



MERIDIAN

BREAK-UP AND CLIMATE CHANGE AT CANADA'S NORTHERN COAST, QUTTINIRPAAQ NATIONAL PARK

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Different climate models vary in their prediction of how fast the world is heating up in different regions, but almost all converge on the conclusion that the north polar region will experience greater temperature increases than elsewhere, and that these changes are likely to become ever faster because of the positive feedback effects of melting snow and ice. This "runaway change" scenario makes northern Canada a particularly important place for monitoring the global climate system. Of course apart from our international responsibilities in this regard, we also have a vital self-interest in knowing how fast the Canadian environment is changing.

One of the remarkable features of Canadian geography is that the landmass spans 41 degrees of latitude, with the northern tip of Ellesmere Island, Nunavut, extending to latitude 83°N, only a few hundred nautical miles from the North Pole (Fig. 1). This northernmost coast includes Quttinirpaaq ("Top of the World" in Inuktitut) National Park, a vast region containing the highest mountains in eastern North America, alpine snowfields, glaciers, rivers, wetlands, striking polar desert landscapes, lakes and deep fiords. These environments and their biological communities are shaped by extreme cold and are likely to be sensitive indicators of climate. Furthermore, they are at the

northern limit of North America, at the highest continental latitudes that are likely to experience the strongest impacts of global change.

Our work on Ellesmere Island first began in the mid-1990s on Lake Hazen, the largest waterbody in the park and one of the deepest lakes in the circumpolar Arctic. The frigid, clear waters of this lake were found to be well-mixed to at least 100 m in summer, in sharp contrast to lakes further to the south where a warm surface layer overlies colder water in summer. This deep summer mixing in Lake Hazen is likely to regulate its ecology, but could eventually be dampened and cease under warmer temperatures. Historical studies in northern Finland, for example, have shown that the shift in lakes from summer mixing to a layered structure is accompanied by major changes in biological species composition and in their aquatic food webs. Lake Hazen is readily monitored from space, and future changes in water colour, temperature and duration of ice cover will provide indications of the pace of environmental change.

The northern coast of Ellesmere Island was first explored by Europeans during the British Arctic Expedition in 1875-76. Lieutenant Pelham Aldrich led a sledging party from this expedition along the coastal fringe of undulating ice, and named many of the

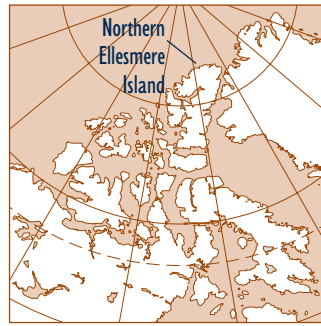
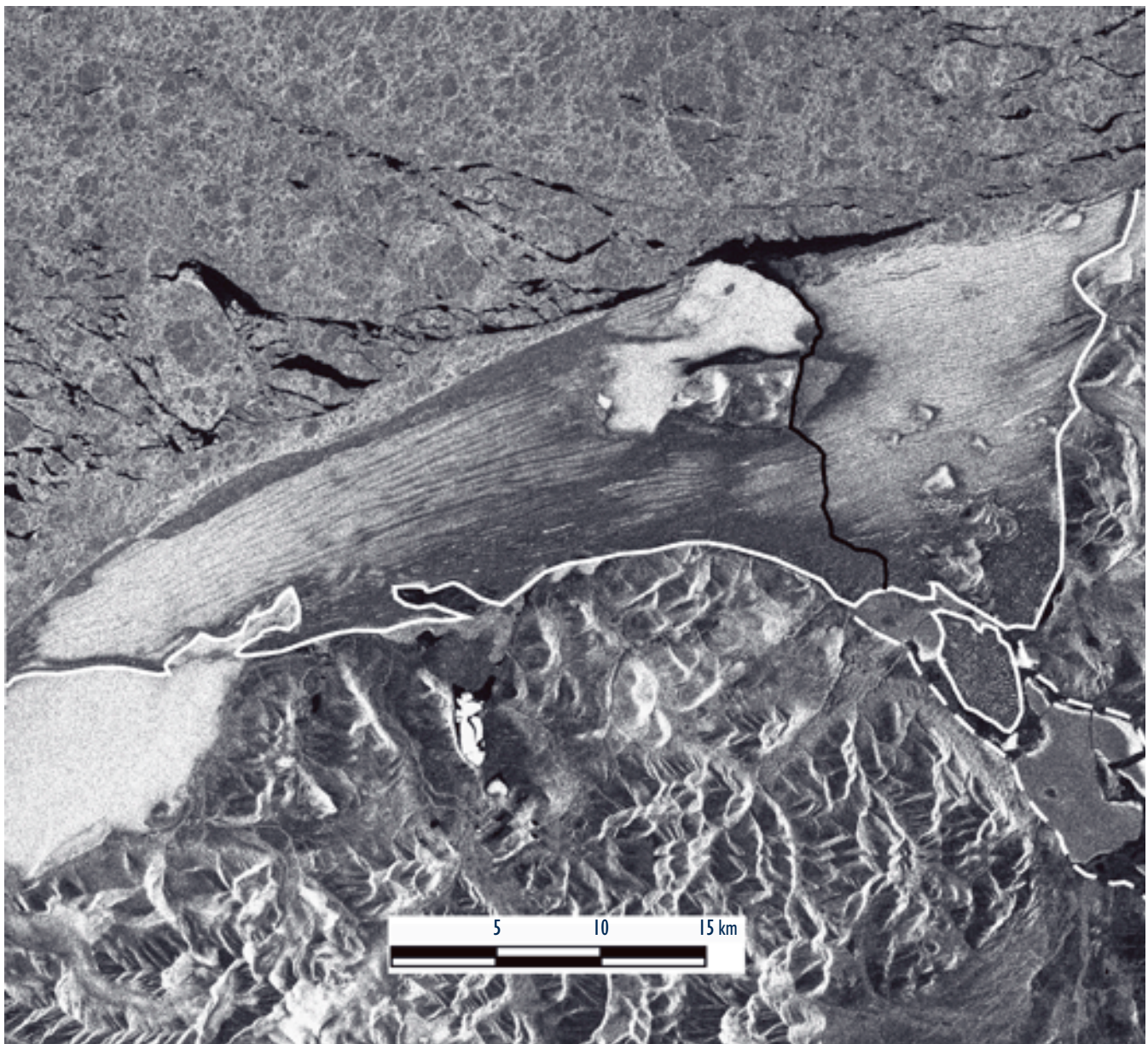


Fig. 1
 Fine Beam RADARSAT-1 image of the northern end of Quttinirpaaq National Park, Nunavut (September 27, 2003). The main crack in the Ward Hunt Ice Shelf is traced in black, the southern edge of the ice shelf is traced in white. The dotted line marks the shoreline of Disraeli Fiord which continues for 20 km off the image. Note the ice breaking up in Disraeli Fiord and in Lake A (unofficial name).
 Photo: © Canadian Space Agency/Agence spatiale canadienne 2003, received by the Canada Centre for Remote Sensing, and processed and distributed by RADARSAT International.



features that lie now within the northern boundary of Quttinirpaaq National Park. Ward Hunt Island, just off the northern coast of Ellesmere Island, was named after George Ward Hunt, First Lord of the Admiralty, while Disraeli Fiord was named after the Prime Minister of England at the time, Benjamin Disraeli. Even today, however, several important features of this remote region have yet to be named. For example, the remarkable set of deep, saline lakes along the northern coastline, only discovered a few decades ago, still bear the unofficial codes Lake A, Lake B and Lakes C1, C2 and C3.

Aldrich had some unfavourable comments to make about the undulations in the coastal ice (“large and troublesome hummocks in the snow and ice”) and later the American explorer Robert Peary further surveyed this region and confirmed the difficulty of travel. Today these undulations can be made out clearly in the beautiful high resolution images produced by the Canadian satellite RADARSAT (Fig. 1). We first visited this region in 1998 and discovered that these undulations are formed by ridges between parallel, elongate meltwater lakes that contain rich communities of microscopic organisms. The latter occur in such abundance that they produce conspicuous red coloured “ice mats” that on closer inspection have been found to contain viruses, bacteria, algae and even minute animals. These self-contained, microscopic worlds are natural laboratories that are helping us gain insight into how life survived, grew and evolved during major freeze-up events on Earth in the past (Vincent *et al.*, 2004). However, these ice-based ecosystems (“cryo-ecosystems”) appear to be dwindling rapidly.

Using RADARSAT data from 1998 and 1999, we estimated the expanse of undulating ice to be about 850 km². This ice is several tens of metres thick, and forms a series of ice shelves that float on the sea and that rise fall with the tides, while attached to

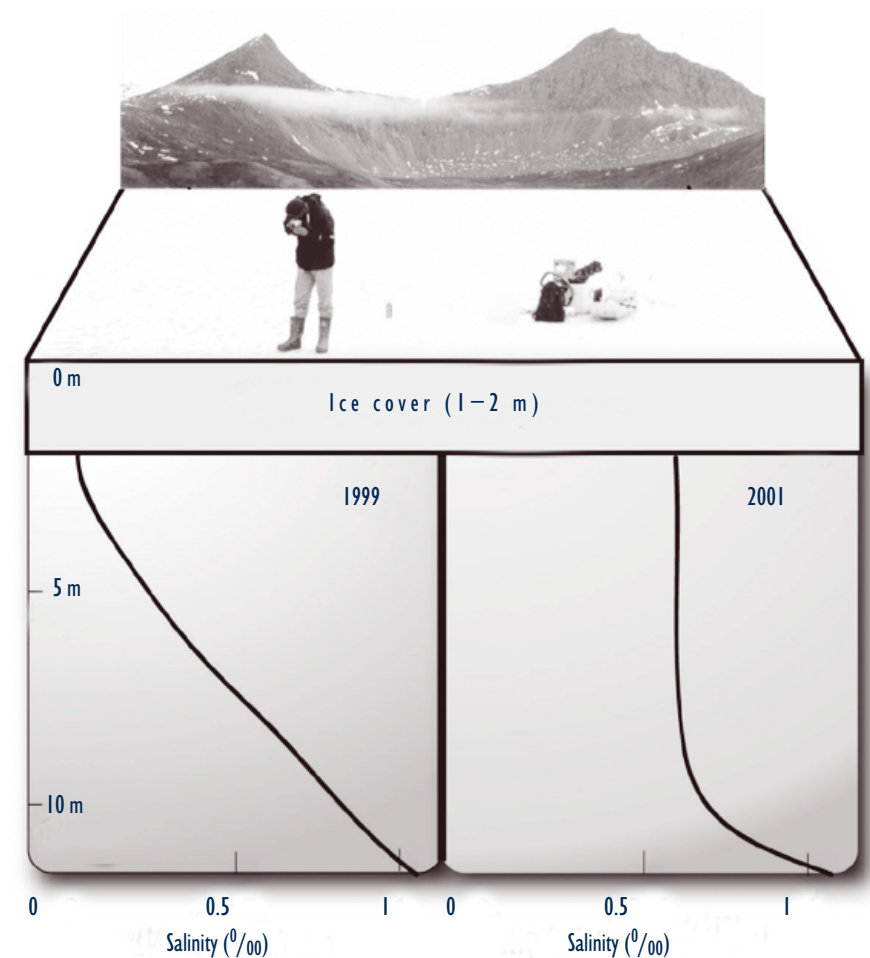


Fig. 2
Salinity changes in the surface waters of Lake A between 1999 and 2001. The unusual ice-out event seen by RADARSAT in late summer 2000 allowed the wind-induced mixing of deeper saline waters into the surface, and eliminated the surface freshwater habitat. Photo: Warwick Vincent.

Ellesmere Island at their southern ends. From Peary’s detailed account of his voyage along the coast from Cape Sheridan to Axel Heiberg Island, we estimated a total ice shelf extent of about 8900 km². This ice shelf is believed to have started to form about 4500 years ago and to be fully in place (surmised from the carbon 14 dating of driftwood trapped on the landward side of the ice) about 3000 years ago (Jeffries, 2002). Our analyses suggest that there has been a 90% loss of this ancient feature over the course of the 20th century.

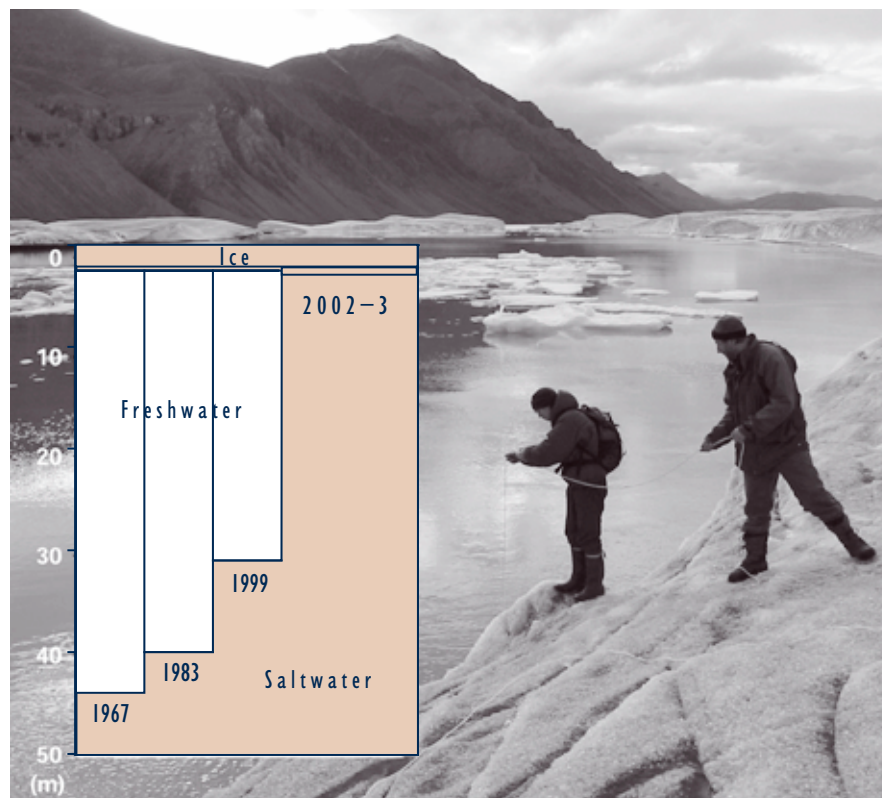
Several other components of the northern Ellesmere Island environment provide evidence of substantial change. The saline Lakes A-, B- and C-series are capped by thick ice through most months of the year, and our initial profiling data from Lake A in 1999 bore a close resemblance to earlier

measurements decades earlier, suggesting that this lake rarely lost its ice cover. These capped lakes show the effects of hundreds if not thousands of years of slow heating by the solar radiation that penetrates through the surface ice, gradually warming their mid-depth saline waters to surprising temperatures. The absence of mixing means that this heat is not returned to the surface to be lost to the atmosphere, but rather can slowly accumulate. Mean annual air temperatures in this region are around -20°C, yet Lake A reaches a stable 8.5°C in its mid-depth, and Lake C1 attains an astonishing

12°C that is likely to stay fairly constant throughout the year despite winter air temperatures below -40°C . In 2001 we observed for the first time that this unusual layered structure of cold freshwater on warmer salt water was being broken down, and that there was evidence of mixing (Fig. 2). RADARSAT images confirmed the loss of lake ice on all the lakes in the year 2000, and in late summer 2003, Lake A again showed substantial break-up of its surface ice (Fig. 1). This abrupt change in temperature and salinity is likely to completely alter the structure and ecology of these unique ecosystems.

The most dramatic shift we have seen in terms of recent change has taken place in

Fig. 3
 Sampling at the southern end of Disraeli Fiord, from the Disraeli Glacier, August 2003. The insert graph shows the layering of freshwater over saltwater at the northern end of the fiord (an epishelf lake) and the observed loss of the freshwater layer in 2002 caused by the breaking up of the Ward Hunt Ice Shelf (from Mueller *et al.*, 2003).
 Photo: Derek Mueller.



Disraeli Fiord. When we first undertook measurements in this deep, 30 km-long fiord we found that it contained a thick surface layer of freshwater sandwiched between a 2.5 m ice-cap above and the sea beneath. The plankton was composed of an unusual mixture of fresh and brackish water species (Van Hove *et al.*, 2001), and provided another fascinating model system for understanding life processes in the polar environment. This so-called “epishelf lake” was formed because the Ward Hunt Ice Shelf acted as a dam across the mouth of Disraeli Fiord (Fig. 1) and allowed the outflow of freshwater only beneath at the base of its 40–50 m-thick mass of ice. Our observations in 1999 confirmed two earlier records, in 1967 and 1983, of these epishelf conditions. However a comparison of our measurements of the freshwater depths with the earlier data showed a loss of more than 10 m depth of the freshwater layer, suggesting a substantial recent thinning of this ancient ice shelf.

When we flew over the ice shelf in 2001 we noted a central fissure, but were unaware of its extent or significance. In 2002, we returned to the site and immediately saw that the fissure was huge, had widened into a crack that extended 15 km over the full north-south length of the shelf, and was accompanied by multiple east-west fissures extending off for many km. Working with our collaborator Martin Jeffries and the University of Alaska Fairbanks SAR Facility, we were able to obtain high resolution RADARSAT images and to confirm that the ice shelf was in the process of disintegrating (Fig. 1). Most strikingly, salinity-temperature profiles that season in Disraeli Fiord (Fig. 3) showed that brackish water now extended to just beneath the surface ice, and more than 3 billion cubic metres of freshwater contained within the epishelf lake had completely drained away through the central crack of the now-broken Ward Hunt Ice Shelf. Our profiling measurements in 2003 confirmed the complete loss of the surface freshwater ecosystem, which from analyses of RADARSAT, probably took place in 2001.

This dramatic break-up and loss of the ancient ice shelf and its associated epishelf lake was the focus of a great deal of public media interest, with front page stories in newspapers around the world. The previously inconspicuous Ward Hunt Ice Shelf suddenly became known on more than 200 websites. One editorial on the event perhaps captured the reason for this unexpected level of international interest: “There has been no end of scholarly studies confirming the gradual rise in global temperatures over the past century. Yet nothing focuses the mind on global warming and its potential consequences quite so sharply as the occasional news flash from some remote corner of the globe documenting startling changes in landscapes once thought to be immutable” (New York Times, 25 September 2003).

Of course what all the journalists wanted to know was to what extent the ice shelf



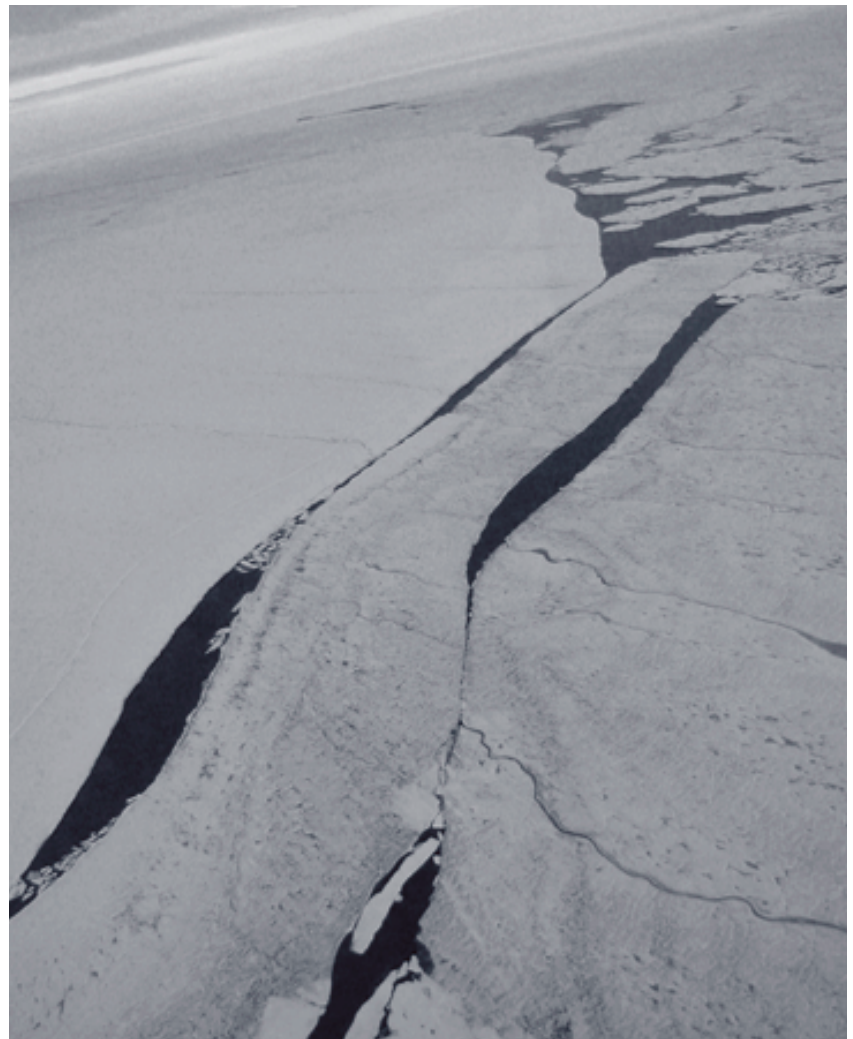
Figure 4
Breakup of the Ward Hunt Ice Shelf. Photo: Warwick Vincent.

break-up and ecosystem loss can be attributed to the increased greenhouse effect caused by human activities. The short answer is we do not know. We do know that Ellesmere Island has been changing for a long time, throughout the 20th century as shown by the ice shelf records, and that the most recent changes correspond to a 30 year period of accelerated warming as indicated by the Environment Canada climate record at Alert (Mueller *et al.*, 2003) and by observations of environmental change throughout the circumpolar Arctic (Serreze *et al.*, 2000). Paleo-ecological work at Cape Herschel, about half-way up Ellesmere Island's eastern coast, showed that there were abrupt changes in diatom fossil indicators of climate in the middle of the 19th century, suggesting the onset of substantial warming at that time (Douglas *et al.*, 1994). Some researchers believe that even this early change may indicate the timing of onset of the effects of industrial society on our global

climate. There are important natural sources of variability to consider, including the Arctic Oscillation (AO) which causes swings in climate and oceanic circulation at various timescales. It has been argued that the current increase in greenhouse gases may have forced the AO into an extreme state that accounts for the recent series of anomalously warm years in the high Arctic (Shindell *et al.*, 1999).

The ongoing debate and discussions about how fast our world will heat up in the future, and how much of the present fluctuations in climate can be ascribed to natural versus anthropogenic effects, should not be

Figure 5
Ice islands calving from the ice shelf. Photo: Warwick Vincent.



allowed to obscure the agreed facts: greenhouse gases are accumulating in our global environment at an unprecedented rate, and the circumpolar environment is vulnerable to relatively minor shifts in temperature across the melting point of ice. The cold ice-dependent ecosystems at Canada's northern coast are providing compelling evidence of change. Quttinirpaaq National Park is playing invaluable, multiple roles, not only as a wildlife preserve and recreational wilderness, but also as a global monitoring site that has begun to issue signals of major change ahead.

Acknowledgements

Our research is supported by the Natural Sciences and Engineering Research Council of Canada, the Fonds du Québec de recherche sur la nature et les technologies and the Northern Scientific Training Program. We are also grateful to Polar Continental Shelf Project for logistic support and to the Parks Canada Agency for its ongoing encouragement of our research and use of their facilities in Quttinirpaaq National Park.

References

- Douglas, M.S.V., J.P. Smol and W. Blake Jr, 1994. Marked post-18th century environmental change in High-Arctic ecosystems. *Science*, 266: 416–419.
- Jeffries, M.O., 2002. Ellesmere Island Ice Shelves and Ice Islands, in *Satellite Image Atlas of Glaciers of the World: Glaciers of North America*, pp. J147–J164. Edited by R.S. Williams and J.G. Ferrigno, United States Geological Survey, Washington D.C.
- Mueller, D.R., W.F. Vincent and M.O. Jeffries, 2003. Break-up of the largest Arctic ice shelf and associated loss of an epishelf lake. *Geophys. Res. Lett.* 30: 2031, doi:10.1029/2003GL017931.
- Serreze, M.C., J.E. Walsh, F.S. Chapin, T. Osterkamp, M. Dyurgerov, V. Romanovsky, W.C. Oechel, J. Morison, T. Zhang and R.G. Barry, 2000. Observational evidence of recent change in the northern high-latitude environment. *Climatic Change*, 46: 159–207.
- Shindell, D.T., R.L. Miller, G.A. Schmidt and L. Pandolfo, 1999. Simulation of recent northern winter climate trends by greenhouse gas forcing. *Nature*, 399: 452–55
- Van Hove, P., K. Swadling, J.A.E. Gibson, C. Belzile and W.F. Vincent, 2001. Farthest north lake and fjord populations of calanoid copepods in the Canadian High Arctic. *Polar Biology*, 24: 303–307.
- Vincent, W.F., J.A.E. Gibson and M.O. Jeffries, 2001. Ice shelf collapse, climate change and habitat loss in the Canadian High Arctic. *Polar Record*, 37: 133–142.
- Vincent, W.F., D. Mueller, P. Van Hove and C. Howard-Williams, 2004. Glacial periods on early Earth and implications for the evolution of life. In: Seckbach, J. (Ed.), *Origins: Genesis, Evolution and Biodiversity of Life*. Kluwer Academic Publishers, Dordrecht, The Netherlands, in press.

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FAT AS AN ECOLOGICAL TOOL: BEARS AND SEALS IN TEMPERATE AND ARCTIC ECOSYSTEMS

Sara Iverson

Most people usually think about fat negatively, as an almost sinister “thing” that we simply have to cope with – a necessary evil. After all, fat is contained in the food we must eat and is readily generated from other nutrients (carbohydrates and proteins) consumed in caloric excess, yet too much of it carried in our bodies can be unhealthy or even life-threatening. Many people abhor the very thought of fat, along with the primary tissue in which it is stored, adipose tis-

sue. However, in the animal kingdom, fat can be one of the most important things in life. Indeed, in many animal species, large fat stores are crucial to survival. Because of its critical place in animal life, understanding aspects of fat and its metabolism can help shed light on a wide range of subjects, from piecing together evolutionary adaptations to providing us with clues as to how some animals make their living in the wild.

For example, we have recently developed a method that uses the basic constituents of fat, fatty acids, to study the diets and foraging strategies of free-ranging animals. Predator-prey relationships and the spatial and temporal scales of foraging in wild animal populations are central issues in the ecology, conservation, and management of animals and the ecosystems on which they depend. Fat is now providing us with some of our first detailed insights into the diet and

foraging behaviour of many species, including arctic marine mammals. For instance, although we know polar bears eat seals, our previous understanding of the foraging ecology of polar bears has come from the collection of left-over specimens from seals killed by bears and direct observations primarily from only one field site. Furthermore, separate subpopulations of polar bears cover the entire Canadian Arctic, but only a few of these subpopulations have been studied. Thus, we have at best an incomplete understanding of their diets. And, because seals generally feed underwater, it is rarely possible to directly observe what they eat or how they make their living. Previous methods to assess seal diet have relied on stomach contents and fecal analyses, which yield biased results and, most importantly, only provide information about the last meal near the haul-out site, which is not necessarily representative of their longer-term diet.

I have been working on aspects of fat for over 20 years. Initially, I was most interested in the physiology and metabolism of fat and the role it played in the lives of marine mammals. Much of the life cycle of many marine mammals depends on storing large amounts of fat in a subcutaneous layer of blubber (a specialized form of adipose tissue covering the body), which then serves as an excellent insulator, body streamliner and buoyancy adjuster. But blubber also serves as a critical energy reserve during natural times of fasting, where stored fat is mobilized and metabolized, providing both energy and water to the animal. Especially critical is the role of blubber fat reserves in fasting lactating females, such as phocid seals, where massive quantities of fat in blubber are efficiently transferred into a high fat milk to feed and rapidly fatten their offspring, who are in equal need of acquiring their own blubber layer. While these may seem like extreme situations, this pattern of



Adult male grey seal, uniquely branded "B448" as a weaned pup on Sable Island in 1973 (i.e., he is now 31 years old!), fitted with a satellite-linked time-depth recorder tag glued to the fur. The satellite tag will provide information about the daily location in the ocean and diving behaviour of this animal for a period of up to seven months, which is coupled with diet information provided by fatty acid signature analysis of its blubber when he returns to Sable for the breeding season. The tag will either be removed at this recapture or it will fall off by itself shortly thereafter when the male molts all its fur in the spring. Photo: Sara Iverson.

alternating the storage and subsequent mobilization of large quantities of fat as part of their normal lifecycle is shared by many mammals, from ground squirrels and woodchucks to penguins and arctic bears.

While studying the roles and dynamics of fat in marine mammals, I began to notice something interesting about the components of their fat; namely that the composition and patterns of fatty acids in the predators' fat stores were remarkably similar to those found in their suspected diets. Thus was born the concept of using fatty acid signatures to study animal diets in the wild.

Fatty acids are the main constituents of all fats, and are basically long hydrocarbon chains that can be saturated (containing no double bonds) or unsaturated (containing one or more double bonds). Fatty acids in the marine food chain are exceptionally complex and diverse and are characterized

by high levels of long-chain polyunsaturated fatty acids, originating from various unicellular phytoplankton and seaweeds. In fact, approximately 70 individual fatty acids can be routinely identified in any marine sample and it is the quantitative distribution of all fatty acids measured that we refer to as the fatty acid signature.

The possibility of using fatty acid signatures to obtain quantitative estimates of predator diets is based on three principles: 1) there are very narrow limitations on the types of fatty acids that animals can biosynthesize, 2) most fatty acids are deposited in adipose tissue with minimal modification from diet and thus travel up the food chain in a predictable way, and 3) the pattern of fatty acids found in many prey items (some plants and in many fish and invertebrates) can be used to accurately identify individual prey species. By sampling a core of blubber or adipose tissue from a free-ranging animal with a simple biopsy tool one may, relatively non-invasively, obtain information about what that individual ate over weeks or months, rather than just its last meal.

Recently, together with colleagues, we have developed a statistical model that provides quantitative estimates of the proportions of prey species in the diets of individual predators using what we call quantitative fatty acid signature analysis, or QFASA

(Iverson *et al.*, 2004). The basic procedure involves characterizing the fatty acid signatures of all potential prey of a given predator, applying weighting factors to the predator's fatty acids to account for fatty acid metabolism within the predator, and then finally, asking which mix (and level) of prey species signatures comes closest to matching the signature of the predator, thereby estimating diet. We have used simulation studies to investigate the properties of the QFASA model and controlled feeding studies of grey and harp seals to assess quantitative characteristics of fatty acid deposition and metabolism in the predator. We then tested and validated the model by estimating the diets of experimentally fed captive grey seals and mink and the diets of individual free-ranging harbour seals fitted with an animal-borne video system (National Geographic's "Cittercam") and filmed during natural feeding events. We are currently conducting similar types of validation studies on other species of seals and sea lions, as well as in seabirds in the Bering Sea. Thus, although we are continuing to refine aspects of the QFASA methods with further research, it has reached the point where it can finally be used to help answer detailed questions about the foraging ecology of predators.

Two of the research projects being conducted by my lab involve applying QFASA to understanding the ecology of several large apex marine predators in the Northwest Atlantic and Canadian Arctic: seals and polar bears. Both are ideal for these studies since, as described above, they alternately store massive amounts of fat prior to breeding once a year, followed by extensive depletion of that fat stored during fasting, only to repeat the pattern again each year. Thus, turnover of fatty acid stores occurs on at least an annual basis. Apex predators are thought to exert important top-down effects on many marine ecosystems and thus it is important to understand their ecology. Although it is believed that seals such as



Blubber sample taken by biopsy from a live seal. Photo: Sara Iverson.

grey, harp and hooded seals may significantly impact major offshore fish stocks, we know little about where these seals actually forage, what they eat outside of the breeding season when they are not accessible, or how foraging effort and success are correlated in both space and time. Our studies began with grey seals, which have increased exponentially for over four decades on the eastern Scotian Shelf. We began by building a database of prey fat content and fatty acid composition. This database now contains such information on over 4000 individuals of 60 species of fish and invertebrates from the Scotian Shelf and the Gulf of St. Lawrence. We have now taken blubber biopsies from over 700 grey seals between 1993 and the present, many of which were also fitted with satellite transmitters. We have found that while most grey seals forage in the vicinity of Sable Island especially before the breeding season, individuals have a large foraging distribution that may range from southern Newfoundland and the Gulf of St. Lawrence all the way down to the northeastern United

States. On average, sandlance and capelin have been the dominant prey in most seasons and years, followed by various demersal species, however, there is considerable individual variability. Diets also show inter-annual variability, strong seasonality, and large differences between adult males and females that correlate to differences in body size (males are one and a half times larger than females), and also between adults and juveniles. Diets estimated using QFASA also differ from those estimated from fecal samples collected on Sable Island during the same time periods. This both underscores the difficulty in estimating the diets of wide-ranging marine predators using traditional methods and emphasizes the value of QFASA estimates, which integrate information on the diet of individuals over periods of weeks to months.

We are now expanding these studies to document the diets of harp seals and hooded seals. Harp seals are the most abundant phocid in the North Atlantic. However, very

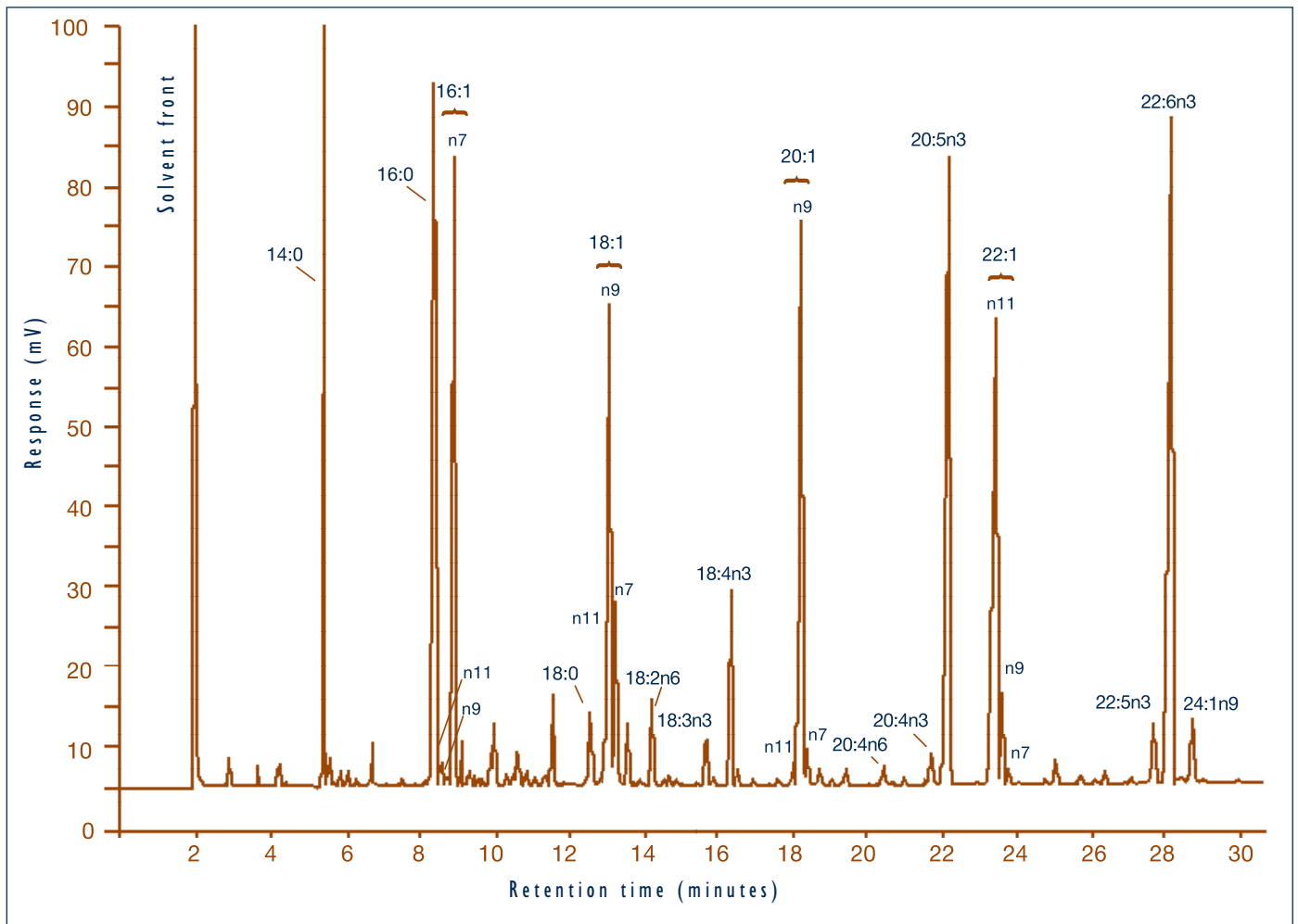
little is known about feeding habits over their entire range, particularly in the off-shore part of their range. The Scotian Shelf prey database is being greatly expanded to include all potential fish and invertebrate prey of these seals in the regions of Newfoundland and Labrador. Although these studies are currently underway, preliminary results reveal strong differences in the diets of harp seals that occupy nearshore (previously the only individuals studied) *vs.* off-shore habitats. This will be information of critical importance to understanding the roles these seal species play in marine ecosystems of the Northwest Atlantic.

Finally, we are moving one last step up the food chain and have begun an extremely ambitious study of polar bears across their entire range in the Canadian Arctic. As a

broadly distributed top predator in the Arctic, polar bears provide valuable information on changes in ecosystem structure and function over time and space. Yet as polar bears are so wide-ranging and difficult to observe in much of their range, there is little quantitative data on the composition of polar bear diets and the ecological (such as climate warming) and demographic factors that influence prey selection and survival. Polar bears depend on ice for hunting and feeding on the seals which also use it for denning and basking. Thus, polar bears' southern range is limited by the amount of ice that forms in the winter and, depending on the location, they may be forced ashore with summer ice melt, when seals are unavailable and they must fast. Most bears then return to the ice as soon as it reforms in

November or early December. Hence, in general, the most important feeding period for polar bears is from early April until break-up (if it occurs) in July. April is the time when ringed seal pups are born and thus when ringed seals in general become most available; but other species of seal also haul out on ice and pup in spring. However, we know that sea ice cover is changing – and in some areas disappearing or at least receding earlier in the year than ever before. Recent data suggest that bears are forced

Fatty acid chromatogram of an individual sandlance from the Scotian Shelf. Here 67 fatty acids are identified and quantified, however, only selected peaks are labeled on this plot. Fatty acids are eluted (“retention time”) in order of carbon chain length, number of double bonds and position of double bonds on a polar capillary column. The integrated area under each peak represents the relative mass percentage of each fatty acid.



ashore earlier and in leaner condition with early ice break-up (Stirling *et al.*, 1999), so that they must begin their fast (and in the case of mothers, their gestation and early lactation) with far fewer energy stores. Thus, this is a critical time to monitor how bears will respond to such environmental changes.

In studying polar bears using QFASA, the seals now become the prey rather than the predator and hence we have to build up a “prey library” of all the seal species from all their different locations. Luckily for us, polar bears feed primarily on the seal’s blubber, leaving behind the carcass – meaning a sample of the blubber only is sufficient to determine a prey signature. Likewise, while polar bears do not have blubber, they do deposit huge quantities of fat subcutaneously in adipose tissue that is easily sampled by the same biopsy procedure used in seals. We have now sampled hundreds of bears throughout the past decade and hope to better understand whether diets are changing

in the way we would predict with changing patterns of prey distributions (*e.g.*, increases in harp and hooded seals in Davis Strait and the Labrador Sea; small but significant increases in harbour and bearded seals in Hudson Bay) and the consequences of diet change on growth and reproduction of this top carnivore. We have indeed found very large regional and interannual differences in polar bear diets. In addition, we have found differences in diets between males and females, and are examining maternal and dependent offspring diets to determine whether patterns established during dependency are retained in later life. Finally, we are using the signatures of terrestrial plant fatty acids to investigate whether, or to what extent, bears are making use of terrestrial food sources when the ice is gone.

Given our research to date, we feel that the study of blubber fatty acids can provide a powerful tool for understanding the feeding habits and foraging ecology of both individuals and populations. But we have literally only scratched the surface of this exciting

technique. The types of questions we might study with such a tool are numerous and important and can be applied to understanding distribution, movements, reproductive patterns and environmental adaptations. The last of these could be particularly significant for polar bears and seals. The presence of sea ice is critical to both groups and the impacts of climatic warming on these species may be profound. Monitoring species at the top of the food web will be important and clearly, we have a tool with which we could do so.

Reference

Iverson, S. J., C. Field, W. D. Bowen and W. Blanchard, 2004. Quantitative fatty acid signature analysis: a new method of estimating predator diets. *Ecological Monographs*, in press.

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NEW LOOK FOR THE CANADIAN POLAR COMMISSION WEB SITE

The web site of the Canadian Polar Commission (www.polarcom.gc.ca) has a new look. The Polar Science Forum is now fully integrated, and accessible from anywhere in the web site. The Forum is an online community centre for the Canadian polar science community – a place to exchange information and ideas, and keep abreast of each other’s activities.

If you have not already done so, you are invited to register and use the forum, post information, and create discussion groups –

and to visit often! You may wish to take two minutes to go through the Tutorial which will introduce the many features of the Forum. The Forum’s URL has also changed. Please update your links to: forum.polarcom.gc.ca/forum.

We also invite you to take a look around the site, which now includes an online Research Directory containing nearly 2000 listings of people involved with polar research, polar knowledge, and related matters. We would ask you to kindly check your own listing to make sure the information is

accurate and current. You may correct and update your listing – to facilitate exchange of information within the polar research community at www.polarcom.gc.ca/english/cpin/directory/search.asp.

As always, your comments and suggestions are much appreciated.

FORTY YEARS OF POLAR RESEARCH

Ian Stirling

The following is an excerpt from comments made by Ian Stirling on being presented with the 2003 Northern Science Award in Edmonton on October 25, 2003.

The honour of receiving this award is a sufficiently strong punctuation mark in a life and career to make me reflect a bit on the last 40 years and wonder if the pathway indicates anything useful to think about for the future.

I have often been asked how I became so fascinated with polar marine ecosystems, both north and south, and the animals that live in them – mainly the seals and polar bears. In reality, I don't know, except that for unknown reasons I was. However, in about 1963 or 64, when I was a student at UBC, I went to a seminar given by Robert Carrick, a Scot who had a brilliant research career with CSIRO Wildlife Division in Australia. He talked about his long-term work with royal penguins and southern elephant seals at Macquarie Island, and some related studies being done by the Australian Antarctic Research Programme. I was simply enthralled and knew I wanted to do similar things.

In the early 1960s, it was hard to get summer jobs or graduate programs with large mammals in the Arctic so after a couple of summer stints in northern BC and Yukon with National Museum, I thought maybe it would be a better strategy to try doing a Ph.D in the Antarctic. I wrote to three different people and Bernard Stonehouse, who was then at Canterbury University in Christchurch, accepted me almost by return mail. My wife Stella and I went to New Zealand in December 1965 and in January of 1966 I found myself on my way to Antarctica in a US Navy Hercules. On a windy morning at about 4 AM with a tem-

perature in the -20°C , I stepped out onto the Ross Ice Shelf, and looked up at the volcanic plume from Mt Erebus. That was when it began to sink in that I was essentially on my own, to start a whole new study on animals I had never seen before, with no idea how I was to catch them, in a completely new and rather demanding environment, and with no one to show me the ropes. This was of course the "British System", where they throw you into the deep end of the pool and if you make it to the shallow end and climb out then they give you a Ph.D. If you drown in the process, no one worries very much. This was one of the times in my life when I wondered if maybe this time I had bitten off a bit too much.

In the end, everything worked out fine but that experience left me with two strong impressions. The first was the critical importance of having a door opened. In my case, the opportunity given to me by Bernard Stonehouse changed my life and I determined that down the line, when possible, I would try to do the same for younger people. Secondly, although figuring everything out for myself was a good learning experience, it was not always the most efficient way to do things. I resolved further that if I took on students myself in similar circumstances, I would try to ensure they had some training and assistance to get started with.

In 1969, I found myself doing a Post-doctoral fellowship in Australia with the very Robert Carrick who I had found so inspiring several years earlier and just couldn't believe my luck. I was in the field about half the time, along with my wife and first daughter. When I was in the lab, we had brown bag lunches most days and it was the most intense learning experience of my life.

In 1970, I was offered a job studying polar bears and seals in the western Canadian Arctic. CWS was more or less in its heyday in the north and that productive role continued for the next ten or so years. It was a truly exciting time with a lot of excellent scientists and a sense of an organization on the move with a lot of spirit. One of the particular strengths of the organization in those days was that biologists and scientists were not only encouraged to work hard but we were given a lot of freedom to follow where our curiosity took us. Managers like Ward Stevens and Joe Bryant were particularly instrumental in their encouragement of curiosity and innovation. It has been my enormous good fortune that CWS has more or less allowed me that flexibility through the last 33 years and it is the aspect of my job I have valued most. Not surprisingly, I think that approach has paid some of the best dividends to the organization over time as well.

CANADIAN
WILDLIFE SERVICE
The 1970s and early 1980s were good years to get to know and work with native northerners. From the beginning, we took local hunters out with us and had more meetings than I can remember with Hunters and Trappers Committees about projects, ideas, and exchange of information. I learned a lot and hopefully the hunters did as well. On weather days, I gave talks in schools. I made a number of good friends, especially in the Western Arctic. Later, working with Andy Carpenter and several other Inuvialuit of the western Canadian Arctic and the Inupiat of Alaska in the late 1980s, we established the first user-to-user conservation agreement for a shared polar bear population in only two years – something that would have

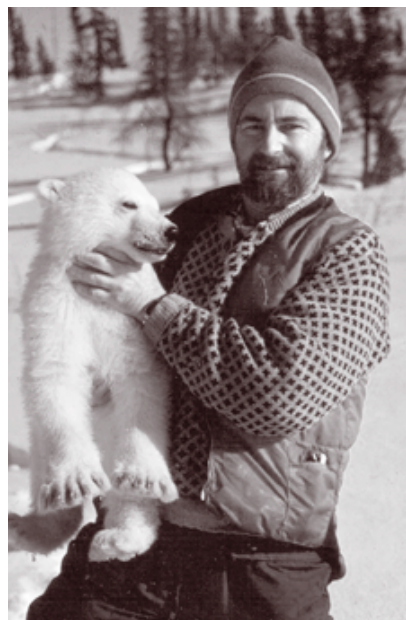
taken 20 years or more if we tried to do it through governments, if the Porcupine Caribou Agreement is any indication. The process of making that Agreement work over subsequent years was a valuable experience for all of us in making co-management effective, and it was very personally rewarding to me to have been part of it. The Agreement has been in effect for almost 15 years now, continues to work and develop, and has since been copied and applied to a number of other user-based conservation issues which I think is probably the most robust test of its efficacy. I am especially appreciative that some of my Inuvialuit colleagues are in the audience tonight.

U N I V E R S I T Y O F A L B E R T A

In 1979, Fu-Shiang Chia was head of the Department of Zoology here at the University of Alberta and he invited me to become what was then called an Honorary Professor and is now an Adjunct Professor. I had already been guest lecturing in the department for several years so I asked what the new potential rank involved. “All the responsibilities of a regular faculty member but no pay” was the cheery reply. This seemed like the proverbial offer that was difficult to refuse because I was ready to start involving graduate students in the program on a continuing basis and we have had two to five working with my program ever since. It also gave me the opportunity to start on my goal of opening doors for Canadian students to work in the Arctic and on marine mammals.

A couple of other criteria were important to me personally. When I worked in the Antarctic, women were not even allowed in the field. By the time I left, a very few exceptions had been made for wives who were qualified to assist their husbands as technicians. This had always seemed unfair to me and, as I had two daughters myself, I thought the only filters for candidates in any

kind of work should be qualifications and ability. Previous experience is always helpful but I looked more for attitude, since if you have a person on fire with enthusiasm you can teach them anything – and some of our most successful students were green as grass when they started out. I had another criterion that came from growing up in southeastern BC. Small town kids had no connections to help them get those neat summer jobs – and most had to work pretty hard at anything they could get, just so they could keep on studying. I never took volunteers on my projects, as I felt it discriminated against kids



For over three decades Dr. Stirling has been a research scientist for the Canadian Wildlife Service, focussing on the study of polar bear ecology, population parameters and the relationship between polar bears distribution and abundance, seal distribution and abundance, and pack ice conditions. Photo: A. Derocher.

from lower income families. If I wanted to take a student on, graduate or undergraduate, I paid them. Intensity of interest and degree of personal preparation were my main criteria and they worked well over the years. There is no doubt that one of the most

rewarding things in my life has been seeing each one of those students go on to jobs and successful careers in northern research or elsewhere with marine mammals.

T R O U B L E S

By the mid-1980s and through the 90s, as the effects of changing government priorities and then deficit reduction came into full swing, northern research suffered as never before with financial cutbacks etc. Despite our obvious northern geography, decision makers and the public seem to continue to look south for their inspiration, guidelines, and priorities. Even the Polar Continental Shelf Project, the most cost-effective invention any government department has ever undertaken in the Arctic, was savagely chopped. Over the same period, new and often inefficient permitting systems became commonplace for everything so that even work that was funded became much more difficult to do. Aspects of the permitting systems are still problematic, desperately needing streamlining and, in some cases, an injection of common sense. At present, I doubt a young scientist could still do many of the things my colleagues and I did routinely only a couple of decades ago because of all the new rules, regulations, and other Lilliputian strings of government, university, and other northern rule-making organizations that dominate the scientific landscape today.

The result was that many people left the arctic scientific community and stopped taking students to work there. Thus, for the most part, a large part of a generation is now missing. The tide has, fortunately, begun to slowly turn back again with some increased funding to Polar Shelf, NSERC, and a modest number of Northern Chairs funded by NSERC. However, while research programs can be destroyed in a very short time, it takes years and considerable reliable funding to build them back up.

The strongest recovery in arctic research so far is being made in interdisciplinary oceanographic studies, at a cost of many millions of dollars. Through the Canada Foundation for Innovation, Canada has completely refitted an icebreaker dedicated to Arctic research. Launching of this flagship arctic research vessel is something Canada can be truly proud of and it will attract worldwide attention. Names of some of our other icebreakers, such as the *Pierre Radisson* or the *Terry Fox* are strong reflections of Canadian culture, history, and values. There are so many outstanding Canadian names our new research icebreaker could have been given. Just a few examples that come to mind quickly include names like Natkusiak (the Inuk who guided Stefansson through the Canadian Arctic Expedition and taught him to travel and live on the land like the Inuit), Qitdlarsuaq (the legendary shaman from eastern Baffin Island who led his people on a coastal trek to Greenland), Fred Roots (the best known and most influential Canadian polar scientist ever and founder of the Polar Shelf Project), or Pierre Trudeau. Thus, it is profoundly embarrassing to me as a Canadian arctic scientist that our flagship arctic icebreaker is named the *Amundsen*, after a famous *Norwegian* polar explorer. I think it is an utter disgrace for Canada. I say this in no disrespect of Amundsen. I once stood on the Ross Ice Shelf at the Bay of Whales near where he wintered before skiing to the south pole and I was deeply moved with admiration of the bravery of those men heading off into the unknown in bitter subzero weather across a landscape that has to be seen to be appreciated. He was a significant polar figure and justifiably almost deified in Norway, but he wasn't a Canadian. Just think of all the publicity and public awareness that could have arisen from a national "name the icebreaker contest"! What an incredible and almost free public relations bonanza! Only in Canada you say? Pity.

FUTURE

As one looks to the future in the Arctic, it still looks immensely exciting but extremely worrisome as well. Just last week, scientists at NASA forecasted the possibility of the Arctic being ice-free in summer by the middle of the century. As this happens, Canada's northern strategic, military, economic, and environmental conservation interests are going to change with a speed that I think few of us can even contemplate. There is an incredible amount of research in all fields needed in a very short time and I don't think we are currently prepared to meet such a challenge. More importantly, from what I can see at the moment, these changes that are rapidly advancing in our direction have simply not yet made it onto the radar screen of the majority of our political leaders.



Photo: A. Derocher.

THANKS

Most important of all though is that whatever successes I have been lucky enough to enjoy have been made possible by the support of a lot of other people. I have been reminded of this most personally and pow-

erfully by the support of all of you here tonight and from the emails and phone calls I have received recently from many others.

No people have been more important than my family. It would be an exaggeration to say they liked that I was away so much but they always supported me. Thank you Stella, Lea, Claire, and Ross.

More organizations than I could name here have supported me over the years but some have been truly exceptional: the Canadian Wildlife Service, the Inuvialuit and Nunavut Wildlife Boards, NSERC, Polar Continental Shelf Project, University of Alberta, and World Wildlife Fund (Canada and International).

Similarly, I would be here all night if I tried to list all the many, many people who have helped in the lab and field over the years but I must acknowledge a few and apologize to those I don't thank individually by name. Dennis Andriashek and Wendy Calvert have been invaluable in both the field and lab work since the mid-1970s. I was fortunate to be able to learn much from Inuvialuit hunters such as David Nasogaluak, Jimmy Memorana, the late Fred Wolki and many others. A true piece of serendipity was that Don Siniff from the University of Minnesota started his work on Antarctic pinnipeds at about the same time as me in McMurdo Sound and Tom Smith from the Arctic Biological Station worked on arctic marine mammals through most of the same years I have been in the Arctic. With those two fine scientists, I have collaborated on many projects all over both polar regions and shared many endless theoretical discussions over coffee on blizzard days for 35 years. I also especially acknowledge the collective contribution of my grad students. You comprised one of the most rewarding aspects of my working life and I have probably learned much more from you than the other way around. Now, it is your job to carry the torch.

A C C L O S I N G T H O U G H T

During the Fifth Thule Expedition, the famous arctic ethnologist and explorer Knud Rasmussen and two Inuit companions spent 18 months in an incredible crossing of the whole of arctic North America from Danish Island north of Southampton Island to Alaska by dog team. By the time he reached the Bering Straits, he was overwhelmed at the rapid pace of irreversible change he saw

entering Inuit life over the entire journey. His observations are documented wonderfully in his book *“Across Arctic America”* which I read for the first time late at night during a blizzard at Churchill. In particular however, a comment in the introduction riveted me at the time and has stayed with me ever since: “And from my heart I bless the fate that allowed me to be born at a time when Arctic exploration by dog sledge was not yet a thing of the past.”

In many similar ways my career too was blessed by simply having happened when it did, when so many things were still new and possible, and because several remarkable colleagues were there at the same time.

Thank you very much.

T H E I N V O L V E M E N T O F W O M E N I N S E L F G O V E R N M E N T N E G O T I A T I O N S

Stephanie Irlbacher Fox

I N T R O D U C T I O N

Comprehensive land claim and self government agreements, which describe indigenous peoples’ legal rights, mechanisms for implementing these rights, and the specific obligations of government toward indigenous peoples, are rapidly transforming life in the NWT. Negotiated agreements are crucial instruments for putting relationships between government and indigenous peoples on respectful and mutually beneficial trajectories.

After spending several years working for the Inuvialuit and Gwich’in during their joint self government negotiations, which included 8 communities of the Beaufort Delta region, I embarked on a Ph.D program at Cambridge University’s Scott Polar Research Institute in England. Focusing on self government in the NWT, I spent 14 months of anthropological fieldwork observing and participating in self government and political development processes in several NWT regions. One thing which intrigued me was that the significant political power of women in communities did not seem to translate into women’s participation at

negotiations. As a woman, I found the seeming lack of women’s involvement significant: could the mostly male negotiators – on all sides of the table – represent women’s interests in these critical negotiations?

S E L F G O V E R N M E N T N E G O T I A T I O N S

Self government agreements are currently being negotiated with representatives of 6 regionally based Indigenous peoples and one community in the NWT, while one agreement with the Tli Cho Tribal Council has been reached. These agreements address rights of indigenous peoples with respect to political self determination which results in Indigenous governments providing locally based services to their citizens. In the NWT, self government institutions are usually public ones – which means that they represent all citizens, with modifications to ensure Indigenous rights-related decision making remains outside the control of non-indigenous people.

The process of negotiations includes representatives from the federal and territorial governments and from indigenous peoples’ governments spending several days each

month negotiating according to a mutually agreed agenda. This agenda is shaped largely by Canada’s policy on the Inherent Right of Self Government.¹ From the outset, subjects which newly recognized governments will take on are restricted to responsibilities currently held by municipal governments, and to some extent, by the territorial government.

C A S E S T U D Y : W H E R E A R E T H E W O M E N ?

Over several years of personal experience and researching the negotiations process, I found that it was not unusual for there to be only one or two women at the negotiating table. I decided to test my observations by generating some statistics. As of May 2002, only 21% of negotiating teams’ members are women; only 2% of Chief Negotiators are women; and only half of the 21% of the women participating in negotiations are Indigenous women – and all of them work for the territorial or federal governments.

1. Canada, 1995. Federal Policy Guide: The Aboriginal Right to Self Government. Supply and Services Canada, Ottawa.

Curiously, almost all of the communications staff – the people having to explain the agreements at the grassroots level – are women.

From a western feminist perspective, a strict numbers analysis told the whole story: women were being excluded. From the point of view that formal negotiations are the most important aspect of negotiating self government, this exclusion pointed to a gap that needed correction. However, I knew this perception was only partly true. While it is important for indigenous women to participate in the formal negotiations, I knew from experience that in community consultations women participated equally alongside men – in terms of both representation and expertise. And in every community I spent time in – about half the communities in the NWT, from Holman to Wrigley – there are women recognized as elders and leaders who are “respected, not elected” as one Dene leader remarked². These respected women are consulted by elected leaders before decisions and plans are made.

Attempts to determine why women were not involved in formal negotiations were generally discouraged by people with whom I spoke. The most common reason given was that women’s roles within their communities – as mothers, grandmothers, family members, volunteers, workers, and professionals – left them with little opportunity or inclination to undertake the extremely demanding and time consuming role of negotiator. Most significantly, I was encouraged to reframe my understanding of negotiations to match communities’ perceptions. A theoretical elaboration of this perspective was found among the writing of Indigenous scholars, who emphasize the importance of taking indigenous cultural ways into account when analyzing indigenous peoples’

2. From fieldwork research interview, November 2001.

decision making processes and actions.³ These writings assisted me in getting a better grasp on what actually constitutes negotiations from a community perspective.

Self government negotiations are not an event: they are a process. They include formal negotiations between governments. They also include intensive consultation processes within communities, which occur between members, elders, and both, elected and “un-elected” indigenous leaders. The most important aspect of negotiations are the community consultations where critical discussions about the nature and shape of self government take place and people exchange knowledge and understandings toward creating a better future.

C O N C L U S I O N

By understanding self government negotiations from the perspective of the community, a greater emphasis is placed on community involvement. Community consultations are where women are heavily and significantly involved. While efforts must be made to bring more women to the negotiating table⁴, the choice to participate through community consultations must also be respected. If consultations cannot occur – due to lack of funding and resources – then women are effectively cut out of the negotiations process. The same is true of elders and youth.

3. For an excellent article on indigenous feminist practice and theory, see Lina Sunseri, 2000, “Moving Beyond the Feminism Versus Nationalism Dichotomy: An Anti-Colonial Feminist Perspective on Aboriginal Liberation Struggles”, *Canadian Women Studies*, Vol. 20, No. 2; and more generally, Taiaiake Alfred, 2000, *Peace, Power, Righteousness: An Indigenous Manifesto*, Toronto: Oxford University Press.

4. This argument is not to say the status quo is sufficient, but rather how to work with reality. How to promote the increased involvement of women in negotiating sessions as negotiators and staff is an issue best addressed by Indigenous women and communities.

The political culture of Indigenous communities is profoundly democratic and participatory. Unfortunately self government negotiations are funded by Canada in a way that fits a western model of political culture – where people delegate their responsibility to an anonymous person of only intermittent accountability. From my experience and observations, it is certain that for Indigenous governments, far more resources are provided for technical staff required for formal negotiations than for communications. Ensuring the participation of women in negotiations, and enabling negotiators to function effectively according to the demands of political accountability of communities, requires adequate resources for community consultation.⁵

Stephanie Irlbacher Fox is a lifelong northerner and currently Magdalene Donner Scholar in North American Studies at Magdalene College, Cambridge University, where she is completing a Ph.D in Polar Studies. She is also an advisor and resource person to Indigenous governments involved in self government negotiations in the NWT.

5. I would like to acknowledge the contribution of the many women I spoke with during my research on this topic, and NWT self government negotiators and leaders who spent time talking with me about this topic, particularly Bill Erasmus, Lois Edge, Bob Simpson, Danny Gaudet, Cathy Towtongie, Kim Thomspson, Julie Jackson and Elana Wilson.

H O R I Z O N

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