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FISHING IN CANADIAN ARCTIC MARINE WATERS: A NEED FOR NATIONAL POLICIES AND PRIORITIES

Terry A. Dick and Chandra Chambers

The lack of information in the Canadian Arctic Ocean on the species distributions, their densities, and their ability to respond to climate change has implications for the development of new marine fisheries and for ensuring that the current subsistence fisheries are sustainable. During 2004 several important reports were published which are relevant to arctic marine ecosystems and fisheries: *Arctic Climate Assessment Policy Document*[1], *Arctic Marine Strategic Plan*[2], *Proceedings of the Canadian Marine Ecoregions Workshop*[3], *A Strategic Framework for Nunavut Fisheries*[4] and *The Nunavut Wildlife Harvest Study*[5]. These reports are useful for some aspects of long term planning but their roles in developing strategies for implementation are less clear.

About 189 fish species have been reported from the Canadian Arctic Ocean but their distributions are incomplete and their densities unknown. The 2004 Strategic Framework for Nunavut Fisheries (SFNF) has identified marine fisheries and arctic char as the key areas for management and potential development. SFNF considered that a multispecies approach is needed to develop fundamental knowledge of Nunavut's marine resources. It identified several areas where research is necessary: marine ecosystems, assessing and modeling climate change impacts, research supporting inshore and offshore industry development, and research related to the conservation and domestic and commercial use of arctic char. Based on the *Nunavut Wildlife Harvest Study*[5] about 200,000 arctic char are consumed annually by residents.

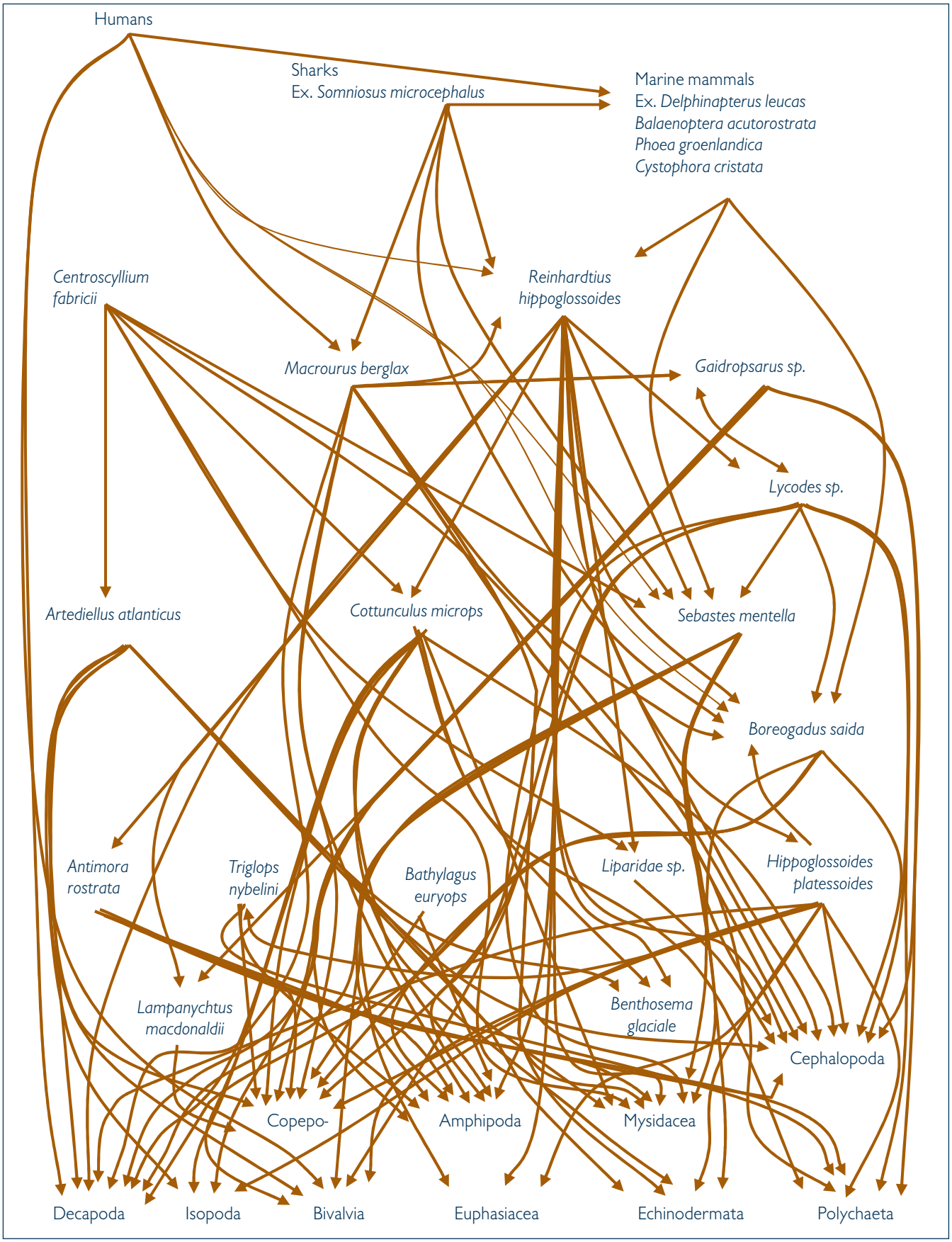
We have been conducting research on arctic marine food webs since 1999 and are particularly interested in by-catch species from the Davis Strait exploratory Greenland Halibut fishery, managed by the Department of Fisheries and Oceans, Central and Arctic Region. We are also studying the subsistence arctic char fishery at the Sylvia Grinnel River, near Iqaluit, and are especially interested in the freshwater marine interface and inshore fisheries.

Exploratory offshore arctic fisheries are currently operating despite the absence of

1. *Arctic Climate Assessment Policy Document*. 2004. Issued by the Fourth Arctic Council Ministerial Meeting, Reykjavik.
2. *Arctic Marine Strategic Plan*. Arctic Council, final draft September 2004, p.13.
3. Powles, H., V. Vendette, R. Siron and R. O'Boyle, 2004. *Proceedings of the Canadian Marine Ecoregions Workshop*, p.47.
4. *A Strategic Framework for Nunavut Fisheries*, 2004. Brubacher Development Strategic Inc. p.54.
5. Priest, H., and P.J. Usher, 2004. *Nunavut Wildlife Harvest Study*, p.821.

Canada

Figure 1
Preliminary marine food web of area 0B, Davis Strait.



an international or national strategy on arctic marine resource development, and new fisheries are being developed without sufficient information on biodiversity and fish resources. Improved baseline information and clarification of ecosystem indicators and reference areas are required before an ecosystem approach for managing arctic fisheries can be implemented.

Our studies in Davis Strait have expanded knowledge of arctic marine food webs by increasing the breadth and depth of knowledge of factors shaping arctic marine biological communities. A preliminary food web is illustrated in Figure 1 and represents a single food web for only one region (zone 0B) of the Davis Strait Region. From the food web it is apparent that *Reinhardtius hippoglossoides,* the turbot, feeds on variety of food items including Cephalopoda, Decapoda, Copepoda and Amphipoda and *Boreogadus saida.* Farther north in zone 0A (Figure 2) another food web has been constructed, which is less complex, indicating several food webs will be needed to understand the complexities of arctic marine systems. Nevertheless, this is a good start on food webs for the arctic marine environment but it needs to be placed in the context of the recent workshop on Canadian ecosystem regions (Figure 2).

Eight ecoregions have been identified for the Canadian Arctic, based on limited data, and can be compared to six ecoregions for the Canadian Pacific region and seven ecoregions for the Canadian Atlantic region. Use of a minimum number of indicator species, as part of the basis for designating ecoregions, is problematic. Some argue that correlations can be made between marine indicator species, such as the zooplankton Calanus finmarchicus, and climate, but often these relationships break down[6]. Clearly much more work is needed. We argue that more, not less, empirical data is required on arctic marine ecosystems as there is a paucity of information necessary to understand and predict change. One of the best ways to acquire some of this data

Figure 2
Eight designated ecoregions for the Canadian portion of the Arctic Ocean. Sampling regions in the Davis Strait area; Canadian 0A and 0B; Greenland (1A,B,C,D,E).

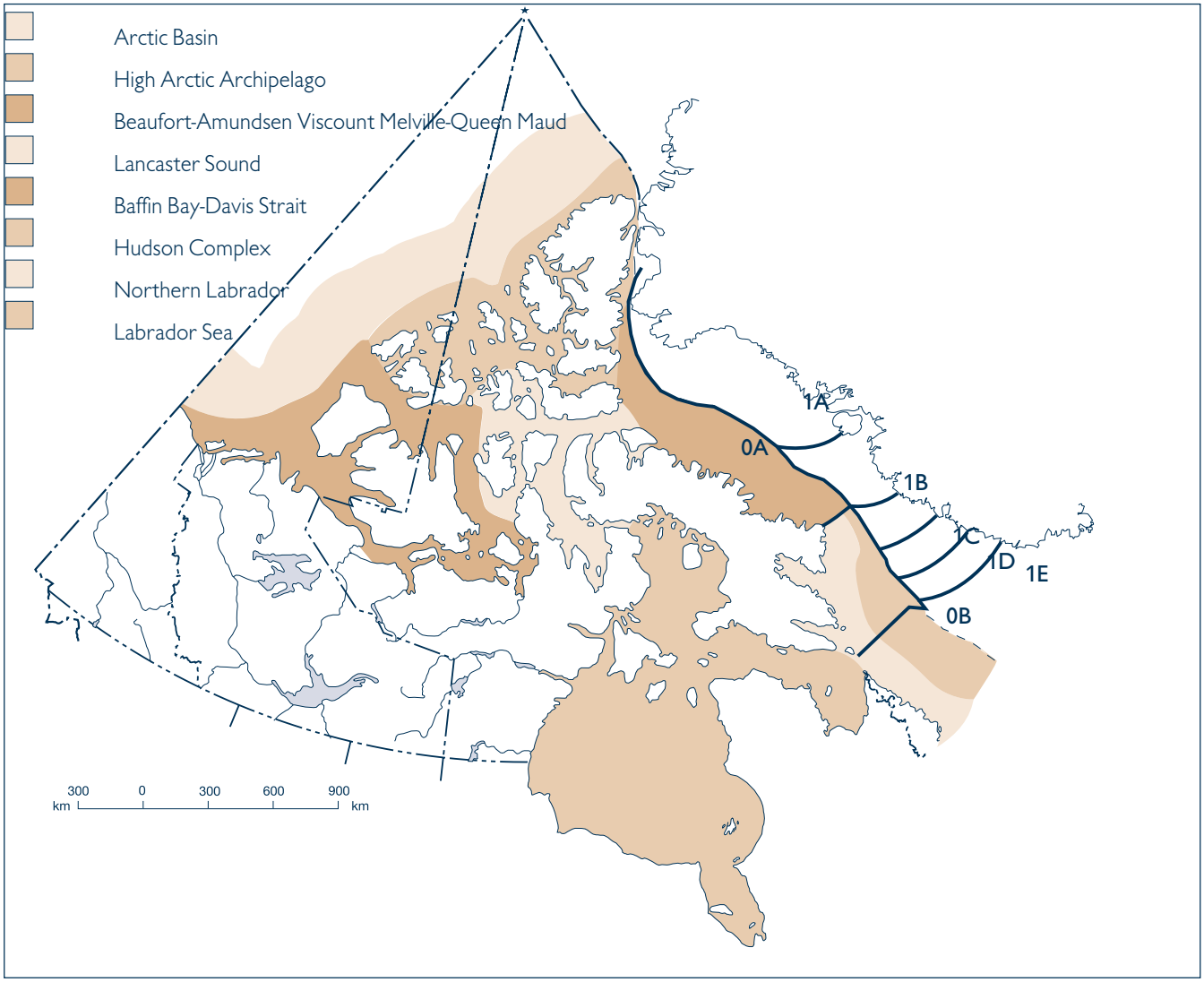


Figure 3
Commercial trawler used for the exploratory fishery in Davis Strait. Photo: T.A Dick.

is by working with exploratory fisheries where a wide range of abiotic and biotic variables can be monitored. This model has been successful in the Davis Strait exploratory turbot fishery where we work with a commercial fishing trawl (Figure 3), the Department of Fisheries and Oceans, and the communities.

In the inshore fishery arctic char is the key species for the subsistence fishery and for a few small commercial fisheries. Research on the subsistence char fishery (Figure 4) at Sylvia Grinnel River ocean interface (Figure 5) reveals that char are growing faster than in the past and this appears to be correlated with the earlier disappearance of ice. Today anadromous char populations in the arctic marine environment have little competition from other fish species for food during open water, and there is limited evidence of predation by other fish species. How char will respond to the invasion of fish predators such as Atlantic cod and Atlantic salmon is unknown, but freshwater char are poor competitors with either brook trout or lake trout. It is also known that char populations recover following intensive fishing as evidenced by our research at the Sylvia Grinnel River and estuary near Iqaluit. Physical changes such as loss of ice cover, changing flow patterns and temperatures, alien species invasion and/or range extensions and new commercial fisheries will affect communities that rely on these char for food. Surprisingly little is known about the physical changes (temperature, salinity, currents), fish movements, char feeding patterns and ecosystem

Figure 4
Subsistence fisherman removing an Arctic char from an inshore subsistence fish net. Photo: T.A Dick.

Figure 5
Marine freshwater interface, Sylvia Grinnel River, Iqaluit. Arrow points to the river and asterisk is the river/ocean interface. Photo: T.A Dick.

6. de Young, B., M. Heath, F. Werner, F. Chai, B. Megrey and P. Monfray, 2004. "Challenges of modeling ocean basin ecosystems." *Science*, 304: 1463–1466.

energetics at the freshwater marine interface. Much more needs to be learned about arctic inshore and estuary fisheries: food availability, competition for food, the influence of tides and ice conditions on char movements and growth, and sustainable fisheries models. These inshore and offshore fisheries must have direct community involvement as management decisions require considerable local input. While these interactions at the community level involve schools, colleges, northern research institutes and the local Hunters and Trappers Associations, emphasis should be placed on employment opportunities for the long term.

FUTURE DIRECTIONS

More financial resources need to be directed towards collecting baseline information on the biota, and particularly fish interactions with their environment. This is especially true for the Canadian Arctic Ocean as there has never been a mature fisheries sector with dedicated budgets and human and physical resources. The model of a commercial fishing vessel plus crew, with university scientists working closely with the Department of Fisheries and Oceans personnel and the communities to evaluate the potential for commercial offshore fisheries, in the context of a marine ecosystem management approach, has worked well to date. A bonus of using this model is that, in addition to obtaining important biological information, data relating to climate change can be collected prior to major fisheries development. This may be the most cost-effective way to accumulate offshore biological information in the Canadian Arctic and at the same time determine the extent of the fisheries resource.

At least three inshore vessels are needed as platforms to study inshore regions of the Arctic Ocean and the estuaries of the large rivers in relation to subsistence char fisheries and changes in the local marine/freshwater interface. The vessels should be located in the Eastern, Western and Central Arctic (Resolute Bay). They should be based out of the communities and need to be larger than the past research vessels *Calanus* (Figure 6) and *Salvelinus*[7]. They should be able to support small scale commercial fishing, benthic and pelagic sampling and physical data collection.

Figure 6
M/V *Calanus* was built in 1948 for the Fisheries Research Board of Canada. The wooden ketch was the research platform for Max Dunbar, who was instrumental in the vessel's design, and Edward Grainger, who undertook pioneering ecological studies of Eastern Arctic waters. The *Calanus* now lies deteriorating in Iqaluit. Photo: T.A Dick.

In summary, a focused, mutifaceted, and high priority national program is required to deal with the arctic marine ecosystem and its potential for fisheries and other marine resource developments. The lead agency should be Fisheries and Oceans with other government agencies contributing appropriate expertise in areas such as oceanography, climate change scenarios and so on. Furthermore, it is essential that the aspirations, traditional values and opportunities for education and employment of the Arctic communities form an integral part of this development.

Unless Canadians have a better understanding of their Arctic Ocean resources it is not clear how Canada can argue for a reasoned and methodical approach to development and at the same time negotiate international agreements concerning access to Canadian territory and resources.

Terry Dick is Professor in the Department of Zoology, University of Manitoba and NSERC Northern Research Chair. Chandra Chambers is a Ph.D. candidate in the Department of Zoology and a recipient of an NSERC northern internship.

Acknowledgements
We thank Colin Gallagher for preparation of the illustrations and Figure 5.

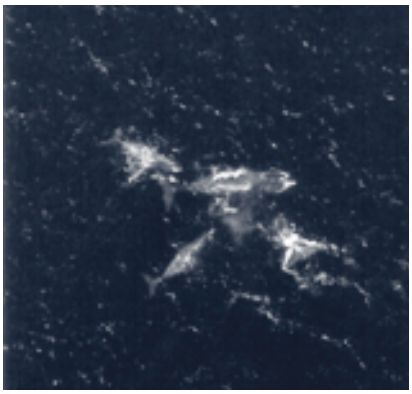
7. Dunbar, M.J., 1948. *Eastern Arctic Investigations*, Appendix VI, 62–63.

THE UNFOLDING STORY OF BOWHEAD WHALES IN CANADA

Sue Cosens

The bowhead whale (*Balaena mysticetus*) is a large baleen whale that starts life at about 3 to 4 m in length and grows to about 18 m or more. It derives its name from the bowed upper jaws that support the very long baleen plates (as long as 4.6 m in a large adult) used to filter zooplankton from seawater. Its head can be up to one third of its body length. Work done on bowheads hunted in Alaska has revealed that these whales mature at between 22 and 29 years of age and they are thought to live as long as 200 years. Adult females mature at a larger size (13–14 m) than do males (12.5–13 m). Females are thought to calve about once every four years. Their distribution is circumpolar, populations being found in the Sea of Okhotsk, the Barents Sea, the Bering, Chukchi and Beaufort Seas as well as in the waters of the eastern Canadian Arctic archipelago and in Baffin Bay and Davis Strait. Although bowheads once occurred as far south as the Strait of Belle Isle in Canada, they are considered to be an arctic whale.

In Canada, the relationship between people and bowhead whales extends at least 1000 years back in time when the Thule Eskimo culture, which relied heavily on the hunting of small bowheads, expanded from Alaska through Canada to Greenland. The Thule used bowheads for everything from food to building materials. Commercial whaling for bowheads in Canada dates back to the 16th century in the Strait of Belle Isle off Labrador. In the late 19th century, commercial whaling began in the Beaufort Sea. Bowheads were hunted first for their blubber and later for their baleen. By the early 20th century, bowhead numbers had been depleted to the point that whaling was no longer profitable. Despite protection measures introduced in 1935 by the Convention for the Regulation of Whaling, bowhead whales appeared to be rare as late as 1980, when they were listed as Endangered in Canada by the Committee on the Status of Endangered Wildlife in Canada. Today there are signs that numbers are increasing and that populations summering in Canadian waters are on the road to recovery. I have been fortunate enough to watch the story of bowheads in Canada unfold against a backdrop of political evolution in the Arctic and a growing relationship between science and Inuit traditional knowledge. It is a story worth sharing.



Bowhead whales

When I first began working at the Department of Fisheries and Oceans (DFO) in 1985, the bowhead whale was thought to have a tenuous hold on existence, especially in the Eastern Arctic. Surveys done during the mid-1970s and early 1980s, in places like Prince Regent Inlet and Lancaster Sound, found few animals and little evidence of calf production. By the early 1980s, a two-population model had been adopted for bowheads in eastern Canada. The Baffin Bay-Davis Strait population was thought to have a few hundred whales occupying high arctic waters in Canada in summer and overwintering off the west coast of Greenland and at the eastern end of Hudson Strait. The Hudson Bay-Foxe Basin population was thought to have as few as tens of animals, summering in both north-western Hudson Bay and northern Foxe Basin and wintering somewhere in Hudson Strait. The situation was somewhat better in the Beaufort Sea where there were thought to be at least 2000 whales.

Back in 1977, Canada was a member of the International Whaling Commission (IWC). At that time, concerns had been raised about hunting losses from the Alaskan Inupiat hunt which takes bowheads from the population that summers in the Canadian Beaufort Sea. The IWC proposed a ban on subsistence hunting, in addition to the ban already in place on commercial hunting. The Alaskan Inupiat objected, indicating that numbers were higher than what the IWC had estimated. Following a special meeting, the IWC allowed the resumption of a carefully managed hunt in Alaska under the condition that better assessment data be collected to estimate abundance. The North Slope Borough Department of Wildlife Management and the Alaska Eskimo Whaling Commission have since put much effort into assessing numbers and studying the biology of this population of bowheads. As predicted by the Inupiat, results showed that this population was more numerous than was expected and continues to recover. The most recent IWC estimates indicate that this population numbers about 10,000.

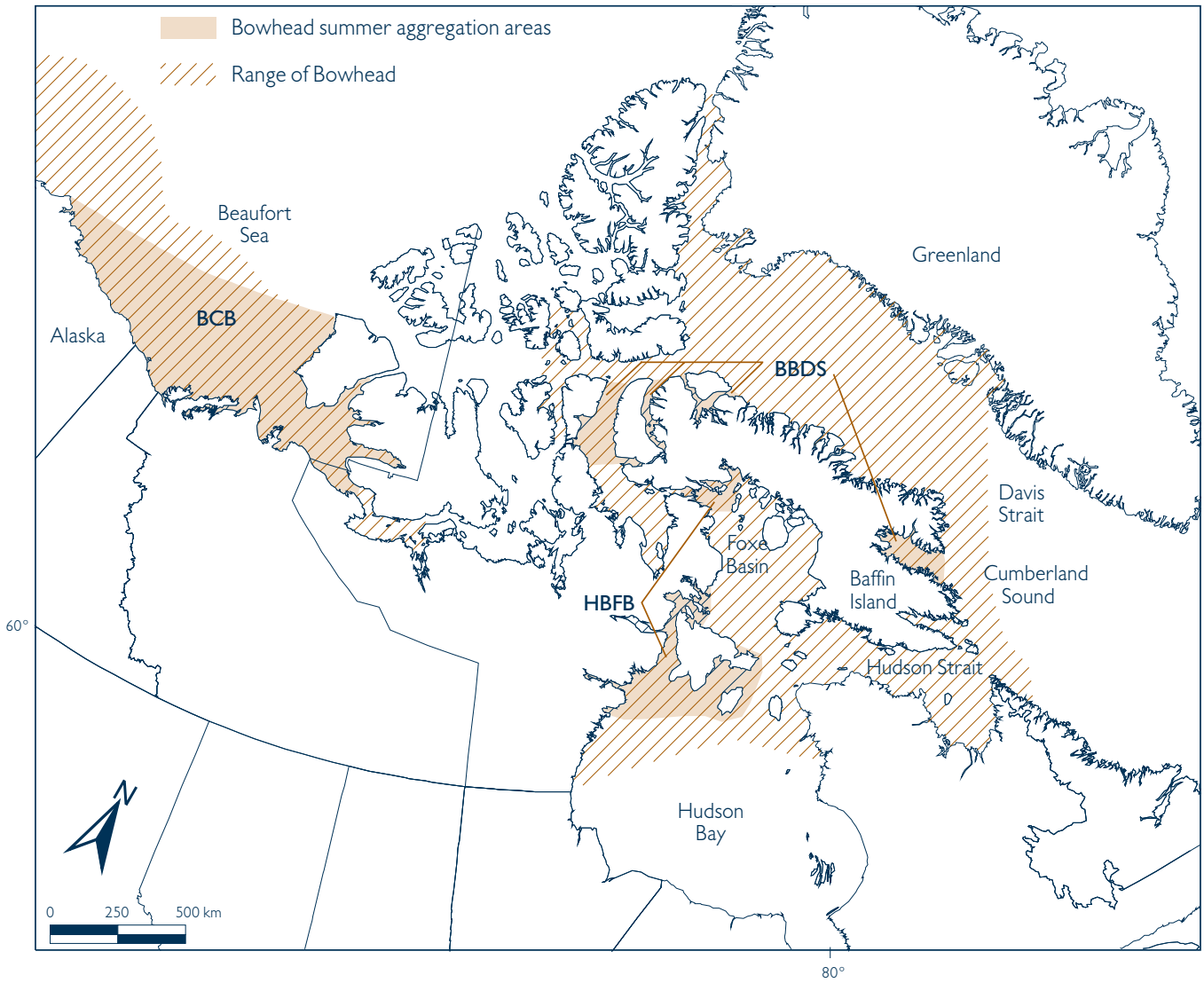
In 1979 Canada, in response to IWC concerns about low numbers of bowheads in both the western and eastern Arctic, began

requiring anyone wanting to hunt a bowhead for subsistence to apply for a licence. From 1979 to 1991, Canada issued no licences for bowhead whales either in the eastern or western Arctic.

In the 1980s and early 1990s, a number of political events set the stage for a renewal of subsistence hunting of bowhead whales in Canada. In 1982, Canada withdrew from the IWC because there was no further interest in commercial whaling in Canada. The same year, aboriginal rights to traditional sources of food became protected under the Constitution Act. The Inuvialuit Final Agreement was signed in 1984 and, by 1988, the Fisheries Joint Management Committee, representing the Inuvialuit in the Northwest Territories, was recommending to the Minister of the Department of Fisheries and Oceans that the Aklavik Hunters and Trappers Committee (HTC) be licensed to hunt a bowhead. In 1990, the Sparrow Decision confirmed the right of Aboriginal people to harvest for subsistence. In 1991, Aklavik received a licence to hunt one whale.

Meanwhile in the eastern arctic the Nunavut Land Claims Agreement was being negotiated. In the late 1980s and early 1990s, interest in a bowhead hunt had been increasingly expressed and Inuit hunters indicated that they believed bowheads were becoming more numerous. The Final Agreement both allowed a bowhead hunt and gave the Nunavut Wildlife Management Board (NWMB) authority to set a Total Allowable Harvest (TAH) for bowhead whales. In addition, the agreement required that a traditional knowledge study be done to document Inuit knowledge about bowhead whales. At that time, the Department of Fisheries and Oceans had no independent scientific data to comment on the possibility that bowhead numbers were increasing in the eastern Canadian Arctic. In 1995, prior

Bowhead summer aggregation areas and range



to the first licensed hunt in the Nunavut Settlement Area, DFO used Inuit traditional knowledge in addition to documented historical subsistence hunting rates to provide advice on a TAH.

Research on the Baffin Bay group of bowheads began in 1983 with the Whales Beneath the Ice program funded by World Wildlife Fund. Kerry Finley initiated a study of bowheads in Isabella Bay and spent many years documenting numbers, photographing individuals and studying their feeding ecology. In 1993, funds for research became available through the NWMB, formed when the Nunavut Land Claims Agreement was signed. DFO began collecting data in 1994.

We began by flying spring reconnaissance surveys from Igloolik Island south along the coast of Melville Peninsula to Southampton Island and Roes Welcome Sound. Later in the season, we experimented with a photographic identification project in northern Foxe Basin. The photo ID project was done in cooperation with Brad Parker of Igloolik who was very interested in working on bowheads. One encouraging result that came from that first year of study was the impression that there were more whales in northern Foxe Basin than we had expected to see. Fortuitously, Brad's budget included some money for air time and we did our first aerial survey. We estimated 270 whales in that summering area. This number surprised us, as it was much higher than the tens of animals we expected to document, and was the first glimmer that the bowhead situation might be more encouraging than had been thought. We eventually abandoned the photo ID project because we found that few of our whales had enough markings to be recognized if they were seen or photographed again. We soon discovered, by estimating body lengths from aerial photographs, that most of the animals in Foxe Basin were too young to have acquired many recognizable scars. This was also good news.

Since that first year we have expanded our program. In 1999, Tannis Thomas completed an MSc project on the behaviour of bowheads at the northern Foxe Basin ice edge. Larry Dueck, with help from local hunters, has completed a satellite-linked telemetry project in northern Foxe Basin and is now working on bowheads in Cumberland Sound. In conjunction with the tracking project, he has been working with John Iacozza of the University of Manitoba to look at remote sensing data of habitat parameters such as sea surface temperature associated with tagged whales. In cooperation with various communities, Larry has also collected skin biopsies from free ranging bowheads which have been analyzed for variability in DNA by Lianne Postma. Randy Reeves and I have looked at historical catches by age class in the Hudson Bay fishery and teams of observers, including Pierre Richard and Holly Cleator, have just completed a three-year aerial survey of summering areas throughout Nunavut to estimate abundance. In Canada many people, both inside and outside of DFO, including the communities of Igloolik, Hall Beach, Repulse Bay, Pangnirtung, and Kugaaruk have worked on various projects over the years. Outside of Canada, Mads Peter Heide-Jorgensen, of the Greenland Institute of Natural Resources, has been developing and putting satellite-linked tags on bowheads off the west coast of Greenland in early spring. These tags have provided data on spring, summer and fall movements.

The picture that is beginning to emerge from the various projects is complex. The telemetry work and distributional information is beginning to suggest that Baffin Bay-Davis Strait and Hudson Bay-Foxe Basin bowheads may, in fact, be a single population, segregated by age and gender. The distributional information suggests that the whales summering in Baffin Bay waters may be primarily adults while those in Hudson Bay, Foxe Basin and Prince Regent Inlet are cows, calves and sub-adults. The genetics results that we have so far suggest, however, that there are genetic differences between animals sampled in Baffin Bay waters and those sampled in Foxe Basin and Hudson Bay. We still have work to do to collect the information that will reconcile these different lines of evidence. Abundance estimates suggest that numbers are in the low thousands but whether these numbers should be assigned to one or two populations is not clear.

In addition to ongoing research activities, the bowhead has also been the subject of a Conservation Strategy developed by World Wildlife Fund, Fisheries and Oceans, and the Nunavut Wildlife Management Board. Now that the Species at Risk Act (SARA) has been passed, this strategy will be updated to meet the requirements of a Recovery Strategy under SARA. Habitat stewardship activities have also been undertaken in Igaliqtuuq (Isabella Bay), led by Ben Wheeler and funded by DFO, World Wildlife Fund, the NWMB, Nunavut Government and Kakivak Association.

The bowhead story in eastern Canada is still far from being completed. I look forward to continuing our research and conservation efforts to unravel the complexities of population structure and to promote the recovery of these unusual animals.

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UNDERSTANDING A POLAR BEAR'S NATURE

Else M.B. Poulsen

Nature selects for cross-species communication. The deer that does not understand what the wolf is doing when it runs circles around it and then crouches down to pounce is a dead deer. Likewise we need to listen to our gut when it tells us something about what another animal is saying in its body and verbal language. We forget that we are animals too.

In the 60s and 70s research psychologists, few of whom had in-depth experience with animals, were energetically teaching their students that animal thought and behaviour was in all ways radically different from that of humans. They dismissed the research of pioneering animal behaviourist Heini Hediger, whose extensive experience with animals began in the 1930s and whose ideas are now widely accepted by zoologists. I have spent the last 25 years working closely with animals, especially polar bears. I have found, like Hediger did, that animals feel as we do and work on problems as we do. Animals are simply adapted to a different environment, niche, or both.

Whether living in the wild or in captivity, the essential nature of a species remains the same. The best way to describe who animals are – in this case polar bears – is to tell the stories of their responses to whatever situations they find themselves in.

In 1976 a one-year-old cub came to the Calgary Zoo from Churchill, Manitoba. She was given the name Misty. She lived with Snowball, who was born at the Calgary Zoo in 1969, and her mother Kandy. Kandy, who came to the zoo as a cub in 1965 from Southampton Island, adopted Misty and acted as her surrogate parent, often making peace between the two siblings. Kandy died in 1990, leaving Misty and Snowball with just each other. Snowball was an outgoing bear who easily developed relationships with me and with other zookeepers. Misty let her look after the necessary dealings with humans, choosing to stay in the background and interact only with other polar bears.

When Snowball grew old she developed very painful arthritis. Eventually, in 1996, zoo staff felt that they could no longer offer her any quality of life and decided to euthanize her. The day before she was to be put down I had to bring her into the building and lock her inside. This was difficult for me, as I had worked with Snowball for many years and we had become good friends. I felt I was betraying her trust, and I wondered if she would ever have forgiven me had she understood. I locked her into a room with plenty of clean straw so she could spend the night comfortably, and stayed with her until I was afraid that my presence would make her suspicious and fearful. Then I dawdled and shuffled my way around, finding small jobs to do as excuses to stay nearby.

As I was leaving the polar bear viewing building I noticed Misty lying in the outside enclosure, on the other side of the solid metal door against which Snowball was sleeping. Perhaps she could smell Snowball

Misty pacing in the old fortress-like enclosure at the Calgary Zoo in 1984. The zoo's managers had this enclosure demolished when they realized that it was a poor environment for bears. Photo: Else Poulsen.

on the other side, since she could not see her. I knew Misty would never see her lifelong companion again.

I came to work early at 5:30 the next morning because I wanted to spend as much time as I could with Snowball before she was euthanized at 7:00. Walking past the outdoor enclosure I was astonished to see that Misty had not moved. She had spent the whole night keeping Snowball company, on the other side of the door. Misty had never done this before. The bears were used to seeing each other going into that room, as any bear to be anesthetised for a checkup or surgery was locked there over night until the procedure in the morning. I wondered if Misty somehow sensed that this time the outcome would be different.

When Snowball died she left Misty alone to deal with humans for the first time in her 20-year life. Although I was not her first choice for a companion animal she accepted me and I came to know and love her like a friend. I was very concerned when at the age of 25 she became very sick, often exhibiting severe stereotypies – repetitive behaviours – and daily seizures.

One day, as I watched anxiously, she had a bad seizure. As she lay on her left side in the enclosure, her leg muscles repeatedly straightened and tensed, then relaxed. Now she was motionless. I jumped over the public guardrail and crouched down by the fence where her back was resting. I could not see her breathing. Instinctively reaching out to her, I put my hand through the bars and placed it on her right shoulder. Misty snapped to life. She reared up her head and grabbed my hand with her mouth. At first she seemed very annoyed that something was touching her. Then her eyes focused on mine and her face softened, taking on a benevolent appearance. She looked at me as she might look at a cub that was behaving absurdly.

Misty sensed that I was worried about her. She let go of my hand and lay her head back down on the ground. I crossed my legs and sat in the snow next to her keeping her company as I would with any sick friend.

At the time my only fears were for Misty's life, as I thought she was going to die; but my staff told me later they had watched with their hearts in their throats, afraid I would lose my hand, my arm, or worse. Afterward I realized that while I had been aware that Misty had grabbed my hand and was holding it in her mouth, I had never actually felt her teeth or any discomfort. She must have just been gradually regaining awareness of her surroundings after the seizure when I touched her. Her sensitivity to my intrusion was remarkable.

Misty was euthanized several weeks later. She, Snowball, and Kandy had lived their adult lives in an 836-square metre cement pit enclosure with a 170,000-litre freshwater pool. Until the mid 1990s the bears were fed once a day in single piled feeds. They did not receive objects to manipulate, nothing to smell, destroy, or play with, and had no bedding material with which to make nests. As a result all three bears exhibited severe chronic stereotypies. Every day the public could watch the bears, each on its own pathway, pacing back and forth. For years this was a common scene in the zoo world, so common that the Dutch created the verb *ijsberen* – to "polar bear" – meaning to walk back and forth restlessly.

Today one might ask why any feeling human would allow the construction of sterile enclosures and develop substandard husbandry routines to care for these animals so obviously in distress. But the quality of care for any species depends on how much is known about the animal, and evolves as more information becomes available. You cannot meet that animal's needs if you know little about its natural environment and its genetic adaptations to that environment. Until recently, caring for polar bears was guesswork.

The absence of factual information meant other criteria took on gargantuan proportions. These included the need to secure the public from "killer" bears, and the need for the public to "feel" that the bears are in the wild, accomplished by creating cement icebergs and snowdrifts or painting arctic scenery on the enclosure walls. The old enclosures were so "secure" that their cement walls were four to six feet thick. Many of them cost a small fortune to destroy, since nothing short of a bomb blast would budge them. The public and zoo professionals may or may not have understood that cement icebergs and snowdrifts were experienced by the bears as cement, and murals of arctic scenery were not experienced at all.

Information on what polar bears actually did in the wild and how they adapted to their arctic niche was not available until the 1970s. The NASA space program indirectly helped biologists by developing clothing materials that made it easier to spend long periods in the polar bear's natural habitat and to dive in its icy waters. Important information on polar bears was published regularly and became available to the captive community. It became apparent that the reason polar bears were pacing, head-swinging, swimming in circles, losing fur (alopecia), killing each other on exhibit, and that mothers were suffocating their young, was that the environments and husbandry routines constructed for them did not work, and were in fact functionless to the point of severe cruelty.

Zoo managements responded to the new information in different ways. Some felt they had to justify the millions of dollars they had spent on the impenetrable cement forts. Theories such as "Polar bears walk great distances in the wild – they are pacing because they are genetically programmed to

The two females Nakita and Aurora in a natural environment enclosure at the Polar Bear Conservation and Education Habitat, Cochrane, Ontario.Photo: Gerry Robichaud.

do so", or "pacing is good for them: it's exercise" abounded. When I first started as a zookeeper I heard the "walking great distances in the wild" theory from senior keepers who were training me.

It is understandable why some zookeepers would choose to believe such theories. In old-fashioned zoos, zookeepers fed and cleaned the animals. They had no jurisdiction over the building of enclosures or the development of husbandry routines. Zoos were managed like most other organizations in those days: through a hierarchy. Zookeepers tend to become attached to their charges and need to feel that they are doing the right thing for their animals. If you have no control over buildings or routines and you have come to understand that you are harming your animals every day, then you need to commit yourself to make change. If you decide to make change you will likely lose your job.

Some zoos such as the Calgary Zoo took a more progressive approach and allowed zookeepers to make a difference. In 1994 Dr. Cam Teskey, a neuroscientist from the University of Calgary, joined a team of researchers including a zoo veterinarian and myself to assess the aberrant behaviours in Snowball. Our hypothesis was that she was exhibiting behaviours similar to human obsessive-compulsive disorder and that she could be successfully treated using medical therapy.

Prior to the this study we had set up an extensive enrichment program that included multiple daily feedings, varying food types, and presenting foods in puzzle-feeders, lunch bags and boxes. The bears were given materials so they could make nests, toys and objects to manipulate, and varying scents to smell. The enclosure was renovated to include natural climbing structures, boulders in the pool to vary depth and provide hiding places for live fish, and some natural substrate. Although Snowball and Misty responded to these changes by using what was offered, their stereotypies persisted.

The study's initial baseline data showed that Snowball paced a mean of 68.6% of her waking hours. In the treatment phase Snowball was administered fluoxetine. When dosages reached levels comparable to those administered to humans, her pacing behaviours stopped and she maintained normal polar bear behaviours. In the final phase, Snowball fully resumed her pacing behaviour 104 days after the last fluoxetine treatment.

In the study we conclude that it is essential to understand the neurobiologic aspects of stereotypical behaviours if we are to improve husbandry practices and abolish or minimize the causes of central nervous system dysfunction, not just treat the symptoms. Also, we advocate that pharmacologic treatment of stereotypies be used in conjunction with improvements in enclosure design and environmental enrichment.

Although there was no doubt that she

enjoyed and benefited from the improvements, Snowball's pacing habit remained unchanged by enrichment programming and enclosure redesign. This is because her stereotypy was completely divorced from its current environment. The initial stressor, now absent, had been a marauding male bear with whom she was forced to live some 20 years previously. But not all stereotypies exhibited in captive polar bears are so deeply entrenched that they cannot be eradicated by environmental and husbandry change. Many have a cause and effect relationship to their current environment. In November 2002 six polar bears were confiscated from the now notorious Mexican Suarez Brothers Circus in the U.S. protectorate Puerto Rico. All six bears had severe stereotypies.

Bärle, a female polar bear thought to originate from Churchill, was 19 years old when she was rescued from the Suarez Brothers Circus and placed at the Detroit Zoological Institute, where I was working at the time. What immediately struck me was how calm she was even though she had just travelled from the south in a huge airplane and then been transferred to a zoo truck and driven to our hospital. We asked her to leave her crate and move into the quarantine rooms which, amazingly, she did with little hesitation. Circus animals are used to a lot of noise and disturbance around them. I suspect that she moved so quickly from the crate into quarantine to avoid getting hit, prodded, and poked. She had no way of knowing that we did not use negative reinforcement at the Detroit Zoo. She was there to be rehabilitated and would never be asked to perform another trick, nor would she be hit, yelled at, or in any way intimidated again. Only time could communicate that to her.

Our quarantine rooms were adequate but not great – better ones were under construction – but Bärle would only have to stay in them for 30 days. Then she would move to the new Arctic Ring of Life facility where she would be able to come and go as she pleased, socialize (not perform) with other bears, and experience natural substrates and enriched environments.

While the quarantine rooms may not have reached our standards they were far superior to her living conditions for the past 17 years. The quarantine space was 20 times larger than what Bärle had been living in at the circus. It was clean. She had been given a whole bale of fresh straw, fluffed to make a bed for her. She had clean fresh water, grapes, peanuts, chow, and fresh herring. Bärle left her crate and walked into the quarantine area and all the way down to the end of the hall where the giant pile of fresh straw was. She stood for a moment and stared at the straw. She carefully touched it with her lips and gingerly placed a paw in the pile. She rummaged through the pile a bit and suddenly began to throw the straw in the air in an explosion of joy. She had a smile on her face when she threw herself onto her left side in the middle of the straw pile. With her right paw she shoved extra straw under her head for support and fell asleep instantly. It was midnight. Our new charge was safe and sound, so we turned out the lights and went home. Bärle slept for two days.

Polar bears do indeed smile. They smile for bear reasons – when they are enjoying their food, their toys, other bears, when they are given attention, when their cubs are doing funny things, and when they are breeding. They smile like we do: the sides of their mouths turn up, sometimes causing the face to lift and producing little laugh lines beside the eyes. The large muzzle makes it difficult to see the smile – you have to crouch down or turn your head upside down to see it.

After Bärle's two-day sleep I began assessing her abilities and understanding of her environment. She did not move around much in her enclosure. I called her name: she did not respond. I knew she could hear me because her ears turned very slightly in my direction. Animals that have been neglected and abused tend not to respond when humans call. Why would she respond? Until now humans did not offer her anything worth responding to.

To help her get used to her new surroundings Bärle and I needed to develop a relationship that she considered worthwhile. Next time I called her name I threw a grape in front of her nose. She noticed the grape, examined it carefully with the tips of her lips, and ate it. From her investigation of the grape I would say that she had never received grapes at the circus. The only information that we could get about her was that she had been fed dog food and bread for the last 17 years. The next time I called her name, she very slightly turned her head to look at me. I threw her many grapes as a reward for responding. By the end of that day she was looking at me when I entered the room.

The next step was to get Bärle to get up off the straw and come over to see me. She needed to become accustomed to moving from one room to the other, and we needed to assess her gait. She had been lying down so much we were concerned about her health. Armed with grapes and peanuts, I called her name. She looked at me and I tossed many grapes a short distance away from where she was lying. I expected her to get up, walk over to the treats, and begin to eat. She surprised me by getting onto her elbows and knees from her lying position and crawling over to the treats. I assumed that was because it was a short distance. Again I called her name and she looked at me expectantly. This time I tossed the treats very close to the fence where I was standing.

Again Bärle surprised me. On her elbows and knees she crawled the 12 feet from the straw bed to the fence and ate her treats. For the last 17 years, when Bärle was not performing, she was lying in a 5 by 8 foot circus crate. Sadly, there was no need to get up and walk to anything – all she could do was crawl over. It took Bärle a couple of tries to figure out that crawling over to me was far more cumbersome than just getting up and walking over. Within a few days Bärle had understood that I always had grapes and gave them out freely when she came over. She would follow me as I walked along the fence into the next room where we could lock her temporarily while her bedroom was being cleaned.

In order to give Bärle a better diet we began to introduce her to new foods. First was raw herring. I tried to hand her one through the fence. She would not take it in her mouth, so I placed it in front of her on the floor. She gingerly put her nose down to it, smelled it, and looked at me. She seemed puzzled, as if to ask, "Am I supposed to eat this?" She did not touch it or any of the other kinds of dead fish that I offered her. I decided I needed to lock into that bit of genetic programming that told her to kill and eat moving things – if indeed she had this information in her genes.

I retrieved six live rainbow trout from our trout pool and placed them in a tub of water for her. Bärle knew they were there, as she could hear them splashing and had briefly watched them swim and then ignored them. In desperation I took one wiggling, gasping trout and placed it on her enclosure floor. That got her attention. Bärle slowly came over and watched with great interest as the poor fish flopped around. She lay down next to the fish and watched. It stopped moving so she touched it with her nose, and it began flopping again. She seemed amused by this and smiled. Finally, she took the fish in her mouth but it was slippery – it moved and fell back out. Then she grabbed the trout by her teeth and killed it. Gingerly she stripped the skin off and ate part of the meat. After this we were able to interest her in eating fish and other meats and fats.

Because Bärle had lived in such a deprived environment, everything was new to her. After the quarantine period we moved her to the Arctic Ring of Life facility where there were other polar bears and a complex environment to fill her senses. Before introducing her to the resident polar bears she needed to understand the layout of the facility. First we brought her to the "tundra" enclosure which was an acre of vegetation, soil, rocks and a freshwater pool. Staff gathered to witness this momentous occasion. Bärle had not set foot on grasses since she was two years old. We opened the door and let her go at her own pace. It took her about five minutes of consideration before venturing outside. Stepping on grass and soil felt odd to her as she placed each foot carefully onto the ground. She was smiling as she bent over and picked up a twig, which she kept in her mouth all day as she investigated her natural surroundings.

Bärle's knowledge grew in leaps and bounds after that. She was introduced to the females one at a time and she learned how to interact with other bears. Even though she had been with other polar bears at the circus they had never been allowed to interact with each other in a normal way without interference from humans. We introduced her to Sissy, our most relaxed female, first. This was a good thing. In her cub-like innocence Bärle walked right up to Sissy and asked to play. Adult bears show reserve when introducing themselves, which Bärle learned when Sissy responded with an unfriendly huffing and jaw-snapping gesture and walked away. It became obvious that Bärle's social growth had also stopped when she was placed in the circus. As she met each new bear she became more sophisticated in her knowledge of proper polar bear introductory behaviour.

The last bear that we introduced her to was Triton, a 1,100 lb. playful four-year-old male. This was an introduction that particularly concerned us because the male bears with whom Bärle had worked in the circus would attack her when given a chance. This attack behaviour was less likely a normal response to a female's presence and more likely a release of tension from the males' fear of the trainer's negative reinforcement tactics such as yelling and using cattle prods and whips etc. In the circus environment Bärle was never given behaviour options. At the Detroit Zoo she was always given choices. She saw Triton go outside onto the tundra enclosure with the other females, and then was given a choice as to whether or not she wanted to join them. She pondered this for seven minutes at the door, then moved outside.

Once on the tundra Bärle went about her business opening enrichment boxes, eating the treats they contained, and manipulating objects, while always keeping an eye on Triton's location. Triton immediately noticed Bärle's entrance and he broke into what human observers could only describe as a big goofy grin. He too wandered about the enclosure, exhibiting displacement behaviour (doing one thing while considering another). About 20 minutes into the introduction Triton had an idea. He would introduce himself by offering a gift. He took a very large tree branch in his mouth, slowly walked over to Bärle, and placed the branch about 5 feet from her face. Bärle looked at Triton and the branch, then continued to pretend interest in her enrichment box. In response Triton picked up the branch and placed it closer to her nose. This time Bärle smelled the branch and carefully inspected it

with her lips. Triton, pushing his luck, moved around the branch to Bärle and attempted to smell her behind. Bärle reared up and backed away, jaw-snapping at him. Triton left the scene hanging his head. He investigated some enrichment items but was apparently still planning an introduction. A few minutes later Triton brought the entire tree over to Bärle and crashed it down in front of her. A little startled but evidently not displeased, as she was smiling, she ignored the tree and Triton. He must have been somewhat concerned since he had a furrowed brow. He responded to Bärle by again picking up the tree and shoving it closer to her face. This time Bärle gently inspected the tree and tested it with her lips. Again Triton pushed his luck and attempted to sniff her hindquarters. Again Bärle thwarted his attempts, but not as angrily as the first time. It was official – they were courting.

Over time Triton and Bärle bred. She became pregnant, denned up, and gave birth to one cub which she is currently raising herself at the Detroit Zoo. Staff have set up live cameras to monitor their progress, and parts of the video can be viewed at www.detroitzoo.org. When Bärle was rescued from the circus she was cub-like, innocent to the complexities of normal living. Her rehabilitation to the point where she is able to raise a cub is remarkable and speaks to a bear's tremendous will to survive.

Bärle's story is one of many showing that the best way to deal with stereotypies is to prevent them. At the Polar Bear Conservation and Education Habitat in Cochrane, in Northern Ontario, we offer rescued polar bears – non-releasable polar bears from sub-standard zoos, circuses and private owners, and orphaned bears from the wild – five acres of natural habitat, plus several pools. In this environment polar bears can express normal adaptive behaviours such as digging a den into the hill to weather out a blizzard, or gathering up all the pieces of a moose carcass and guarding it by lying on top of the pile and trying to stay awake all night. Here, polar bears can be what they are: opportunistic, intelligent, gentle, tough, nasty, playful, loving, and spirited.

Else M.B. Poulsen is General Manager and Head Zookeeper at the Polar Bear Conservation and Education Habitat in Cochrane, Ontario.

CLIMATE CHANGE AND LANDSLIDES IN THE ALASKA HIGHWAY CORRIDOR, YUKON

Crystal Huscroft and Panya Lipovsky

INTRODUCTION

Climatic factors play a central role in present day slope stability along the Alaska Highway corridor in the Yukon. Most landslides in the region are related to river migration, intense summer rainfall, rapid snowmelt, forest fires and permafrost degradation, all of which are subject to significant changes in frequency and/or magnitude with changes in climate.

A recent study conducted by the Yukon Geological Survey described the settings, causes and geological controls of landslides in the Alaska Highway corridor, and provided an estimate of how climate change may affect landslide activity there. This article consists primarily of excerpts from the study, and emphasizes the potential impacts of projected climate change on landslide processes in southern Yukon.

THE ALASKA HIGHWAY CORRIDOR

The 1000-km Yukon section of the Alaska Highway corridor extends from the British Columbia-Yukon border near Watson Lake in southeastern Yukon, to the Alaska-Yukon border near Beaver Creek in west-central Yukon (Figure 1). It encompasses the valleys and mountain ranges adjacent to the Alaska Highway and a proposed Alaska Highway pipeline route.

The corridor is critical for transportation, settlement, tourism and resource development in Yukon. The Alaska Highway is the main land-based transportation corridor connecting Yukon, Alaska and western North America. Over 80% of the 315,000 tonnes of goods annually shipped into the Yukon move along the highway, 85% of Yukon's population live within the corridor, and 70% of tourists visiting the Yukon travel the highway. A proposed railway and a pipeline linking the Alaskan natural gas reserves near Prudhoe Bay to the Midwestern United States may boost future settlement and infrastructure in the corridor.

The corridor spans diverse geologic, geomorphic and climatic environments. The Alaska Highway traverses varied physiographic regions, from the Liard Lowlands in the east, to the rounded uplands of the Yukon Plateau in central Yukon and the

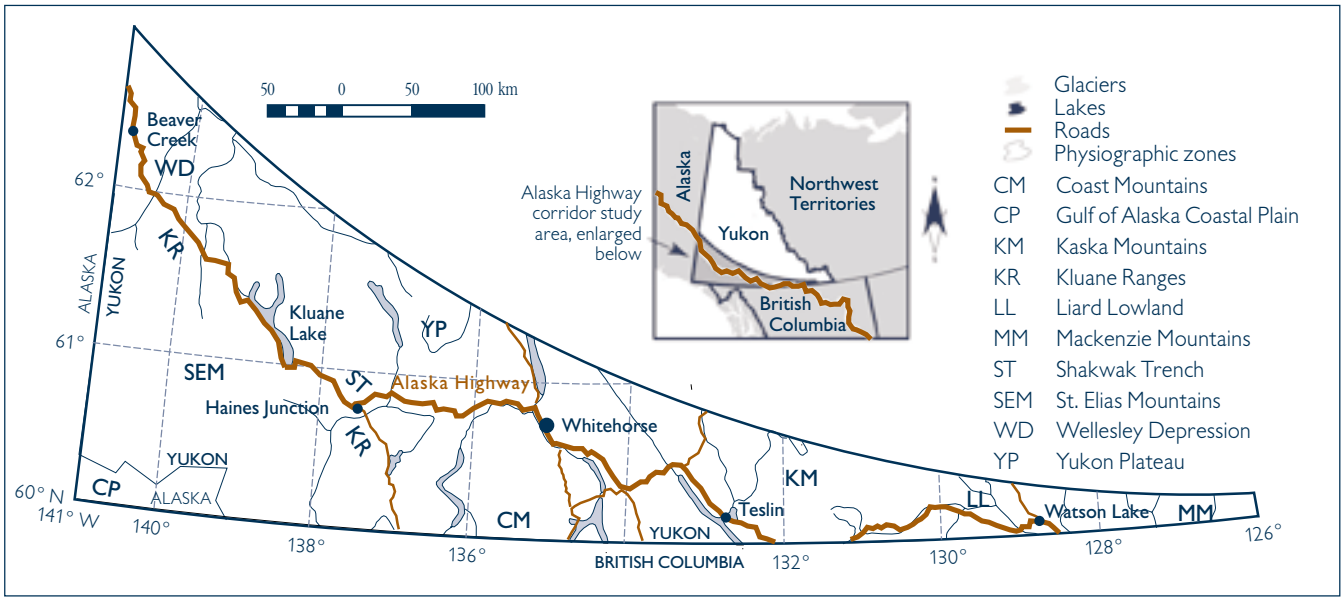

Figure 1

steep rugged mountain ranges of the St. Elias Mountains in the west. Surficial geology along the corridor is heavily influenced by the several periods of glaciation that occurred in the last two million years; most hillslopes have a surface layer of till and colluvium, with extensive glacial lake deposits in many valley bottoms.

The corridor is underlain by discontinuous permafrost. Local climate, vegetation cover, aspect, surficial materials, hydrologic conditions and snow depth all affect permafrost distribution. The corridor's subarctic continental climate means long, cold winters, short mild summers, low relative humidity and low to moderate precipitation. Local climates vary significantly with distance from the Pacific Ocean, mountain influences, and local temperature inversion patterns.

LANDSLIDES AND THEIR POTENTIAL IMPACTS

Landslides – the mass movement or gravitational, downslope movement of rock, debris or earth – signficantly alter landscapes, and are capable of damaging property and habitat, and potentially causing injury or death. Linear developments like highways and pipelines that flank potentially unstable slopes are particularly at risk. Landslides can suddenly sever, bury and block roads, bury buildings and undermine their foundations or fill, and cause pipelines to buckle or rupture. They can cause loss of nutrient-rich soil, enhanced surface erosion, stream scouring and stream sedimentation, all of which can damage fish and wildlife habitat. Landslides can have severe consequences for communities whose economies rely on regional infrastructure and ecosystem integrity.

Most landslides are related to the presence of shallow bedrock or permafrost, unconsolidated sediment on steep slopes, weak bedrock, groundwater hydrology, river erosion or the degradation of ice-rich permafrost. In permafrost terrain, two unique landslide types are found: active layer detachment slides and retrogressive thaw slumps. Active-layer detachment slides occur where a shallow permafrost table prevents drainage and acts as a slip plane. Retrogressive thaw slumps involve the initial exposure of a steep frozen headscarp (by human or natural disturbance) from which thawing material continually flows away.

Intense rainfall, rapid snowmelt and seismic events can trigger landslides. Debris flows triggered by intense prolonged rainfall have historically posed the highest risk to low-lying regions and have significantly damaged transportation routes and recreational areas within the corridor.

CLIMATE CHANGE PROJECTIONS IN SOUTHERN YUKON

Knowledge of anticipated climate change is still only sufficient to characterize the direction, not the magnitude, of future climate trends. Figure 2 summarizes the range of climate change projections based on global circulation models (GCMs) for southern Yukon over the next 50 years. Although each scenario projects a slightly different set of future conditions, all projections share two common themes. First, air temperature will rise, with more warming in winter than in the summer. Second, precipitation will increase, most likely in winter and spring.

These are regional generalizations; local projections are less certain. Complex local

Figure 2

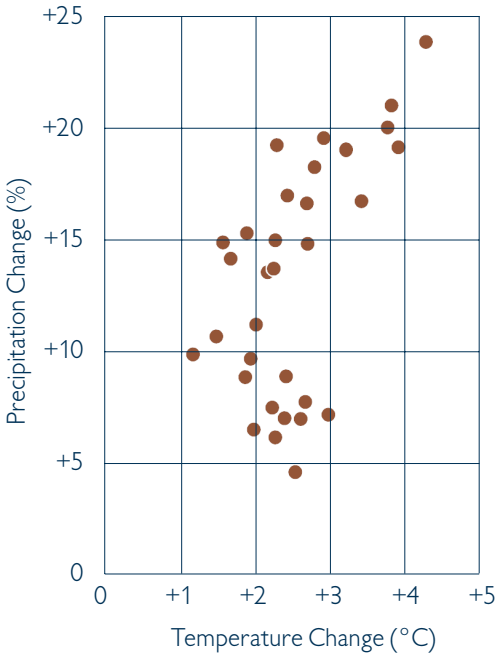

Figure 3

conditions, unaccounted for in GCMs, can change the many climatic factors that determine permafrost stability and rainfall patterns. For example, the geometry and orientation of individual valleys influence the local effect of winds on snow depth as well as the establishment of temperature inversions. The seasonal timing of precipitation also affects how much precipitation falls as rain and how much falls as snow. All of these factors strongly affect permafrost distribution and related landslide activity.

In addition to seasonal climatic trends, individual extreme events like forest fires and intense rainstorms also affect landslide activity. In its third Assessment Report (2001), the Intergovernmental Panel on Climate Change concluded that more intense precipitation events are likely around the world. This could mean that more cyclonic activity in the Gulf of Alaska would penetrate through the St. Elias Mountains to the corridor, bringing more frequent rainstorms or warm spells.

IMPLICATIONS OF CLIMATE CHANGE ON FUTURE LANDSLIDE ACTIVITY

Snow Melt and Rainstorm Events: Heavy rainstorms and intense periods of snowmelt quickly saturate the ground, triggering many landslides in the Alaska Highway corridor (Figure 3). Slopes subject to groundwater and runoff concentration (such as in gullies, or where shallow permafrost and bedrock impede drainage) are most vulnerable to rainstorm and snowmelt-triggered failures, provided an adequate supply of unconsolidated materials exist on the slope. We can therefore expect more landslide activity in these settings if climate change leads to more frequent or more intense precipitation, increased snowpack, and/or intense periods of warm weather.

Permafrost Degradation: The anticipated future climate conditions will likely lead to a gradual warming of permafrost, a deepening of the active layer (the upper layer of permafrost that freezes and thaws annually), and a decrease in the areal extent of permafrost throughout southern Yukon. The rate of such regional permafrost degradation and the precise response of permafrost at a given site will depend on local conditions such as soil moisture, snow cover, vegetation cover, and ice content of permafrost at the base of the active layer.

Permafrost plays an important role in landslide activity in the corridor because it controls soil moisture, strength and drainage. When ice-rich permafrost thaws it increases soil moisture and the supply of unconsolidated materials, while the impermeable shallow permafrost table restricts drainage.

The effect of permafrost degradation on slope stability depends on the ice content of the permafrost. High ice contents are characteristically found at the base of the active layer within silt-rich tills and lake sediments throughout the corridor. In these settings, ground warming leading to the deepening of the active layer will likely increase the frequency of active layer detachment failures

due to increased soil moisture and loss of soil strength. In contrast, where sediment is not ice-rich, deepening of the active layer may actually improve drainage and reduce the likelihood of snowmelt- and rainstorm-induced failures.

The impact of permafrost degradation may be especially acute on the alpine slopes of the Kluane Ranges, where ice-cored moraines, rock glaciers, buried river icings and ice-rich colluvium are all commonly found in the upper catchments of the region. Because permafrost provides much of the soil strength in these periglacial settings, its degradation could cause extensive slope failures. This would increase sediment and channel instability to the large alluvial fans which drain the Kluane Ranges into Kluane Lake, crossing the Alaska Highway and pipeline right of way.

Fire Frequency: Current estimates of forest fire frequency in boreal forests range between 30 to 500 years; in the last 20 years, the annual burn area in Canadian boreal forests has doubled. In Yukon, it is uncertain whether increased precipitation will be sufficient to offset the drying influence of increased evaporation in a warmer climate. Models predict that forest fires in Canada will increase in size by 40% and in severity by 46% for a climate with twice the current carbon-dioxide levels. Increased regional aridity, drier fuel, more lightning strikes, and changing wind patterns all contribute to the increased likelihood of forest fire activity.

More and bigger fires will mean more landslides in the Alaska Highway corridor (Figure 4) as forest fires lead to reduced evapotranspiration and permafrost thaw, both of which increase soil moisture. Permafrost thaws rapidly following a forest fire because ground thermal conductivity can increase by up to ten times with the destruction of organic mats, and surface albedo may decrease by 50% with reduced shading from vegetation and darkening of the ground by charcoal. Increased runoff resulting from the lack of live vegetation and evapotranspiration promotes gully erosion and concentrates water in new channels, setting up more slopes for potential failure.

River Migration: Increased channel instability can be expected if global warming causes changes in the amount and timing of precipitation, snowmelt, or sediment supply to streams. Enhanced bank erosion rates may occur as rivers adjust their gradients to accommodate changing flow levels and sediment loads.

Bank erosion frequently leads to slope failures. Channel migration causes oversteepening and undermining of river banks and terrace slopes and has historically initiated numerous debris-slides and -flows throughout the corridor. Where rivers migrate through permafrost terrain, the exposure of ground ice in eroded banks and the removal of insulating streamside vegetation causes retrogressive thaw slumps. Therefore, if climate change causes enhanced river migration, debris flows, slides, and retrogressive thaw slumps in the corridor will also increase.

Glacier Mass Balance: The impact of climate change on glacier extent in the region is expected to be complex. The location and size of glaciers and perennial snow patches in any area is determined by the amount of annual snowfall and summer temperatures. Despite the expected warmer temperatures, snowfall will likely increase and cause most glaciers in the study area to advance.

Glaciers and snow patches with low-elevation accumulation zones, however, would likely recede or disappear completely. Locally, this retreat may lead to increased landslides because of the exposure of previously ice-covered sediment on steep slopes or the unloading of rock slopes. Newly exposed sediment is especially vulnerable to debris flows because it is unvegetated, forms steep slopes, and may be ice-rich or ice cored. Glacier recession may also debutress rock slopes and cause slope instabilities ranging in size from deep-seated failures of valley walls to small-scale rock falls.

Although there are few glaciers directly adjacent to the Alaska Highway corridor, many glacially fed streams drain into it. Therefore, the direct impact of increased landslide activity due to glacial recession would be mainly restricted to upper catchments in the Kluane Ranges. However,

Figure 4

increased landslide activity would likely supply more sediment for subsequent fluvial transport, leading to increased channel migration in rivers and on alluvial fans which cross the corridor.

CONCLUSION

Climatic factors are critical to slope stability along the Alaska Highway corridor. Climate change will likely have the greatest impact on landslide processes where climatic and thermal factors control the strength and availability of material that is subject to failure. The classes of landslides most strongly influenced by climate are active-layer detachment failures and retrogressive thaw slumps. An increased frequency of rainstorm- and snowmelt-triggered debris flow events may be moderated by the availability of material for transport.

At a regional scale the most significant impact of climate change-related landslide activity may be increased sediment inputs into drainages, leading to increased channel instability further downstream. This would be particularly acute on alluvial and colluvial fan complexes along Kluane Lake where highway maintenance is already a challenge.

Existing infrastructure will likely suffer continued direct impacts from permafrost-related landslides, the extent of which will depend on the degree of long-term climate change, seasonal climatic variability and fire frequency. Where there are ice-rich soils on sloping ground, anthropogenic or forest-fire related removal of ground cover will almost certainly either initiate new failures or accelerate the rate of pre-existing failures within a very short time frame (1–10 years).

The Alaska Highway corridor is critical to settlements, tourism, economic development and transportation in Yukon, and is the focus of several proposed development projects. Risks to future development can be minimized only by thorough management plans that carefully identify and avoid sensitive terrain subject to landslide hazards and permafrost degradation.

Several aspects of slope stability require further work before a course of action for the management of landslide hazards in the Alaska Highway corridor can be implemented and an informed regulatory policy drafted to ensure safe, economic and sustainable development in the Alaska Highway corridor.

The distribution, ground ice characteristics and ground temperature of permafrost on the hillsides and mountainous terrain adjacent to the Alaska Highway remain largely unstudied. Detailed permafrost investigations and mapping are urgently needed to support land-use planning, environmental assessments, cumulative effect assessments, fire-management, development regulatory policies and determination of permafrost landscape sensitivity to climate change.

A regional landslide inventory or database also needs to be established and maintained to characterize the range of geological conditions susceptible to the various landslide processes operating in the region. The database should also incorporate temporal and climatic information to aid in defining the relationship between the occurrence of slope failures and annual or seasonal climatic variables. The relative importance of landslide-triggering factors such as the rainstorm intensity and duration could then be ascertained. Unfortunately, recording relevant climatic factors is difficult due to the limited number of weather stations in the corridor, particularly in mountainous environments.

Panya Lipovsky is a geomorphologist at the Yukon Geological Survey in Whitehorse, Yukon. For the duration of this study, Crystal Huscroft was also at the Yukon Geological Survey. She now instructs at the University College of the Cariboo.

Acknowledgements

Much of this article was modified from the Yukon Geological Survey's fully referenced Open File 2004-18, which is available for free download (43.7 Mb) in portable document format (pdf) from www.geology.gov.yk.ca/publications/openfile/2004/of2004_18.pdf (this does not include the interactive CD-ROM).

Hard copies are available for $5 (report only) or $35 (report and interactive CD-ROM containing GIS data, digital photos, field database). This and other Yukon Geological Survey publications, may be obtained from:

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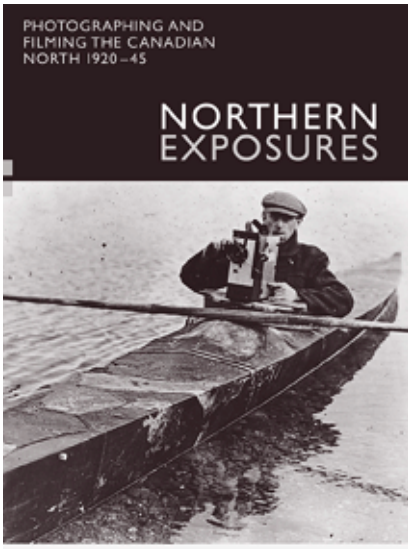
BOOK REVIEW: NORTHERN EXPOSURES

Jim Burant

Northern Exposures: Photographing and Filming the Canadian North, 1920–1945, by Peter Geller. University of British Columbia Press, 2004, 256 pages. Illustrated with 86 photographs (ISBN: 0774809272).



The North exerts a powerful pull on everyone who visits there, and sometimes affects them in unusual ways. The Governor-General, Adrienne Clarkson, was recently quoted as saying that "[The North] is a mythological problem and it is something that we have to understand. If we know – and we do know, intellectually – that the North is part of our country and that we go right up to the North Pole and yet you never see it, it is like living in a house with a phantom. It is like saying this doesn't really exist, except it exists" (*Ottawa Citizen,* November 24, 2004). Her husband, John Ralston Saul, suggested during the same interview that more Canadians should forego a Caribbean holiday and instead fly north in a 30-year old Hawker-Siddeley to spend a couple of days in a co-op hotel on Baffin Island (not an idea that most winter-bound Canadians are likely to go along with!). Prime Minister Paul Martin's remarks about the possibility of provincial status for the northern territories, made during a state visit to Brazil in November, were enlarged into a feature article on "The Notion of North" in the same newspaper on December 4, 2004.

But for all of us who haven't been to the North, do we have a notion of North? How do we buy into the North as part of our collective psyche – the "Idea of North" (as Glenn Gould presented it), the North as a "binding force" in nation-building (according to former Governor-General Lord Tweedsmuir in 1937), or Pierre Berton's "Mysterious North"? How has the North entered into Canadians' collective thinking, and what has made it real to us?

Part of the answer, I think, lies in the massive output of visual material about the North which exists, and which has permeated our collective thought processes about the North since the mid-19th century, what Peter Geller refers to as our "photographic and filmic" past. Although the search for Franklin's expedition was widely documented in works of art, especially prints, the use of the newly-discovered technology of photography in Northern exploration began as early as 1853, when British naval officer Edwin Augustus Inglefield brought a camera and glass plates on board the H.M.S. *Phoenix* during his summer search for information about the fate of Franklin. Although very few of his plates ever turned out, he did set an example for later visitors to the Arctic. The rest, one can say, is history. Canadians' visions of the North are tied as much into the early photography of the Geological Survey of Canada, beginning in 1860, as they are into the present-day photography of such practitioners as Fred Bruemmer and Hans Blohm. The millions of photographs and hundreds of thousands of feet of film which have been taken in the North explore every facet of human and natural existence.

But this mass of photographic and cinematic images is difficult to master without some sort of iconographic road-map. What meaning did photography and film convey? Who created these images and why? What were they used for? Fortunately for anyone interested in the history of the Canadian North and the complex inter-relationships between the Inuit and western civilization, Peter Geller, a professor at University College of the North, has provided us with an excellent study. In *Northern Exposures,* he has done a masterful job of examining the wide range of Arctic photography and cinematography between 1920 and 1945, as well as setting the context by examining pre-1920 developments, and looking at activities following World War II until the present. Geller's work is an attempt to help us, the reader, understand the powerful role that photographic and filmic images have played both in our perception of "North" and the ways such images have been used to present and re-present the notion of "North" to targeted audiences.

Geller looks at three aspects of the visual record of the North: the recording of the landscape and the environment; the documentation, for various reasons, of the original inhabitants of the region, the Inuit, who are, as John Amagoalik, former president of the Inuit Tapirisat of Canada (now Inuit Tapiriit Kanatami) is quoted in the book as saying, "... probably the most photographed race of people on Earth (p. 14)"; and the record of the interaction between the North and the three sites of power which held

dominion in the period from 1920 to 1945 – the federal government, the Hudson's Bay Company, and the Churches, particularly the Anglican Church. Geller states at the outset his hope that the book "allows for a clearer and more thoughtful understanding of the ways in which to see the North at the beginning of the 21st century and how we can respectfully make and view northern images today (p. xvi)". He also encourages the reader to read the photographs, as a complementary essay to the text, to bring our own understandings, and to ask our own questions about what is seen and not seen (p. xiv).

Pangnirtung men experimenting with Richard Finnie's cine camera. The original caption reads: "An Eskimo Lon Chaney *[referring to the early 20th century film star]* is given a screen test. Pangnirtung, Baffin Island, 1929". Photo: R.S. Finnie, National Archives of Canada/Archives nationales du Canada.

How exactly does Geller tackle what seems to be a herculean task? Without trying to précis the entire book, I would like to briefly review how he attacks his subject. He has divided the book into six chapters, with the core of his analyses occurring in the middle three chapters: "Visualizing the State in "Canada's Arctic"; "Archibald Lang Fleming and Missionary Messages of the North"; and "The Business of Representing the North: Filmmakers, Photographers, and the Fur Traders of the Hudson's Bay Company". These chapters relate the power of government, religion, and business in taking and making use of photographic and filmic imagery. The federal government carried out photographic work through the Geological Survey, the Department of the Interior, the RCMP, the now Department of Indian Affairs and Northern Development and other departments, for a wide variety of purposes. On the other hand, the chapter on Fleming is almost exclusively devoted to the use of photography to support the work of the Anglican Church in the North, to the exclusion of any other religious communities' efforts – something which should attract the attention of other scholars in the field. Finally, his chapter on the Hudson's Bay Company looks at the ways the HBC tried to create a mythic "history" through film and photography, and how it began to employ its own staff to develop an image of itself in the North, eventually resulting in the popular Beaver magazine, still an invaluable source of knowledge of activities and events in this period. These three chapters are sandwiched between a skillfully presented introductory chapter, "Taking Pictures and Making History: Photographic Representation and the Canadian North", which uses the 1937 voyage of the HBC supply vessel *Nascopie* as a starting-point for his effort to explain the power and the ritual of image-taking within the context of the North, and two final chapters. Chapter 5 examines the career of photographer and filmmaker Richard Sterling Finnie, who performed a variety of roles as an Arctic image-maker, working first for the government, then for business, and finally for himself, over almost sixty years. Finnie's films and photographs, now mostly found at Library and Archives Canada, are key to our understanding of what such images could accomplish. As Geller notes:

> *In Finnie's representations people and events became components of an argument and an entertainment, constituting an evocative example of the relative powerlessness of Aboriginal peoples in formulating the contours of a public discourse on the North. Aboriginal peoples remained the subjects of these northern stories, their power and knowledge as storytellers relegated to that of a picturesque sidelight, silent bystanders to the unfolding story of the ever-advancing frontier.* (p. 164)

Geller concludes his powerful study in chapter 6, "Remaking It into Here": Representation and Power in Northern Imagery, which closely examines the images themselves, what they present, and represent, the point of view, the perspectives, and the inclusions and exclusions; that is, how such images are taken and why. As he states, "the desire – indeed at times perceived as the need – to capture the North on film was part of a set of cultural attitudes encompassing the relationship between photographic seeing and the acquisition of knowledge (p. 165)". The point of view, the labeling, the use and re-use of images, the romanticization of the North, the effect of imagery on the northern inhabitants, and their own subsequent response to such imagery, which continues today, are all part of this chapter. Geller tries to demonstrate how shifting attitudes, and the use of both "constructed" and "re-constructed" imagery continues to reshape our current thinking on the North. In some senses I am wary of Geller's conclusions, since nothing is fixed in time, and history is an ever-changing phenomenon depending on whose history one is examining, but his ability to jog our consciousness about the whos, whats, whens, wheres, and whys of the specific image is to be commended.

In sum, I think this is a masterful effort in trying to capture the enormous spectrum of photographic and filmic representation of the North. The text is intelligently written and the major concepts are easily understood. The 86 images reproduced in the book are skillfully interwoven into the text, and they do, as Geller states, form an essay on their own. One wishes there had been two or three times as many to examine, and that

the book had been printed in a larger format, allowing the images to be more fully reproduced – the design of the book is such that while many pictures are framed within the page, others bleed off the page, or are printed over two pages with some loss in the binding. The reproductions are generally very good, and well-labeled and credited, not something that all such books accomplish. There is an excellent bibliography.

What did I miss in this volume? I wished there had been more about other filmic and photographic efforts, such as the work commissioned by Révillon Frères from Robert Flaherty, or the photographs taken by many anonymous nuns and priests of the Roman Catholic Church throughout the North, and their use of such imagery. The work of Inuit filmmakers and photographers is briefly touched upon, but not the use made by Inuit creators of sculpture, prints and drawings to depict Inuit visions of themselves and their own vision of the world around them – this could very well have been an entirely different chapter, and one well worth the effort to link with the conceptions of visualization mentioned by Geller in chapter 6. The book invites a whole host of further studies – on current Inuit use of historical imagery to recapture their own past, on the effect of radio and television on the North, on the use of photography in documenting changes in everyday life over a period of time, and on the mercenary attitudes of commercial photographers from the 1950s onwards in exploiting Western civilization's desire for novelty and to know the unknown and the "Other". These are all topics that cry out for further work. But these concerns don't take away from the Geller's major accomplishment in *Northern Exposures.* This is a fine book, and should be read by any Canadian with even a remote interest in the North.

Jim Burant is Manager, Art and Photography Archives, at Library and Archives Canada.

NEW BOOKS

Breaking Ice: Integrated Ocean Management in the Canadian North, Edited by Fikret Berkes, Alan Diduck, Helen Fast, Rob Huebert and Micheline Manseau. University of Calgary Press, 496 pages (ISBN: 1-55238-159-5).

The 15 papers in this volume result from a project undertaken by the Oceans Management Research Network that examines carefully the nature of Arctic environmental evolution and sustainability. From the pressures of development, technological advances, globalization and climate change to social and cultural life, this book attempts to define the nature of competing demands and assess their impact on the environment. (University of Calgary Press)

Do Glaciers Listen? Local Knowledge, Colonial Encounters, and Social Imagination, by Julie Cruikshank. University of British Columbia Press, 288 pages (ISBN: 0774811862).

Glaciers in America's far northwest figure prominently in indigenous oral traditions, early travelers' journals, and the work of geophysical scientists. By following such stories across three centuries, this book explores local knowledge, colonial encounters, and environmental change. Do Glaciers Listen? *examines conflicting depictions of glaciers to show how natural and social histories are entangled.* (University of British Columbia Press)

The Making of an Explorer: George Hubert Wilkins and the Canadian Arctic Expedition, 1913–1916, by Stuart E. Jenness. McGill-Queens University Press, 432 pages (ISBN: 0773527982).

The Making of an Explorer *reveals how George Hubert Wilkins' experiences with the Canadian Arctic Expedition of 1913–16 helped a little-known Australian photographer develop into the world-famous polar explorer Sir Hubert Wilkins. Making extensive use of Wilkins' Arctic diary and other sources, both archival and published, Stuart Jenness provides new information about Wilkins, explorer Vilhjalmur Stefansson, the Canadian Arctic Expedition, and the early history of North America's Western Arctic.* (McGill-Queens University Press)

INTERNATIONAL POLAR YEAR UPDATE

The Canadian National International Polar Year (IPY) Steering Committee has now met three times. In January 2005 the Committee met at the University of Alberta to examine the project pre-proposals received so far. This is an open process, and new pre-proposals are welcome. So far, 240 have been received, and the list is posted on the Canadian IPY web site (www.ipy-api.ca), which has recently become an interactive site. Researchers interested in participating in IPY projects are invited to contact the principal investigators of relevant projects, and also to consult the international list on the International IPY web site, at www.ipy.org.

HORIZON

Arctic Science Summit Week
April 17–24, 2005
Kunming, China
www.chinare.gov.cn/artic/

Conference: Rapid Landscape Change and Human Response in the Arctic And Sub-Arctic
June 15–17, 2005
Yukon College, Whitehorse, Yukon Territory, Canada.
www.taiga.net/rapidchange

Conference: Forum for Development Cooperation with Indigenous Peoples
October 5–7, 2005
University of Tromsø, Norway
www.sami.uit.no/forum/indexen.html

2nd International Conference on Arctic Research Planning (ICARP II)
November 10–13, 2005
Copenhagen, Denmark
www.icarp.dk

LETTERS

In the Fall-Winter 2004 edition of *Meridian* I noticed an error in the "New Books" Section. In the book by Dege and Barr, War North of 80, the vessel "Blåsel", sent out to pick up the personnel of the German weather station on the north coast of Nordaust-landet, was not dispatched on May 9, 1945 but rather at the end of August of the same year, and arrived on September 3. They were the last group to surrender, yes, but they were fortunate enough to get in a whole summer of geomorphological and other fieldwork first! I had a fairly extensive review of this fascinating book in the December 2004 issue of *Arctic,* and in 1966 I was fortunate enough to work along most of the northern coast of that isolated island, including the site of the wartime German station!

Dr. Weston Blake Jr.
Ottawa

NEW WEBSITES

UKALIQ

The Arctic Hare (Canadian Museum of Nature) presents a comprehensive picture of the Arctic hare (Lepus arcticus). The site includes unpublished research as well as games, activities, photographs, video clips, 3D images and lesson plans.
www.nature.ca/ukaliq

UTKUHIKSALIK INUKTITUT DICTIONARY PROJECT

This site provides information on the creation of a dictionary of the dialect of the Utkuhiksalingmiut Inuit of Nunavut (see *Meridian,* Spring-Summer 2002, "Interview: Jean Briggs")
www.chass.utoronto.ca/%7Einuit/UIDP/index.html

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