on a 22 x 22 array with a grid size of 42.3 km and a time step of 3 hours. Model integrations out to 48 hours have been performed and the simulations are compared with data collected during the November/December 1979 Winter Ice Experiment in the Beaufort Sea (WIEBS). The drift comparisons show the simulated velocities and observed drift to be in reasonable agreement especially considering that errors due to poorly resolved wind and water currents can be substantial. A number of sensitivity and model sophistication tests are planned to further validate the model and the results from it.

2525 PEARSON, D., LIVINGSTONE, C.E., HAWKINS, R.K., GRAY, A.L., ARSENAULT, L.D., WILKINSON, T.L., and OKAMOTO, K. - 1981
Radar detection of sea-ice ridges and icebergs in frozen oceans at incidence angles from 0° to 90°; *in* Proc. Final SURSAT Ice Workshop, Atmos. Env. Serv., Toronto, June 23-27, 1980, eds. R.O. Ramseier and David J. Lapp, Section 5.12, 12 p.

Dual-polarized 13.3 GHz scatterometer data and X-Band SAR data, collected in the Beaufort Sea and in the eastern Arctic, during the SURSAT sea-ice experiment deployments in March 1979 and April 1979 respectively, have been analyzed to determine the radar contrasts (signal to sea-ice clutter) between sea-ice ridges and the surrounding sea ice in the Beaufort Sea and between icebergs and the surrounding sea ice in the eastern Arctic. The effects of radar resolution cell size on ridge detectability were examined using aerial photography to estimate ridge dimensions.

Over the incidence angle range observed, the contrast between ridges and the surrounding sea-ice is nearly independent of incidence angle for all ice types. Cross-polarized radars produce larger ridge contrasts than like-polarized radars, with the largest contrasts and greatest polarization dependence being observed for rough first-year ridges in smooth first-year ice and the smallest contrasts and least polarization dependence being observed for multi-year ridges in multi-year ice.

The contrast between icebergs and the first-year ice background is nearly independent of incidence angle over the observed range.

Cross polarized radars enhance iceberg detectability but synthetic aperture radars operated at satellite incidence angles are found to be unsuitable for iceberg detection.

2526 RAMSEIER, R.O., and LAPP, D.J. - 1981
Proceedings of the Final SURSAT Ice Workshop; *Fish. & Oceans*, Atmos. Env. Serv., Toronto June 23-27, 1980, 440 p.

A total of 22 papers are included. Some are extended abstracts of presentations made at the workshop while others were separate reports. The papers have been organized into several different subject areas: a. sea ice classification based on active and passive microwave systems; b. radar parameters vs. ice parameters; c. microwave signatures of ice morphological features; d. digital processing techniques and their evaluation; e. operational considerations and demonstrations; f. impulse radar for ice thickness; g. future experiments and sensors.

It is hoped that these proceedings will serve as a useful reference for the state-of-the-art in microwave remote sensing of sea ice as well as provide insight into future directions and priorities, in support of NOSS and RadarSat.

2429 SADLER, H.E., and SERSON, H.V. - 1981
A survey of some Arctic beach zones in southwest Cornwallis Island, N.W.T.; *Defence Res. Est. Pacific*, Nat. Defence, DREP Rep. 81-1, 84 p.

2527 SINHA, N.K. - 1981
Sea Ice - growth processes in saline ice, Eclipse Sound; *Ice*, no. 65, 1st issue, p. 8.

2528 SINHA, N.K. - 1983
Field tests on rate sensitivity of vertical

strength and deformation of first-year columnar-grained sea ice; *in* Proc. VTT Sym. 27, Seventh Inter. Conf. on Port and Ocean Eng. under Arctic conditions, Helsinki, Finland, April 5-9, 1983, vol. 1, pp. 231-242. NRCC 22806.

Observations on rate sensitivity of uniaxial, unconfined compressive strength and deformation of freshly recovered columnar-grained first-year sea ice are described. Loads were applied parallel to the axis of the columns over a wide range of displacement rates, using a portable test machine in a field laboratory at Mould Bay in the western High Arctic of Canada. Results are analysed in terms of measured stress and strain rate to peak stress. Strengths up to 16 $MN \cdot m^{-2}$ at $-10^{\circ}C$ were obtained, with failure strains in the range of 0.1 to 0.3 per cent.

2529 SNELLEN, J.B., and ROSSITER, J.R. - 1981
Remote Estimation of The Properties of Sea Ice Surface Truth Measurements, Beaufort Sea, March 1979; *C-CORE*, Mem. Univ. Nfld., Pub. no. 81-17, ISBN 0-88901-068-4, 112 p.

As more work is carried out in the Canadian Arctic during winter, there exists a greater need for the ability to make remote estimates of the physical properties of sea ice. The critical properties are the thickness and strength of ice, whether it be for operations on the ice surface, or movement of ice-breaking vessels. Although progress has been made in recent years in the observation and classification of sea ice using remote sensors, little success has been achieved in remote measurement of ice thickness and strength. This ability is particularly important because of the high variability and dynamic nature of sea ice and the increased industrial activity in Canada's North.

In spite of this lack of success, there is promise of being able to sound sea ice using radio waves in or near the VHF band. At least three instruments are actively being developed in Canada which have possible application to the remote determination of sea ice thickness.

During 1978, a need was recognized for more effective co-ordination of research efforts in the field in Canada. As a result of a contract arising from an unsolicited proposal to the Canadian Government, C-CORE mounted a joint government-industry-university program. Field measurements were made in the Beaufort Sea during March 1979 and over Lake Melville, Labrador in April 1979. The sites were chosen to coincide in time and place with other investigations, including the SURSAT Project, which involved a number of sea ice studies including a number of remote sensing overflights. This report describes the ice surface truth measurements made in the Beaufort Sea during this project.

2530 TAM, S.Y.K. - 1981
Sea Ice - Remote Sensing - Pulse Radar; *Ice*, no. 65, 1st issue, p. 8.

2531 THORNDIKE, A.S. - 1981
Tests of the Ice Thickness Distribution Theory; *in* Sea Ice Processes and Models; Proc. Arctic Ice Dynamics Joint Experiment, Intern. Comm. Snow & Ice Sym., ed. R.S. Pritchard, Univ. Wash. Press, Seattle, pp. 144-150.

Early investigators of sea ice distinguished many types of ice, the main categories being multiyear ice, first-year ice, various forms of very thin ice, and open water (which can be considered to be ice of zero thickness). A large region (100 x 100 km, say) contains many ice types. It is natural to describe the ice in such a region in terms of the proportion of the different ice types. Since to some extent the ice types can be labeled by their thickness, the term *thickness distribution* was used by Wittmann and Schule (1966) to refer to the composition of the ice pack in a given region.

Many local properties of the ice pack depend on its thickness - for instance, its surface temperature, its albedo, its strength. Large-scale averages of these quantities therefore depend on the thickness distribution. This fact was an incentive for developing a theory to show how the thickness distribution depends on the thermal and mechanical history of a region. During AIDJEX a theory was developed and incorporated into a more general sea ice model. Unfortunately, no satisfactory technique exists for measuring the ice thickness distribution, and therefore the theory itself has not been verified, despite attempts by several investigators to test parts of the theory. This note outlines the techniques and results of these first attempts in the hope that such an outline may be useful to future investigators.

2532 TIMCO, G.W., and FREDERKING, R.M.W. - 1983
Flexural strength and fracture toughness of sea ice; *Cold Regions Sci. & Tech.*, vol. 8, pp. 35-41. DBR Paper No. 1146, NRCC 22788.

A series of mid-winter experiments were carried out on the ice in the rubble field around Tarsiut Island in the Beaufort Sea. The tests included grain structure determinations, salinity and density of the ice, small beam flexural strength and fracture toughness. Typical values for flexural strength and fracture toughness were 0.6 - 1.0 MPa and 100 - 140 kPa $m^{\frac{1}{2}}$ respectively. Both properties were dependent on brine volume and depth in the ice sheet. In comparing these results with identical tests on fine-grained freshwater ice it was found that for comparable loading conditions, the strength of the sea ice was significantly lower than the strength of the freshwater ice, whereas the fracture toughness of the sea ice was higher than the fracture toughness of the freshwater ice.

2533 UNTERSTEINER, N. - 1981
AIDJEX Review; *in* Sea Ice Processes and Models; Proc. Arctic Ice Dynamics Joint Experiment, Intern. Comm. Snow & Ice Sym., ed. R.S. Pritchard, Univ. Wash. Press, Seattle, pp. 3-11.

The basic nature of pack ice dynamics has been understood for some time. Ever since the early explorers realized that arctic sea ice is not a solid plate covering the ocean but is continually moving, breaking, and shifting, these phenomena have been the subject of scientific curiosity. Beginning with Fridtjof Nansen's crossing of the Eurasian Basin in the years 1893-96, knowledge has been accumulated about the ocean, the ice, and the atmosphere in the high Arctic by means of some thirty long-term drifting ice stations and numerous aircraft landings and submarine crossings. Data from these isolated points enabled scientists to gain a more precise picture of pack ice as an ensemble of irregularly shaped, interlocked pieces of ice driven by air and water currents, influenced by internal stresses, deflected by the Earth's rotation, and subject to melting and freezing as dictated by the regional climate. Recently, however, it became clear that significant progress would be possible only by acquiring a set of synoptic (rather than single-station) data. The need was thus perceived for a scientific program such as the Arctic Ice Dynamics Joint Experiment.

In 1969 a "trial balloon" scientific plan for what was to become AIDJEX was prepared. After consultations and workshops involving many arctic researchers, a final version of the AIDJEX scientific plan was published in 1972. At that time, two small pilot studies in the field (in 1970 and 1971) had been performed. A larger pilot study with three manned camps and several automatic data buoys took place in March and April 1972. The main experiment was launched in March 1975. By early June 1975 four camps surrounded by a ring of eight data buoys were in operation. With some minor variations, this array continued to function until the predetermined end of the experiment, in early May 1976.

SURVEYING

2534 CROSSLEY, S. - 1979
Doppler Surveys - Primary Horizontal Control; *Energy, Mines & Res.*, Surv. & Mapping, Geodetic Surv., internal report, 48 p., 6 maps.

2535 DOUCETTE, V.J. - 1979
Arctic Islands Traverse - Supplementary Control; *Energy, Mines & Res.*, Surv. & Mapping, Geodetic Surv., internal report, 13 p.

2536 EATON, A.R. - 1982
Arctic Islands 1982 (Doppler); *Energy, Mines & Res.*, Surv. & Mapping, Geodetic Surv., internal report, 13 p.

2537 EATON, A.R. - 1982
Beaufort Sea; *Energy, Mines & Res.*, Surv. & Mapping, Geodetic Surv., internal report, 8 p.

1986 LEHN, W.H., and EL-ARINI, M.B. - 1978
Computer-graphics analysis of atmospheric refraction; *APPLIED OPTICS*, vol. 17, pp. 3146-3151.

1987 LEHN, W.H. - 1979
The Novaya Zemlya effect: An arctic mirage; *J. Opt. Soc. Am.*, vol. 69, no. 5, pp. 776-780.

1988 LEHN, W.H. - 1979
Atmospheric Refraction and Lake Monsters; *Science*, vol. 205, no. 4402, pp. 183-185.

1989 LEHN, W.H., and SCHROEDER, I. - 1980
Atmospheric optics and Norse navigational techniques: an analysis; *Univ. Man.*, TR80-1, 1980 0116, 40 p.

1990 LEHN, W.H. - 1980
On the sighting of distant unidentified objects; *J. Atmospheric and Terrestrial Physics*, vol. 42, pp. 471-475.

2372 LEHN, W.H., and GERMAN, B.A. - 1981
Novaya Zemlya effect: analysis of an observation; *APPLIED OPTICS*, vol. 20, no. 12, pp. 2043-2047.

2538 LEHN, W.H. - 1983
Inversion of superior mirage data to compute temperature profiles; *J. Opt. Soc. Am.*, vol. 73, no. 12, pp. 1622-1625.

Information derived from the superior mirage is used to compute the average vertical temperature profile in the atmosphere between the observer and a known object. The image is described by a plot of ray-elevation angle at the eye against elevation at which that ray intersects the object. The computational algorithm, based on the tracing of rays that have at most one vertex, iteratively adjusts the temperature profile until the observed image characteristics are reproduced. An example based on an observation made on the Beaufort Sea illustrates the process.

2360 MORTIMER, A., and MILNER, P. - 1980
Loran-C and Omega Navigation System tests in the Beaufort Sea; *Fish. & Oceans*, Inst. Ocean Sci., Pac. Marine Sci. Rep. No. 80-4, 84 p.

2493 QUEK, S.H. - 1983
LOREX (1979) - Ice Station Positions and Velocities Using Two-Dimensional Cubic Spline Approximation; *Univ. New Brunswick*, Dept. Surveying Engineering Tech. Rep. no. 97, 159 p. *LOREX Contr. No. 20.*

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