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THE IGLOOLIK ORAL HISTORY PROJECT

John MacDonald

Across Nunavut, new emphasis is being placed on the importance and relevance of Inuit traditional knowledge in the contemporary world. Increasingly, efforts are being made to record and document the knowledge, life experiences, and family histories of Inuit elders throughout Nunavut. A community-based Oral History Project in Igloolik provides an example of successful ongoing work in this important field.

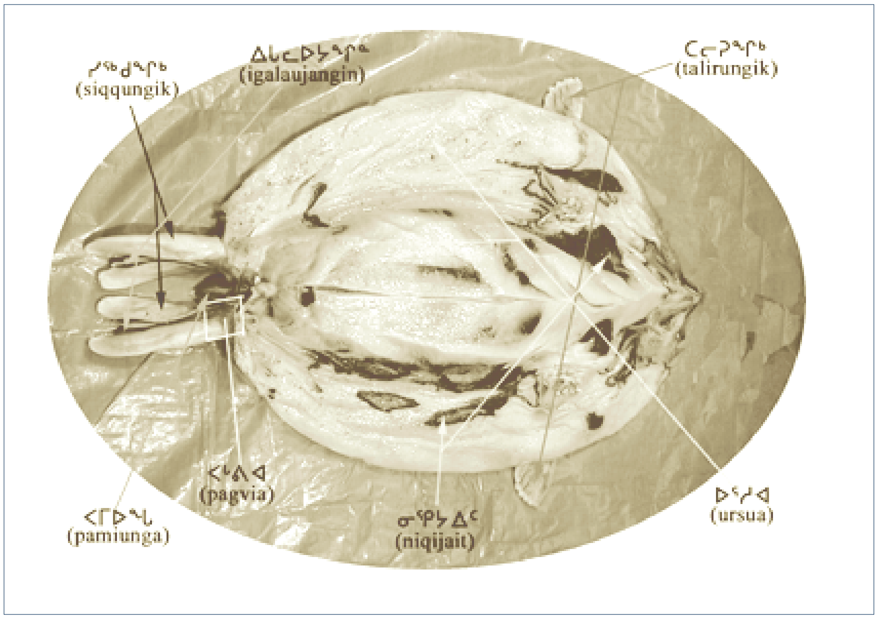
The Igloolik Oral History Project is a collaborative project run by the Inullariit Elders Society of Igloolik in collaboration with the Igloolik Research Centre. The project had its formal start in 1986 following a meeting of Igloolik elders. At this meeting there was general agreement on the importance of embarking on a project to record and document the traditional knowledge and oral history of the Amitturmiut – the Inuit living in the Northern Foxe Basin area of Nunavut. The project would have the following goals:

1) Inuktitut language retention (the elders expressed great concern over the increasing loss of language skills among the younger generations, and felt that recordings would show how Inuktitut should be spoken);
2) Create a record of how things were done in the past, for the benefit of future generations of Amitturmiut;
3) Create a record of Amitturmiut family histories;
4) Record a body of accessible Inuit traditional knowledge to inform the larger world, especially southern researchers (this point was based on a deeply felt sense that researchers in general, and biologists in particular, tended to be dismissive of Inuit knowledge).

During this meeting the question of payment for interviews was addressed. Some elders felt they should be paid while others thought that they should pass on their knowledge free of charge. In the end it was decided that a fee, or honorarium, should be provided, not to pay for the knowledge offered, but strictly to compensate the elder for the time spent on the interview.

The project's start coincided with the fieldwork of a researcher, Wim Rasing, who was studying the administration of Canadian justice in Igloolik, and who later published his findings in a book, *Too Many People.* Rasing conducted a series of audiotaped interviews with Igloolik elders covering aspects of Inuit traditional law and social organization. These interviews – numbering around thirty – became the nucleus of the project's collection that has now grown to include almost five hundred interviews. Additions to the collection derive from two principle sources: the project itself, and copies of taped interviews donated by visiting researchers.

Over the years, funding for the project has come, piecemeal, from a wide variety of sources including federal and territorial



A draft page from the seal anatomy section of the Inullariit Elders Society visual dictionary, showing the anterior part of the seal after skinning. Photo: Inullariit Society.

government departments and agencies, regional Inuit political and cultural organisations, charitable foundations, and private donations. Unfortunately, there has been no one source of sustaining funding and the continuation of the project from year to year depends largely on the continuing success of fund-raising efforts. It is estimated that the "processing" of a single interview from the recording phase through translation, transcription and word-processing, to dubbing and archiving can cost upwards of $800.00 a tape.

Igloolik Research Centre staff manage the project on behalf of the Inullariit Elders Society. Major administrative tasks include: fund-raising, financial management, interviewing, translation, transcribing, management of the local collection, archiving, and the provision of access to project materials.

From the outset it was decided to try to cover as broad a range of topics as possible. The choice of topics is determined variously by the elders themselves, by the staff of the Igloolik Research Centre, and, sometimes, by visiting researchers. This approach necessarily involved a mix of interests which, by and large, proved highly productive in eliciting information which otherwise might not have been considered had the choice of topic rested with a single or even a few individuals.

Major topics covered to date – some in greater depth than others – have included: personal and family histories; contact history (including the introduction of Christianity); social change; dispute resolution and social control; child rearing, traditional medicine and childbirth; spirituality and shamanism; hunting techniques; animal behaviour and biology; skin preparation and sewing; tool making; sled and kayak construction; shelter construction; local geography and place names; astronomy; snow-drift formation; weather conditions; navigation; and legends and myths.

Interviews are usually planned a day or two ahead of the actual interview session at which time the topic is agreed between the elder and the interviewer. This gives the elder time to prepare, and to engage in some recollection in advance of the interview. Immediately prior to the interview a waiver form is completed and signed by both the elder and the interviewer. This ensures informed consent to the interview and allows the elder to choose, from a number of options, the conditions under which the information given in the tape will be accessed. And, finally, prior to the interview an identification number is assigned to the audiotape, a number that will be used subsequently on the translations, transcripts and computer files deriving from the interview.

Interview sessions usually last approximately an hour. Apart from keeping the interview within the bounds of the agreed topic, or topics, very little structure is imposed on the session. A conversational flow is encouraged in which the elder responds to a question fully before the next question is asked, usually based on some point raised in the response just given.

Every effort is made to have the audiotape translated into English as soon as possible after the interview. This ensures that points in need of clarification, particularly those to do with archaic or specialized vocabulary, can be checked while the interview is still fresh in the minds of both the interviewer and the elder. In the course of translation specialized terms are noted and explained fully, either in parentheses within the text, or as footnotes. Usually the interview is word-processed concurrently with translation.

Over the years, Louis Tapardjuk and Leah Otak, both of Igloolik, have painstakingly translated most of the project's interviews. This has ensured not only a broad consistency in translation style but also a growing ability on the part of these translators to work confidently with the elders' material. Regrettably, many younger translators have difficulty working with elders' interviews where they frequently encounter unfamiliar topics and vocabulary. This situation is unlikely to improve until there are intensive training courses in place aimed exclusively at the translation and interpretation of Inuit oral history documents.

As resources and time permit, interviews – or more often portions of interviews – are transcribed into Inuktitut syllabics in preparation for eventual publication. This, for instance, is the case with some seventy hours of interviews contributed to the project by the late Noah Piugaattuk. Numerous portions of his interviews, selected, sorted and compiled thematically, have been transcribed into syllabics, and, along with their English translations form the basis of a current book project that will portray the life experiences and knowledge of Piugaattuk.

From the beginning of the project it was decided to deposit copies of all audiotapes, translations, and transcriptions with the Prince of Wales Heritage Centre in Yellowknife. All original materials are kept in Igloolik at the Igloolik Research Centre. When Nunavut establishes its own archives the project's materials currently held at the Prince of Wales Heritage Centre will be transferred to the Nunavut archives.

The interview collection is accessed in three ways: by listening to the Inuktitut audiotapes, by reading the translations or transcripts, or by viewing the files on a computer monitor. The latter method is preferred when searching for information on a specific topic. Using various word-search programs it is possible to locate quickly all references to a given topic occurring in the entire collection. Having done this, the user has the choice of referring to the audiotapes identified in the search, reading the selected interview printouts, or simply browsing the appropriate files on-screen.

The interviews are widely and increasingly used within Igloolik and beyond. Educators and researchers, particularly those engaged in linguistic, social, and biological studies, consult them regularly, as do regional, national, and international media organizations. In Igloolik the tapes are cherished by family members, and broadcast from time over the community radio.

Conditions relating to the access of the project's materials have evolved over the years. Generally, in keeping with the elders' wishes that their knowledge should be used as widely as possible, unlimited access is usually permitted. Some restrictions, however, have evolved to govern the collection's access by academic researchers, the main one being that while the researchers are able to consult the entire corpus they may only copy portions of it directly relevant to their specific area of study. Material from the project used in academic publications requires citation of the elders' name, together with the interview number. Acknowledgement of the Igloolik Inullariit Elders Society and the Igloolik Research Centre is also required.

There is a growing emphasis on getting the material more widely circulated and, to this end, consideration is being given to producing a CD-ROM of selected, edited, interviews representative of the entire collection to date. In addition, work is well underway on compiling a visual dictionary, using digital technology. The first volume of the dictionary focuses on animal anatomy and biology.

While the project is ongoing, unfortunately its scope is being reduced each year by the passing of elders. About half of the original thirty contributors have died since the project's inception in 1986. Nevertheless, the interviews continue and, increasingly, younger elders are offering to record their own unique perspectives and experiences for the benefit of future generations of Iglulingmiut and others.

John MacDonald is co-ordinator of the Igloolik Research Centre.

The Inullariit Society won the 1998 Northern Science award for its oral history work (see Meridian, *Spring/Summer 2000).*

NUNAVIK RESEARCH CENTRE: COMMUNITY-BASED RESEARCH IN NORTHERN QUEBEC

Experienced Inuit hunters can easily identify animals that are unfit to eat – most of the time. But even the most observant cannot spot evidence of the microscopic pathogens that infect some game. Since 1992 Kuujjuaq's Nunavik Research Centre, operated by Makivik Corporation, has been offering Nunavik Inuit the assurance that the food they eat is free of *Trichinella nativa,* the microscopic nematode that causes trichinellosis.

Michael Kwan (left) and Alix Gordon using acid to digest a tissue sample that will be analysed for mercury in the atomic absorption spectrometer. Photo: Nunavik Research Centre.

Trichinellosis outbreaks are rare, but when it strikes the disease is serious and may affect a relatively large number of people. In 1987, 41 Salluit residents contracted trichinellosis after eating walrus, and suffered the typical symptoms: muscle pain, diarrhoea, vomiting, and swelling. Trichinella infect about 25% of northeast Hudson Bay walrus, and while cooking destroys the organisms, they can survive in raw or aged meat (*igunaq*).

Before eating or distributing walrus meat to the community Nunavik hunters send samples to the research centre, which employs two biologists, a toxicologist, four wildlife technicians, and a veterinarian. Under veterinary supervision technicians perform a Canadian Food Inspection Agency (CFIA) diagnostic procedure for trichinella larvae and pass the results on to the hunter within a day of the sample's arrival at the lab.

The research centre's facilities include an analytical lab, a pathology lab, and a wet lab, offering plenty of scope for a variety of research. In collaboration with CFIA, Health Canada, and the US Department of Agriculture (USDA), the centre has initiated epidemiological surveys on food-borne diseases in the subsistence harvest. Researchers use a USDA agglutination test to detect anti-*Toxoplasma gondii* antibodies in plasma of wildlife and to investigate the sources of human toxoplasmosis, which can cause neurological disorders in newborns.

Centre staff are also working on botulism, caused by the *clostridium botulinum* neurotoxin, which thrives in anaerobic conditions. Standard Inuit methods of aging meat or oil – which include placing it under rocks in a cache or in a sealskin bag buried in gravel – allow air to circulate, preventing the *clostridium* spores from flowering. But incorrect aging in a sealed container like a plastic bag provides a perfect breeding ground for the disease, especially if placed in a heated house or outside in the sun. *Clostridium* is common in soil, and the centre is conducting research to determine whether it is present at butchering sites, and also to find out what environmental conditions it thrives in.

A beluga whale swimming underwater at the Nastapoka River (Eastern Hudson Bay) where it has been tagged with a satellite transmitter, July 1999. This is a joint project with the Department of Fisheries and Oceans and the local Hunting Fishing and Trapping Association to measure the time belugas spend underwater (to correct population estimates done by aerial survey) and to discover where the whales spend their time offshore. Photo: Nunavik Research Centre.

The Nunavik Research Centre, showing the new section added in 2000 (right) . The centre also houses a cartography section that conducts land-use studies, creates GIS databases, and provides mapping services. Photo: Nunavik Research Centre.

For studying contaminants in country food, a major concern of Inuit since the 1980s, the centre has a trace metal analytical laboratory, the first of its kind in the Eastern Arctic. Two state-of-the-art atomic absorption spectrometers perform electrothermal and flame modes of metal analysis as well as cold vapour analysis for mercury. Specially equipped for trace-level sample preparation, the laboratory has a Class M3.5 clean bench, an ultra-pure water supply, and a HEPA filter ventilation system. A full-time analytic toxicologist manages the lab, and trains analytical assistants. A strict quality assurance program ensures high data quality.

The centre also does wildlife population dynamics studies needed for wildlife management, and its biologists have many years of experience conducting demographic studies on fish, mussels, waterfowl, and beluga. They collaborate with government scientists from the south in migration studies, satellite tagging of beluga, and goose banding. Technicians at the centre determine the age of fish, shellfish, caribou, and marine mammals – an important factor in predicting their future population status – by examining layers of calcareous material deposited annually in thin sections of mammal teeth, in scales and otoliths (ear stones) of fish, and umbo (hinges) of shellfish. The centre is working with the Department of Fisheries and Oceans, with Environment Canada on goose studies, and with the provincial government on caribou and musk ox.

Research centre scientists do in-house studies and provide environmental expertise on contract to organizations like the Kativik Regional Government. They undertake baseline studies for mining environmental impact monitoring, and stream enhancement to assist arctic char migration. They have also been involved with a local project to raise arctic char.

The centre is very much a community-based facility. Hunters, highly observant and constantly travelling over the land and sea ice, are its eyes and ears. If they report a problem, researchers investigate. The centre also relies on their assistance for sampling.

Many Inuit have said that the way to improving life in their communities lies in using the best of Inuit knowledge alongside the best of southern knowledge. The Nunavik Research Centre provides an excellent example of this principle in action.

For more information contact: Makivik Corporation, Nunavik Research Centre, P.O. Box 179, Kuujjuaq, QC J0M 1C0. Phone: (819) 964-2951, Fax: (819) 964-2230. E-mail: research @makivik.org.

ABANDONED MINING EXPLORATION SITES IN NUNAVIK

Robert Lanari

Mineral exploration fever in the 50s and 60s left its mark on many places in Nunavik. Before 1976 companies were not required to clean up their exploration sites; when they left, most abandoned everything – heavy equipment, buildings, fuel drums, and unused acid – marring Nunavik's landscape with a hodgepodge of litter, and contaminating the soil in many places.

In 1997, after requests from nearby communities, the Kativik Regional Government began cleaning up a few sites, assisted by funding from Indian and Northern Affairs Canada. The project was interrupted in 1998, resumed in 1999, and halted again at the end of that year. The communities turned to Makivik Corporation, which agreed to take over the project despite limited resources. Site cleanup is now in progress.

In summer when the debris is free of ice and snow, workers travel to the sites by all-terrain vehicle and move it to hilltops. They return in winter and transport it to the municipal dump by snowmobile. This method costs less than using helicopters, and brings some economic benefit to the community.

Once work began the inadequacy of a piecemeal approach to site restoration, working only when funding was available, soon became clear. Workers were discovering an astonishing amount of debris, and the villages were reporting more and more sites. In light of the need for systematic planning Kativik Regional Government, Makivik Corporation, and Laval University established a joint inventory project to find and identify abandoned mine exploration sites. In 2000 the Kawawachikamach Naskapi Nation joined; and the project completed an exhaustive inventory of the entire region north of the 55th parallel.

More than 600 abandoned mineral exploration sites like this one lie scattered across Nunavik. Photo: Robert Lanari.

Our project has successfully combined indigenous traditional knowledge with the scientific approach. We have integrated information from interviews with key informants in all villages with data from government sources; and in a small part of the area we are experimenting with high-resolution remote sensing for identifying sites.

The inventory has produced convincing results, identifying 600 sites scattered across the area, mostly in the Labrador and Ungava troughs. Some are near villages, including major sites near Tasiujaq and Aupaluk on Ungava Bay. The inventory shows the number and approximate size of sites but not the quantity of material or level of contamination. Determining the amount of waste requires on-site investigation.

Our *Evaluation and Priorities Program* will evaluate 85 of these sites over the next two years. The Kativik Regional Government, Makivik, Laval University, the Kawawachikamach Naskapi Nation, and Environment Canada created and partly finance the program, the remainder coming from Indian and Northern Affairs Canada's Northern Ecosystem Initiative, and the Quebec Ministry of Natural Resources. The program will develop site characterizations for twenty-five priority sites and will investigate 60 more, ranking each according to potential environmental risk. In this context we will evaluate the potential of IKONOS remote-sensing technology for inventory and characterization of mining and other sites.

We hope these efforts will soon result, at the very least, in the creation of a restoration program for significant sites. We believe this project constitutes a fundamental step toward sustainable development in the region by reconciling mining exploration with the exploitation of renewable resources for subsistence or tourism.

Robert Lanari is Project Director for the Makivik Corporation, which speaks for Inuit regarding implementation of the James Bay and Northern Québec Agreement.

TUNDRA NORTHWEST 99

What happens when foreign scientists working on global environmental issues require information from the Canadian Arctic – information that Canadian researchers on shoestring budgets can't provide? The Tundra Northwest 99 expedition provides an example of how foreign countries with well-funded arctic science programs can take the lead in conducting priority arctic research in Canada.

In the summer of 1999 the expedition's Swedish and Canadian researchers made a two-way trip though Canada's Arctic waters on the *CGS Louis S. St-Laurent* to gather ecological data. Using the icebreaker as a base for boat and helicopter excursions ashore, they gathered ecological data to compare with information from a similar project in Russia, the 1994 Swedish-Russian Tundra Ecology Expedition.

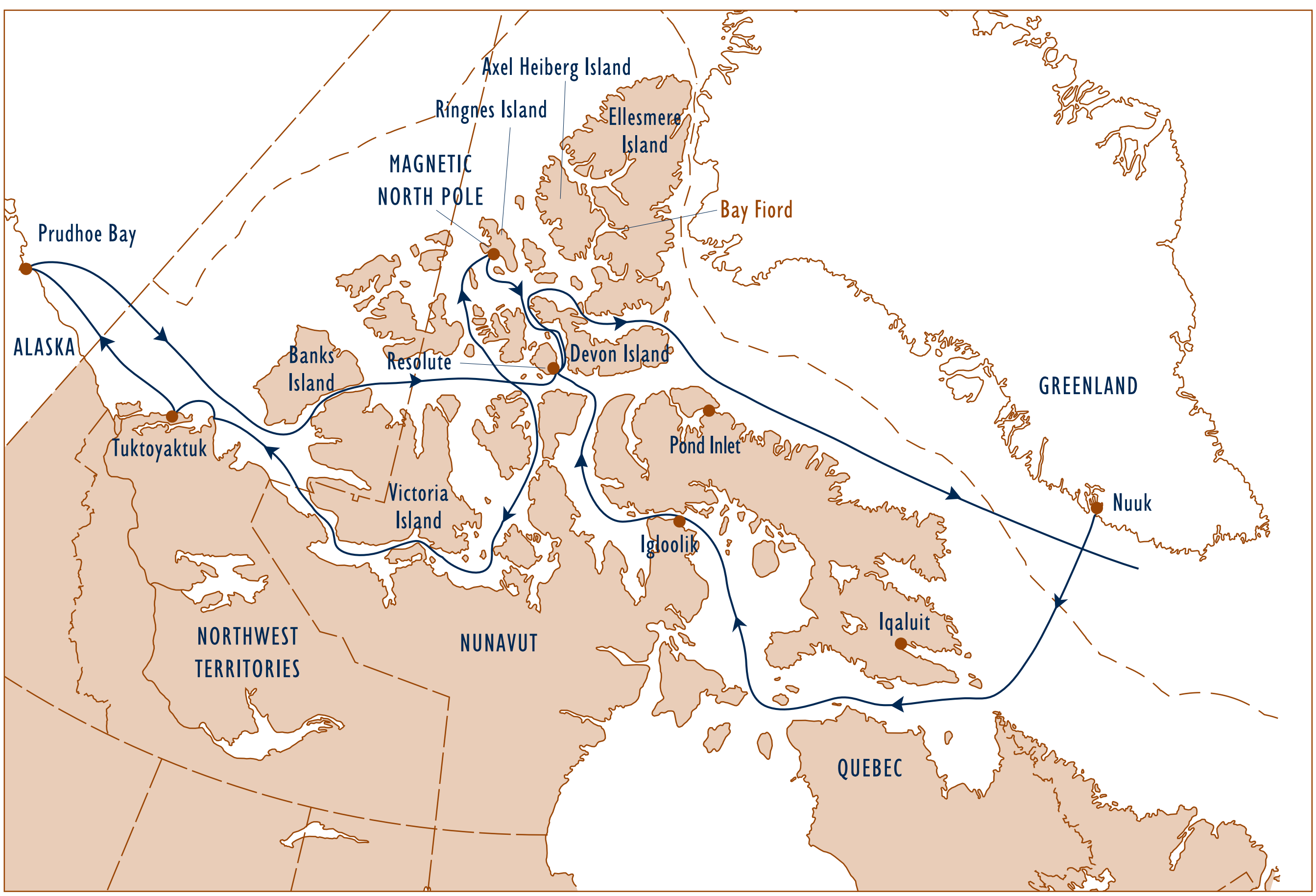
Sweden covered most of the costs of Tundra Northwest 99, including the substantial bill for using the vessel and its equipment, while Canada contributed expertise crucial to the expedition's success. Scientists from Fisheries and Oceans Canada, Environment Canada, Natural Resources Canada, and Canadian universities worked with Swedish researchers to supplement and improve the design of the programs, and to choose the sampling locations. Some participated in the expedition itself.

The scientific programme included five main themes: interactions between plants, herbivores, and predators; biodiversity in the arctic tundra; migratory birds in the arctic environment; freshwater ecosystems in the High Arctic; and climatic change and pollution in the arctic tundra.

Terrestrial community studies looked at interactions between plants, herbivores, and predators. The relatively few species in the arctic make it ideal for this kind of research.

Tundra biodiversity studies examined a wide variety of organisms on the same spot

John Davis (left), Assistant Deputy Minister of Science at Fisheries and Oceans Canada, presenting a painting – "Icebreakers", by Christopher Walker – to Swedish Ambassador Lennart Alvin at the Canada-Sweden Arctic Science Workshop held in Winnipeg in May. Photo: Fisheries and Oceans Canada.



at the same time using a standardized sampling technique, thereby making a unique contribution to the discipline.

Bird studies aimed at a comprehensive investigation and analysis of migration ecology in high arctic Canada and Alaska. Because the arctic is in some ways an extreme environment for migrating birds, this kind of research helps in understanding the stresses on migratory birds in general.

Lake ecosystem studies tested new theories, developed in temperate climates, in arctic lakes.

Studies relating to climate change and pollution emphasized the role of arctic bioindicators as "early warning systems" and of the arctic as a global sink for pollutants. Because many of the expedition's climate change scientists work together through international research networks, their findings will become part of the current body of international climate change knowledge.

The Tundra Northwest 99 Expedition also recognized that understanding the Arctic's importance to humanity - and communicating that importance to the public - demands a collaboration of different viewpoints and means of expression. Invited along was one of Sweden's foremost composers, Karin Rehnqvist. Ms Rehnqvist drew inspiration from the trip for a major new orchestral work entitled *Arktis Arktis!,* which orchestras have performed in Sweden and Scotland.

This past May the Canada-Sweden Arctic Science Workshop, held in co-operation with the Government of Canada and the European Union, presented some of the expedition's findings. It also included presentations by two Canadian authors, Elaine Dewar (*Bones*) and Wayne Grady (*The Quiet Limit of the World*), and a cultural evening featuring a performance by the Winnipeg Symphony of *Breaking the Ice,* and *Between Sky and Sea,* two movements from *Arktis Arktis!.*

Tundra Northwest 99 was an imaginative and ambitious project, an excellent example of international scientific cooperation, and a credit to those who planned it. Canadian scientists need the resources to be able to mount expeditions of this quality in our own arctic. Then we can invite foreign scientists along – instead of relying on our well-funded guests to take the initiative and foot the bill.

NEW INTERNATIONAL BATHYMETRIC CHART OF THE ARCTIC OCEAN

H.R. Jackson and R. Macnab

After twenty years a new International Bathymetric Chart of the Arctic Ocean (IBCAO) has been produced. All five coastal states that border the Arctic Ocean participated in making the map as well as Iceland, Germany and Sweden. This group constructed a digital database containing all data north of 64 degrees. Data coverage in the older map at lower latitudes tended to be fairly good where ice cover was not a hindrance but at higher latitudes where ice was more prevalent, major features were not well delineated. New data from recent icebreaker and submarine cruises were merged with older soundings. These came from newly declassified bathymetric data collected from US and British submarines and the public archives of a number of national data centres.

The new bathymetric data provide an updated description of the major features of the Arctic Ocean including the Lomonosov and Alpha ridges and the Chukchi Plateau. The East Siberian and Laptev seas are incised by paleo-river channels only tens of metres deep. The information contained in this improved representation of the seafloor is expected to advance our understanding of the geological framework and the ocean circulation by providing constraints for geophysical and oceanographic modelling. It will also be useful to coastal states in defining the outer juridical boundaries of their continental shelves by providing a common description of the bathymetric features that impinge upon implementation of Article 76 of the Law of the Sea.

Through Article 76, the Law of the Sea authorizes wide-margin coastal states to exercise sovereign rights beyond the normal 200 nautical mile limit. Bathymetric and geological criteria provide the basis for defining the outer limits of extended jurisdiction. This requires well-documented assembly and analysis of a wide range of information in a manner consistent with the reporting requirements of the UN Commission on the Limits of the Continental Shelf.

H.R. Jackson and R. Macnab are physical oceanographers with Geological Survey of Canada, Atlantic.

IS ARCTIC SEA ICE RAPIDLY THINNING?

Adapted from an abstract by Greg Holloway and Tessa Sou

Global warming focuses attention on the Arctic as an "early warning system" where environmental changes may happen more quickly than further south. Some, like shrinking glaciers and melting permafrost, are fairly easy to track. But others, like changes to sea ice, are more difficult. Unlike glaciers and permafrost, sea ice moves around.

Historical records from whaling and sealing logs provide a long baseline for assessing climate trends, but they generally report only on a loosely defined sea ice "edge". Satellites have provided nearly pan-Arctic coverage year-round since 1978.

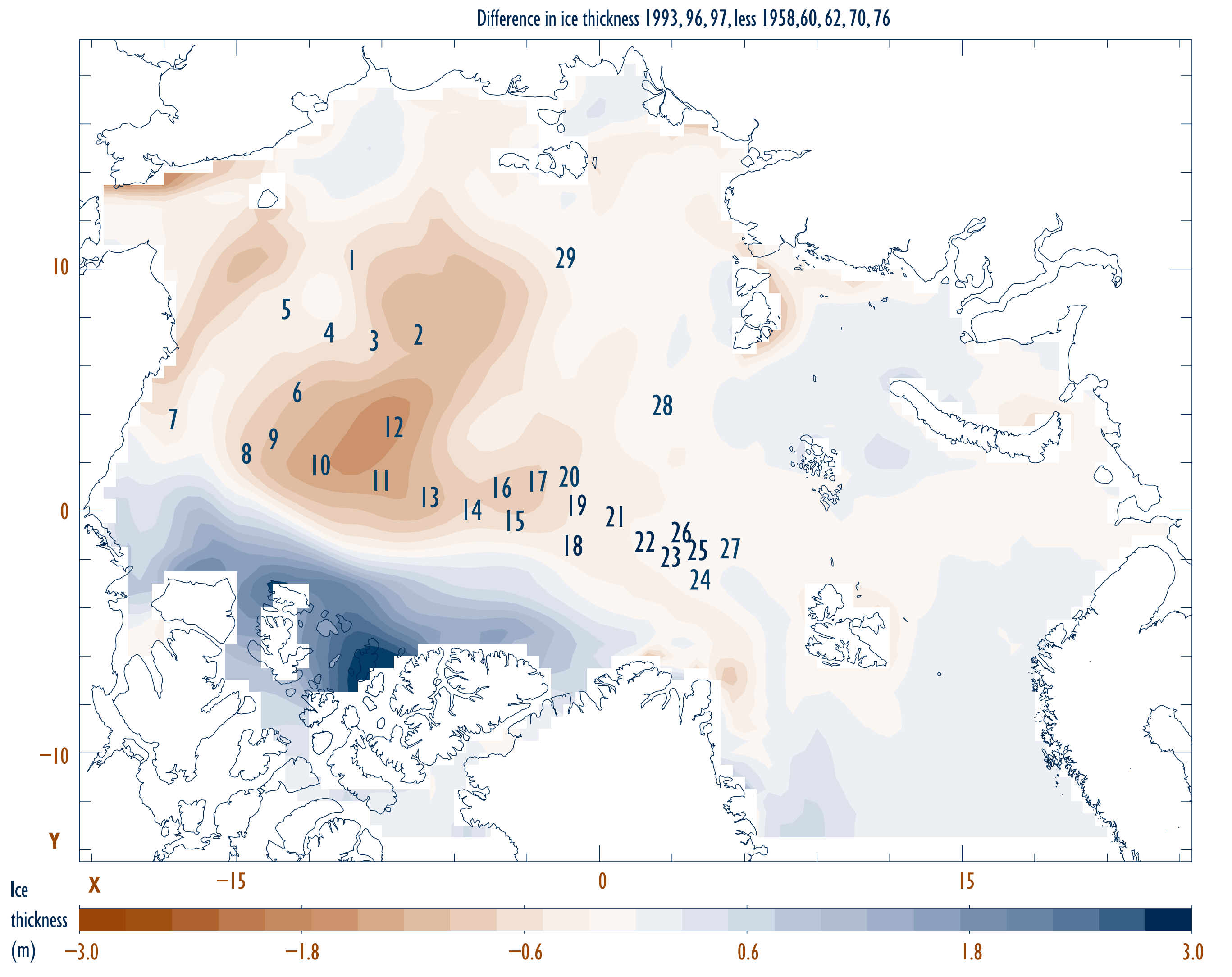
Passive microwave imagery allows us to measure the amount of ice in a given unit of sea surface, and from there we can calculate total ice cover. Satellites can monitor ice motion fields and permit climate trend assessments of total areal extent. But determining the thickness of the ice – and therefore its total volume – is a greater challenge.

Only very recently have satellites been able to monitor ice thickness. Most thickness data, apart from information from isolated stations, has come from U.S. and British military submarine sonar measurements of sea ice draft. Though they cover more area than records from isolated stations, these observations are still few and far between, and it is difficult to infer total ice volume from such limited data. To help estimate total volume and therefore average thickness, we use numerical ice-ocean modelling.

WALKING ON THIN ICE?

Scientists have used satellite observations to estimate that from 1979 to 1999 Arctic sea ice cover has been decreasing at nearly 3%

Figure 1
Changed ice thickness latter minus earlier submarine periods, showing 29 submarine evaluation locations.



per decade. Coming up with a figure for thickness change over wide areas of the Arctic has been more difficult. Estimates from submarines and moored sonars – near the North Pole, in the southern Beaufort Sea, along a transect from Fram Strait to the Pole, and along a transect from the Alaska Beaufort to the Pole – are regionally limited. They suggest differing results, from no significant trends at the Pole or along the Alaska Beaufort to the Pole transect, to substantial thinning along the Fram Strait transect.

In 1999 a broader arctic basin study by Drew Rothrock of the University of Washington captured media attention. Data from US military submarine cruises from autumns of 1958, 1960, 1962, 1970 and 1976, when compared with subsequent cruises during 1993, 1996 and 1997, showed stunning changes to arctic ice. Over all the regions sampled, thicknesses had decreased markedly from the earlier to the later period. From the 29 locations where records could be compared, the ice was on average 42% thinner, far beyond a 3% reduction per decade.

What could cause such rapid loss of ice volume? The Rothrock study postulated that either changing winds were blowing more ice down to the Atlantic, or warmer conditions were causing less growth or more melt, or both – or perhaps that both winds and temperature were involved.

OR BLOWING IN THE WIND?

In our study we used a numerical ocean-ice-snow model to try formulating a freshwater and heat budget for the arctic ocean-ice-snow system. Then we forced the model – that is, we accounted for the mechanisms that drive wind, weather, and the movement of water – with atmospheric data from 1948 through 1999. The results fell within the estimated 3% ice cover loss per decade.

This was nothing like the rapid thinning the submarines reported. We checked for shortcomings in the model and errors in forcing data: we sent "virtual submarines" to the locations and the times (corrected to Septembers) of the actual submarine cruises.

Figure 2
Difference of 8-month-average windstress, later period minus earlier.

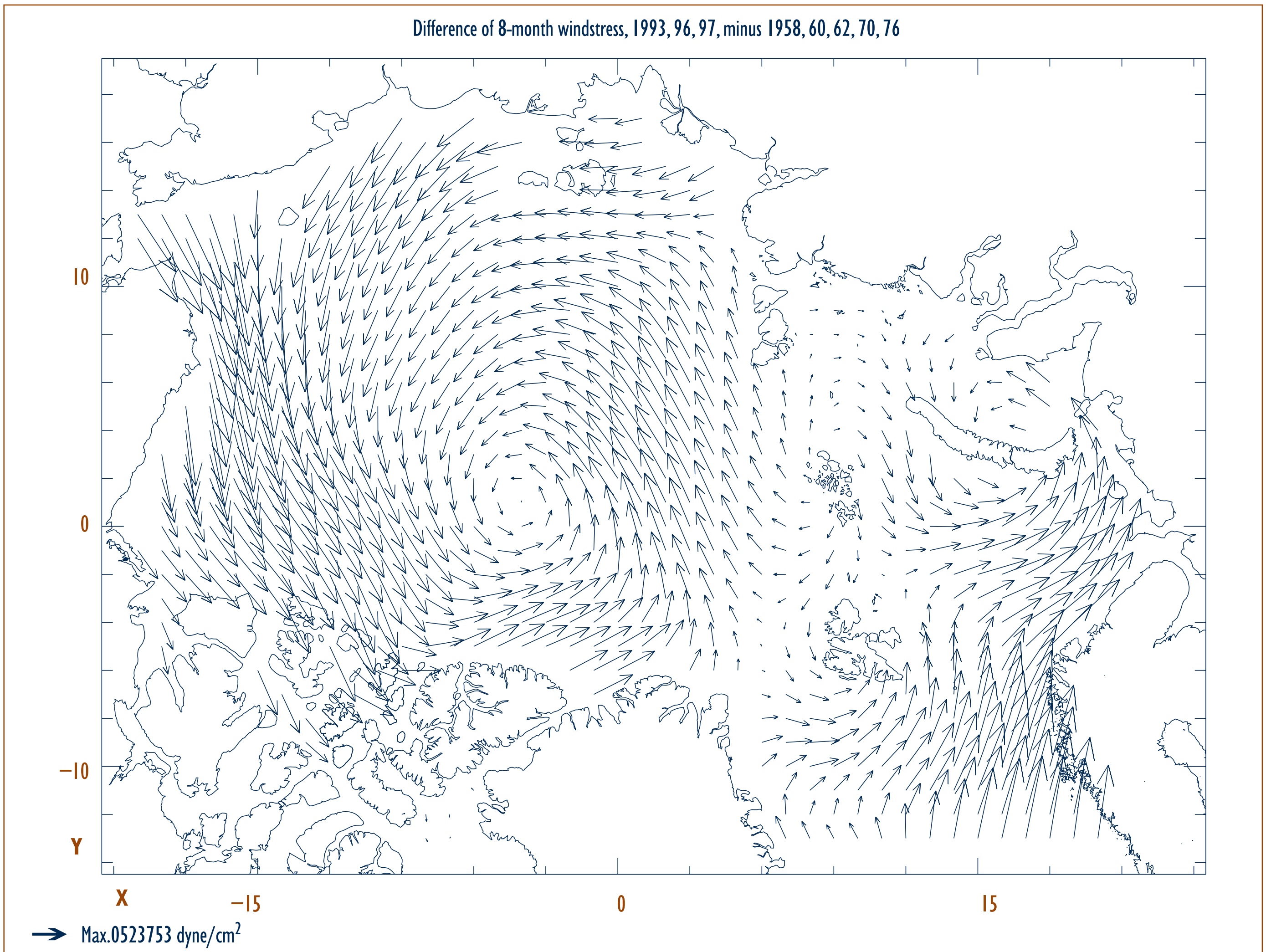


Figure 1 shows the differences in average thickness of the later three cruises from those of the five earlier cruises, and the 29 locations identified in the Rothrock study from which difference statistics were computed. At these 29 locations, total ice volume loss is 45%, consistent with published results. But over the entire arctic, total loss is near 12%.

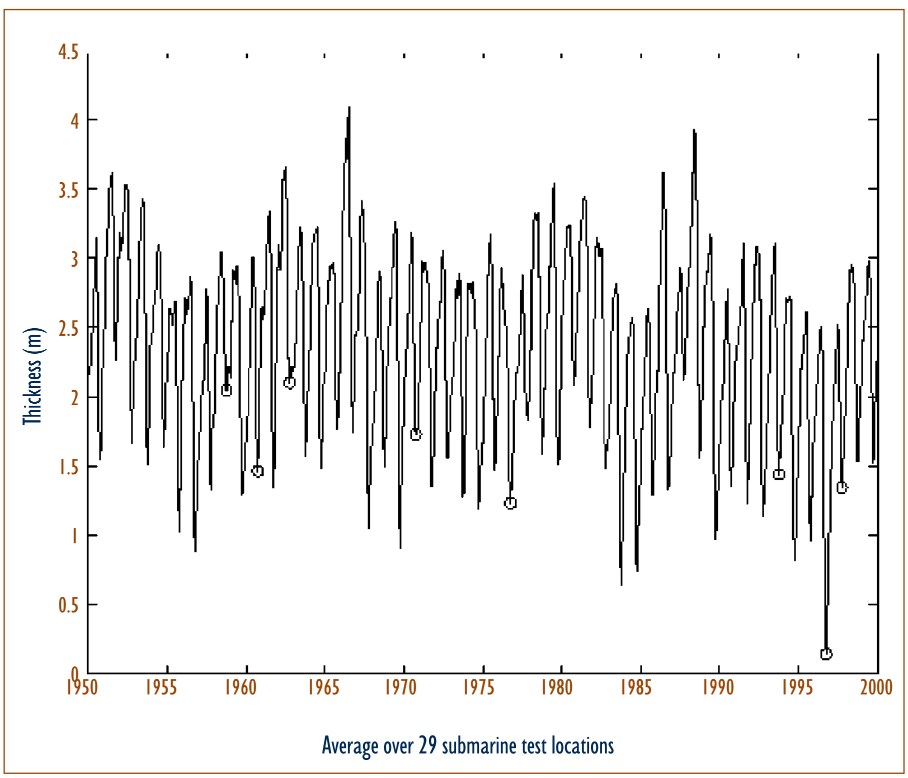
While details of the thinning pattern differ from observation, the overall picture suggests a simple explanation: rather than either melting or export, the apparent ice loss was only a shift of ice within the Arctic – a shift that the submarines' sampling pattern missed.

According to the model, wind blowing more ice out of the Arctic accounted for 9% of the 12% ice loss, while thermodynamics (less growth or more melt) accounted for 3%. On a cautionary note, these numerical values are quite specific to the particular years of the submarine cruises. Twelve percent volume loss, while less than 45%, is not a valid representation of even a modest trend.

Wind patterns over large areas are constantly changing and rearranging the Arctic ice pack. Figure 2 shows windstress differences between the years of the later submarine cruises and the earlier ones. Windstress is averaged over the first eight months of each year, the time of submarine observation. Averaging over other periods (only winter months, for instance) produces qualitatively similar pictures. The pattern in Figure 2, like the pattern in Figure 1, is robust; different procedures might change only the details.

To completely explain the changes in Figure 1 we would have to get into the complex physics of the model – but generally, this is what is happening: differences in windstress mean that winds blow the difference in ice along and to the right, expelling ice from the more central Arctic and driving it into Canadian waters.

Figure 3
Timeseries of ice thickness averaged over 29 submarine sample locations.



TIMING IS EVERYTHING

We can use the model to continuously monitor ice thickness at the 29 locations from Figure 1; Figure 3 shows a time-series of thickness averaged over those 29 locations. Circles mark the times of the five early cruises and the three later cruises. Let's hypothesize that the five early cruises each occurred one year earlier (September 1957, 1959, 1961, 1969, and 1975) and the three later cruises each one year later (September 1994, 1997, and 1998). This spreads out the baseline for detecting change. What would the result have been? The submarine surveys would have shown *no change at all* to average Arctic ice thickness. And so the actual results from the actual submarine surveys appear to be a fluke of timing – coupled with a natural mode of Arctic sea ice variability.

Everywhere on the planet the environment is changing constantly. Scientists have limited ability to sample all those changes, and inferring too much from sparse data can be misleading. But we can refine our inferences with numerical ice-ocean modelling and by analysing the effect on ice of atmospheric processes, especially wind patterns. When we used these techniques we found that sea ice did not rapidly diminish; instead, it moved.

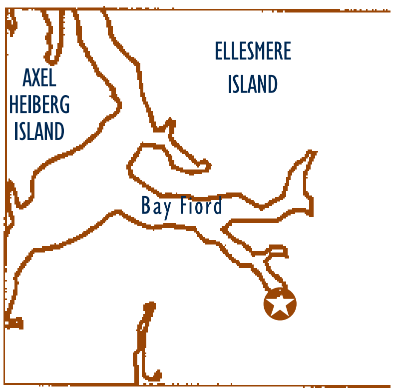
Observations to date, together with model physics, imply only that the loss of sea ice *volume* is *not inconsistent* with the 3% per decade loss of ice area calculated from three decades of satellite observations. That's a modest rate – and it's within the range of natural variability.

Greg Holloway and Tessa Sou are physical oceanographers at the Institute of Ocean Sciences, in Sidney, B.C., Canada.

LIFE AT A 3.5 MILLION-YEAR-OLD BEAVER POND IN THE CANADIAN ARCTIC ISLANDS AND THE MODERN SCENE

C.R. Harington

Fishes, frogs, birds, shrews, rabbits, small beaver, other rodents, a forerunner of the black bear, several weasel-like carnivores (including the first Eurasian badger from North America, and an ancestral wolverine), a three-toed horse (the most northerly

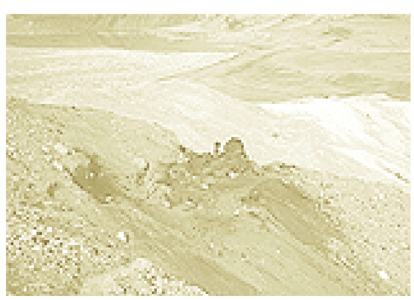


Strathcona Fiord fossil site, Ellesmere Island.

record of horses in the world), and a primitive deerlet, like the small living Asian musk deer, occupied boreal-forest margin habitat near what is now Strathcona Fiord on Ellesmere Island during the Pliocene (about 5 to 2 million years ago).

The fossil site preserves remains of an ancient beaver pond occupied by a small beaver *Dipoides,* one of the most common members of the fauna. We know that this beaver (about two-thirds the size of the living beaver, *Castor canadensis,* and ancestral to the giant beaver *Castoroides ohioensis,* that died out at the end of the last glaciation some 10,000 years ago) lived at the site because a large part of a skeleton was found, and it has left many beaver-cut sticks and saplings. Indeed, an ancient feeding-pile has been noted during the excavation, although no lodge or dam has been located yet. Another of the commonest fossils at the site represents the rabbit *Hypolagus:* even droppings of this animal have been recovered, allowing us to determine in part what they were feeding on.

Many other fossils have been found at the site, and help to indicate the kind of environment that existed in the vicinity 3.5 million years ago when the Arctic was much warmer than present, but when it was gradually cooling towards the last ice age (Pleistocene) which began about 2 million years ago. The warming of climate about this time (3 million years ago) involved increased transport of heat northward by the Gulf Stream and North Atlantic Drift. Sea ice must have been substantially reduced or absent in large parts of the Arctic Ocean during this interval. The warm climate could have been caused by elevated CO_2 levels, which would have increased sea-surface temperatures globally, or enhanced ocean circulation – leading to increased temperatures mainly in polar regions. July temperature was up to 5°C warmer than present at the beaver pond site. However, a specimen of a tundra-adapted ground beetle *Carabus truncaticollis* suggests that the climate was not much warmer than the present forest tree line. It is interesting that this site could be considered an analogue for a similar level of global warming forecast for the Arctic by the end of the 21st century.



Beaver-pond site at about 1000 feet above sea-level, with the head of Strathcona Fiord in the background. Photo: R. Harington.

The face of the exposure discloses masses of mossy peat with sandy partings, freshwater mollusc shells (at least five species including *Gyraulus albus,* perhaps the first North American record of this European species), insect remains (including attractive iridescent beetle-wing covers), beaver-cut sticks, rooted tree trunks probably not more than 3 metres tall, and a few boulders and

The Pliocene beaver-pond environment would have looked somewhat like this burned-over larch forest – typical of the boreal forest at the headwaters of the Phillipova River in northeastern Siberia. Photo: R. Harington.

rocks – as well as the bones which are sometimes pressed between the layers of peat.

The deposit contains some of the oldest Arctic siliceous microfossils known. Several freshwater diatoms (minute algae) indicating water no more than 3 metres deep are present. Some of the diatoms lived on mosses and larger aquatic plants. They also indicate a shift from alkaline to more acidic conditions later in the history of the pond.

Table 1
Preliminary list of vertebrate taxa represented from a Pliocene beaver-pond site at Strathcona Fiord, Nunavut, Canada

Class Pisces –		small perch-like fish – new genus and species
Class Amphibia –		frog?
Class Aves –		unidentified birds
Class Mammalia		
	Family Soricidae –	*Arctisorex polaris* – new genus and species of shrew
	Family Leporidae –	*Hypolagus* cf. *H. vetus* – hare-like lagomorph
Order Rodentia – ground squirrel-sized rodent		
	Family Castoridae –	*Dipoides cf. D. intermedius* – small beaver
	Family Muridae –	cf. *Baranomys* sp. – extinct mouse
	Family Ursidae –	*Ursus abstrusus* – primitive black bear
	Family Mustelidae –	*Plesiogulo* sp. – wolverine-like mammal
		cf. *Mustela* sp. – small weasel (?)
		Martes cf. *M. pennanti* – fisher-like mammal
		Martes cf. *M. americana* – marten-like mammal
		Meles sp. – Eurasian badger, probably related to a northern Chinese Pliocene species
	Family Equidae –	"hipparion," probably related to a northern Chinese Pliocene species – three-toed horse
	Family Moschidae –	*Blastomeryx (Parablastomeryx)* sp. – "deerlet"

Overhead view of a beaver-cut stick projecting from the deposits. Photo: R. Harington.

Microscopic bits of freshwater sponges are known from the pond (*e.g. Spongilla* is presently found in the Nuuk area of Greenland, and another of its species occurred in West Greenland during the last 500 years). Also, siliceous plates of amoeba, cysts of golden brown algae, and phytoliths (silica bodies apparently originating from grasses and found in the upper part of the deposit) are known from the site.

Studies of microscopic pollen and larger parts of plants (*e.g.* seeds, leaves and fruiting bodies) indicate that a boreal-forest margin environment with standing water and extensive grassy patches (microwear on the deerlet's teeth show that it was mainly a grazer, and remember the phytoliths mentioned earlier) surrounded the pond. Larch (*Larix* sp., sometimes called tamarack) is the only conifer identified from wood in the pond deposits. Alder and birch seem to have been the only other trees growing near the pond. Some of the wood is charred as a result of forest fires (indeed, a study of charcoal from the site, now underway at Carleton University, may indicate the incidence of such fires), and has bark beetle grooves and galls. Perhaps this kind of boreal-forest habitat is best exemplified by that in northeastern Siberia, where larch, rather than spruce is dominant. I recall a scene of burnt-over larch saplings in a marshy area near the source of the Phillipova River in Siberia

A 3.5 million-year-old larch cone, showing the excellent preservation of some of the fossils. Photo: J.V. Matthews.

that must be like the ancient beaver-pond environment. At least 10 species of mosses and 34 species of vascular plants are known from the beaver-pond site. The vascular plants are dominated by wetland species (*e.g. Carex diandra, Scirpus* sp., *Scheuchzeria* sp. and *Menyanthes* sp.). The abundance of larch needles, short shoots and cones indicates that the pond was surrounded by an open larch forest.

The plant fossils suggest that the beaver deposit is slightly older than an approximately 3.1 million-year-old site on Meighen Island (380 kilometres northwest of Strathcona Fiord) and a good deal older than the 2 million-year-old fossil site at Kap København on the northern coast of Greenland, where only two vertebrate fossils have been found (*Hypolagus* and the modern hare, *Lepus*).

In fact, no other recorded sites of this age with comparable faunas are known. The site is unique. However, it shares a few elements with the similar-aged Hagerman fauna from Idaho (about 43°N compared to about 78.5°N for the beaver-pond site), such as the beaver *Dipoides,* the rabbit *Hypolagus,* and the bear *Ursus abstrusus.* The hipparion (three-toed horse), badger and some plants indicate a source in northeastern Asia.

At present, the beaver-pond site is a stiff, daily 300-metre climb above our camp site near the shore of Strathcona Fiord. The fossils are collected under weather conditions varying from baking hot (rare) to blizzards (more common), and boxes of matrix are packed down to camp each day after work for eventual shipment to our laboratory near Ottawa, where samples can be carefully screened and examined microscopically. However, most of the fossils are excavated by trowel at the site.

The high-terrace sands and gravels containing organic remains, such as the beaver-pond deposit, occur in many places in west-central Ellesmere Island. These deposits accumulated on ancient valley floors and broad alluvial plains around mountains that originated earlier in the Tertiary period (65 to 2 million years ago). The deposits, now several hundred metres above sea level and deeply cut by fiords and modern stream valleys, are not geologically deformed. The beaver-pond is underlain by about 12 metres of fine sand but largely covered by slumped sediment to bedrock (shale and sandstone of the mid-Tertiary Eureka Sound Formation). It is interesting to look down from the fossil site and see the Eureka Sound coal deposits with massive stumps of dawn redwoods (*Metasequoia*) across a gully to the south. The site is overlain by nearly 6 metres of sand and 12 metres of loose pebble gravel capped by boulders. Massive boulders can slide or roll downhill – another hazard of our excavation.

Looking eastward from the site, you can see the near-perfect arc of an end moraine just behind our camp. It is easy to imagine the massive snout of the glacier that left these high mounds of rubble just before it melted back some 8,000 years ago. On its margin are clearly marked raised beaches indicating a rapid rise of land during the last few thousand years.

Well-preserved remains of sea shells, marine mammals (such as seal limb bones and narwhal tusks) and rust-coloured pumice – drifted over the sea following volcanic eruptions in Iceland – characterize the ancient beaches. On some of the beaches are lichen-covered tent rings, caches and traps of paleoeskimos. Farther in the same direction lies the gleaming Ellesmere Island ice cap, scalloped by glaciers, with occasional nunataks (mountain tops surrounded by ice) looking like the horns of a viking helmet. Plants are generally sparse on the regional tundra – mainly arctic avens, purple saxifrage, and grassy tussocks (which impede walking). Sometimes herds of muskoxen and rarely, small bands of pale grey Peary caribou may be seen. Snow geese feed on the ponds behind the moraine, and low, fast-flying oldsquaw and eider ducks whistle over the camp, while long-tailed jaegers and glaucous gulls circle overhead, looking for prey. Turnstones and red knots, the most common shorebirds, often nest locally.

The boreal-forest margin environment of the ancient beaver pond stands in marked contrast to the stark tundra landscape now surrounding the fossil site, and may provide useful clues to changes that may occur in our Arctic Islands should recent predictions of rapid global warming come true.

C.R. Harington,
Curator of Quaternary Zoology Emeritus,
Canadian Museum of Nature (Research Division)

2001 CANADIAN POLAR COMMISSION SCHOLARSHIP WINNER

The 2001 Canadian Polar Commission Scholarship ($10,000) has been awarded to Marie-Andrée Fallu, a PhD candidate in geography at Laval University. Ms Fallu is a specialist in paleo-environments. She is currently studying freshwater diatoms (microscopic algae) and chironomides (insects whose larvae develop at lake bottoms) in Nunavik and Labrador lake sediments for clues to the effects of climate change. We congratulate Ms Fallu and wish her all the best in her research.

Left mandible with teeth of a small extinct beaver (*Dipoides*). Photo: R. Harington.

HORIZON

Indigenous Peoples and Forest Management in Fennoscandia and Canada

10–12 October, 2001
International Conference
Jokkmokk, Sweden
www.sapmi.se/forestconference

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Geoff Quaile
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Fax: 1-613-761-1388
E-mail: gcquaile@gcc.ca

Alliance for Marine Remote Sensing Workshop:

Remote Sensing & Resource Management in Nearshore and Inland Waters

22–24 October, 2001
Wolfville, Nova Scotia, Canada
www.waterobserver.org/workshop-10-2001/index.html

Conference: On Thinning Ice – Climate Change and New Ideas about Sovereignty and Security in the Canadian Arctic

Canadian Arctic Resources Committee and the Centre for Military and Strategic Studies at the University of Calgary
25–26 January, 2002, Ottawa

Melissa Douglas
Canadian Arctic Resources Committee
Tel.: 1-613-759-4284, ext. 247
info@carc.org

Impacts of POPs (persistent organic pollutants) and Mercury on Arctic Environments and Humans: Arctic Monitoring and Assessment Program Conference and Workshop

21–24 January, 2002
Polar Environmental Centre
Tromsø, Norway

AMAP Conference
Polar Environmental Centre
NO-9296 Tromsø, Norway
Phone: 47-777-502-10
Fax: 47-777-502-01
E-mail: AMAPcon@npolar.no
www.nilu.no/web/amapconf/

13th Inuit Studies Conference

1–3 August, 2002
Anchorage, Alaska

WHAT'S NEW

NEW MEMBER APPOINTED

The Minister of Indian Affairs and Northern Development, Robert Nault, has named former Yukon Government Leader Piers McDonald to the Board of the Canadian Polar Commission.

Piers McDonald was Yukon government leader between fall 1996 and spring of 2000. He spent 18 years as a Member of the Legislative Assembly and served as Minister of Education, Community and Transportation Services and Finance. He and his wife Ofelia Ondrade have three children. Mr. McDonald has worked as a private businessman since retiring from politics last year.

INDICATORS OF CANADIAN POLAR KNOWLEDGE

"Indicators of Canadian Polar Knowledge 1999" (June 2001) is available in print from the Commission, or on-line at www.polarcom.gc.ca/pdf/indicators_report_en.pdf.

ANTARCTIC SUBGLACIAL LAKE AND DEEP ICE WORKSHOP

The Antarctic Subglacial Lake and Deep Ice Workshop report (July 2001) is available in print from the Commission, or on-line at www.polarcom.gc.ca/pdf/workshop_en.pdf.

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