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THE ARCTIC CIRCULAR

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MEETINGS

The following meetings have been held:

One hundred and seventy-ninth meeting. 12 November, 1969. Professor George Kish, Department of Geography, University of Michigan, Ann Arbor, gave an illustrated lecture on "A.E. Nordenskjöld, Scientist, Arctic Explorer, and Explorer of the North East Passage". This lecture was sponsored jointly by the National Museum, The Royal Canadian Geographical Society, the Swedish Embassy and the Arctic Circle, and carried by the Museum in its regular series. It was held in the auditorium of the National Gallery, after which there was a reception at H.M.C.S. Bytown to meet the speaker. Professor Kish spent a year in Sweden in 1967-68 on a National Science Foundation Grant to work on a biography of Nordenskjöld, who discovered the North East Passage in the 1870's and made the first sea voyage around Asia. Little has been available in English about his exploration activities. Many old photographs were shown and the account of little known aspects of Nordenskjöld himself and his explorations made this a very interesting lecture.

Annual Dinner. 25 November, 1969.
The Annual Dinner was held at the Eastview Hotel in Ottawa. About sixty people attended. An excellent illustrated lecture on the voyage of the oil tanker S.S. Manhattan through the North West Passage was given by Rear Admiral A.G.H. Storrs, Chief of the Marine Operations Branch of the Department of Transport and the senior Canadian to participate in this project. He visited the shipyard in Philadelphia where Manhattan was refitted for the voyage and he spent a week on the ship during its passage through the Canadian Arctic Archipelago. He gave a

very graphic account with colour slides of the voyage and the ship's performance in the ice. It was a most memorable evening and Admiral Storrs was later presented with an Arctic Circle tie as a token of the Club's appreciation.

One hundred and eightieth meeting. 9 December, 1969.
Dr. Roy M. Koerner of the Polar Continental Shelf Project gave an illustrated talk on the British Trans-Arctic Expedition under Mr. Wally Herbert, of which he was a member. He has kindly provided a brief article on the expedition for the Arctic Circular (see below). Dr. Koerner was Scientific Director on the expedition and his description of the changing character of the ice which he traversed, which varied geographically and seasonally, was unique and fascinating.

One hundred and eighty-first meeting. 13 January, 1970.
The Arctic Circle Club held its Annual General Meeting, approving a financial statement and electing officers for 1970. The latter are as follows:

Members of the Executive (no change from 1969)

President	R.J.E. Brown
Vice-President	W. Blake, Jr.
Secretary	J.R. Weber
Treasurer	S.D. MacDonald
Editor	A.H. Macpherson
Publicity Secretary	Mary Murphy

Committee Members

1968:	Elizabeth Macpherson	1969:	G. Hattersley-Smith
	E.F. Roots		A.H. Clarke, Jr.
	A. Stevenson		F.P. Hunt
			P.D. McTaggart-Cowan

The following were nominated and elected for 1970:

G. Brassard
D. Hodgson
S. Kanik
D.E. McAllister

The Treasurer, Mr. S.D. MacDonald, presented a financial statement, audited by Dr. D.E. McAllister. Some concern was expressed at the rising cost of our meeting facilities, which now amounts to $39.00 a night for 50 members or less, and an additional per capita charge for each member attending when there are more than 50. Mr. S. Kanik presented the report of the Dinner Committee: there was some discussion on possible places to have the next dinner, and on obtaining the traditional northern foods which will be required (suggestions and offers will be welcomed by Mr. Kanik). The Editor reported on the Arctic Circular and thanked his helpers, Dr. Jeanne Ferrari and Mr. Peter Usher.

Following the business meeting a U.S. Navy film on polar oceanography was shown.

NEWS

Symposium on Arctic Development and Ecological Problems - 22 January, 1970.

A symposium on January 22, at Ottawa University, explored the attitudes of government officials and interested members of the public on development strategies for the Canadian Arctic. Sponsored by the Ottawa Biological and Biochemical Society, the symposium featured speakers from government, industry, and university circles. The audience actively participated, and left little doubt that its greater proportion favoured a moratorium on further industrial development.

Mr. G. Rempel, Arctic Co-ordinator of Imperial Oil Ltd., Calgary, stressed that industry was trying to understand ecological problems concurrently with developmental problems. For example, permafrost studies may clarify certain ecological problems, and at the same time help in the design of development techniques. Exploratory drill holes are being used by co-operating scientists for studying temperature gradients. He ably demonstrated that his company is taking a long-term, multiple-use view of resources. The expense, both in terms of money and of goodwill, of such accidents as Santa Barbara (it is reported that a half billion dollars were spent by Union Oil to clean up the Santa Barbara disaster) makes economic sense of a cautious approach to exploration and development in areas where such operations are exceptionally difficult.

Mr. Rempel showed with colour slides that bulldozer trails through the tundra will re-vegetate, and can even be seeded with grasses. Dr. G. Harris, a lichen specialist in the audience, from McMaster University, noted that cat trails may nonetheless persist as "scars" on the tundra for perhaps hundreds of years, even if re-vegetated.

Dr. Tom Wise, Assistant Director, Northern Economic Development Branch, Department of Indian Affairs and Northern Development, spoke for the government's role in encouraging arctic development. He stressed that government is interested not only in promoting development in the Arctic, but also in preserving the North, and that government policies are evolutionary rather than static. He said his Department now recognizes five different development zones in the Territories, each of which presents a different combination of problems, and that his officers were not only trying to draft land-use regulations in co-operation with both industrial representatives and conservationists, but were planning similar "sea-use" regulations, and intended to monitor industrial operations, and if necessary to prosecute offenders. He was hotly and sceptically questioned by the audience as to whether development would be delayed until these regulations and their enforcement were in operation, and whether the rules would be retroactive.

Dr. Wise provoked sharp rejoinders from the audience for views such as: (1) conservation work should be concentrated in more populous parts of Canada, where pollution is worst, (2) we have a responsibility to foster development throughout the world, to improve the lives of rapidly increasing populations, (3) tourism in the Arctic is feasible only if there is an industrial base there, (4) pollution of the arctic seas is of little consequence, as there are few people living on the arctic shores, and (5) the poor record of industry, as a whole, in hiring native people must be seen in perspective: After all, the native people comprise a small proportion of the Canadian population. There are no doubt pros and cons to all these concepts, but unfortunately one evening was far from sufficient time for an adequate discussion.

Dr. John Lambert, Biology Department, Carleton University, spoke of the delicate balance of life in northern ecosystems, how easily entire life systems can be disrupted, and how long they take to recover. He reminded us that we will get no second, third, or fourth chance in the Arctic as we do in more southern latitudes; that unfortunately, industry and

government are moving at fantastic rates to exploit and control arctic resources; and that we have little biological data by which to judge consequent environmental change. We are 10 years behind industry in our research, and there is no time to close the gap. His remarks were echoed by many members of the audience, and several speakers said that the government should declare a moratorium for several years, until we have the necessary data.

Dr. Lambert said that most conservationists were not asking that there be a complete ban on development, but only that there should be good land-use regulations, more precautions taken on operations in the field, and clear evidence that the government is ready and able to monitor and enforce its regulations. One might ask, for example, "is the government ready to spend $2,000.00 to check on a single offshore drilling rig if it becomes necessary", or "is the government ready to destroy and burn a multi-million dollar ship if it seems about to break up and pollute the sea with oil?". He showed that Canada has had its "disasters" already this past year with a well at Drake Point blowing gas and salt water freely into the environment, and possibly other uncapped wells elsewhere, and that only by good fortune have we so far been spared a major oil spillage. One wonders if we are any better prepared today than Britain was before the wreck of the Torrey Canyon, or California was before the Santa Barbara disaster.

Biologists are suspicious, an ecologist in the audience declared. Too often conservationists have seen multiple-use plans result in multiple-abuse, and repeatedly the question was asked: How soon will land-use regulations be in force? Dr. Lambert concurred with these remarks, and he asked what motivated industry to seek and government to encourage development, when Alberta oil wells today have their capacity curtailed to 34% of capacity because of limited markets.

In summary, Dr. Chas. Jonkel, Chairman of the Symposium, reminded the audience and the panel that there are many definitions of "progress". An area with few people, clean water, and clean air has what the whole world wants; progress in such areas just might mean maintaining the status quo. Furthermore, he said, organisms in the Arctic still live in conditions most similar to those under which they evolved, and arctic areas may provide us with our last chance to discover important new principles of ecology, genetics, and evolution.

Second Working Meeting of Polar Bear Specialists, 2 to 4 February, 1970, Morges, Switzerland.

The Survival Service Commission of the International Union for the Conservation of Nature and Natural Resources has convened a second meeting of its Polar Bear Group, composed of biologists from each of the five nations within whose borders the polar bear occurs.

Several Canadian provinces and the two territories manage substantial polar bear populations, for the exclusive benefit, to date, of their native people, and with emphasis on the conservation of the resource. On the ice off Alaska, and in the waters around Spitsbergen, American and Norwegian outfitters have built up substantial polar bear trophy hunting industries in the last few years. In addition, adventurous Norwegians are still permitted to hunt polar bears commercially on Spitsbergen, largely by means of set-guns which, unfortunately, kill lone males and sows with dependent cubs, indiscriminately. Greenland (Denmark) manages the polar bears of its own waters and of adjacent seas regionally, also for the benefit of its native people. In the U.S.S.R. the polar bear has been protected from all exploitation, except the capture of cubs for zoos, since 1960.

The polar bear has at times been very heavily hunted in the waters north of the Soviet Union, and it seems reasonable to suppose that its great rarity there in the 1950's was due to over-hunting. However, hunting has now been prohibited for nearly a decade, and the population has failed to show a substantial increase.

The key to this problem may possibly be that polar bears move from the Soviet sector of the Arctic to the High Seas, and perhaps into other jurisdictions, temporarily for a season, or permanently. It is possible, for example, that some part of the Norwegian Spitsbergen kill, or of the Alaskan trophy kill, or even perhaps of Greenlandic and Canadian resident kills, are of bears that were born in, or move regularly into, the Soviet sector. The annual world polar bear harvest is approximately 1,250, no doubt large enough, if unequally spread, to cause regional declines or to prevent local increases. It became clear at the first meeting of the polar bear group, in 1968, that insufficient evidence was available upon which to base a diagnosis of such problems and efforts to remedy them. In the past two years, much progress has been made in developing techniques, particularly of capturing bears and marking them in various ways,

in finding means to differentiate between certain more or less discrete bear populations, in obtaining harvest statistics, and in gaining an understanding of the broader ecological requirements of the species.

At the second meeting, plans were made and, where desirable, co-ordinated internationally, for the next phase of the necessary research. Present research results were exchanged, and these will doubtless help in perfecting management plans by the responsible jurisdictions. Finally, there was some discussion on important problems of maintaining a satisfactory habitat for polar bears in the face of oil and mineral development, and possible ways in which the delegates could contribute from their studies of the polar bear, an animal which more than any other symbolizes the unspoiled arctic seas, where the physical forces of the environment are harsh and fierce, but where the web of life is correspondingly weak and thin.

Recent Volumes of "Problemy Severa" Translated.[1]

A note on "Problems of the North", the English translation of the Russian series "Problemy Severa", appeared in an earlier issue of the Circular (Vol. XVII p.36). Issue #11, which deals largely with the biology and utilization of wildlife in the Arctic, was published in June 1968. Number 12, issued in the U.S.S.R. in 1967 and translated in July 1969, has also been published. Its table of contents is as follows:

G.I. Granik	Economic specialization and integrated development of the Soviet European North.
I.L. Freidin	Regional specialization of Murmansk Oblast
M.K. Mazurov	Basic problems in the development of the apatite industry
A.V. Istomin	Methods of increasing the iron content of concentrates obtained from Kola Peninsula
A.A. Tumanov N.A. Iskritskii	Exploitation of Kola Peninsula vermiculite
N.A. Iskritskii	The production of building materials from the raw material resources of the Kola Peninsula

[1] Information kindly provided by G.W. Rowley, Scientific Advisor, Department of Indian Affairs and Northern Development, Ottawa.

K.V. Shkonda	Problems of improving equipment maintenance in Murmansk Oblast
V.A. Vityazeva G.N. Parashchenko	Problems of industrial development in the Komi A.S.S.R.
B.A. Davydov I.M. Semenov	Problems of increasing the efficiency of developing the Pechora Coal Basin
L.A. Bratsev P.P. Vavilov G.T. Mamaev	The Kama-Pechora-Vychegda water management complex and its possible effects on separate sectors of the economy of the Komi ASSR
V.A. Raznitsyn	The search for large oil and gas fields in the Komi ASSR and the Nenetskii National Okrug
N.A. Nevskii	The influence of natural environmental factors on the structure of the fuel-energy balance of the Komi ASSR
G.N. Anikina V.A. Startsev	Some questions pertaining to the development of the chemical industry in the Komi ASSR
D.V. Belorusov	Specific features of the West Siberian economic complex
L.N. Shelest	Certain aspects of the development of electric power in the northern parts of Tyumen' Oblast
Z.M. Kipper S.N. Katkov A.I. Novikova	Possible effects of the projected Lower Ob' Hydroelectric Station on the fishing industry
V.A. Kerov	The development of a construction materials industry within the Western Siberian Economic Complex
V.S. Varlamov	Transport development in the West Siberian Lowlands
B.V. Ivanov LI. Kolesov	Theoretical considerations of the development of transportation in the Ob' North

S.Ts. Golod R.Z. Kosukhkin B.F. Shapalin	Fuel industry in Northeastern USSR
E.G. Egorov	Better use of mining equipment in the Northeast of the USSR
E.I. Bogdanov	Development of special equipment for placer mining in the northeast of the USSR
A.D. Orlovskii	Certain questions involved in reducing the amount of labour required in construction.
V.N. Gerasimov	The transport potential of the Asiatic North of the U.S.S.R.
V.F. Puzanova	Some aspects of the development of labour forces and industrial centres in the Canadian North.
L.N. Karpov S.L. Lebedeva M.N. Sokolov	Progress in the development and distribution of the factors of production of the arctic regions of Norway, Sweden, and Finland since the Second World War
N.A. Utenkov	The Canadian North and the problems of its development
A.A. Bukin Yu.M. Dogaev	The efficiency of machines modified for northern use

Requests for individual issues at $7.00, single papers at $1.00, or information, should be addressed to:

Translations Section,
The Library,
National Research Council,
Ottawa 2, Ontario.

Issue #13 is now being translated. It consists of 40 articles, the majority of which are in the fields of wildlife, agriculture, and animal husbandry.

ARTICLE

The British Trans-Arctic Expedition 1968-69.

By Roy M. Koerner, Polar Continental Shelf Project, Department of Energy, Mines and Resources, Ottawa.

Between February 1968 and June 1969 a four man expedition under the leadership of W. Herbert crossed the Arctic Ocean from Barrow in Alaska to a small island off the shores of Spitsbergen. Four dog teams, run either on modified fan or full fan trace, were used. Originally, each team consisted of 10 dogs but these were reduced in number by dog fights to 2 teams of 9 dogs and 2 of 7 dogs. All the dogs were from Qanak in Greenland. The sledges were of two types - Greenland and Nansen - modified to suit the broken terrain of the Arctic Ocean. Each sledge weighed a little over 200 lbs. Despite the robust build of the sledges, and the fact that the original (and unbroken) sledges which were used from Barrow to 81°N, 160°W were replaced by new sledges for the last leg of the journey, the oak runners split badly during the cold weather of March 1969. One replacement sledge of the Nansen type was air-dropped in April 1969 and the remaining sledges repaired.

Air-drops, some by the Naval Arctic Research Laboratories in Barrow but the bulk by the Canadian Armed Services, were at 4 week intervals during the travelling period. New loads, with the sledge, weighed over 1,000 lbs. In deep, soft snow in May 1968 these loads slowed progress a lot but on harder surfaces a mileage of 5 to 10 miles a day could be maintained.

The shear zone between the land-fast ice along the Alaskan coast and the Arctic Ocean pack-ice was a very dangerous area where fracturing and ridging presented frequent hazards. Once across this 50 mile wide zone the greatest obstacles to progress were leads of open water and areas of chaotically ridged ice. Whereas leads were skirted, broken and ridged ice was crossed after clearing a route with ice axes. An average of about 8 ridges a mile were crossed. Most of the ridges were less than 6 ft. high but occasional ones 25 to 30 ft. high were seen. Three leads were crossed using either one or two sledges, covered with PVC, as boats. This procedure took 6 to 8 hours on each occasion. Once, after spending the greater part of a day crossing a lead and camping on the far side, the lead was found to have closed by the morning.

Travelling conditions deteriorated after mid-May with deeper snow, increasing frequency of open water, and finally, in late June, with slush and huge melt-pools. In July and August 1968 the expedition camped on a 6 mile multi-year floe. September travelling conditions were bad with new snow overlying melt pools, and large areas of open water. After one of the party injured his back, winter camp was made in September on the same floe that had provided a home for the summer. During both summer and winter a scientific program was conducted which included an energy balance study, air-sampling, magnetometer, weather and aurora observations. By sledging daily around the local area fracturing and ice growth in fractures was recorded. Pressuring and/or fracturing was observed on an average of 1 day in 4. Fracturing near the Parcoll hut in October forced us to make a move to a more substantial floe a mile away. By this time the 6 mile floe of July had broken to form 10 individual floes. Fracturing was disturbingly common in December, January and February and by late February the original floe was in about 50 pieces. On the morning of departure for Spitsbergen on February 23, 1969, fractures approached to within 10 yards of the hut and one ran through a working tent, fortunately vacant at the time.

Cold weather in March (a minimum of -54^{o}F and a monthly average of -3^{o}F) slowed down both the dogs and men. Clothing was difficult to dry out and the diet of 5,000 cals. a man per day seemed inadequate. The return and rise of the sun, even without any increase of air temperature, made travelling and camping easier and more enjoyable. Once the expedition left the heavy ice of the Beaufort Gyral (between Barrow and the North Pole) and entered the TransPolar Drift Stream the rate of progress improved. Up to the North Pole the maximum daily mileage was 15 miles but beyond the Pole daily mileages of over 20 miles were occasionally made. The furthest travelled in a day was about 28 route miles. This distance was achieved by the lead sledge in 8 hours of almost continuous travel with a 15 minute rest half way through the day and one or two pauses for manoeuvering over narrow fractures or through pressure ridges. Greater rate of progress beyond the Pole was in part due to improved dog driving and in part to greater familiarity with the ice conditions, but also to easier travelling conditions.

The expedition was picked up by HMS Endurance off the north shore of Spitsbergen after having travelled over 3,000 miles to cover some 27 degrees of latitude.

REPORT

Highlights of Field Activities of the Geological Survey of Canada in the North - 1969.

By R.G. Blackadar, Geological Survey of Canada, Ottawa.

The Geological Survey is one of Canada's oldest scientific agencies and is, among other things, responsible for providing geological information that can be used in evaluating the Nation's mineral potential. In support of this objective the Survey has been active in unexplored frontier-areas from the days of its first director, Sir William Logan, who in the 1840s examined the wilderness of the upper Ottawa Valley and the northern shores of Lake Superior. Geological studies were extended to the Arctic in the late 19th century and the names of A.P. Low, J.B. Tyrrell and Robert Bell are familiar to those versed in northern exploration. With the increasing interest in our North these studies have expanded and in 1969 there were more than 30 field projects in various parts of the Northwest Territories. In January 1970 the Geological Survey published its "Report of Activities, April to October 1969" (Paper 70-1, Part A) and that report forms the basis for the following brief notes on some of the Survey's northern work, notes that are designed to alert those interested in specific areas or subjects.

Several helicopter-supported geological reconnaissances were carried out, the two largest areas covered being parts of the western District of Mackenzie and Southampton Island.

Operation Norman, a three-season project begun in 1968 and which will cover 145,000 square miles between 64°N and the arctic coast and 119° and 132°W, combines bedrock mapping, stratigraphic studies and investigations of surficial deposits. The 1969 work was in the Mackenzie Mountains, the Mackenzie valley, the McConnell Range and the plains south of Great Bear Lake. Thirty-one stratigraphic units were mapped and it was determined that pronounced regional unconformities occur at the base of the Cretaceous, Devonian, Upper Ordovician to Lower Silurian, and Middle Cambrian to Lower Ordovician successions. In the Mackenzie River valley there is evidence that compressive deformation continued into the Tertiary whereas southof Great Bear Lake the last significant deformation was pre-Cambrian. In Mackenzie Mountains the last orogenic movement appears to have been pre-Middle Cambrian; pre-Tertiary, pre-Cretaceous, pre-Devonian and pre-Upper Ordovician uplifts

were epeirogenic. Faulting has affected the area and many of the faults, although originally formed in Cambrian time, appear to have been reactivated as late as Upper Devonian time. Although diabase dykes and sills intrude Precambrian strata no metallic minerals of economic significance were noted.

The data derived from this regional study are of value in developing a regional picture of the geology of the northern extension of the Interior Plains, an area which has great potential as an oil-bearing region.

Associated with J.D. Aitken who was in charge of this project were D.G. Cook, H.R. Balkwill, R.W. Macqueen, W.S. Mackenzie and W.S. Hopkins.

In conjunction with Operation Norman, C.J. Yorath carried out a study of Cretaceous and Tertiary stratigraphy. Deposition of Cretaceous rocks occurred within a deep, northwesterly-trending, narrow basin bounded on the south and southwest by probable source areas (the present Mackenzie Mountain). More than 210 feet of nonmarine Tertiary sand, gravel, and coal is exposed near Fort Norman along the banks of the Mackenzie River and similar deposits are found north of Keele River, east of the Mackenzie Mountain front, on the east side of Mackay Range and along Brackett River.

Reconnaissance geological mapping of Southampton Island was carried out by W.W. Heywood, W.L. Davison, and B.V. Sanford who used a Bell 47 B-2 helicopter for traversing. The island is underlain by Precambrian and Paleozoic rocks. The former rise gradually from sea level at the south end of the island to a high plateau in the north which is commonly bordered by steep fault-scarp cliffs. The Precambrian rocks comprise massive to foliated granitoid rocks, migmatite, gneiss, and paragneiss. The structural trend is northeasterly to east. Traces of molybdenite were found in rusty graphite-rich zones on Bell Peninsula and molybdenite was also seen in pegmatite dykes in the Terror Point and Cape Welsford areas.

Paleozoic rocks, which occupy the southern and western parts of the island, are lithologically similar to those of the Hudson Bay Lowlands. Carbonate rocks dominate the succession and in some units biohermal reefs are extensive. Such features, if found at subsurface and at sufficient depth, could be potential oil and gas horizons. A 7-foot-thick highly petroliferous shale unit occurs near the base of the Paleozoic sequence and may be

worthy of future exploration. Although no metallic mineral deposits were found it appears that the major fracture systems, developed by post-Silurian uplift of Precambrian strata, should be examined for possible base metal deposits. Such fractures are best developed along the Paleozoic-Precambrian contact.

The geological reconnaissance of eastern Devon Island was continued by R.L. Christie who used motor toboggans for transport. The area is composed of grey granitic gneiss that is usually well foliated. No deposits of economic interest were seen during the survey. The site of a 100-milligal positive Bouger anomaly discovered by the Observatories Branch was examined but no unusual rocks were found that might explain the feature.

D.K. Norris carried out stratigraphic and structural studies between the Mackenzie delta and the Barn Mountains, an area that lies at the crossroads of the Franklinian, Cordilleran and Alaskan geosynclines. The sedimentary succession is highly variable laterally and vertically and is punctuated by a series of orogenic deformations, uplifts and periods of erosion. The area is characterized by ovate domes and long north-trending folds bounded or cut by near-vertical faults. The hydrocarbon possibilities are promising and there are several potential horizons of both Paleozoic and Mesozoic age.

As in 1968, considerable interest centred on the Coppermine River area. W.R.A. Baragar and J.A. Donaldson using helicopter-support mapped map-sheets 86 O and N, an area of about 7,500 square miles. The oldest rocks, greenstones and metasediments, are overlain by two groups of younger Precambrian sediments, then by the more than 14,000-foot-thick predominantly volcanic, Coppermine River Group, which in turn is overlain by another sedimentary succession. Diabase dykes and sills intrude the latter group but they are in turn overlain, unconformably, by Paleozoic dolomite.

During the 1969 field work a hitherto unreported copper showing was found near the base of the uppermost late Precambrian succession. E.D. Kindle and R.V. Kirkham, who in 1969 visited most the known copper deposits in the Coppermine area, examined this new discovery in some detail. Mineralization is widespread in a succession of mudstone, siltstone, sandy siltstone and silty pebble conglomerate 7 miles northwest of the junction of Husky Creek and Coppermine

River. Chalcopyrite, bornite, and chalcocite are the principal metallic minerals and are most abundant 10 to 50 feet above the unconformity separating these rocks from the Coppermine River Group. The highest assay obtained was 0.44 per cent but it is possible that higher results may be found elsewhere and the showing is an indication that sedimentary copper ores may occur in other parts of the post-Coppermine River Group rocks.

A preliminary study was made of the feasibility of geochemical surveys as an exploration tool for locating copper deposits in regions of permafrost. This work was carried out by E.W.H. Hornbrook and R.J. Allan 42 miles southwest of the settlement of Coppermine. Preliminary data indicate that there is active dispersal of Cu from known deposits and that there is much potential for the development of geochemical prospecting techniques in permafrost regions.

P.F. Hoffman began a study of the Epworth Group of Proterozoic sedimentary rocks in the Coppermine area. Among the objectives of the work is an assessment of the probability of occurrence of stratiform copper or lead-zinc mineralization of the Mississippi-Valley type and an evaluation of the use of stromatolites for long-range biostratigraphic correlation. Several formations which have potential for the occurrence of base metal deposits were outlined.

T.N. Irvine carried out a further study of one aspect of the well-known Muskox Intrusion and has shown that dolomite and basalt associated with the intrusion are in fact younger than the emplacement of the pluton. Thus it appears that the Muskox Intrusion is older than the basalt of the Coppermine River Group and has no genetic relationship to it.

Field studies in Precambrian geology were carried out in other parts of the District of Mackenzie. J.A. Fraser completed mapping of Artillery Lake map-area for publication at a scale of 1:250,000. The area is of interest because of current prospecting in areas along the Thelon Front (the boundary between the Slave and Churchill structural provinces of the Canadian Shield). Helicopter traverses were supplemented by ground work. The northwest corner of the area (within the Slave Province) is underlain by massive muscovite granite; the remainder is within the Churchill Province and comprises gneiss, schist, granite, granodiorite, diorite, and gabbro. Many claims have been staked in the past two years - most lie along the trend of magnetic anomalies which in turn parallel the Thelon Front.

J.C. McGlynn continued a study of the Proterozoic Nonacho Group in an area south of Great Slave Lake. This project is designed to study the stratigraphy, structure, and sedimentary petrology of the rocks to correlate them with similar rocks in the region and to determine their age relationships with adjacent metamorphic and igneous rocks.

A number of uranium showings and copper prospects have been discovered; most are in basement rocks near their contact with Nonacho sediments and are found in shear and breccia zones. In addition to looking for such features prospectors should consider the possibility that the Nonacho Group contains relict placer deposits.

Several projects were carried out west of Hudson Bay. R.T. Bell continued a study of the Precambrian Hurwitz Group of sedimentary rocks between Rankin Inlet and Wallace River. K.E. Eade carried out reconnaissance mapping of Ennadai Lake and Nueltin Lake map-areas. The Proterozoic sedimentary rocks in these areas appear to be correlative with the Hurwitz Group but in this area they are overlain unconformably by polymictic conglomerate and arkose to subgreywacke containing scattered pebbles. No mineral occurrences of economic interest were discovered although many of the conglomerate exposures were tested for radioactivity.

A. Davidson mapped Eskimo Point and Dawson Inlet areas, a region that covers the southern part of the northeast end of the Ennadai-Rankin Inlet green-stone belt. This belt contains extensive linear, high aeromagnetic anomalies caused by sedimentary iron-formation. An annular magnetic anomaly, 2.5 miles across just north of the mouth of Wallace River, is similar to anomalies associated with alkalic plutons and carbonatites and might thus be a possible source for rare-earth minerals. A similar pluton on the northeast side of Kaminak Lake was reported in 1968.

The study of more recent geological features also received considerable attention. Marian Kuc continued an examination of peat deposits and fossil mosses from Banks Island. O.L. Hughes studied the Quaternary geology west of Mackenzie River, in particular the upper limit of Laurentide glaciations and the extent of former valley glaciers that originated in the Mackenzie Mountains. Organic deposits, from a few feet to 10 feet thick,

are widespread in the valleys and plains of the area studied and permafrost underlies almost all parts. V.N. Rampton spent a few weeks east the Mackenzie delta in order to assess what work remained to be done to supplement earlier studies designed to map Quaternary deposits and landforms.

D.M. Barnett continued a study of the proglacial geomorphology of Generator Lake, central Baffin Island. Samples were collected for further radiocarbon dating.

H.M. French, using Nodwell RN 21 vehicles, continued geomorphological studies on Banks Island as did J.R. Mackay along the Mackenzie Valley and Arctic Coast.

J.A. Heginbottom began an investigation of erosion in a permafrost environment. In this study attempts are being made to assess the importance of surficial material, geomorphology, snow cover, vegetation, depth of active layer, ground ice distribution, and other factors. Observations made last summer were limited to the site of the 1968 Inuvik forest fire. Although the fire itself had no effect on the thickness of the active layer, the removal of the surface organic layer has caused a 9-inch increase in the thickness of the active layer.

ANNOUNCEMENTS

Arctic Activities of the National Museum of Natural Sciences, 1969 and 1970.

By D.E. McAllister, National Museum of Natural Sciences, Ottawa.

R.K.S. Lee, curator of phycology, collected benthic marine algae, largely by dredging, from sites in Mackenzie Bay, and at Sachs Harbour, Banks Island, N.W.T. in the summer of 1969. In 1970 collecting will again be based at the Polar Continental Shelf camp at Tuktoyaktuk and will range from Mackenzie Bay to Coronation Gulf.

P.M. Youngman, curator of mammalogy, plans to collect material for cytogenetic and serological studies, as well as skins and skulls, in the Seward Peninsula area south to the base of the Alaska Peninsula, Alaska. Species that have a bearing on Bering land bridge migration will be emphasized. The manuscript, The Mammals of Yukon Territory, is virtually complete. It treats 64 species, discusses zoogeography, and provides distribution maps for all native terrestrial species.

T.A. Bilbock, assistant to the curator of fishes surveyed the fishes in the area being flooded by the Churchill Falls hydroelectric development, Labrador during June and July, 1969; he is writing a paper on the subject. D.E. McAllister, curator of fishes, may accompany J.G. Hunter of the Fisheries Research Board of Canada on a survey of Frobisher Bay, N.W.T. in August 1970.

A.H. Clarke, curator of molluscs, plans to collect deep-sea marine molluscs from the abyssal basin of Baffin Bay in August, 1970, in collaboration with the Arctic Institute of North America and the Polar Continental Shelf Project.

Mackenzie Eskimo Historical Study.
By F.F. Cooper, Cooperstown, N.Y.

Fr. R. Le Meur, O.M.I., Roman Catholic missionary at Tuktoyaktuk, and the writer of this note are collecting material on the history of the Mackenzie Eskimos, to use in writing an essay on the way of life of these people and its changes during the last hundred or hundred and fifty years.

Most of the surviving Mackenzie Eskimos now live in Tuktoyaktuk, and three lines of study are currently being followed there:

1) Establishment of genealogies. We now have reasonably complete records of Mackenzie Eskimos for the period since 1912: surviving families have been extended backwards as far as living memory allows. In addition to family relationships, an attempt is being made to find the dates of birth and of death of as many people as possible and also to learn their tribal origin. Our goal is to describe in detail changes in the population of Mackenzie Eskimos during the present century and its distribution.

2) Collection of Eskimo language place names. A systematic effort has been made to record what names are still remembered for places between Tununuk and the mouth of the Horton River. About 225 names have been listed and located on maps. The meanings of nearly all of them have been recorded on magnetic tape.

3) Reminiscences. We are attempting to obtain reminiscences from the older residents of Tuktoyaktuk. These, we hope, will eventually include both memories of times before 1920 and also a sampling of descriptions of, and opinions about, the days of white fox trapping between the wars. So far about six five-inch reels of tape have been gathered on this subject.

In addition to this, we are trying to collect what material on the history of these Eskimos is available in the south. A collection of photographs is being formed to show individual Mackenzie Eskimos and to illustrate their way of life. Here too southern sources predominate, though some photographs belonging to residents of Tuktoyaktuk have been copied and are included. At present we have only some forty to fifty pictures, but the final number should be considerably larger. We would be most grateful if any reader of the Arctic Circular able to contribute written material, or photographs (taken particularly between 1915 and 1945), would so inform us.

Finally, an attempt is being made in Inuvik to have the taped material transcribed and at least some of the Eskimo-language parts - which form the larger fraction - translated.

Fur Trade Posts of the N.W.T., 1870-1970.
By Peter J. Usher, Northern Science Research Group, Department of Indian Affairs and Northern Development, Ottawa.

An appeal for assistance in this project, published in the last issue of the Arctic Circular, surprisingly brought no response. The preliminary list is now ready for limited distribution to those who can add to or correct the entries. A total of 644 trading posts are known to have operated within the present boundaries of the N.W.T. since 1870, about 85 per cent of them in the Mackenzie River valley or along the arctic coast, and most operated between the wars. The list gives the location, ownership and duration of operation of these posts, plus certain other information where pertinent. The completed list, incorporating revisions, is scheduled for publication in the late summer of 1970, as a N.S.R.G. report.

I appeal again to interested readers to advise me if they can assist. Many Arctic Circular readers doubtless remember the various trading establishments in the regions with which they are familiar. If you can help, please write to me at the following address: Room 1460, 400 Laurier Avenue West, Ottawa 4, Ontario.

The Arctic Circular

The Arctic Circular is published three times a year for members of the Arctic Circle Club, Box 68, Postal Station "D", Ottawa. Membership is open to all, and may be arranged by writing to the Treasurer, Mr. S.D. MacDonald, at the above address, and enclosing, for a single Ottawa member or couple $5.00, for an out-of-town member $1.50 and for an institution $3.00. Members are requested to notify the Club promptly of any change of address.

Back issues are available at $0.50 each, and complete sets of Volumes 1 to 19 at $100.00.

Arctic Circle ties, featuring a white narwhal on a dark blue background, are available from the Treasurer at $3.50 each.

Reports for publication are welcomed from those living in the North, or having information on northern activities, particularly news of research, travel, and technological, industrial and social developments. Opinions on content and format are also welcomed. The address of the Editor is 258 Powell Avenue, Ottawa 1, Ontario.

THE ARCTIC CIRCULAR.

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MEETINGS

The following meetings have been held:

One hundred and eighty-third meeting. February 10, 1970.

An illustrated talk entitled "An Antarctic Experiment - A Canadian observer to an experiment in international co-operation in the pursuit of scientific knowledge" was given by L.A.C.O. Hunt, Secretary, Advisory Committee on Northern Development, Department of Indian Affairs and Northern Development. He described his visits to American and New Zealand installations, interesting historic sites, unique wildlife and the splendid scenery of the ice-bound Antarctic continent.

One hundred and eighty-fourth meeting. March 10, 1970.

Dr. Alfred Jahn, Head of the Geographical Institute, University of Wroclaw, Poland, addressed the Arctic Circle and its guests from the Ottawa Geographical Society. He described his work on periglaciology in Svalbard as a member of the Polish Expedition and his visits to Siberia. He illustrated his remarks by interesting slides of characteristic soil phenomena due to glacial activity and frost action.

One hundred and eighty-fifth meeting. April 14, 1970.

Mr. Douglas Hodgson, Quaternary Research and Geomorphology Division, Geological Survey of Canada gave a beautiful pictoral tour of northern Baffin Island and discussed the problems of arctic travel and research, focussing mainly on the glacial history of the region.

One hundred and eighty-sixth meeting. May 12, 1970.

An illustrated talk on "Manned Underwater Operations in the Arctic" was given by Cdr. Ben Ackerman who retired from the navy in 1965 as Chief Diving Officer of its Diving Branch. His most interesting lecture dealt with the art of underwater technology today and showed how it is applied in arctic regions.

EDITORIAL.

Crisis in the North

The statement reprinted below is by R.C. Passmore, Executive Director of the Canadian Wildlife Federation. Copies were sent on February 13th to Prime Minister Trudeau and to Minister of Indian Affairs and Northern Development Mr. Chretien, and also to the Directors of the Federation and to the Press. The statement has received considerable support and has provoked much discussion. Its text follows:

Ecologists and conservationists are becoming increasingly concerned with the damage to fragile ecosystems caused by the current rush to explore and develop oil and other mineral resources in the Canadian North. The Canadian Wildlife Federation believes there is an urgent need to slow the rate of exploration -- and damage -- until research and experimentation have produced techniques for coping with the special problems of the north.

Similar kinds of damage wrought in more southerly climates might be expected to heal naturally, in time. But the North poses an entirely different set of problems. Here the flow of energy within these natural communities is so delicately balanced that disturbance creates scars which will persist for an extremely long time. The problem is further complicated by permafrost underlying the tundra to depths of 1200 feet. Disturbance of surface vegetation destroys its insulating qualities and permits slumping of the local terrain -- a process known as "thermokarst" -- which alters drainage patterns, induces soil erosion, forms barriers to the movement of animals and results in serious, probably irreversible change in an ecological balance which has taken thousands of years to develop.

Damage in the Canadian North is already extensive, as indicated by scientists attending the Tundra Conference in Edmonton in October, 1969. Across the Alaskan boundary, the "oil rush" near Prudhoe Bay has been absolutely devastating. Obviously, the oil techniques developed in Texas or Alberta cannot safely be applied in the north, but modification of these, or development of new techniques, requires time for research and experimentation. Research is needed, also, to determine the precise level of disturbance which northern ecosystems can tolerate without suffering permanent damage. A limited amount of such research is already under way, through grants provided by the Federal Government to four Canadian universities, but these studies are not expected to produce significant results until 1974. In the meantime, it appears that the government is

encouraging the oil boom without waiting for better information on how to conserve the renewable natural resources of the North.

The geology of the north suggests that significant finds of oil are likely. Although the oil deposits will be quite localized, speculative exploration will, of necessity, be widespread and general. What kind of land will be left to support native populations, and the wildlife on which they depend, when the exploration crews have done their damage and moved on? The attractiveness of the northern landscape and the interesting variety of wildlife it supports may yet prove to be the long term economic foundation of much of the area, if they are not destroyed before tourism has a chance to grow.

Development of proven oil deposits poses problems as troublesome as exploration. Storage, handling and transport form a long series of potentially dangerous unknowns. Transporting warm oil by pipeline involves problems of insulation to prevent thermokarst. Transport by sea, despite the "successful" voyage of the Manhattan (it sustained two gaping holes in its hull) is frought with uncertainty.

Recent experience with the tanker Arrow, off the coast of Nova Scotia, has pointed up the problem of oil spills at sea. A similar spill in Arctic waters, whether from tankers, offshore drilling or losses at transfer points, would pose enormous problems. Avoidance of such spills, clean-up techniques, and the damage to be expected if they are not cleaned up immediately have scarcely been discussed. Legislation is lacking. Research has not been initiated. Surely there is reason to proceed with caution, to limit exploration and development until research and experimentation have shown how to perform these tasks without seriously damaging the sensitive northern environment.

But the stage is set for northern Canada's own oil boom: Imperial Oil Limited struck oil in mid January at their Atkinson Point drill site, 120 miles northeast of Inuvik in the Northwest Territories. This new find will certainly precipitate a rush of seismic reconnaissance and exploratory drilling, particularly in the Mackenzie Delta where find grained, unconsolidated silts are particularly sensitive to thermokarst and irreversible damage. Must this rush take place now, while so many questions remain unanswered?

The Department of Indian Affairs and Northern Development, with assistance from mining, oil and conservation interests, is drafting a set of land use regulations designed to minimize damage to northern environments. But these regulations are still months away from becoming law. Even when they are approved, there will

be virtually no machinery for administering them nor qualified personnel available to enforce them. Meanwhile, indications are that the Canadian North will be devastated in an all-out, unsupervised rush of exploration and development. It seems that long-term consideration of the North and its inhabitants is to be steam-rollered under the short term expediency of a rush to find oil.

The Canadian Wildlife Federation believes it is in the best interests of all concerned, including the oil companies, for the government of Canada to take action to delay this sudden and uncontrolled acceleration in oil exploration. What is needed is a partial moratorium which wouldallow time for research and experimentation to provide information and technology which are presently lacking.

A partial moratorium, lasting until 1974, would do much to bridge the serious knowledge gap which now exists. It would allow time for:

1. Completion of government-sponsored research now being carried out by Canadian universities.

2. Development of new techniques, or modification of existing ones, for exploration, development and production without excessive damage.

3. Ecological research to establish the levels of disturbance which can be tolerated in the different zones to be explored.

4. Testing the feasibility of transport of oil through arctic waters by tanker or submarine.

5. Conducting research into the effect of oil spills, on land and sea, under arctic conditions and development of techniques for accomplishing the degree of clean-up indicated by that research.

6. Development of stand-by facilities, equipment and staff necessary to ensure adequate clean-up in case of accidential spills.

7. Studying the feasibility of permitting offshore drilling under the conditions of ice, wind speed,and temperature prevailing in the Arctic.

8. Training Indians and Eskimos in the skills used in all phases of exploration, development and production of oil, so that native people can play a significant role in helping to develop their country.

A partial moratorium would require flexibility of attitudes and arrangements on the part of both government and the oil industry. Exploration leases would have to be extended, at little or no cost, during any period of inactivity. Experimental work on exploration and drilling techniques for arctic conditions would need to be closely supervised and the effects of such work should receive careful study by ecologists.

This is truly a time of crisis in northern Canada. Must we stand idly by while an uncontrolled oil boom threatens the renewable resources of the North and the life-support systems of its native people? The Canadian Wildlife Federation believes that Canadians will insist on a more rational, reasoned approach to northern development.

NEWS

TRANSFER OF ADMINISTRATIVE FUNCTIONS TO NORTHWEST TERRITORIES GOVERNMENT ANNOUNCED - from a Press Release of the Department of Indian Affairs and Northern Development.

The Honourable Jean Chrétien, Minister of Indian Affairs and Northern Development, on March 31st, 1970, announced an imminent step in the development of government in the Northwest Territories.

"On April 1, 1970", Mr. Chrétien said, "the Federal Government is transferring to the Government of the Northwest Territories responsibility for the administration of government services in the Eastern Arctic. Control of the various programs is being assumed by the Commissioner in Yellowknife who joins me in this announcement".

This transfer represents completion of a major recommendation of the Advisory Commission (Carrothers) of 1966 that "administrative functions be transferred to the Territorial service on a specified schedule as soon as practical". All residents of the Northwest Territories can now obtain from their government in Yellowknife the full range of government activities.

The Government of the Northwest Territories, until recently, had been largely dependent upon the Federal Government for staff to operate its public services. Until 1963, the Deputy Minister of Northern Affairs (now the Department of Indian Affairs and Northern Development) was the Commissioner, and the Northern Administration Branch of the Department staffed most government services in the Territories. In 1963, a full-time Commissioner, located initially in Ottawa, was appointed and charged with developing a territorial administration. In September 1967, following the designation of Yellowknife as the seat of government for the Territories, the Commissioner and his staff moved to take up residence there. At that time, the Government announced plans for the transfer from Federal to Territorial control of operational responsibility for existing government services including education, welfare, municipal affairs and other administrative services of local importance, as quickly as the new Territorial Administration could assume these responsibilities. On April 1, 1969, this took place for the District of Mackenzie and April 1, 1970 completes the transfer to the Territorial Government of such of the above programs and services as have been administered by Federal public servants in the Eastern Arctic districts of Keewatin and Franklin.

The Territorial Administration has grown from less than 100 persons when it moved to Yellowknife in 1967 to about 1700 after the Eastern Arctic transfer. For 1970-71, the total cost of NWT provincial-type services (other than resource development) is expected to run about $82 million. Although the Department of Indian Affairs and Northern Development will no longer be administering these services, it will be providing over 85 per cent of the funds through various grants, loans and other payments to the Northwest Territories.

The Minister also said that the next step in the development of the Northwest Territories Government would soon ensur, in the amendments to the Northwest Territories Act which he will introduce soon to Parliament. In these he will propose that the size of the Territorial Council be increased to allow more elected members and better representation of the scattered population. Many aspects of the operation of the Council and the Territorial Government now under Federal control will be placed in the hands of the Commissioner and his Council. With the rapidly increasing interest in the North, in Canada and throughout the world, the development of government for northern residents must be given a high priority, said Mr. Chrétien.

NEW NATIONAL PARK FOR NORTHWEST TERRITORIES - from a Press Release of the Department of Indian Affairs and Northern Development.

A 2,860 square-mile area around Fort Reliance on the East Arm of Great Slave Lake in the Northwest Territories has been set aside by order-in-council as a basis for planning a future national park (see Figure 1).

The announcement was made on April 10, 1970 by Mr. Chrétien, who said the move to create a park during the Northwest Territories centenary year would draw attention to the magnificent northern topography and the need to preserve a part of it in its natural state, and that it would also assist the North to realize its potential for tourism and recreation, particularly as this area could become one of the greatest national parks in the world with characteristics and features to be found nowhere else.

The future park will be the first national park completely within the Northwest Territories.

Studies of the proposed park will begin right away. The eastern half of the area contains a segment of the tree line at Artillery Lake, which lies partially in the northern or boreal forests and partially in the treeless barrens. The theme of the

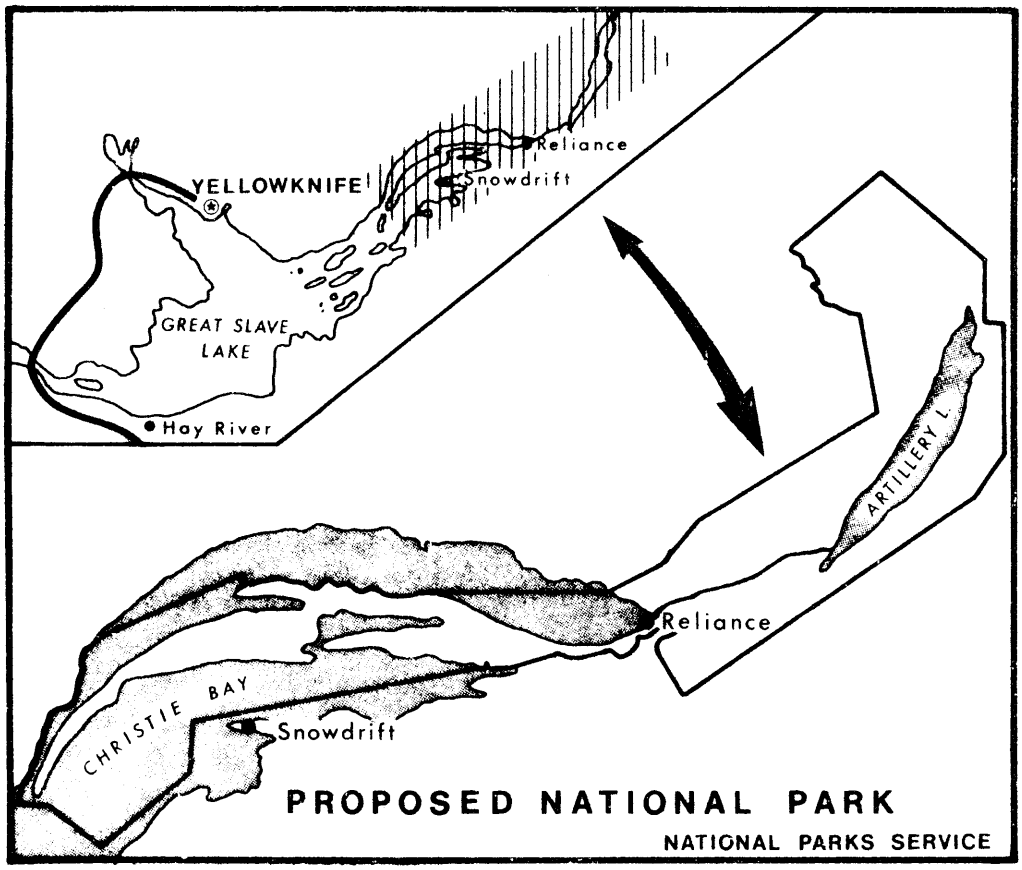

Figure 1. The proposed park area around the East Arm of Great Slave Lake subject to a recent withdrawal. Appropriate scales of the two maps are 100 and 27 mi to the inch.

new park will be "Edge of the barrens".

The area encompasses the spectacular cliffs, pillared rocks and other geological formations that characterize the peninsulas in the East Arm of Great Slave Lake, a portion of a 350-mile-long fracture in the earth's crust known as the McDonald Fault, the historic Pike's portage route, the waterfalls and fast-flowing waters of the Lockhart River, and at Christie Bay, the deepest known fresh water in North America (more than 2,000 feet deep).

The land withdrawal at this time means no further staking or recording of claims will be permitted in the proposed park area. However, the hunting, trapping and fishing rights of members of the Snowdrift Indian Band who depend on game resources will not be affected.

In addition, a small parcel of land encompassing Tyrell Falls on the Lockhart River is being reserved for potential hydro-electric development in the event that a future power need should arise in this area.

The federal government began studies of the area in 1962 and presented the results to the Northwest Territories Council in January 1969. Public meetings were held in June 1969 in Yellowknife and Snowdrift. Discussions with the Indians are continuing.

CANADA ACTS TO AVERT OIL POLLUTION DISASTERS IN ARCTIC WATERS.

On April 8, 1970, the Canadian Government introduced new legislation designed to lower pollution risks off Canada's coasts. A bill, recently given a unanimous second reading in the Commons, establishes authority to inspect shipping and control any resulting pollution within a line running from the Yukon - Alaska boundary around the Arctic Archipelago at a distance of approximately 100 miles, and thence down Baffin Bay to 60°N. lat., halfway between Canada and Greenland. In addition, amendments to the Territorial Sea and Fishing Zones Act (1964) extend Canada's sea limits from three to twelve miles, and enable Canada to close off such water bodies as the Gulf of St. Lawrence to foreign fishing fleets without established rights.

Bill C-202, "An Act to prevent pollution of areas of the arctic waters adjacent to the mainland and islands of the Canadian Arctic" applies to the waters there defined. It prohibits the deposit of wastes in waters or on the mainland or islands from which it may escape to pollute waters, under pain of liability. It requires all escapes of polluting substances to be reported. It requires evidence of financial responsibility to be provided by any resource developer or potential large scale polluter operating in the arctic waters or on submarine areas within the line above described. It gives powers of inspection and allows for the application of government standards to all construction of works in the area, and to incoming shipping. Standards may govern not only construction but operation, for example in setting freeboard limits. The Act also encompasses the Governor in Council to destroy or remove distressed or abandoned shipping causing a pollution threat. It establishes the powers of pollution prevention officers, who are enabled to inspect and control any ships or works within the area specified. Persons polluting arctic waters are liable to fines up to $5,000 and ships $100,000 for each day they offend. These are some of the provisions of

the Act which will shortly be coming into force.

Opposition to the Act has been voice by certain nations with large merchant fleets and whose oil drilling companies, for example, might run afoul of its provisions. In spite of the fact that there are precedents for unilateral claims over areas of sea (and airways) outside generally accepted territorial limits, Canada has decided not to be governed by any decision that might be reached by the World Court at the Hague. Rather, she views international law as deficient in not yet being equipped to handle adequately the disastrous pollution threats that modern technology has unleashed.

THE NORTHERN INLAND WATERS ACT (BILL C-187).

Mr. J.K. Naysmith, Department of Indian Affairs and Northern Development, has kindly provided the following description of the new Act.

The Act is designed to permit the effective management of Canada's fresh waters north of 60°, and to prevent deterioration of its current high quality, in the face of economic expansion. By acting now, it is hoped that the pollution problems that have resulted from lack of water management in southern Canada may be avoided in the North.

The purposes of the Act are as follows:

1. To provide for the equitable distribution or sharing of rights to use water in the North among interests with legitimate and sometimes conflicting claims on this resource.

2. To ensure that the disposition or allocation of water rights is done in a manner that is consistent with immediate and longterm regional and national interests.

3. To ensure that all works and undertakings planned for the use, diversion, storage or treatment of water are designed and constructed to acceptable engineering standards.

4. To establish and maintain the principle that rights to the use of water are dependent on the users accepting full responsibility for maintaining its quality or

restoring its quality to acceptable standards before returning the water to the natural environment.

Major features of the Act are the following:

1. All property in and right to the use of surface or ground waters north of 60° will be vested in the Crown, i.e. northern waters become public property.

2. Allocation of rights to the use of northern water will be accomplished by a system of water rights licensing, whereby a water user applies for a water right, and his plans and subsequent construction are subject to government approval and inspection before a final licence is issued. The proposed development must include acceptable pollution abatement facilities. In a licence will be spelled out its term, the allowable quantity of water to be used, conditions of water quality that must be maintained and annual water rental costs.

3. Up until now water users in the North have been subject to a wide variety of rules, regulations and directives. This new Act will provide a single water authority in each of the territories to carry out the federal responsibility for northern water management. The Bill does this by creating two territorial Water Boards. The Boards will be made up of the senior federal water officials in each territory and officials from the territorial governments.

4. The deposition of waste either directly or indirectly into northern waters will be prohibited, except in accordance with conditions written into a licence or permitted under the Regulations. Water management today must be based on the concept of overall basin development. It must take into account all of the various uses and needs that the water resource will be expected to meet.

5. Any person who unlawfully uses water or deposits waste, or uses more water than authorized in a licence, is liable to a fine of up to $5,000 per day of offence. Designated government inspectors will enquire into whether water is being used and determine if waste is being deposited in northern waters.

6. The Act facilitates long-term multi-purpose planning in northern watersheds, by enabling reservation of lands to protect water bodies and reservation of water bodies from licencing.

ARTICLES

PRE-COLUMBIAN EUROPEAN TRACES IN UNGAVA PENINSULA. By Thomas E. Lee.

Formal archaeological investigations in Ungava Peninsula had their beginnings in the 1948 discoveries of Jean Michéa and Jacques Rousseau at Payne Lake, during the historic Rousseau expedition across the peninsula. Since then several expeditions have examined specific sites, either at Payne Lake or along the coast, and some survey work has beendone. Prior to 1964, in the absence of historic records to the contrary, it was customary to attribute every cultural trace to the Eskimos or to the controversial Dorset culture. As we shall see, some very strange evidence was lumped together in this way.

In 1964, sponsored by the Centre d'Etudes Nordiques, I undertook some excavations at Payne Lake on the Michéa site. On a minor survey exploration along the south shore of the lake, near its eastern end and outlet, I came upon cultural remains of a very different character that I could not consider as Eskimo. The arrangement of stone alignments inrectangles of 16 x 12, 24 x 16, and 27 x 16 feet, the end-to-end placement of the blocky stones and their remarkably large size (up to 31 inches in diameter), together with the square corners, all suggested European activity to me. Excavations were not then possible, but throughout the winter I made enquiries. It became evident that Dr. Rousseau's party, even as recently as 1948, had been the first white group ever at Payne Lake within historic times. That seemed to leave only the Irish and the Norse, with probability heavily in favour of the latter, because of the relative proximity of Greenland.

In the following season, with one assistant, two weeks of rainy, cold weather were devoted to this site, now known as the Cartier site. Results were astonishing. A 16 x 12 house ruin contained a raised fireplace platform in one corner but out from the wall in Norse fashion, and a partly paved floor of pebbles set on end to a common level. The floor was remarkable for its being swept nearly clean of debris, which is not a notable Eskimo characteristic. There were almost no artifacts or chippings, but one large fragment of a soapstone bowl seemed significant for its divergences from illustrated Canadian material and its close resemblances to Shetland bowls on Norse sites.

But our next excavation was still more remarkable, although this building floor was also almost entirely devoid of either trash or tools. Instead of a ruin 27 feet long, as we expected from surface indications, it developed into a structure

45 feet long by 16 feet wide. It included a long room or hall, a 6 x 6 feet appendage on the southwest corner, a 4-feet-wide gallery at the east end, a paved semicircular feature beyond that, in the form of an apse with two narrow entrances, and outside that a semicircular wall running parallel to the curving inner wall in the manner of an ambulatory, although the passage was too narrow for use. The church-like character of the building plan was striking, yet I would not suggest that it was ever so used.

The long sides of the hall were slightly outcurved in Norse fashion. The south wall was broken by a doorway and a wall-fireplace, the latter astonishingly modern in its arrangement, with the "chimney" outside and the wings projecting into the room. I do not know of a parallel for this in Eskimo archaeology.

Facing the fireplace was a broad semicircle of paving its wings spaced exactly 5 feet from either end of the room. Quite obviously, here was a gathering place for the telling of stories or the conducting of village business. A narrow exit opened onto the eastern gallery.

But there were more surprises on the Cartier site. Heavy rains revealed the presence of a low dam, 37 feet long, placed across a shallow drainage channel leading from the bogs behind the village. Below it, and parallel with it, was a stone causeway 27 feet long, only a few inches high but fully 5 feet wide! Obviously this is no footpath, as is evident from its width, its placement at the rear of the site forcing a considerable detour in moving across the village, and by its existence where no aid was needed in crossing this slight depression dry-shod at all times.

Upon seeing these evidences on the spot, and especially the causeway, the famed Canadian writer, Farley Mowat said, "This is unquestionably and unmistakably a European village".

Although myself satisfied with a Norse explanation, remembering that here was the major caribou migration route through Ungava, together with superb fishing and 4 foot trout, I well realized that there would be those who would find it hard to accept a village of seafarers some 130 miles inland over difficult terrain. I therefore turned to the Ungava Bay coast in search of what might be called staging post remains, places that would have been settled first, logically. In this search I was superbly aided by Mr. James Ford of Fort Chimo and an elderly Eskimo Zachariasi, who served as guide in 1966.

Although Zachariasi knew of several occurrences of "longhouse" ruins up the coast from Payne Bay, his efforts to find them failed in all but one case, Pamiok Island, a site that already had become known in the literature. Also, through an unfortunate break in

communications on that occasion, I missed seeing the largest ruin of all, 50 miles north of Pamiok, on what has since been named the Ford site. This structure, represented by earth ridges and a semi-subterranean interior, seemed to have four partitions but only one doorway. It is 115 x 24 feet, measured from crest to crest of the ridges.

On Pamiok Island three longhouse ruins were observed. The first of these, 45 x 16 feet, was completely excavated. Deposits were shallow, but stratigraphy showed an unidentified, possibly Norse, stone culture at the bottom, overlain by two stages of late Dorset culture. The sidewalls were outcurving and the ends were rounded, as is the case in some Norse dwellings. Down the centre was a double row of rather uniformly spaced firepits, stone-lined in some cases; in others, carefully constructed as stone boxes set in the floor. These are known as ember pits in Norse archaeology and at L'Anse-aux-Meadows, Newfoundland. The building dimensions and shape are common in certain Norse sites. A vestibule opening off the main room near one end is also a well known Norse feature.

The narrowness of the remaining floor space in the main room, the absence of sleeping platforms there, and the occurrence of raised platforms in the end rooms led me to suggest that the latter were for sleeping. The presence of firepits in both further suggests such use, rather than for storage.

The longhouses were roofed with timbers, of course, and post moulds were found. The rounded ends, as one would expect, were roofed with poles butted into the earth ridges and leaned into a gable end in tipi fashion.

The second longhouse ruin on Pamiok was 83 feet by 23 feet across its ridge crests. It had three partitions and differed from all other ruins in the extreme sizes of the boulders used in the walls. Some boulders ran over 1000 pounds. Nearly all had been tumbled out of place.

Excavations to date show that the kitchen of this large ruin was almost square, with a little over 19 feet to a side. Doorway positions leading into the other rooms were established. The stubs of foundation walls were uncovered and left undisturbed. The tumbled boulders, upon completion of work on this room, were restored to approximately former positions over the wall stubs. Again central firepits were found, and one of these produced enough charcoal for a radiocarbon date, which was about A.D. 1050. Architectural features, however, favour a date between A.D. 1100 and 1200.

Along the inner sides of the side-walls were post moulds, again proving the presence of timber in the construction. The

posts had been set in a fairly straight line, but irregularly spaced. Diameters ranged from 9 to 3 inches. None was set deeply enough in the gravels to support either rafters or itself. The rafters, then, must have passed over the stone walls to butt on the ground outside, another Norse custom in some places. The inner vertical posts must have been tied to the rafters, perhaps to support a curtain of hides for warmth.

An important Norse feature, and one discovered through knowledge of Norse custom, was a trash heap. This occurred off the north end of the longhouse ruin, and a little to one side. It was roughly 20 feet across, but disappointingly thin. Very few animals were represented in the bones identified. Although no Norse tools were found, it is particularly significant that there was neither Dorset nor Eskimo debris in the heap.

The timbers for the longhouses was not obtained from driftwood, which does not come to this shore except when thrown from boats. Pamiok, to say nothing of the Ford site 50 miles farther north, is far north of the tree line. The evidence of the fireplaces almost devoid of charcoal or ash indicates a turning to the native custom of using seal oil, and shows that wood was not available for fuel, either on the coast or at Payne Lake. All Pamiok timber had to come from a distance of about 150 miles by ship. And ships mean Norse, not Eskimos.

In this connection we must mention a series of remarkable stone beacons, all but two of which are situated along the coast in conspicuous places. They tend to be 9 or 10 feet high by 5 feet in diameter, but one attains a height of 13 feet, with a diameter of 6 feet. Stones used are remarkably large and neatly fitted, in European, not Eskimo fashion. Comparison with photographs of cairns elsewhere across the Arctic, even where such sizes are attained, leave no doubt that we are dealing with non-Eskimoan features, and several Eskimos have said, through the decades, that these are not the kinds of things that Eskimos would build. Zachariasi, from legends handed down by father and grandfather, attributes the beacons to "white men before the Eskimos", as he does also the longhouse ruins. Similarly, it will be apparent that more recent explorers cannot have built them, unless it can be shown that explorers built such beacons elsewhere in the past 300 years. I am not aware that they did, and the Ungava authority, Alan Cooke, has emphatically rejected such explanation.

The beacons seem related to the longhouses and almost restricted to the area containing them. They also seem related to the Payne Estuary, the principal haven on this entire coast. Many who have seen them believe they were for navigational purposes, and Mowat has pointed out that they were intended to have permanency.

Eskimo cairns occur in the same area and are distinguishable at a glance.

If ships were used to bring in timber, as I contend, it would be interesting to identify the source. The coastal area does not support trees. Therefore we must look up a river or inlet. The violence of the Leaf Estuary rules it out completely, even supposing that it once had more than scattered, stunted and gnarled forms. The Koksoak is not greatly better. But right beside the Koksoak is a relatively quiet inlet to the False River, and it seems the best choice. Additionally, a stone beacon stands at its entrance.

Two other items of importance must be mentioned. One is a stone monument 10 feet high, standing on the north shore of the Payne River estuary. Although called a cross by some, it far more nearly resembles a hammer, being asymmetric in its cross member and cap stones, and has been named the Hammer of Thor. Its vertical member alone runs close to 4000 pounds, and erecting it must have presented a challenge in this treeless land. Again Zachariasi put it prior to the arrival of the Eskimo.

The other item is the eider duck shelter. Robert Williamson, working years ago on the problem of teaching the Eskimos to build shelters like those used long ago by the Norse in Iceland, found that such shelters already existed in the region of the Payne River estuary. He also found that the Eskimos regarded the whole idea with amusement, to them seeming unnecessary since there were already lots of eider ducks. Further, the Eskimos were not interested in the down but only in the entire skin. To them the shelters were useless.

In closing, it is of interest to note that a little known saga, that of Arrow Odd, contains a number of references to the Kingdom of Skuggifjord, in terms that seem to apply to Ungava Bay. It is tempting to think that the renegade leader, Ogmund, may have been thebuilder of the great longhouse on Pamiok Island, for it alone of the 6 known ruins answers the given description, while only the Payne River estuary satisfies the given geographical requirements.

OBSERVATIONS BY A CANADIAN ON AN INTERNATIONAL SCIENTIFIC PROGRAM IN THE ANTARCTIC. By L.A.C.O. Hunt, Department of Indian Affairs and Northern Development.

Nothing in this world, or for that matter in space, in this latter half of the twentieth century can be kept away from man's inquisitive scrutiny. Antarctica's geographical isolation, its vastness, its cold and wind and great heights, its covering of ice, its lack of native human population, are no longer effective hinderances to detailed scientific investigation of the great southern continent.

Ever since the International Geophysical Year, the first real example of international scientific co-operation, scientists have been anxious to continue co-ordinated endeavours on an international scale. Antarctica was the scene of a massive effort during the I.G.Y., and the success of the program there encouraged a particular interest in developing a continuing program.

On October 15, 1959 at a converence convened to draft an Antarctic Treaty, 12 nations agreed to use the continent for scientific inquiry. Today, after 10 years of working in harmony and mutual trust, scientists from these and four additional nations, have demonstrated that international co-operation in research is possible and practical.

I visited Antarctica to help celebrate, at Scott Base, the tenth anniversary of the signing of the Treaty, and also in company with Dr. Laurence L. Gould, to commemorate the 40th anniversary of the flight of Admiral Byrd to the South Pole. Dr. Gould was Byrd's scientific adviser and second in command of the 1929 expedition. (At the age of 73 Dr. Gould is President of the Scientific Committee on Antarctic Research (SCAR) the advisory body of the Antarctic Treaty). How dedicated Dr. Gould is to international co-operation may be summed up in a remark he once made to the National Academy of Sciences, "The Antarctic Treaty is indispensable to the world of science which knows no national or other political boundaries; but it is a document unique in history which may take its place alongside the Magna Carta and other great symbols of man's quest of enlightenment and order".

Two of the heros of Antarctic exploration in the 20th century are Shackleton and Scott. A base used by both explorers is Ross Island on which today both McMurdo and Scott bases are situated. Scott built a cabin at McMurdo in 1901 at what is now called Hut Point Peninsula. It was here that Scott's ship the 'Discovery' was based during his oceanographic reconnaissance, 1901-4. (The 'Discovery' which during World War I belonged to

the Hudson's Bay Company, can still be seen tied up at London's Embankment).

I took the opportunity on my trip to visit Cape Evans, Scott's base for the ill fated expedition of 1911. A few miles further away, near the most southerly rookery of the Adélie Penguin, is the Shackleton cabin at Cape Royds. The New Zealand Government has declared both these sites Historic Monuments.

Ross Island, at 77°S latitude, and at the beginning of the Ross Ice Shelf with a permanent ice cover, is larger than the area of France. Our destination was McMurdo Station on the southern flank of Ross Island. It has been called Antarctica's first city, and its beginnings date from the IGY. The base commander, a U.S. navy captain, receives each day a census of the population under his care, which while I was there varied between 700 and 750, but has occasionally reached 900. The airport, named "William Field", is a vast complex of Jamesway and Nissen huts situated on permanent land-fast ice. Here when we landed on December 1st, 1969 there were several Hercules aircraft, the standard work horses of the continent. Ross Island is dominated by two volcanos, Mount Erebus and Terror. Fine wisps of smoke curl ever upwards from the summit of Erebus which is over 13,000 feet. In similar fashion McMurdo is dominated by Observation Hill site of a satellite tracking station which we also visited during our ten day stay. The U.S. Navy, whose personnel form the major segment of McMurdo's population, maintains transport and accommodation services for scientists and their research needs.

My visit to Antarctica originated about a year ago with an invitation from the National Science Foundation, but the actual flight started in Washington at Andrews Air Force Base on November 24th, 1969. On November 28, five days later (one day lost crossing the International Date Line), we arrived in Christchurch, South Island, New Zealand. The aircraft which took us all this distance was a 19 year old Super Constellation with a top speed of 240 knots. We stopped overnight at San Francisco and Honolulu. The stop-over in the Hawaiian Islands was extended to 30 hours to enable the crew to rest up, and to permit those of us who were making our first visit to the 51st state to gain personal impressions of developments there. Christchurch has the look of an English provincial town, dominated by a central square and cathedral. The river Avon winds its lazy way through the centre of the city, endowed with open spaces such as the Botanical Gardens and sundry grassy bowling greens, tennis courts and cricket pitches. In fact, later, after visiting other parts of New Zealand, I decided that this little country was the epitome of middle class respectability.

Our arrival at Christchurch was the commencement of 'Operation Deep Freeze' and the next two days were spent in being

fitted out with special clothing. I was issued two extremely heavy duffel bags, containing two suits of thermal underwear, mackinaw shirts, and a specially (but poorly) designed parka, gloves, mitts and four pairs of various kinds of footwear. We had to await favourable weather for our journey onward, and our poor hotel clerk was forever advising us of different times of departure due to the constantly-changing orders emanating from the Admiral's office at Christchurch aerodrome. For our final departure, we were up at 4.30 a.m., in a taxi by 5.15 and arrived at the airport at 5.30. Here all our normal gear was stowed away in lockers, and in 80 degree weather we solemnly changed into our Antarctic clothing. As we all trooped into the airport café for breakfast clothed for the South Pole we must have looked very peculiar to the other passengers clothed for the fine, sunny weather. Again in the same Super Constellation that had brought us from Washington, we eventually took off at 10 a.m.. At an altitude of 8,000 feet we passed over the Canterbury Plain, the origin of so much New Zealand lamb, skirted Dunedin, and flew southward to ice and the mysterious continent.

There is an area within the Southern Ocean where warm and cold water come togeher in a belt 25 to 30 miles in width. Oceanographers call this the Antarctic Convergence. Apart from the great influence it has on the southern hemisphere's climate, it is of great biological interest, as indicated in the species of wildlife which inhabit either side of the convergence. The Captain pointed out Cape Adare as we passed, and here we got our very first glimpse of Antarctica. Not far from Cape Adare, there is a joint U.S. - New Zealand Hallet Station for meteorological and upper atmosphere investigations, but it could not be seen for fog and ice. Between six and seven o'clock that evening we passed over McMurdo and finally landed on the ice at Williams Field. We had arrived.

The size of the buildings and their solid steel girder construction indicated that the U.S. is in Antarctica to stay. The new mess hall is a building of huge proportions, containing navy wardrooms, complete recreational facilities, galleys, PX, etc. all under one roof. As on our DEW-line stations, no expense is spared to feed the personnel, and the galley provides a varied menu of the best of food in gargantuan quantities. McMurdo also houses excellent scientific facilities. The biological sciences are centred in the Biolab. The earth science laboratory is well equipped for glaciologists, topographical engineers, geologists and soil scientists, with, for example, cold storage lockers for keeping ice cores and frozen soil and silt samples. Each of the laboratories contains reference libraries, machine shops where scientists can devise and build their own equipment, and of course the standard workshops for regular repairs to tracked vehicles and other mechanized equipment.

McMurdo is currently undergoing a major face lift. During my visit a new building was being constructed, complete with conference rooms, film studio and offices. Next to this building is the almost completed U.S. Antarctic Research Program Headquarters which when ready will displace the old Nissen huts.

The main problem at McMurdo is water. The Antarctic, like the Arctis, is essentially a desert. The average snowfall in Antarctica is equivalent to an annual precipitation of 6.5 inches. It is true that 95 per cent of the 5,000,000 square miles of Antarctica is covered with snow and ice, and that at the Pole itself the ice cap is over 9,000 feet thick. Water is nonetheless hard to obtain at McMurdo, in quantity, by conventional means, and recourse has been had to nuclear power for distilling sea water from the Sound, at the present rate of 15,000 gallons per day. However this is barely enough to meet summer requirements and signs in the washrooms suggest that one shower a week is adequate.

McMurdo is at the extreme northerly edge of the Ross Ice Shelf, which is fed from the many glaciers which stretch down from the interior, commencing at the summits of the peaks in the Trans-Antarctic Mountains. There is, we are told, constant movement of the ice due to its viscous and plastic properties which enable it to bend and flow under pressure. The most famous of the glaciers which feed the Ross Ice Shelf is the Beardmore, about 100 miles in length and 12 miles in width. Both Scott and Shackleton struggled painfully up and down this obstacle, killing of their ponies in the process. When we flew to the Pole, we travelled at 18,000 feet up the Beardmore, above the route taken by those early explorers.

We flew to the Pole in comparative luxury, in the belly of a Hercules freighter. We were transporting fuel oil for this was the season when all the outlying fuel tanks were being topped up from the storage tanks in McMurdo, which would in its turn have its tanks refilled by the tanker due to arrive in early February. Each Hercules had an inside tank, bolted to the floor, with a capacity of 2,500 gallons. Logistically, I am told that it takes 1.8 gallons of fuel oil to deliver 1 gallon to the Pole.

Arrival at the Pole station, officially named the Amundsen-Scott Station, one is confronted with a jigsaw of aerials and very little else. Buildings are not visible, but a tractor with a flat-bed on skis met us and we trundled off to some distant speck which turned out to be a vast hole in the ice-cap into which we entered. Here was a vast cavern literally carved from the ice-cap and entering through a door we saw a long dimly-lit tunnel leading into others. In fact, the whole underground complex is

reminiscent of a troglodyte city, and was thoroughly depressing. Prefabricated modules, transported to the station in Hercules aircraft, lined many of these tunnels. Each module had a specific purpose, i.e. living quarters, recreation, galley, wardroom, hospital, etc.. On the day of our arrival at the Pole, the temperature was -22°F. with a 3 knot wind. I was told that in the winter of 1965 the thermometer had dropped to -113°F. Walking on the ice cap at an altitude of over 9,000 ft. was arduous, and slow when equipped in the heavy garments we had to wear. The ceremony took place at the exact site of the geographic pole. In a small circle the flags of all nations signatory to the Antarctic Treaty were flying. A plastic wreath of red roses was placed in the centre of the ring by Dr. Gould, to commemorate the 40th anniversary of the flight to the Pole by the late Admiral Byrd.

Returning that evening from the Pole station we stopped at a camp east of the Beardmore Glacier, near a paleontological site on Coal Bluff Mountain. In 1912, Scott had found here signs of anthracite coal, evidence that Antarctica once had a heavy vegetation. A few days before our landing the geologists had discovered some fossil remains of an amphibious reptile called Lystrosaurus which lived during the early Triassic period, about 825-225 million years ago. Bones of the same kind have been found in South Africa, Indo-China and Southern China. These finds serve as another link in the chain of evidence demonstrating that Antarctica was once part of a much larger land mass comprising Africa and Asia. "Gondwanaland" the name given by geologists to their surmised southern continent, is now fact, not theory. The Antarctica of today evidently owes its position to a continental drift, which carried it south at the rate of several inches per year. Fascinating discoveries of this kind will only serve to stimulate scientific investigation of Antarctica, and even now provide the impetus for great appropriations. As I returned to McMurdo that evening I reflected on a memorable day, one on which I had begun to feel as enthusiastic about antarctic research as my scientific companions.

The flight to Byrd, and the visit to its under-the-snow camp gave me the opportunity to see some more of the landscape and of camp life. At Byrd, because of its location on the ice plateau some 6,000 feet above sea level, and in the general area of the south magnetic pole, a geophysical observatory had been sited. It will in the future be automated as far as possible, with power coming from batteries continuously charged by windmills or radio-isotope-fueled generators. Interesting experiments have been made at Byrd with a hold drilled by a diamond bit to the bottom of the ice cap. I was told that ice cores have been brought up and shipped to Hanover, New Hampshire, still frozen. Unfortunately, the drill had stuck together with an instrument designed to investigate the ice at various levels.

While at Byrd, I was taken by a tracked vehicle across

the ice cap to a small, two-man station named Longwire. Thirty feet below the surface of the snow, two men are living for one year studying such phenomena as the Earth's magnetic field and recording the effects of sun spots. Longwire is so named because it passes a main aerial laid on the snow to a length of 21 miles. Investigations on the propagation of energy particles into the polar cap are relevant to an understanding of the character of the magnetic regime in this region, where the field lines extent in a poorly defined manner far into space.

I had the opportunity on further field trips to see some of the biological investigations in progress. At Cape Royds, a large colony of Adelie Penguins was under continuous observation by a group of international biologists. These interesting birds were highly photogenic, and quite unafraid of man. On the other hand they were very suspicious of the skua, a bird which, if the opportunity occurs, will steal the penguins' eggs. At this colony, the females were sitting on their eggs, while on the ice some distance away the males were out seeking sustenance, or at any rate they were walking out in their customary single file to a hole in the ice, which I presumed was their local fish-market. At Cape Royds, the cabin built by Shackleton can be visited. I found the cabin and its interior most fascinating. It had been restored by the New Zealand government, and the interior arranged as it was in 1909. Canned food, 1909-variety, was in evidence, together with a copy of the London Illustrated News dated 4th July, 1908. Twenty miles away, at Cape Evans, Scott's hut built for his last, ill-fated expedition has also been restored. Here one can see the stables built outside the cabin for the ponies, and bales of hay and bags of oats are still well preserved after all these years.

I visited an interesting research project on the behaviour of the Weddell Seal. A television camera and a hydrophone had been introduced into the water and observers were at watch on a screen some 50 yards away. This struck me as a clear case of voyeurism, the universities of the world having clearly penetrated into the bedrooms of these amusing animals. I was informed that this particular seal colony contained 150 seals of which 50 were pups and only 9 were bulls. Older bulls are apparently chased away by the younger and more virile members of the colony. By attaching a small electronic gadget to the flippers, observers have noted that the Weddel seal can dive to unprecedented depths of 2,000 feet and can wander many hundreds of miles.

What was quite obvious from my short visit to Antarctica was the complete ease and freedom in which scientists from many nations worked together in harmony and understanding. The pains-taking investigations carried out by the scientists at the various

remote stations which dot the continent add considerably to the storehouse of knowledge about Antarctica. Men's lives have been sacrificed in the pursuit of polar knowledge and the hills on Ross Island, as also on the continent itself, bear witness to tragedies in the name of science. At Hut Point at McMurdo stands a cross to the memory of Seaman Vince, and on Observation Hill, another to the memory of Captain Scott and his companions. At Cape Royds stands a wooden cross in memory of three seamen of the "Endurance", who lost their lives during the ill-fated Shackleton expedition. More recently, there has been loss of life at Scott base, the New Zealand station, and others. Exploration will always have its cost in life, but as Antarctica becomes better known the dangers will lessen. The experiment in international co-operation which has been made possible by the Antarctic Treaty has become a workable success. It is possible that this success could be extended to other parts of the world, the Arctic, for instance? It is a thought worth considering. Canada is not a member of the Antarctic Treaty, yet, as a polar nation I believe Canada should become a supporting and active partner in this great experiment in scientific co-operation.

REPORT.

LIFE HISTORY OF ROCK PTARMIGAN ON BATHURST ISLAND, N.W.T.

By S.D. MacDonald, National Museum of Canada.

On May 18, 1968 a small field research station sponsored by the National Museum of Natural Sciences and the Polar Continental Shelf Project was established on Bathurst Island, N.W.T.. Since that time ten research projects have been started at the station to study the behavioural adaptations of territorial animals in high arctic environments. The following resumé is based on observations from May 18 to August 15 in 1968, and during May and June in 1969.

The Rock Ptarmigan (Lagopus mutus) is circumpolar grouse, and in Canada its breeding range extends to the most northerly land at the edge of the Arctic Ocean. Its preferred habitats are on rocky hillsides or ridges, near moist hummocky tundra with well vegetated depressions providing an ample food supply throughout the breeding season.

Although Rock Ptarmigan have been recorded as early as March 21 on Ellesmere Island, our records suggest that, like shorebirds, they may not all reach their breeding grounds on Bathurst Island until mid-May. Early arriving males are soon joined by females to form mixed flocks frequenting wind-swept slopes where the vegetation has been exposed. In colder weather the birds crouch low to the ground while foraging and all movements except the rapid pecking motions of the head are slow and deliberate. When they have filled their crops they seek shelter in the lee of surface irregularities, and for overnight roosting they frequently dig cavities in the snow so that their backs are just below the snow surface.

Dominance patterns exist throughout this period of flocking, and the most aggressive birds displace subordinates at favoured feeding and sheltering spots. Increasing aggression in the males causes the flocks to disintegrate and by late May individuals have selected suitable summer habitat. Rising aggressiveness is coupled with the onset of ground vocalizations and flight song displays, and with an increase in the size and brilliance of the scarlet combs in males. The black tail feathers are almost continuously exposed during all activities related to territorial advertisement. Females are first attracted to the male's home range because it includes optimum habitat. The male's display activity and watchfulness allow her to forage without

disturbance, and she soon adopts a submissive pattern of behaviour. In early stages of pair bonding the male follows the female continuously and will not leave her unattended. The pair bond is secure when the female chooses to hide rather than to fly when the male gives an alarm call, or he leaves her to fly after a trespassing male.

The flight song display (Figure 1) is the most spectacular display of the male, and the one most often seen by travellers in the Arctic. The movements are coupled with loud, far-carrying, croaking vocalizations to effectively advertise and mark the position and territory of the male. The display is an elaborate development of the drumming and flutter flights seen in other members of the grouse family, and like them it is a visual signal involving parts of the body which are highly contrasting in colour. As in all other of its displays the black tail is very conspicuous against the sky and snow, and the white body plumage is very apparent against the bare ground. The height attained in the flight song display is directly related to the male's aggressive feelings and the strength of his attachment to his territory. The first flight song displays may be less than ten feet in elevation, but at the peak of reproductive activity an aggressive male may soar to two hundred feet or more and sing three or four times as he descends.

Males with adjacent territories spend much effort in threat, and in advertising displays. Actual fighting occurs in the air after erratic chases, and on the ground where combatants attack each other vigorously tearing out feathers and sometimes drawing blood. Ritual fighting occurs more frequently, and the adjacent males meet at specific spots along the otherwise vague territorial boundary to engage in aggressive encounters.

High intensity threat patterns include the raising of the crown feathers to expose their gray bases and to increase the apparent dark area around the eyes and bill. Some trespassing males when pursued by territory holders will effectively block a violent attack by assuming the submissive, sex-soliciting posture of a female and thus escape unscathed. Courtship patterns appear and develop during the process of pair bonding as the female begins to rely upon the watchful nature of the male. His vivid scarlet combs are conspicuously displayed in an elaborate head bobbing movement which presents them against his white body and black tail which is frequently spread and elevated. He fluffs out his body plumage and appears much larger and more conspicuous. The female, on the other hand becomes less conspicuous as her brown plumage develops and matches the irregular patterns of melting snow patches.

As the female becomes more submissive towards the male, he approaches her more closely and attempts to direct her movements towards the shallow depressions in which copulation typically takes place. Persistent males crouch in display indepressions in front

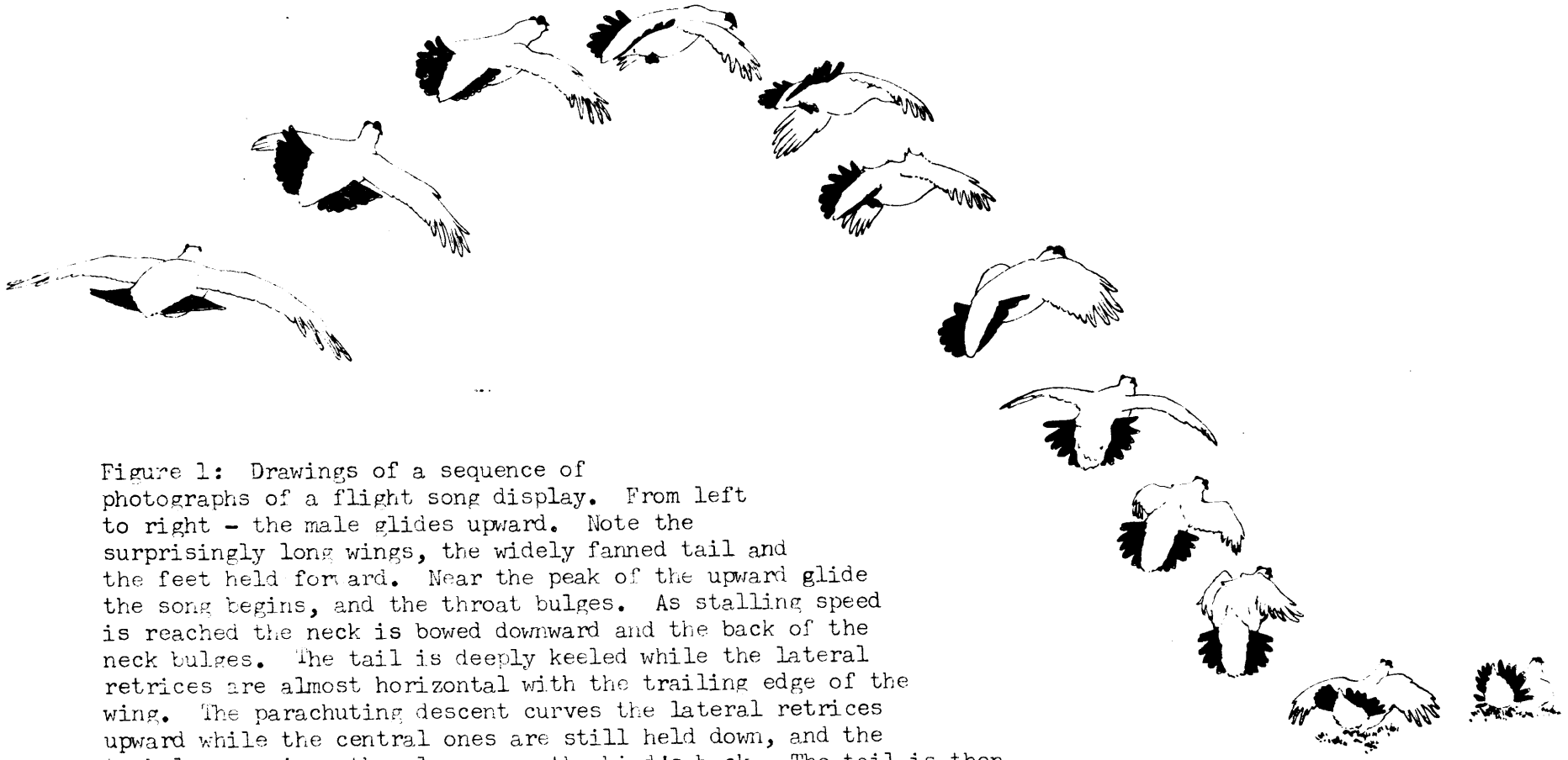

Figure 1: Drawings of a sequence of photographs of a flight song display. From left to right - the male glides upward. Note the surprisingly long wings, the widely fanned tail and the feet held forward. Near the peak of the upward glide the song begins, and the throat bulges. As stalling speed is reached the neck is bowed downward and the back of the neck bulges. The tail is deeply keeled while the lateral retrices are almost horizontal with the trailing edge of the wing. The parachuting descent curves the lateral retrices upward while the central ones are still held down, and the turbulence raises the plumage on the bird's back. The tail is then flattened as the body moves into a more vertical position and with rising momentum the bird can again glide as the second spluttering part of the song is delivered. After alighting the tail is tipped up, conspicuously marking the male's position. This movement is followed by a ground vocalization which also attracts attention to his location.

of the females to elicit sexual response. Throughout the courtship period the male makes continuous and monotonous ticking notes given in a staccato sequence of two or three. This "contact" or "assurance" song is audible to humans at twenty to thirty feet, and quickly changes in alarm to a ratchet-like sound resembling that made by a fishing reel when the line is pulled off. The female crouches inconspicuously when the male makes an alarm signal and remains hidden while he makes himself apparent by moving about calling. This is why males are more often encountered than females.

When the paid bond is secure the male stays close to the female and appears not to court her as actively as before. He merely follows her until she crouches in a depression soliciting copulation. Following mating the male ptarmigan, unlike most other grouse, performs an elaborate post-copulatory display.

Polygamy occurs periodically in Rock Ptarmigan and may be more common than the literature indicates. One male on Bathurst Island had three mates. This bird held a large territory, exhibited almost continuous display activity, and displayed large combs, all of which demonstrate a high level of male hormones present in the blood. A hierarchy which existed among his three females seemed to be related to his unequal preference for each individual female. The female he preferred had the largest amount of brown feathers in her plumage. The early development of brown plumage may be an indication of increasing estrogen in the female's system, and of imminent sexual response. Our experiments with mounted specimens of female Rock Ptarmigan in which the brown pattern could be manipulated suggested that territorial males are more sexually-oriented toward females with piebald plumage than to whiter ones.

The male always left a subordinate female, even just before copulation, to escort his favourite whenever she appeared on the feeding ground. When the male left one female to direct his attentions toward another nearby, the deserted female attempted to divert the male by placing herself in front of him; and by sexual solicitation, but would not allow him to copulate. The vocalizations of Rock Ptarmigan are difficult to describe. The male has a repertoire of at least six distinct calls, all of which are variations of a predominantly low frequency pulse burst of cyclic clicks. If the frequency response is ignored, the pattern resembles the sound produced by pulling a stick across the slats of a picket fence at varying speeds. The female's calls are whining and clucking notes which are similar to those of other female grouse.

Four nests were found on Bathurst Island, containing a total of twenty-five eggs, of which two did not hatch. The first eggs were laid at the end of the second week of June, and until the clutch was complete the female carefully covered the eggs with vegetation. Freshly-laid eggs are a very rich cinnamon-red with deep chestnut brown markings. During incubation, which lasts 21 days, the colour of the shells faded to drab buff, and the markings

darkened to almost black. Once incubation has begun and the eggs are less brilliant, the female does not cover them when she leaves to feed. The females incubate steadily for long periods, and may leave the nest to feed, possibly only at twelve hour intervals. Incubating females eat their white feathers which are lost at the nest, even those four inches in length. The male knows the location of the nest and remains nearby at an observation post which provides a view of the nest site. When the female leaves the nest, the male accompanies her to the feeding area. Should he be absent when the female leaves the nest she flies off alone and performs a conspicuous fluttering flight which attracts the male. The presence of the watchful male allows the female to feed uninterruptedly and if danger threatens his still-white plumage attracts attention to himself while the cryptically marked female crouches unnoticed. After feeding he escorts her back to the nest.

A male with more than one mate divides his time between them while they are incubating. This increase in territorial display activity multiplies the chances of the male being killed by an avian predator early in the breeding season. This may be a selective factor against polygamy.

Females sit very closely on their nests and rely upon their camouflage to conceal them. Once the nest is discovered the female will fly fearlessly at any potential danger to attract attention to herself through distraction displays. Few of the Bathurst Island males made any attempt to protect the young, and usually deserted their mates soon after the young appeared.

The males move to sheltered gullies and hummocky tundra to moult, and are often joined by moulting females that have lost their nests or young. In the High Arctic, Rock Ptarmigan have three complete plumage changes which match the changes of the environment as the season advances. In autumn the fresh white plumage is flushed with pale pink, and harmonizes with the new snow in the low light of the declining sun.

Grateful acknowledgement is expressed to the Polar Continental Shelf Project for their support, and especially to Dr. E.F. Roots and Mr. Frank Hunt for their interest in the Bathurst Island Project.

ANNOUNCEMENTS.

TWENTY-SECOND INTERNATIONAL GEOGRAPHICAL CONGRESS, 1972.

The 22nd Congress will open in Montreal on August 10th 1972. The program for the following week will include the presentation of:

(a) the presentation of technical papers and lectures, the convening of special panels and workshops, the exhibition of films, maps, atlases, other books and photographs, and the opportunity to participate in local and regional excursions.

Most of the Commissions plan to meet at universities across Canada prior to the Montreal meetings. A broad program of symposia and field tours will take place before and after the main Congress, the latter extending from coast to coast and from the United States border to the Canadian Arctic.

Throughout the Congress, the Canadian organizers will encourage the dynamic interchange of ideas between scientists of diverse specialization, through meetings and by discussion. A compromise will be sought between the traditional formal offering of papers and novel methods of presentation. While the 13 Sections are broad enough to encompass the major areas of the study of geography, the proposed themes will set the focus on current problems and new research and concepts. The deadline for technical papers will be September 1, 1971.

Details of the Sections, Symposia, Commission meetings and Field Tours are listed in the 'First Circular' which will appear in the May issue of the IGU Bulletin, 1970. Provisional registration for the Congress should be made by September 15, 1970. Separate copies of the First Circular and the application form may be obtained on request from the Executive Secretary, 22nd International Geographical Congress, P.O. Box 1972, Ottawa, Canada. Provisional registrants will be placed on the mailing list for the Second Circular to be issued in November, 1970.

Events of special interest to northern specialists will include the technical sessions on Climatology and Glaciology, Biogeography, Political Geography, and Remote Sensing; the map exhibits; symposia on Frontier Settlement, Mass Wasting in Arctic Mountains, Developing the Subarctic, and Glaciers of the Rocky Mountains; meetings of the IGU Commissions on Periglacial Morphology and High Altitude Geoecology; and the various field excursions, in particular those in Northwestern Canada, the Arctic Archipelago, Northern Ontario and Northern Quebec.

RESIGNATION OF THE EDITOR.

The Editor, A.H. Macpherson, resigns with the publication of this issue of the Arctic Circular. He would have been happy to continue in his post but has been newly appointed to the Western Region of the Canadian Wildlife Service and has regretfully decided that he should not attempt to edit this Ottawa club newsletter from Edmonton.

Dr. Macpherson wishes to thank publicly the many contributors to whom he is indebted, and in particular his generous assistants, Dr. M. Jeanne Ferrari and Dr. Peter J. Usher. The President of the Arctic Circle Club will shortly announce the appointment of a new Editor for the Arctic Circular.

THE ARCTIC CIRCULAR.

The Arctic Circular is published three times a year for members of the Arctic Circle Club, Box 68, Postal Station 'D', Ottawa. Membership is open to all, and may be arranged by writing to the Treasurer, Mr. S.D. MacDonald, at the above address, and enclosing, for a single Ottawa member or couple $5.00, for an out-of-town member $1.50 and for an institution $3.00. Members are requested to notify the Club promptly of any change of address.

Back issues are available at $0.50 each, and complete sets of volumes 1 to 19 at $100.

Arctic Circle ties, featuring a white narwhal on a dark blue background, are available from the Treasurer at $3.50 each.

Reports for publication are welcomed from those living in the North, or having information on northern activities, particularly news of research, travel, and technological, industrial and social developments. Opinions on content and format are also welcomed. The address of the Editor is care of the President, Dr. R.J.E. Brown, Division of Building Research, National Research Council, Ottawa.

THE ARCTIC CIRCULAR

VOL. XX No. 3 Published by The Arctic Circle Ottawa December, 1970

Nineteen-seventy has been a milestone year for Canada's northlands. For the Northwest Territories, and for Manitoba whose northern areas adjoin those of the Territories, it has marked 100 years within Canadian confederation. It also marked the tricentenary of the founding of the Hudson's Bay Company.

To honour this anniversary, the Company brought from England a replica of Nonsuch. Although it did not emulate its illustrious predecessor by sailing into Hudson Bay, this second Nonsuch did make a triumphal progress through the Seaway on its way to Winnipeg, reminding all those along its route of Canada's North and its early history.

The first Arctic Games were held in Yellowknife, bringing visitors not only from the Yukon and all parts of the Northwest Territories but also from the other provinces of Canada and from Alaska.

The highlight of the celebrations that marked these anniversaries was the visit by Her Majesty the Queen, accompanied by Prince Philip, Prince Charles and Princess Anne, to the Northwest Territories and Manitoba. Other official visitors included Governor General and Mrs. Michener, Prime Minister Trudeau and various members of his Cabinet.

Northern Region Headquarters was established in May, 1970, to co-ordinate increased levels of Service activity and surveillance in the north and will be operational from its headquarters in Yellowknife in 1971. This brings the Armed Services back into an area where they are no strangers but where their interest and activity have been on a very reduced scale in recent years.

During the year, oil was discovered in the Mackenzie Delta area and gas deposits were found in the Arctic Islands. Sounding, drilling and surveying for oil continues, and at an accelerated pace, in view of the proven finds on the north slope of Alaska. To test the feasibility of moving oil south by year-round tanker transport, Manhattan continued her research program on the character and properties of ice, this time in the Milne Inlet - Lancaster Sound area of Baffin Bay and, while plans for more suitable tankers are being studied, research continues, especially at Inuvik, to determine the feasibility and requirements of the alternate means of oil transport - pipelines.

Not only have the events of 1970 aroused enthusiasm and self-assurance in the residents of Canada's North but they have given a new awareness of the region to the country as a whole. Although the discovery of oil has opened possibilities for economic development, it has also aroused great concern in many quarters lest this development result in the destruction of valued aspects of present northern life and bring catastrophic changes to the delicate ecological balance. In order to avoid repeating the ecological and sociological mistakes made during the opening up of southern Canada, problems already recognized as inherent in northern development are being studied by researchers in many and varied fields. For, it is now clearly recognized that the required solutions make demands beyond the limits of any single discipline and require a concerted interdisciplinary approach.

The Arctic Circle, concerned with all matters pertaining to the North, will follow with keen interest the activities resulting from the events of 1970 and their effect on the environment and the people.

MEETINGS

Except in the case of the Annual Dinner, all meetings of the Arctic Circle are held in the Officers Mess, No. 9 Transport Company, R.C.A.S.C., Catherine Street at the corner of Bank Street.

. . .

Correction VOL. XX NO. 1
Page 1, line 19, Annual Dinner should read One hundred and eightieth meeting, The Annual Dinner.
Page 2, line 5, One hundred and eightieth meeting should read One hundred and eighty-first meeting;
line 14, One hundred and eighty-first meeting should read One hundred and eighty-second meeting.

. . . . .

One hundred and eighty-seventh meeting. Tuesday, 13 October, 1970. The speaker was Mr. Keith C. Arnold of the Glaciology Subdivision, Inland Waters Branch of the Department of Energy, Mines and Resources. He was introduced and thanked by the President, Dr. Roger J.E. Brown. Mr. Arnold has spent four summer field seasons on Meighen Island and, as a result of his knowledge of the island, became interested in the Cook-Stefansson controversy as to whether or not this was indeed the first land seen by Cook on his return journey in 1908. The title of this most interesting address was " 'The Problem of Meighen Island' - a possible solution." The following summary was prepared by the speaker:

> "The Problem of Meighen Island" was originally written by Vilhjamur Stefansson as a chapter for "Unsolved Mysteries of the Arctic", but was withdrawn by the publishers because of a threatened libel action by Dr. F.A. Cook, mistakenly so, in Stefansson's opinion. He had the "suppressed" chapter printed privately in 1939. Three hundred copies were printed, and the pamphlet is available in most Arctic libraries.
>
> The problem, which was first posed by Peary in 1909, and was restated by Stefansson in 1918, arises out of two conflicting accounts of Dr. Cook's purported North Pole journey in 1908. Cook claimed that he sledged to the north end of Axel Heiberg Island, and from there to the North Pole. On his return journey he gained his first glimpse of land on June 13th, 1908, from a point on the ice at 79° 32' N, 101° 22' W, a point which lies between Ellef Ringnes, Amund Ringnes and

Meighen Islands, and some fifteen miles from Anderson Point on the southwest corner of Meighen Island. Peary's account of this journey was based on interviews with Cook's Eskimos, and from these interviews he was able to sketch a hitherto unknown island of approximately correct size and shape and in the correct position for Meighen Island. Cook steadfastly denied having seen this island.

Stefansson landed at Anderson Point in 1916. In 1919, in "Solving the Problem of the Arctic", he used his knowledge of Meighen Island to write a destructive criticism of Cook's account, claiming that the spot on which Cook first gained his sight of land actually lay in the centre of Meighen Island. This criticism lost some weight when Meighen Island was moved further east on later maps, in the light of new longitude observations. Twenty years later Stefansson returned to the attack, and in the closing paragraph of his monograph he stated:

"So there appear to be three main conclusions:

1. It is impossible to believe that Stefansson was the discoverer of Meighen Island.

2. It is difficult to believe that Cook did not discover it - either on such a journey as Peary describes or on such a journey as he himself describes.

3. But it is difficult to believe and seemingly impossible to explain, that Cook discovered Meighen Island and then refused to acknowledge the discovery.

It is one of those problems where every answer seems wrong."

Mr. Arnold, who spent the summers of 1959 to 1962 on Meighen Island, believes that the problem can be satisfactorily explained if one assumes that Cook's latitude observations were in error (possibly due to a misapplied semi-diameter correction) and that the first land on which he set foot on his return journey was in fact Meighen Island, although with the maps of Sverdrup at hand he would have easily thought that it was Amund Ringnes Island. If this assumption is correct, flaws in Cook's account that were criticized by Stefansson are removed, and his account becomes consistent. With our present knowledge of drift in the Arctic Ocean, the intriguing possibility is opened that Cook made a far more considerable journey over the Arctic Ocean than he has generally been given credit for.

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One hundred and eighty-eigth meeting. Tuesday, 10 November, 1970. This was the occasion of the Annual Dinner which was held at R.C.A.F. Headquarters Mess, Gloucester Street, Ottawa.

The speaker was Dr. Patrick D. McTaggart-Cowan, Executive-Director of the Science Council of Canada, and a member of the Arctic Circle Committee.

Following the dinner the formal part of the meeting was announced by the ceremonial blowing of the narwhal tusk by Keith C. Arnold. The speaker was then introduced, and later thanked, by the President, Dr. Roger J.E. Brown. The following is the speaker's own summary of his address:

> Dr. P.D. McTaggart-Cowan spoke on what he called "Operation Oil", the activities of the Task Force he headed which was responsible for cleaning up the oil spill at Chedabucto Bay that resulted from the grounding of the Liberian tanker, Arrow.
>
> He started by presenting a very worrisome picture of the world situation where the records reveal that there is, on average, a grounding of a tanker of equivalent size to Arrow every week somewhere in the world. Estimates made by others indicate there are up to 300 million gallons of petroleum products going into the ocean, either deliberately or accidentally, each year. Knowledge of the ability of the oceans to cope through oxidation or biodegradation with petroleum products are fragmentary to nonexistent, and evidence beginning to accumulate suggests that the level of pollution is exceeding the oceans' natural ability to cope with this material. As evidence of this there was the report from Heyerdahl, on his voyage on his papyrus raft, where he sailed for 1,500 miles through chunks of oil, and there is also the growing level of pollution on the beaches of Bermuda that seems to be reaching alarming proportions without any nearby sinking of a tanker.
>
> To add further to the ecological concern, there is the work of Max Bloomer, of Woods Hole, on the entry of non-degraded long-chain molecules from petroleum products into the food chain, and the work of Drs. Sprague and Carson, of the Fisheries Research Board of Canada, regarding the toxicity of dispersants. It appears that, in spite of the lessons of Torrey Canyon, the use of prodigious amounts of dispersants in clearing up oil spills around the British Isles and on the coast of Sweden

was a matter of conscious decision. Oil companies were pressing the use of dispersants or of sinking agents on the basis that their interest was principally to get the oil out of sight of the public. It was obvious that they had little or no concern for the ecological consequences of this act.

Discipline among the ships sailing the oceans of the world, particularly tankers flying flags of convenience, is far from satisfactory and the world's shipping interests are deliberately obstructing any improvement or move towards the positive control of shipping analogous to the positive control of international avaiation.

Against this gloomy background Dr. McTaggart-Cowan showed a set of slides of the problems and accomplishments of his Task Force at Chedabucto Bay, pointing out that some 2.3 million gallons of oil that had been spilt there, contaminating some 190 miles of coastline in the Bay itself. Some of the oil travelled as far as Sable Island, fouling the shores and causing substantial loss of bird life.

The Task Force was appointed 17 days after the tanker had gone aground and the work is still continuing. Between March 13 and April 11, 1970, one and one-half million gallons of oil had been recovered from the stern section of the wreck sunk in 100 feet of water. A further 100,000 gallons had been recovered in September. Oil floating on the surface of the water had been recovered with the use of slick-lickers, and all the tourist and community beaches in the area had been kept clean during the summer although this accounted for only 30 miles out of the 190 miles of polluted coastline. Sixty-eight wharves and jetties had been cleaned. The total cost of the operation has been $3.1 million to date, but work still remains to be done in the spring of 1971.

As this spill took place in February when sea ice was forming in Chedabucto Bay, some conclusion could be drawn as to the problems that would be faced should a similar disaster take place in the Arctic. From the experience gained, questions could be posed that make research on Arctic pollution problems much more specific.

Following his address Dr. McTaggart-Cowan answered numerous questions. He discussed, among other subjects, the frightening

sizes of tankers now on the drawing board and their difficulty and slowness in manoeuvring, as well as the various forms of financial responsibility it might be possible to impose on oil companies and oil carriers as a deterrent against careless navigation or dumping and to compensate the human victims of spills. Ecological damage in such cases is still difficult to calculate and even more difficult to repair.

One hundred and eighty-ninth meeting. Monday, 7 December, 1970. The 189th meeting of the Arctic Circle was held on Monday, 7 December, 1970 (instead of the regular "second Tuesday" date) to permit the members to have as guest speaker Dr. B.D. Loncarevic, Assistant Director (Research) Atlantic Oceanographic Laboratory, Bedford Institute, Dartmouth, N.S. Dr. Loncarevic was in Ottawa only briefly and was leaving next day for Dartmouth. The title of his illustrated address was "With Hudson's scientists through the Northwest Passage".

Dr. Loncarevic described briefly the origins of project "Hudson 70" which in 1970 took the floating laboratory, C.S.S. Hudson, and her complement of scientists from many disciplines, on a voyage of circumnavigation of the Americas. He dealt specifically with that leg of the voyage through the Arctic from Alaska to Baffin Bay, describing some of the scientific findings and showing slides of the various activities. One discovery that aroused considerable interest at the meeting was the locating of submarine pingo-like structures in the Beaufort Sea.

Dr. Loncarevic added his own "first visit" impressions of the Arctic. He had been struck by the happiness emanating from the wildlife seen there in a world ecologically in balance - a balance that is, today, threatened.

It is hoped that the author's summary of his address may be carried in a later issue of the Circular.

PRODUCTIVITY STUDIES OF HIGH ARCTIC MUSK-OXEN

by

Milton M.R. Freeman
Institute of Social and Economic Research,
Memorial University, Newfoundland

Commercial hunting of musk-ox is a possibility that has recently been reviewed by the respective administrations of arctic Denmark, the United States, and Canada. The proposal currently appears to be unacceptable for Greenland, undecided in Alaska, and acceptable in the Northwest Territories of Canada.

It is not the purpose of the present paper to enter the controversy (see Lent, in press, for a review of much of the current debate). The intention here is to suggest what the author hopes may prove to be a useful model for understanding recruitment dynamics of arctic musk-ox, and thereby to further the rational management of one of the world's irreplaceable and especially vulnerable resources, namely an exotic species of large mammal, Ovibos moschatus.

The problem

The usual means of setting quotas for game species includes, as a first step, establishing within reasonable limits of reliability the vital statistics of the population or regional stock to be exploited; as a second step, providing the required explication of the nature of the dynamic processes that inter-relate, control or limit the forces tending to increase or decrease the size of the population. To give a specific example, Vibe (1967) concludes that the musk-ox population size in East Greenland is controlled by density-independent events, whereas the present author suggests that musk-ox populations in the Canadian arctic archipelago are limited in large part by density-dependent nutritional stress (Freeman, 1971:107). The resolution of such diverse opinions is of the utmost pertinence to basic management decisions, and it would seem a priori, that rational management practices cannot be formulated or defended without secure knowledge as to whether the most basic demographic characteristics of this species are, in fact, determined by processes relating to the population density.

Basic vital statistics, once available, are generally used to construct a so-called life-table, wherein age composition of the population is represented, and from which the statistical probability of death overtaking an individual at any point in time can be computed. There are few responsible game managers who would venture to suggest levels of productivity, and hence safe quotas for cropping, without such basic data at hand. Nevertheless, in the case of some species, where the biological research necessary to provide such basic data has not been carried out, yet where long term and more or less sustained cropping has occurred, attempts at "rational" management can be made. This is the current situation with polar bear, though obviously the management rationale employed has its dangers as well as its critics. Management in this case is attempted, utilizing comparative statistics obtained from the crop rather than from the main population. However, the commercial value of the polar bear has finally spurred research efforts that should, before too long, produce the necessary biological information to permit more certitude in management programs governing the harvesting of this species.

This type of cautious "guesstimating", based on long series of crop statistics, cannot unfortunately be applied to musk-ox. Since 1917, a strongly enforced total ban on hunting has precluded setting up any statistical record that could serve as a standard or base-line against which to evaluate future changes.

Pressure to begin commercial exploitation of arctic musk-ox appears to have succeeded in Canada despite a) the absence of more than barely minimal scientific data pertinent to the management of these particular regional stocks, and b) the absence of any management program to ensure as a high priority, that these vital data will be obtained. Present regulations allow twelve musk-oxen to be killed each year by Eskimo hunters at Grise Fiord, south Ellesmere Island. The small size of the crop and the high degree of hunter selection precludes the possibility of utilizing this annual sample for constructing any sort of heuristic management model.

It is urgent, therefore, to determine as accurately as possible the regional population size and the limits of fluctuation which that population may experience under actual, variable conditions of recruitment and natural loss.

Method of obtaining data

Limitation of funds and personnel generally restrict even the best organized and best advised game management services. However, for these studies, the data necessary were obtained at no cost by using local residents as observers and recorders. Adult male hunters living at Grise Fiord recorded, during the period October 1966 to August 1967, the following data:

1. Musk-oxen seen during their travels (including re-sightings of the same herds, provided that at least 48 hours had elapsed between sightings): date; location; and total number of animals in each group.

2. Observations on newly dead musk-oxen: sex; relative age; whether fat, thin or emaciated; whether wolf-killed or not; any abnormalities; location; date of find and estimated date of death.

3. Number of calves present in the herds.

Results

With the exception of calf data, whose importance was deliberately under-communicated because of higher research priorities of other observations, the resulting data sheets were of sufficient quantity and apparent quality to allow a number of demographic conclusions to be drawn. More especially:

- that a minimum regional population of 970 musk-oxen inhabit 20,000 square miles of the Arctic Archipelago extending northward from the north coast of Devon Island,

- that herd size varied seasonally with a high mean of 14.9 in winter to a low of 5.0 in late spring and summer (based on observation of 141 individual herds),

- that calf crop varies throughout the region within a given year as well as annually, but that a mean calf crop of 12.5 percent was suggested for the region on the basis of admittedly limited data,

- that about one-half of the natural mortality of all age-classes of musk-ox in the region was due to wolf predation (Freeman, 1971:104-106).

Suggested model

The present paper is primarily concerned with communicating the theoretical and synthesizing aspects of this research. Specifically, it aims to develop a population model, embodying information reported elsewhere as well as six assumptions capable of empirical refinement through further fieldwork. A critique of the assumptions is included, though the author hastens to add that the critique of each assumption is far from exhaustive as the principal purpose of this report is largely paradigmatic, that is, to propose a simple, tentative methodology that may be improved through discussion and criticism with the eventual aim of facilitating rational development of an undoubtedly valuable arctic resource.

The total musk-ox population of the Jones Sound region is conservatively estimated at 970 (Freeman, 1971:104).

Assumption 1: 50 per cent of this population are females;
Assumption 2: 67 per cent of the females are of breeding age;
Assumption 3: Females of breeding age produce calves in alternate years.

Given these three assumptions, a population of 970 musk-oxen would produce a potential annual crop of 163 calves, i.e. a theoretical calf crop equal to 16.8 per cent of the original herd.

However, from published sources (see Tener, 1965), observed calf crops of high arctic musk-ox vary from 7 per cent (69 calves) to 15 per cent (146 calves), and elsewhere (Freeman, 1971:106) 12.5 per cent (121 calves) is suggested as an average figure.

Assumption 4: The discrepancy between observed frequency of dead calves and the frequency of calves in the total population gives an empirical measure of calf mortality to that of other-age groups combined.

Observed ratio of calf mortality to non-calf mortality, in a total sample of 24 carcasses, was found to be 1:11, whereas, with calf production of 12.5 per cent, calves are present in the population with a frequency of 1:7.

Based on this discrepancy between these two frequencies, it is concluded that calf mortality is $\frac{1}{0.636}$ times as great as the total mortality in other-age groups.

Assumption 5: The difference between observed and theoretical calf crop represents the total post-natal calf mortality.

From empirical evidence calf crop is assigned an average value of 12.5 per cent, whereas theoretical production is 16.8 per cent; the difference, in absolute terms, represents 42 calves (163-121). The mortality of other-aged animals in this population (see Assumption 4) is therefore calculated to be 66 (i.e. 42 x $\frac{1}{0.636}$).

Assumption 6: Mortality of other-aged animals is density-dependent. In some years calf crop is not 121 (12.5 per cent), but may range from 69 (7 per cent) to 146 (15 per cent). In such extreme years, mortalities of other-aged animals will range from 146 to 27 animals.

Depending on calving success the net annual change in this population of 970 musk-oxen will range between -79 and +119 animals, with a mean of +55.

If this regional population of 970 has been underestimated, say by 50 per cent, which is rather extreme, the annual increase of the corrected population of 1455 animals, according to the model outlined above, might range from -120 to +177 animals with a mean of +85.

Critique of the Assumptions entered in Suggested Model

Assumption 1. Tener (1965:92) suggests the sex ratio may be skewed in favour of cows, perhaps to the ratio 0.76:1. However, the limited data show considerable variation and the author adopted a conservative 1:1 ratio pending more precise information of this regional population.

Assumption 2. This figure is taken from Leslie (1965:154).

Assumption 3. Under favourable nutritional conditions, or if the calf is lost, cows may produce calves with greater frequency than this assumption allows. However, the finding of carcasses of emaciated adult musk-oxen in the study area (see Freeman, 1971: Table 2), and the low calf production figures in some years (Tener, 1965: Table 28) suggest that nutrition does exert a negative effect on fertility in this region.

Assumption 4. This assumption is most speculative and admittedly imprecise, but present knowledge does not allow any qualification. In weak support of the idea, field observations indicate that about as many females die as males, and that, as one would expect, fewer "young" animals are found dead than those classified as either "adult" or "old" (Freeman, 1971: Table 2).

Assumption 5. This assumption excludes the possibility that some reduction in fertility results from barren cows, aborted fetuses or stillbirths. The important relationship existing between nutrition and fertility has been stressed by Tener (1965: 85, 111) but no qualification of this assumption is possible at the present time.

Assumption 6. Whether mortality results from predation, disease or nutritional insufficiency, the ecology of this species suggests the plausibility of density-dependent population control mechanisms. Nutritional inadequacy, rather than predation or climate, appears to be the prime factor in population control (see Watts, 1968:22 for discussion on density-dependent nature of nutritional stress), and such a population depressant would simultaneously affect calf production and mortality as well as the survival of other-age groups.

Conclusion

The quota of twelve adult musk-oxen legally harvested each year is an insignificant number in relation to the total musk-ox population of arctic Canada and even in relation to the population inhabiting the Jones Sound region where the hunting takes place. However, in some years, that number may be a significant fraction of the annual

increase in the stock, even if the estimated size of that stock has been grossly under-estimated. Furthermore, in some years the net increase will be negative, that is, the natural mortality will exceed the number of calves produced even before losses from hunting are taken into account.

It is important for management purposes to know what is the probability of the stock achieving a net annual increase. A low probability (implying frequent years when the herds either do not increase or actually decrease) may suggest the need for very stringent protection during the breeding season, and indeed, may probably indicate the need for further behavioral research to elucidate thoroughly the total breeding cycle.

Calculations based on the population model outlined would indicate that a calf crop of 10.3 per cent is required if production is to balance losses (ignoring the effects of migration into or out of the area). Data reported in the literature (Tener, 1965: Table 25) and from recent game surveys (Kwaterowsky, personal communication) indicate that on 8 out of 17 separate occasions the calf crop of the herds on Ellesmere Island was below this level. Observations made by Grise Fiord residents in 1969 and 1970 indicate that calf crops of 15.1 and 3.1 per cent respectively, occurred in those two years (Kirbyson, personal communication).

Using the observations on calf crop obtained for many of the years between 1950 and 1970, it is seen that there is a slightly less than even chance (0.47 probability) that in any given year the regional musk-ox population will make good its natural losses. However, two important riders must be added, (1) in some years, perhaps most, herds in various parts of the region experience different degrees of calving success; the effect these differences have on biassing the sampling or overall population increase remains undetermined; and (2) for the purpose of obtaining the probability 0.47, no account was taken of the magnitude of the positive and negative annual increments. It is obvious that one "good" calving year cannot be taken as the demographic or statistical equivalent of one "bad" year.

If, rather than providing the answers required for rational management, this tentative model indicates or suggests the sort of questions that still need to be asked, then this exercise has not been in vain. The author is grateful to Dr. David Sergeant of Montreal and Dr. Glen Sanderson of Urbana for helpful comments on earlier versions of this paper; however, the opinions and errors are wholly his own.

References

Freeman, Milton M.R., 1971. Population characteristics of musk-ox in the Jones Sound Region of the Northwest Territories. Journal of Wildlife Management 35 (1): 105-110.

Kwaterowsky, P.A. Letter, July 17, 1968. Fort Smith, N.W.T.

Kirbyson, A.D. Conversation, May 30, 1970. Grise Fiord, N.W.T.

Lent, Peter C. In press. Musk-ox management controversies in North America. Biological Conversation.

Leslie, P.H. 1965. Theoretical considerations of the intrinsic rate of natural increase pp. 152-255 in Tener, J.S. (see below).

Tener, J.S. 1965. Musk-oxen in Canada. Canadian Wildlife Service, Monograph 2. Ottawa.

Vibe, Christian, 1967. Arctic animals in relation to climatic fluctuations. Meddeleser om Grønland 170(5).

Watt, Kenneth E.F. 1968. Ecology and Resource Management. McGraw-Hill. New York

CONSTITUTION OF THE ARCTIC CIRCLE ✯
(Original Constitution, 15 January, 1948)

1. The Club shall be called the ARCTIC CIRCLE (1948)

2. The object of the Club shall be: (1948)

   (a) to enable those interested in the Arctic to meet for informal discussion;

   (b) to keep Club members informed of current events in the Arctic.

3. Membership shall be open to all those who are or have been actively interested in the Arctic. (1948)

4. The annual membership fee shall be Seven Dollars for residents of the Ottawa district, and Three Dollars for non-residents (defined for this purpose as those living more than ten miles from Ottawa.) The fee for Libraries and Public Institutions irrespective of their location shall be Five Dollars. Membership fees become due on January 1st, each year. Members whose fees remain unpaid after March 1st shall have their names removed from the Club list. Fees paid by members joining in October or later shall cover the period to December 31st of the following year. (1971)

5. A member may be suspended from the Club by a majority vote at a regular meeting. (1948)

6. The officers of the Club shall consist of: (1949)

   President
   Vice-President
   Secretary or Joint Secretaries
   Treasurer
   Editor of the Arctic Circular

7. The Club business shall be transacted by a Committee consisting of these officers and not fewer than ten and not more than fifteen additional resident members. Five members of the Committee shall constitute a quorum. (1948)

✯ This is the Constitution as amended following the Annual Meeting of the Arctic Circle in January, 1971.

8. (a) The President and Vice-President of the Club shall be elected at the Annual General Meeting for a term of two years, after which they shall automatically retire and not be eligible for re-election for the same office until one year has elapsed. The retiring President shall become an ex-officio member of the committee during the term of the succeeding President. (1968)

(b) The Secretary shall be elected at the Annual General Meeting for a term of three years. The Secretary shall be eligible for immediate re-election.

(c) The Treasurer shall be elected at the Annual General Meeting for a term of three years. The Treasurer shall be eligible for immediate re-election.

(d) One-third of Committee members other than the Club officers shall retire each year. New Committee members shall be elected at the Annual General Meeting for a term of three years, after which they shall not be eligible for re-election until one year has elapsed.

(e) The Committee shall have power to fill temporarily any office that may become vacant between the Annual General Meetings.

9. The Club will, so far as possible, hold regular meetings once a month during the winter. (1948)

10. An Annual General Meeting shall be held in each year during the month of January for the election of officers, and the presentation of the audited financial statement. (1948)

11. Two members shall be elected at the Annual General Meeting to act as auditors for the ensuing year. (1948)

12. Any amendments in the Constitution shall be considered at a regular meeting, notice having been given at the previous meeting, and shall require for adoption a two-thirds majority of those present and voting. (1948)

Arctic Circle correspondence - Correspondence shoul be addressed to the officer concerned,

c/o The Arctic Circle,
Box 2068, Postal Station D,
Ottawa, Ontario
K1P 5W3

Arctic Circle Meetings

The regular meetings of the Arctic Circle are held on the second Tuesday of every month at 8.30 p.m. in the Officers Mess, No. 9 Transport Company, R.C.A.S.C., Catherine Street at the corner of Bank Street. The bar opens at 8 p.m., giving members half an hour for social and business discussions before the meeting begins and the guest speaker gives his address.

Out-of-town members who wish to receive notices of these meetings and, thereby, be informed in advance regarding the guest speakers and the topics to be discussed, should address their requests to the Secretary, Mr. Keith C. Arnold.

The Arctic Circular

The Arctic Circular is published three times a year - oftener if the amount of material received permits. Correspondence, papers and reports are welcomed from all members, from persons living in the North, or from anyone having information on general northern activities, research and travel, or on technological, industrial or social developments. Contributions and correspondence should be addressed to the Editor, Mrs. Margaret Montgomery Larnder.

Back issues of the Arctic Circular are available, single copies at $0.50 and complete sets (Volumes I to XX) $100.00. Requests should be addressed to Miss Mary Murphy, Publications Secretary.

Arctic Circle Ties

A few Arctic Circle ties - featuring a white narwhal on a navy blue background - are still available. The cost is $3.50 each. Members wishing to purchase ties should forward their request to the Treasurer.

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