



# MERIDIAN

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## THE DWINDLING NUMBERS OF CARIBOU IN CANADA'S ARCTIC

Anne Gunn and Don Russell

### INTRODUCTION

Canada's polar regions are home to a diversity of caribou: the small Peary caribou scattered across the high and mid-arctic islands, the distinctive Dolphin and Union herd on Victoria Island, and the large herds of migratory tundra caribou on the mainland and Baffin Island. The picture of caribou abundance in these areas is one of losses and gains, with the losses outweighing the gains. Not only have populations fallen from their historic highs, but their ranges have also shrunk. Caribou have disappeared from some arctic islands, and the southern extent of mainland winter ranges has contracted. The same pattern holds true for mountain and boreal caribou in southern Canada (Festa-Bianchet *et al.*, in press). The causes are both complex and interacting, but if management actions are taken in time there is a chance of halting further declines. However populations do not always recover or return to their historic highs.

In this brief article, we will sketch the current state of caribou in the polar regions and describe the changes that have swept across the caribou ranges. In addition to the warming climate, those changes include new technology, with its implications for tracking caribou abundance, hunting, collaboration among caribou users and managers, and sharing information. Co-management, implemented through land claims settlements,

and better access to information bring hope for halting declines and helping recovery. Recovery, however, is neither easy nor quick. It takes much effort and many years to rebuild caribou herds.

### DIVERSITY AND STATUS OF CARIBOU ACROSS THE POLAR REGIONS

Peary caribou, which inhabit the high arctic islands (Queen Elizabeth Islands) and the mid-arctic islands (Banks, Victoria, Prince of Wales and Somerset Islands) are comparatively small-bodied, with white winter pelage. They tend to be scattered across the arctic islands in small bands as they follow the migration pathways between their seasonal ranges, sometimes crossing the sea ice between islands. Their numbers have dropped about 70% from 1980 to 2004 (COSEWIC, 2004). Within that overall decline, there have been some recoveries, aided by Inuit who have reduced their harvest (COSEWIC, 2004). The formerly large population inhabiting Prince of Wales and Somerset Islands essentially disappeared in the 1990s (Gunn *et al.*, 2006).

The Victoria Island caribou are notable for their appearance, history, and movements (Poole *et al.*, in press). Named after the straits they cross to the mainland for winter, caribou of the Dolphin and Union herd are

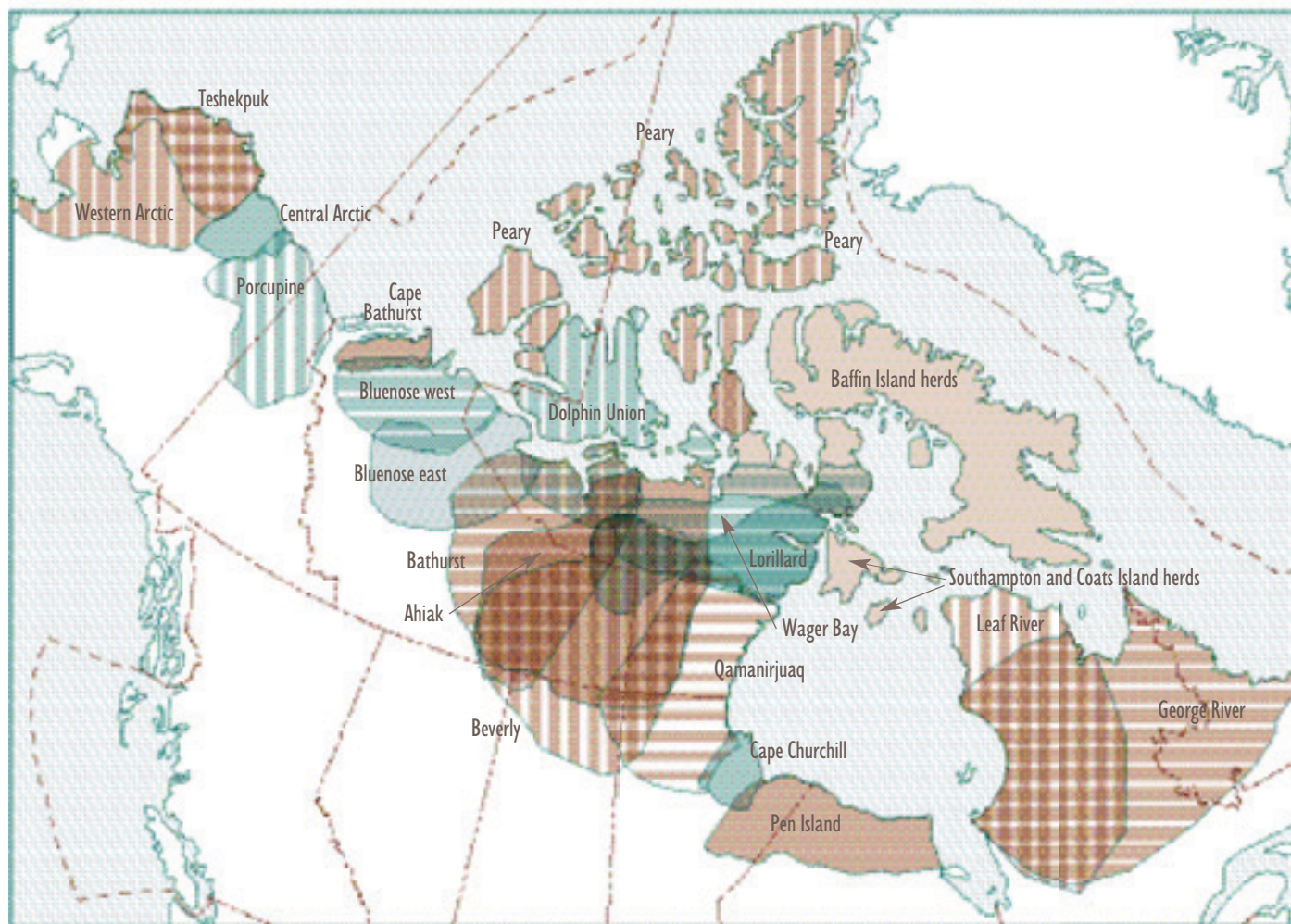
larger than Peary caribou, but resemble them in appearance, with the Peary's characteristic light slate-grey antler velvet rather than the dark chocolate-brown antler velvet of other caribou. The Dolphin and Union herd once numbered perhaps 100,000, but almost disappeared in the early 1900s. It was not until the 1980s that it began to recover although not to anything like the historical estimates. In fall 2007, the Dolphin and Union herd numbered 22,000–28,000 and the trend was stable to declining. Although in the late 1980s the caribou resumed their fall migration across the newly forming sea ice to winter on the mainland, this migration could be affected by a trend toward later ice formation as temperatures warm (Poole *et al.*, in press).

Perhaps most familiar to people are the large herds of migratory tundra caribou on the mainland, Baffin Island, and the larger is-

lands of Hudson Bay. Those herds evoke images of seas of bobbing caribou heads, grunting cows, and bleating calves. The herds that seemed to make Canada's tundra come alive have grown quieter and quieter over the last decade. Canada's ten best known herds of migratory tundra caribou have all declined, in some cases to a shadow of their former selves (Figure 1). Herds that peaked during the 1980s and totalled about 3.4 million caribou declined about a third by 2009 (exact numbers are lacking as the herd-specific information is variable). The nine herds whose ranges extend from the Yukon coast across the mainland coast to Hudson Bay are the best known. The northeast mainland, including Boothia Peninsula, Melville Peninsula and Wager Bay hosts several less known herds. Estimates there have been infrequent and do not indicate large numbers.

Although a million caribou may seem enough to lay concerns to rest, the spectre of formally abundant bison, cod, and salmon should give pause. It is the rate of decline and the fate of individual populations (or herds) that determine the persistence of a species. The loss of individual herds is a glaring sign of trouble. The Beverly herd, one of the best known, which peaked in the early 1990s at 270,000, had essentially disappeared from its traditional calving grounds by 2009 (BQCM, 2009). The herd's crossing of the Thelon River to its traditional calving grounds near Beverly Lake was part of the lives of the Dene for 8,000 years, as revealed by an unbroken archaeological record of deep layers of caribou bones and stone tools in the banks of the Thelon River (Gordon, 2005; pers. comm. 2010). The

Figure 1  
Caribou herds





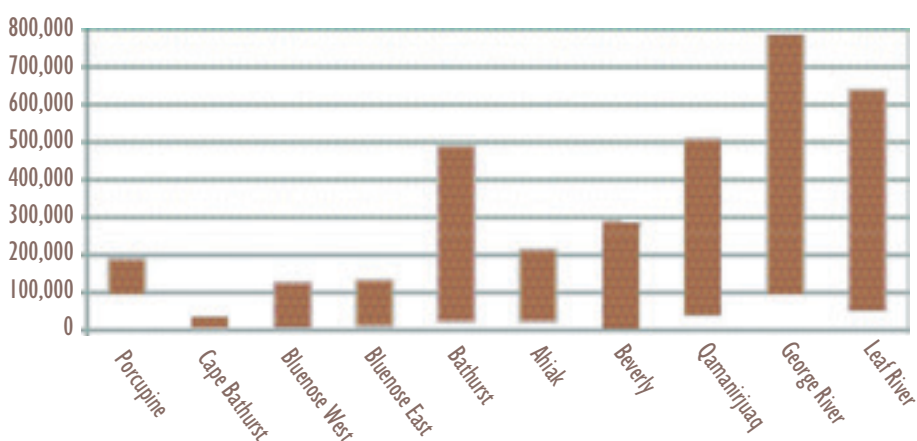
rate of decline, while variable between herds, has been rapid for the Cape Bathurst, Bluenose West, Bathurst, and Beverly herds. The rate of change can be expressed by how many years it takes for a herd to halve (if declining) or double (if increasing). The halving rate for the Bathurst herd was four years (1996–2009) although that period also included an accelerating decline between 2006 and 2009 when the halving rate jumped to two years. In contrast the decline of the George River herd (1993–2001) had a halving rate of eight years.

Our understanding of changes in migratory tundra caribou abundance comes largely from aerial photography, either of cows on their calving grounds or post-calving aggregations when the animals gather in jam-packed groups to reduce their exposure to insect parasites (warble flies) and mosquitoes. Rates of calf survival, adult survival, and body condition have been measured for a very few herds. However, for most of the time and most of the herds, monitoring has been infrequent – and for the Beverly herd, so infrequent (once between 1994 and 2007) that its population dwindled almost to the point of disappearing. The reasons include a complex mixture of other priorities, funding and technical issues, and the fact that the warning signs were missed. Back issues of *Caribou News* and other information posted on the Beverly and Qamanirjuaq Caribou Management Board web site ([www.arctic-caribou.com](http://www.arctic-caribou.com)) trace the story.

Inuit and Dene elders relate how herds have fluctuated over time and their knowledge is now being used in monitoring. An ingenious application of dendrochronology has allowed us to trace the abundance of the Bathurst and George River herds for 100 to 200 years (Payette *et al.*, 2004; Zalatan *et al.*, 2006). As the caribou follow migration trails their hooves scuff exposed spruce tree roots, leaving distinct marks. The age of those scars can be determined from the tree's growth rings, and more scars means more caribou. This data indicates that the Bathurst popula-

Figure 2

Maximum and minimum population estimates for Canadian Rangifer herds



tion was high during the mid-1940s and the 1990s, and low during the 1920s, the 1950s to the 1970s, and at the turn of the 21st century. This correlates closely with the reports of Dene elders (Zalatan *et al.*, 2006).

#### CARIBOU ECOLOGY AND THEIR CHANGING WORLD

Climate, especially large-scale decadal patterns such as the Arctic Oscillation, has a prominent influence on caribou ecology and abundance (Griffith *et al.*, 2001; Zalatan *et al.*, 2006). Weather sets the pattern at the annual and seasonal scale. Summer weather influences the timing and amount of plant growth as well as the levels of harassing insects and parasitic intestinal worms. Winter weather influences the availability of food through the amount of snow and the corresponding energy it takes the caribou to move and to dig through it for their forage. Interacting with the weather are the predators – wolves and grizzly bears, and less often wolverine, golden eagles, and lynx. Caribou and other herbivores move through what is called a “landscape of fear”. This perhaps fanciful terminology is a reminder of the choices caribou make as they weigh the risk of predation and parasites versus their need for high forage quality and quantity.

The interaction between climate, weather, forage, predation, and parasites is

intricate and complex, and we are at only an early stage in unravelling the cascade of connections. Once the population is falling, and before the number of predators has dropped as a result, predation and hunting become more important factors and can even accelerate the decline.

Over thousands of years, this cyclic pattern of caribou abundance has played out again and again, as is well recollected through traditional knowledge. Changing times, however, introduce two complexities. First, superimposed over the decadal climate patterns are trends such as warmer temperatures. Second, the relationship between hunting and caribou abundance has been partially uncoupled through technology. Aircraft, snowmobiles, and winter roads have made it equally easy to find and hunt caribou whether numbers are high or low ([www.wrrb.ca/public-information/public-regisry](http://www.wrrb.ca/public-information/public-regisry)).

Added to these changes for the caribou is a growing human presence across their seasonal ranges. Oil and gas exploration and development increased on the winter ranges of the Bluenose West herd during the 1990s, while mining activities have expanded since the 1990s on the summer ranges of the Bathurst and Beverly herds. The influence of this on caribou abundance is not clear. Aboriginal elders express concerns about how extractive industries affect caribou. Analyses of summer



The Bathurst herd crowding together in summer to reduce the torment inflicted by mosquitoes and warble flies. Warble fly larvae burrow under the skin and cut breathing holes in it. Photo: Anne Gunn.

movements of the Bathurst herd suggest that caribou are avoiding open pit mines at greater distances than expected – the influence of the open pit diamond operations extends some 10–15 km out from the mine (Boulanger *et al.*, in press).

The causes for the decrease in caribou numbers are often debated. Because they have declined in the past, a frequent response is that the caribou have moved elsewhere and will come back. However, more and more information suggests that the caribou have not simply moved elsewhere. While the winter ranges of migratory tundra caribou may sometimes overlap, cows almost invariably return to the traditional calving grounds of their own herds. Analyses of satellite-collared cows, and extensive of aerial surveys support this. Since 2007, a large part of the mainland has been simultaneously covered by aerial surveys during calving, and no unexpected calving distributions were found ([www.wrrb.ca/public-information/public-registry](http://www.wrrb.ca/public-information/public-registry)).

#### MANAGING RECOVERIES AND ADAPTIVE CO-MANAGEMENT

If the caribou across Canada's polar regions are spread across a landscape of change, then it is also a landscape of hope. Two changes have brought hope for halting caribou declines and building recoveries. The first is co-management. Since 1984, land claims settlements and the establishment of Nunavut have led to sharing of wildlife management between governments and wildlife co-management boards with legislative powers. The earliest two caribou co-management boards, the Beverly and Qamanirjuaq Caribou Management Board (1982) and the Porcupine Caribou Management Board (1984) are advisory bodies to governments. The co-management boards and governments are able to work together more collaboratively and with less emphasis on "top down" management. Co-management builds trust with aboriginal hunters, helping the boards gain support for tough decisions such as restricting caribou hunting. In

recent years, the Inuvialuit, Gwich'in and Sahtu co-management boards have all recommended and implemented reductions in caribou hunting. In August 2010 the most recent co-management board, the Wek'eezhii Renewable Resource Board, established in 2005 under the Tlicho Land Claim, completed public hearings for a joint proposal between the Tlicho and Northwest Territories governments for the Bathurst herd ([www.wrrb.ca](http://www.wrrb.ca)). The proposal, with its emphasis on collaboration and adaptive co-management, offers a glimpse into the probable future of caribou management.

The second change underpinning hope for halting declines and building recoveries involves information technology, especially the Internet. This is because co-management and collaboration depend on prompt and equal sharing of information and data. Survey results and other data were once the preserve of the wildlife management agencies, and often slow to be disseminated. Minutes of meetings and other information disappeared into government files. Co-man-



agement, however, requires access to data, and cannot operate effectively without it. (Dion, 2003). Now, more and more information is available through the co-management board web sites and the public registries for public hearings.

While the amount of information is increasing, it is still scattered among various agencies and web sites, especially if it relates only to an individual herd or co-management board. In response, a network of researchers, managers, and community people are sharing information on circumpolar reindeer and caribou and how they are affected by such factors as climate change and industrial development. Although established in 2004, the CARMA (CircumArctic Rangifer Monitoring and Assessment) Network ([www.carma-network.com](http://www.carma-network.com)) has in recent years received substantial funding from the Canadian International Polar Year Program and is working closely with the Arctic Council's working group on circumpolar flora and fauna (CAFF). The network shares information among agencies and users and is developing standardized protocol manuals to improve our ability to compare across herds and ranges. This will enable an overall assessment of the impacts of global changes on caribou.

Although the disappearance of two herds (Prince of Wales-Somerset and Beverly), and the significant declines and changes across caribou ranges are alarming, we do not foresee extirpation. Rather, we see this as a sign that collectively we need to change our behaviour. We have, however, no illusions about the difficulty of rebuilding herds. Recovery can take decades, as with the Fortymile herd shared between Alaska and the Yukon (Gronquist *et al.*, 2005; also see *Meridian*, Spring-Summer 2003, pp. 1–4); and recovery back to historic levels, as well as slow, is uncertain which raises a particular danger on its own. A fisheries biologist identified a tendency toward what he called shifting baselines (Pauly, 1995). A shifting baseline means that as populations slowly dwindle,



Cows of the Bathurst herd in fall. Photo: Anne Gunn.

each generation's standard for how "it used to be" is gradually degrading. For example, the number of caribou in the last generation is the baseline we try to manage for – but there were already fewer caribou around in the last than in previous generations. In other words the extent of the reduction is lost as each generation redefines what is "natural".

Recent declines and the realization that agencies must monitor their herds better have contributed to an increase in monitoring activity, particularly with respect to population estimates. In the last two years (2009 and 2010), most major herds will have been counted and estimates are available or soon forthcoming. Reduction in hunting for the Cape Bathurst, Bluenose West, and Bathurst herds has coincided with a stabilizing trend. The Ahlak and Qamanirjuaq are declining, and we are still awaiting the results of the 2010 counts of the Porcupine, Bluenose East, and George River herds. Unfavorable conditions prevented the 2010 Leaf River herd count, which will have to wait until 2011. However, the smaller migratory tundra herds on the northeast mainland of Nunavut remain largely unmonitored as is the case for most Peary caribou (except Banks Island).

Although the most recent population counts are reason for cautious optimism, it is still far too early to conclude that declines

have halted. The past decade has taught us that we have to develop a coherent strategy to monitor and manage these herds throughout their cycle. It will be a challenge to agencies and boards to agree on such a strategy and to ensure that it is implemented in times of plenty and times of scarcity.

*Anne Gunn is a wildlife biologist (retired, Government of the Northwest Territories). Don Russell is a wildlife biologist (emeritus, Canadian Wildlife Service). Both serve on the steering committee of the CircumArctic Rangifer Monitoring and Assessment (CARMA) Network.*

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## MONITORING THE DOMESTIC HARVEST OF WILDLIFE RESOURCES IN NUNATSIAVUT, LABRADOR

David C. Natcher, Larry Felt, Andrea Procter and the Nunatsiavut Government

### INTRODUCTION

For countless generations, aboriginal peoples across the Canadian north have lived and thrived in a variable and changing environment, adapting their land use patterns, stewardship practices, and harvesting strategies in response to the presence or scarcity of wildlife resources (Natcher *et al.*, 2009). Unencumbered by government intervention, they relied on their own norms, values, and institutions to mediate their relationship with the land and animals. Yet over the past 50 years the situation has changed dramatically as government, often in the name of conservation, has assumed a principal role in wildlife management. In place of the traditional knowledge that always guided aboriginal use

of wildlife, government scientists and managers now stress the need to calculate resource population levels against human demand, and use probability statistics to chart species population dynamics in order to allocate harvesting rights. The seeming legitimacy of this process has been so compelling that aboriginal peoples, who continue their struggle to regain control over their lands, agree to participate, even though they often have difficulty reconciling this approach with their own values.

The Nunatsiavut government of Labrador, following ratification of its comprehensive land claim (2005), implemented a domestic wildlife harvesting research program that contrasts with many of the govern-

ment sponsored harvest studies conducted elsewhere in the north. While still quantifying the number of birds, mammals, and fish harvested by Inuit households, the Nunatsiavut government has emphasized the social dimensions of wildlife harvesting and the role that wildfoods play in maintaining the social, cultural and economic continuity of Nunatsiavut communities.

### BACKGROUND

On December 1, 2005, the Labrador Inuit Land Claims Agreement Act came into effect, and the Nunatsiavut government took its place as a regional Inuit government within the Province of Newfoundland and Labrador, with



administrative authority over health, education, justice, culture and language. In addition, it assumed responsibility for the protection, use, and development of renewable and non-renewable resources in the Nunatsiavut settlement region; a 72,500 km<sup>2</sup> land base and 48,690 km<sup>2</sup> coastal zone that extends from the southernmost community of Rigolet approximately 800 km northward to the Torngat Mountains National Park (see Figure 1). The Nunatsiavut government, through its Department of Lands and Natural Resources, is now responsible for the “sustainable management of Nunatsiavut land and natural resources while maximizing benefits from the development of these resources for Inuit” (www.nunatsiavut.com).

To help manage human uses of Nunatsiavut's natural resources, two co-management boards were formed. The Torngat Wildlife and Plants Co-Management Board manages use of wildlife and plants while the Torngat Joint Fisheries Board oversees fisheries and marine mammals management. Each board has seven members: three appointed by the government of Nunatsiavut, two by the province of Newfoundland and Labrador, one by the government of Canada, and a neutral, appointed chair. The mandate of each board is to use the best available information from both local and scientific knowledge to ensure that the Inuit domestic harvest of wildlife resources is protected. Where wildlife conservation concerns arise each board has the authority to establish Inuit Domestic Harvest Levels (IDHL) for non-migratory wildlife species. For migratory species the boards can recommend the appropriate IDHL to the federal minister. As defined in the land claims agreement, the IDHL represent “as accurate a quantification as possible of the amount of a species or population of wildlife or plant required by Inuit for the Inuit domestic harvest” (Labrador Inuit Land Claims

Figure 1



Agreement, 12.4.6). More succinctly, Inuit Domestic Harvest Levels represent the annual sum of all non-commercial uses of plants and wildlife Inuit need to satisfy their nutritional and cultural needs.

In order to determine the IDHL for species used by Inuit communities, the Nunatsiavut government, with additional funding from the Canadian Wildlife Service, implemented a research program that would identify the IDHL for 140 different resources and wildlife species. The intent was to establish an accurate base line of current harvesting levels

for Nunatsiavut households. The research program also explored the social organization of wildfood production, for instance the level of household cooperation in the harvest and exchange of wildfoods.

#### METHODOLOGY

In August 2007, ten bilingual community research assistants were hired by the Nunatsiavut government and underwent a multiday training session, which included survey design, interview methods, data entry, analysis



Hopedale (Agvituq) is the capital of the Nunatsiavut land claims area. Photo: D. Natcher.

and management, and report writing. The survey instrument – which consists of stand-alone, non-repetitive household surveys, and follows the “Alaska Survey Model”, identifying baseline-harvesting levels – was then tested with several key informants, and adjustments were made.

The research assistants administered the household surveys in the fall of 2007. Using local terms for the various species and photographs where appropriate, especially for waterfowl, they asked hunters to recall the number of animals and birds taken during each season of the preceding year. The objective was to achieve a saturation sample of all Nunatsiavut households. The household was the primary sampling unit and the community was the secondary unit of analysis. A household was considered resident if its members lived in the community during the previous 12 months. Due to movement to and from communities, refusals, and other difficulties in locating household members, completed surveys varied from 70 to 85% of households, with an overall mean completion percentage, weighted by size of community of 80% – 665 out of 842 households surveyed. For each of these the research assistants recorded the total harvest over the preceding year (2006–2007), seasonality of harvest, perceived population trends based on local

knowledge, household demographic information, and patterns of social organization relating to the harvesting, processing and distribution of wildfoods.

## S U M M A R Y O F M A J O R F I N D I N G S

### Harvesting Participation

Household participation in wildlife harvesting varied by community from 73% to 92% with an overall, unweighted average of 85%. Households that had taken at least one animal in the preceding year were classified as harvesting households, and among these participation levels were generally consistent with the 30:70 Rule (Wolfe, 1987), where 30% of households provide approximately 70% of the total community harvest. Variability between household harvest levels can be attributed to different stages of household development. As defined by Magdanz *et al.* (2002) household development stages include: 1) inactive single parent – retired elder – inactive single households (single grouping); 2) developing households (households with heads 20–39 years of age); 3) mature households (households with heads 40–59 years of age); 4) active elder households (households with heads 60 years or more and still actively harvesting); and

5) active single person households. In Nunatsiavut, the overall frequency of household types were as follows: inactive single parent – retired elder – inactive single households (92 households) producing less than 1% of the total harvest; 2) developing households (171 households) producing 23% of the harvest; 3) mature households (199 households) producing 67% of the harvest; 4) active elder households (46 households) producing 4% of the harvest; and 5) active single households (76 households) producing 5% of the total annual harvest.

These normative cycles of development appear to directly affect the household's ability to procure wildfoods. For instance, as developing households mature their labour force increases in age, number, and harvesting ability. For a period of time mature households have the means (*i.e.*, labour and income) to participate in a full range of harvesting activities, thereby securing a greater volume of wildfoods. Eventually, the children of mature households leave to establish their own households, thereby perpetuating their own cycle of household development. Depending on the health and social configuration of the remaining household members, wildlife harvesting begins to decline. Some households fall outside the normative development cycle: single parent households, individuals with disabilities, or elders no longer able to hunt and fish. These households produced a limited amount of wildfoods. Reasons cited for not harvesting wildfoods include physical disabilities or obstacles associated with old age (14% of responses); prohibitive cost of equipment and gas (19% of responses); time commitments related to wage-earning employment and school (20% of responses); and a general lack of interest in pursuing harvesting activities (47% of responses). It is interesting to note that low interest in harvesting was not exclusive to the younger age cohort but rather was evenly distributed generationally, by gender, and among all household types.



### Harvesting Effort

There is considerable debate in academic circles concerning the effect of the wage economy on subsistence production. Some argue that wage earning has displaced traditional forms of wildfood production and exchange, while others hold that participation in the wage economy actually facilitates the harvest of wildfoods, and in some cases has strengthened communal social networks. Hart (2006: 22) attributes much of this debate to the compartmentalization of subsistence and wage economies into distinct “sectors” – as if subsistence and wage economies function in different places, like agriculture and manufacturing, or “western” and “traditional” (Natcher, 2009). While the distinction between subsistence and wage economies may be useful in analytical terms, Nunatsiavut household involvement in subsistence and wage economies is best seen as occurring along a continuum, with participation occurring at varying points on the scale. As reflected in Table 1, both male and female heads of households allocate considerable time to wage earning and subsistence harvesting. The number of weeks spent earning wages or harvesting wildlife were spread over the course of the year. Given this dispersion of time, the economic make-up of most Nunatsiavut households is quite diverse, with a blend of economic activities.

Table 1

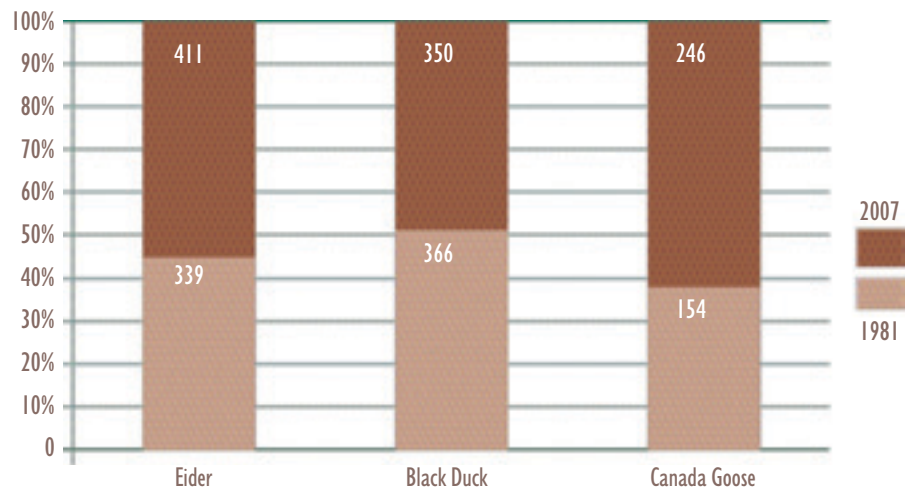
Time allocation in economic production (weeks per year)

	Wage earning		Harvesting	
	Male	Female	Male	Female
Weeks\year	29.85	32.80	47.19	37.70

Figure 2

Comparison of Rigolet waterfowl harvests for 1981 and 2007

showing the number of birds taken as a percentage of the total waterfowl harvest for both years



Some household members hunt and fish, some receive government transfer payments (employment insurance, social assistance, pensions), and others have full-time or seasonal jobs. Most households participate si-

multaneously in multiple economic activities, which may change according to circumstances. Rather than depending on any one form of economic activity, most Nunatsiavut households attempt to find a balance, deriving income from multiple sources.

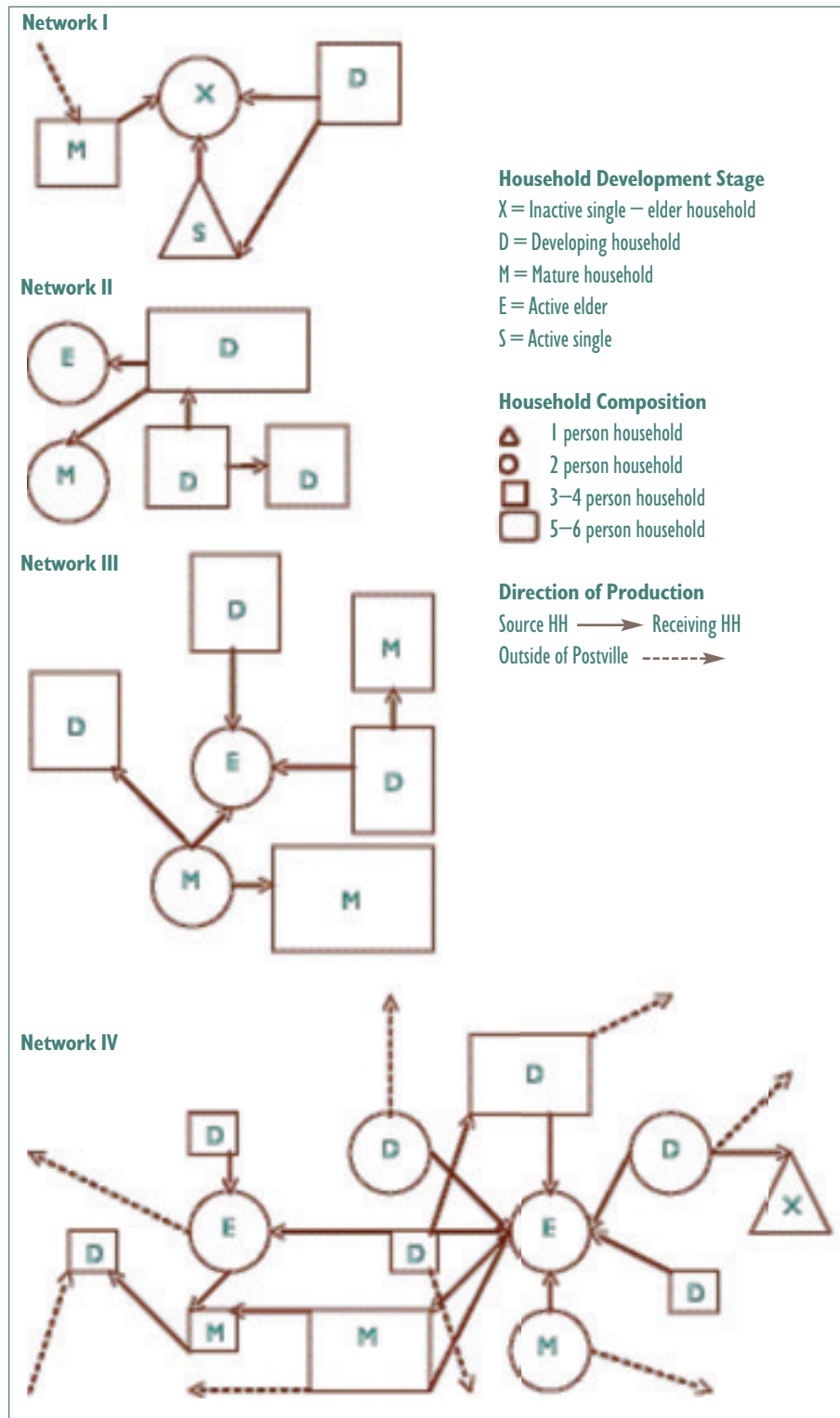
### Harvesting Continuity

While this research suggests that wildlife harvesting remains an important component of the Nunatsiavut economy, the results represent only a single year, and thus do not provide enough data for definitive conclusions. We have therefore compared the 2006–2007 harvest estimates with those of Mackey and Orr (1988) for Rigolet in 1980–1981. The population and number of households in Rigolet have remained remarkably consistent. By this assessment, harvest levels in 1980–1981 and 2006–2007 are also quite similar and demonstrate some continuity in the waterfowl harvest, at least for this community (see Figure 2). The 2006–2007 Nunatsiavut caribou harvest shows similar continuity with

Dried caribou meat (*nikku*) outside a home in Nain.



Figure 3  
Social organization of wildfood distribution in Postville



data from the 1970s collected by Usher (1980). In fact, the 1979 and 2007 mean per capita harvest is nearly identical: 62 in 2007 compared to 59 in 1979.

#### Food Sharing

While harvest participation is an important measure of wildfood use, it is not the most inclusive measure. As noted, households may be unable to hunt and fish, or uninterested in doing so, yet still receive food from others. Linking the harvest and the subsequent distribution of wildfoods between households reveals a number of distinct, bounded networks in each community. When calculating the exchange of wildfoods between households the total percentage of households benefitting from wildlife harvesting extends to 96%, with the community of Postville emerging as the most inclusive community with 98% household involvement.

To illustrate, Figure 3 shows that 29 Postville households comprise four food-sharing networks, of differing social complexity. These networks are based on cooperative wildfood distribution among households. Network I is a parent-children network headed by inactive male and female elders (grandparents). Active elders (grandparents) head Network II with a son as male head-of-household for a mature household, and three grandchildren heading developing households of their own. Active male and female elders again head Network III with children heading one mature and two developing households. In this network food sharing occurs between sibling and parental households as well as between three non-kin related households (two developing and one mature). Network IV, which consists of 13 Postville households and eight households outside the community, represents the most complex network examined. However, it shares many attributes with Networks I, II and III. Specifically, Network IV is headed by elders whose children and grandchildren comprise a large (seven households) food-



sharing network, including an inactive single female. However, Network IV differs in the inclusion of a second affinal household of active elders (in-laws of married son). Last, Network IV is involved in an extensive network of non-local households outside Postville. In each of the networks described, kinship is to a large extent the defining factor for food exchange. Extending beyond the physical confines of a single or even multiple dwellings, these social networks represent unbounded organizations of economic activities that derive their basis from established kinship relationships (Jorgenson, 1984). While food sharing does occur outside established kinship networks, such non-related household networks occur far less frequently (12% of all exchanges).

Based on our survey results and conversations with community members, it is clear that the exchange of wildfoods unites households on economic and social grounds. This form of generalized reciprocity (Sahlins, 1971) not only facilitates the distribution of food as an economic resource, but also affirms personal relationships and the social networks that support them. By encompassing important social dimensions, food sharing and norms of reciprocity entail broader

conceptions of social responsibility and account for an entirely different set of motivations that extend beyond economic rationality. Thus, by embodying both social and economic attributes, food sharing – which is an important part of Inuit culture – continues to represent a defining feature of the Nunatsiavut economy.

#### S U M M A R Y

The research program developed by the Nunatsiavut government has successfully documented the importance of customary and traditional uses of wildlife by Nunatsiavut communities. A baseline of information has now been established that is sensitive to community-level participation and harvest variability and will allow the Nunatsiavut government and affiliated co-management boards to monitor and track changes in community harvesting patterns over time. It seems clear that despite experiencing significant social and economic change, Inuit households have nonetheless retained an intimate connection to land and sea through hunting, fishing, and gathering of wild resources. Thus despite predictions of imminent economic transformation, the use of wildfoods remains integral to the health, econo-

my and overall well-being of most Nunatsiavut households. Equally important has been the training of Inuit community researchers. This training has transferred analytical skills. Nunatsiavut will need to continue the research and monitoring program to track changes in IDHL over time. Through these training efforts, a cadre of Inuit community-based researchers has been established who are now participating in research and wildlife management activities that reflect of Inuit culture, values and principles.

*David C. Natcher is an associate professor at the College of Agriculture and Bioresources, University of Saskatchewan; Larry Felt is a professor in the Department of Sociology, Memorial University; Andrea Procter is a PhD. candidate in anthropology at Memorial University.*

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Arctic char drying, Nain. In the past Inuit had an extensive system of partnerships and other formalized social links through which they assisted each other. This network was their insurance against hard times. Sharing food remains central to Inuit culture.

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## WETLANDS : SIMPLE AND EFFECTIVE WASTEWATER TREATMENT FOR THE NORTH

*Brent Wootton and Colin Yates*

In the ten years since the Walkerton tragedy there has been a significant increase in awareness of water as an important resource. Perhaps more than ever, when we turn on the tap we consider how clean the water is and appreciate the value of safe drinking water. This is especially true in northern Canada where there is a disproportionate number of boil water advisories compared to southern communities. But the same awareness cannot be said to exist for wastewater. Most of us that live in urban areas don't know where the wastewater goes once it leaves our drains and toilets. It simply vanishes from our lives. Northern communities, however, have limited options for wastewater disposal and have a keen awareness of where wastewater goes.

For many years the focus (and spending) in northern communities has been on drinking water treatment. This is sound public policy because potable water is a basic human need. But as the recent UN report entitled *Sick Water?* emphasizes (Corcoran *et al.*,

2010), addressing wastewater is key to reducing poverty, improving human health, and sustaining ecosystem services in communities around the world.

In northern communities, wastewater treatment has lagged behind the south. Sewage treatment plants which treat wastewater to an acceptable quality to protect both the environment and human health require large inputs of infrastructure capital, constant operation and maintenance funds, a highly trained work force, and in many cases round the clock supervision or a sophisticated computerized monitoring system. The sewage treatment plant in Iqaluit is perhaps the best known example of costly and delayed wastewater infrastructure with a history of problems. Another example of a high maintenance facility is the plant in Pangnirtung. Many conventional systems simply won't work properly in an arctic climate or are just too costly and complex to operate in small and remote communities. All of this makes con-

ventional sewage treatment plants ill-suited for northern applications.

The approach in most northern communities in treating wastewater is to use passive technology. Lagoons that discharge into wetlands are a common example of a passive system used in many northern communities. Formal research on these systems in the north, however, has been virtually non-existent.

Like many northern researchers, my (*Brent Wootton*) introduction to the north was serendipitous. In 2005, one of the organizers of the annual conference of the Northern Territories Water and Waste Association (NTWWA) convinced the leadership at Fleming College that it was very important that someone from Fleming's Centre for Alternative Wastewater Treatment (CAWT) attend the conference in Rankin Inlet that year. This pivotal moment started a multi-year research project on northern wastewater treatment.

The CAWT is a dedicated applied research centre at Fleming College that special-



izes in studying innovative and alternative forms of wastewater treatment, particularly for cold climates. At the time “cold” meant a typical southern Ontario winter, but the NTWWA organizers were happy to invite anyone claiming to be a “cold expert”. With no experience in northern research, I went off to Rankin Inlet to make a presentation on cold climate wastewater treatment. My presentation was well received in spite of having little connection to an arctic context.

The water and wastewater community is very tightly knit and this annual meeting, which alternates between the NWT and Nunavut, is the one place and time they all come together. I was able to make connections quickly and easily in this network, and hear stories from many remote communities. Shortly afterwards the federal government solicited proposals for the International Polar Year Program and we were strongly encouraged by northern government wastewater professionals and community members to apply for funding. In the end, we succeeded in getting four years of funding to study treatment wetlands in the Arctic. We knew very little about wastewater treatment in the north and as the CAWT specializes in constructed wetlands for wastewater treatment we pro-

posed building and studying a pilot system in Nunavut. During the first year of our IPY funding we travelled to several communities in the Kivalliq region and discovered that wetlands were in fact already in use as treatment systems for wastewater.

As anyone living in a northern community knows (except in those few communities that have piped wastewater), a sewage truck comes to your house regularly to suck up the wastewater from your holding tank and then haul and dispose of it somewhere else – usually a lagoon but often just a depression in the tundra on the outskirts of the ham-

let. After seeing many such systems in the north and listening to community and government officials, we decided to turn our attention to studying the existing systems and postpone the building and assessment of a pilot system.

For the next few years, we studied treatment wetlands in Whale Cove, Baker Lake, Arviat, Chesterfield Inlet, Coral Harbour, and Repulse Bay. More recently we have been working with Environment Canada to study treatment systems in Paulatuk, Ulukhaktok, Pond Inlet, Gjoa Haven, and CFS Alert which had a treatment wetland constructed



Above: Wastewater disposal site in Chesterfield Inlet as it was in 2008



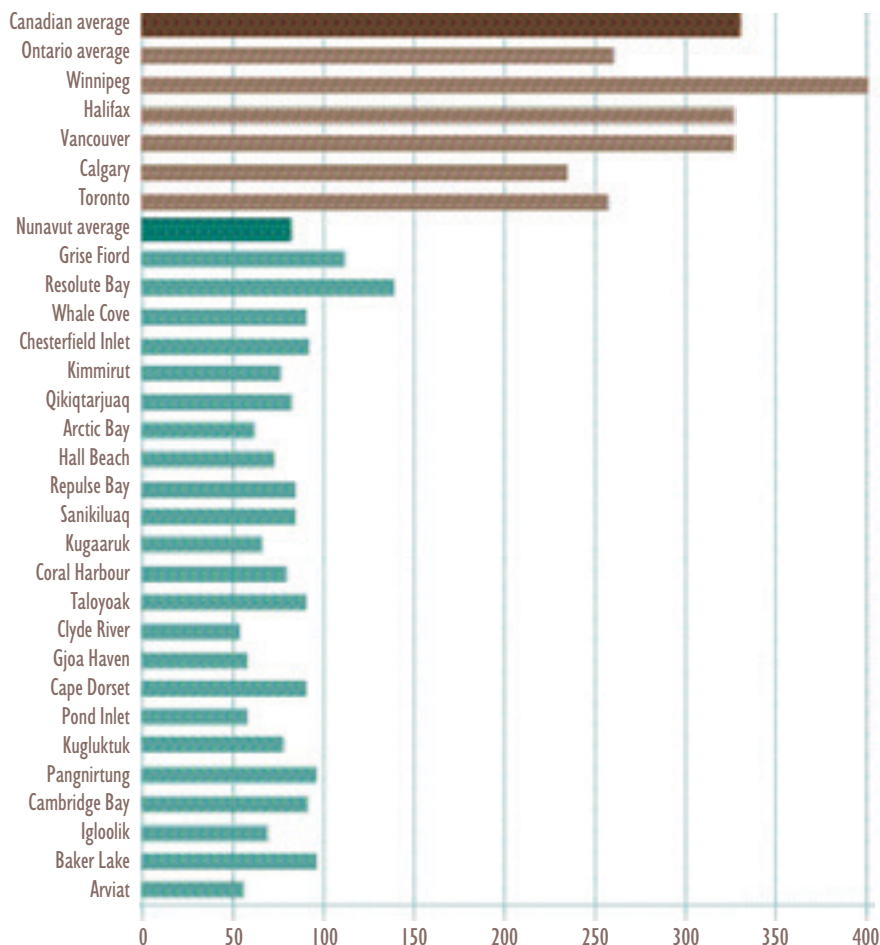
Left: Wastewater disposal in Baker Lake: northerners know where their wastewater goes after it's flushed.

and commissioned in summer 2010. It will have the distinction of being the northernmost treatment wetland in the world, as Alert is the northernmost inhabited place on earth.

What we found is that all of the wetland systems are unique and incorporate, in most cases, natural features (*e.g.*, topography, ponds or lakes, natural wetland area, etc.). The influx of high strength wastewater stimulates the growth of pollution-tolerant vegetation – typically sedges and grasses –

Figure 1

Water use per capita (litres per person per day)



which eventually dominate the area. The plants that colonize these areas are very tolerant of high ammonia levels. Because water use per person is very conservative (as low as 40 litres per person per day, compared to the average 260-litre per capita consumption in Ontario), the wastewater is much more concentrated resulting in very high ammonia levels.

Unlike treatment wetlands in southern Canada which can operate throughout the winter by means of subsurface flow and treatment processes driven by microbial communities, we found that northern systems simply shut down in the winter. Things just get too cold and the water eventually stops flowing resulting in large areas of frozen wastewater. Freezing, however, can be another form of treatment, because it can kill bacteria – and as water freezes it expels

solids, resulting in pretreatment at the front end of the wetland.

The spring thaw does bring significant flows of meltwater, and we found concern in

communities around where this goes and what it contains as it moves over the still-frozen land. In most of the systems we studied the wetland systems were large enough to accommodate these spring melts, but more research is needed. After the thaw, and in the 24 hour daylight, the plant communities explode and microbial activity begins to break down large compounds and molecules. It should be no surprise that in a treatment wetland in the north the biological processes that treat the water work much faster than in the south. Like the northern lights, the dramatic growth and bloom of wildflowers on the tundra is an often cited northern phenomenon. A few weeks after the thaw, the treatment wetlands start processing the influx of nutrients. With the ability to photosynthesize throughout the day, it appears that nutrients are literally sucked up by the plants. This continues until the fall when the plants slow their growth and eventually shut down for another winter. The release of nutrients and organic matter may occur at this point but it would be inappropriate to consider it as the same as the organic matter in domestic wastewater. We are finding though that the wetlands appear to be holding onto their plant fibre and don't release carbon or nutrients in the fall. This may be because decomposition is so slow in such a cold environment.





Generally speaking, the mechanisms at work may be the same as for treatment wetlands in the south but there appear to be unique differences. For example phosphorus, a nutrient required for plant growth which in excess causes eutrophication or enrichment of lakes leading to decreased dissolved oxygen when the plant matter dies, is removed to very low levels by the treatment wetlands in the north. This is attributable to the lack of this

Table 1

Average of weekly testing carried out for 13 weeks at the Chesterfield Inlet sewage treatment wetland—summer 2008

	Total coliforms (cfu/100 mls)	<i>E. coli</i> (cfu/100 mls)	Ammonia (mg/L)	Total P (mg/L)	CBOD5 (mg/L)	Dissolved oxygen (mg/L)
Raw sewage	42,850,000	1,670,000	40.8	5.86	228	1.78
Final post wetland effluent	760	130	0.09	0.42	14	10.9
% Removal	99.99%	99.99%	99.8%	92.8%	93.9%	−83.6%

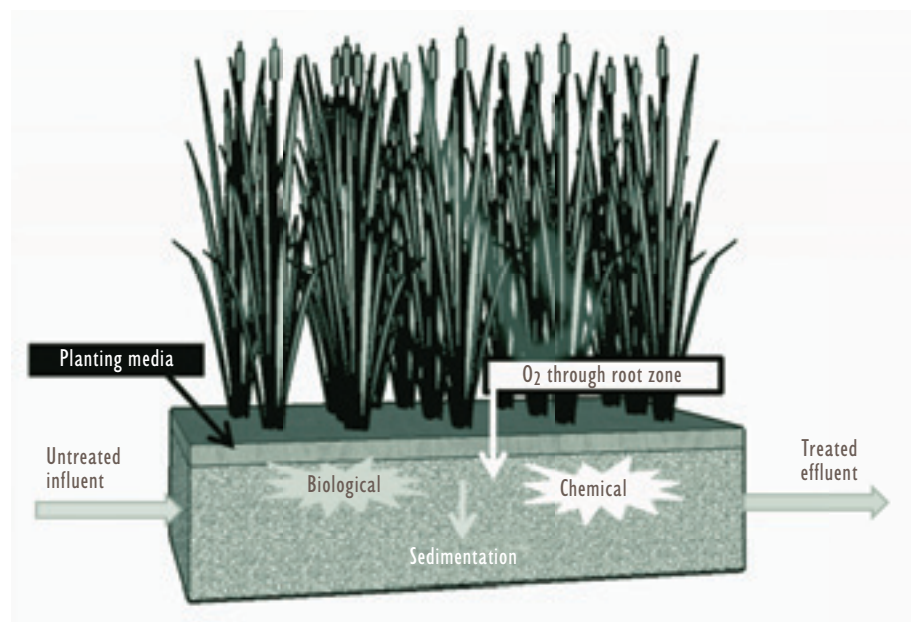


Figure 2  
Biological and chemical processes and sedimentation clean wastewater in a wetland.

nutrient in northern ecosystems, and the aggressive growth of plants in the 24-hour sunlight of northern summers. This contrasts with southern wetlands, which typically do

Left: Treatment wetland in Chesterfield Inlet showing robust plant growth not typically found in nutrient poor tundra environments.

Right: Clean water after passing through 700 metres of wetland at Chesterfield Inlet.



not remove any significant levels of phosphorus after the wetland stabilizes.

Weekly monitoring of wastewater contaminants over an entire summer period showed remarkable consistency in treatment and very high treatment levels (Table 1).

In Chesterfield Inlet, the sewage is deposited into a natural depression in bedrock and flows through a 700 m long stretch of natural tundra wetland cradled in a bedrock channel before entering the ocean. This wetland has been naturally filtering wastewater for at least the last 15 years. The government has plans to build a lagoon which will allow for storage, the settling of solids, and overall better pretreatment prior to the water entering the wetland.

Communities such as Baker Lake have fenced their treatment wetland to keep wildlife out for their own protection and also for the protection of human health from the theoretical risk of transmission of communicable pathogens in the wastewater.

While the use of wetlands to treat wastewater in the Arctic started as somewhat of an accident, they are proving to be an important treatment option for communities with very limited choice. The use of wetlands for treatment of wastewater isn't a new discovery, however—the capacity of wetlands to treat wastewater has been long recognized and the application of this treatment method has been gaining acceptance around the world in recent decades. There has been skepticism, however, regarding the ability of wetlands to function in cold climates. Treatment

wetlands improve water quality – including removing pathogens (such as *E. coli* and fecal coliform bacteria), excess nutrients and other types of contaminants – by taking advantage of complex natural wetland processes. A long arctic winter with sub-zero temperatures and minimal sunlight restricts wetlands use to the summer, and for the rest of the year wastewater must be stored in lagoons. Also, the *ad hoc* way in which the use of treatment wetlands developed in the Arctic, and an accompanying lack of formal research, means that the design and operation of wetlands varies between communities – and so does their success. However, wetlands like the one in Chesterfield Inlet demonstrate that this treatment method can be effective even in extreme climatic conditions.

Besides being functional and inexpensive, treatment wetlands are intuitive, acces-

sible, and congenial with their surrounding environment. The United Nations Environment Programme (UNEP) has recognized treatment wetlands as an appropriate and environmentally sound technology (EST), and has been facilitating their application to improve quality of life in areas like water and sanitation, while protecting the environment. With appropriate research culminating in design and use guidelines, treatment wetlands can continue to provide a viable alternative to conventional sewage treatment plants in the arctic.

*Brent Wootton is Director and Senior Scientist at the Centre for Alternative Wastewater Treatment at Fleming College, in Lindsay, Ontario. Colin Yates is a PhD. candidate in Planning at the University of Waterloo. He received the 2010–11 Canadian Polar Commission Scholarship.*

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## BOOK REVIEW

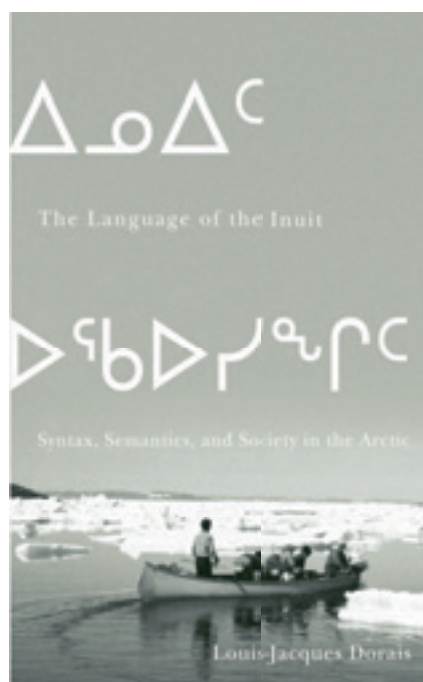
*John Bennett*

**The Language of the Inuit: Syntax, Semantics, and Society in the Arctic**, by Louis-Jacques Dorais, McGill-Queens University Press, 2010. 296 pp. \$45.00 cloth. ISBN 9780773536463.

In January 1997 an elder named Weyi died in a Siberian community on the Bering Sea. During her final years no one could understand her when she spoke her native language. She was the only remaining speaker of Sireniki, and the language died with her.

Each language, says Laval University anthropologist Louis Jacques Dorais, is like an animal species. When it disappears, a form of life – a form of thought – has gone extinct.

For centuries the language of the Inuit was the only one spoken along the expanse of Arctic coast from the Bering Sea to the east coast of Greenland. For decades it has been losing ground to English, and in some areas is



rarely heard except as a second language taught in schools. In Greenland its survival seems assured, and in northeastern Canada it has a reasonable chance.

Inuit use words like *ajurnarmat*, “it can’t be helped”; *pualuktanikpuq*, “the time of year after the midwinter darkness when you can first see the sun over the top of a mitten aligned with the horizon”; and *tungasugit*, “welcome, make yourself at home”. Louis-Jacques Dorais has felt at home with the Inuit language for over forty years. He has made it his life’s work to study the language and its place in Inuit culture and society, and he is widely respected in the north and south for his expertise. *The Language of the Inuit* is based on his 1996 book *La Parole Inuit – Langue, culture et société dans l’Arctique nord-américain* (Peeters Press, Louvain and Paris). Rewritten and updated, it gives a comprehensive view of the linguistic, social, and cultural di-



mensions of the Inuit language by examining its geographic distribution, origins, linguistic structure, history and meaning, and current status.

The book starts with an overview of the Eskaleut language family, to which the Inuit language belongs along with Yupik in Alaska and Siberia, Sireniki, and Unangan in the Aleutian Islands. The writing is clear and the information well organized, with maps showing language distribution and charts comparing words in different languages and dialects. Lively historical and cultural information provides context, and statistics show the relative strength of the languages by region.

Next comes a discussion of the Inuit dialects spoken from northern Alaska to Greenland. While their differences may seem substantial at first, close examination reveals strong similarity. Inuit (Inupiat) in Western Alaska, for instance, would more easily understand their fellow Inuit (Kalaallit) from Greenland than the speech of their Alaskan Yupik-speaking neighbours. This is why the Greenlandic ethnologist Knud Rasmussen found he could easily adapt to the dialects of the many different groups of Inuit he met as he travelled by dog team across the Canadian Arctic to Alaska, during the Fifth Thule Expedition (1921–24). Had he spoken the East Greenlandic dialect Canadian Inuit would have found Rasmussen more difficult to understand. Before they converted to Christianity, around 1900, East Greenlanders practiced a death taboo against speaking the name of the deceased, even if it was a name used in everyday speech, like *Natsiq*, meaning ringed seal. As it could no longer be uttered, the word had to be replaced: *natsiq* became *miigattak* (the very small one). As a result the East Greenland dialect is full of metaphors.

The book then looks at how the Inuit language works, using as an example the grammar and phonology of the Nunavik (Northern Quebec) dialect of Inuktitut, and then discusses the origins of the language

and the migrations and other factors that have influenced its evolution. Linguistic evidence suggests that its most distant ancestor emerged from group of prehistoric languages spoken by northeastern Asian peoples. Similar words and other linguistic elements hint at ancient links between Inuit and Asian languages: *silá* (Inuit) *sula* (Manchu) and *sora* (Japanese), meaning “outside, space, sky”; *ani* (Inuit), *ani* (Japanese) and *enni* (Korean), meaning brother. Centuries of migrations established today’s pattern of regional dialects, and their sound and structure have been influenced by social changes associated with Christianity, formal education, and the trade and wage economy.

There is much in this book to appeal to general readers with an interest in the Inuit as well as specialists and others very familiar with Inuit language and culture. Those hoping for a list of words for snow, for instance, will not be disappointed. Terms like *sirmiq* (melting snow used as cement for the snow-house), *piiqturiniq* (thin coat of snow deposited on something) and *isiriaqtaq* (yellow or reddish falling snow) demonstrate that subjects which Inuit consider important have a large associated vocabulary. The Inuit language, Dorais writes, uses human beings in harmony with their environment as a model for describing the world. It frequently names objects after their relation to human activities (*aalisakkat*: fish caught with a line) and uses the human body itself as a reference (*tallimat*: five – “an arm is complete”). Although it has incorporated some foreign loan-words to express new concepts, the polysynthetic Inuit language, a linguistic Lego of small parts with regular meanings that can be assembled to form new words, offers endless possibilities. The word for airplane pilot, for instance, is *qangatajuuqti*, “the one whose usual occupation is flying”. The author also describes the Inuit oral literature, starting with the ancient myths, legends, songs, and magical incantations, and moving on to today’s hymns, popular song, radio, television, theatre, and film.

The book next discusses the writing systems – syllabics in the central and eastern Canadian Arctic, and Roman orthographies elsewhere – and gives an overview of the impact of formal education and southern media on the language. Greenland is unique in the Inuit world in having a strong literary tradition, and students there are expected to master the written language, which is not the case in Canada. The Canadian federal schools of the 20th century attempted to assimilate students: but as Dorais points out it was in those schools that the first generation of Inuit political leaders learned the skills they needed to fight for their identity, including their language.

The final chapters discuss contact with other languages, bilingualism, the current state of the Inuit language, and its links with identity. Dorais’ assertion that the survival of the Inuit tongue is by no means guaranteed may surprise those who have visited communities where everyone speaks it. In other communities however, visitors will hear grandparents speaking in Inuktitut to their grandchildren, who reply in English; and in some areas they will probably not hear it spoken at all. It has been replaced by English as the main language in Nunatsiavut (Labrador), in the Inuvialuit communities of the Western Arctic, and in Alaska. One quarter of Inuit no longer speak their native language.

In Nunavik and eastern Nunavut it is relatively strong, but under great pressure from the dominant language. In those areas, younger people often speak a mixture of Inuktitut and English. Their Inuktitut schooling ended in grade four, and from then on most learned only English vocabulary in the classroom. As a result many have difficulty talking about subjects related to contemporary life in Inuktitut, even though they feel strongly about using the language and promoting it. While the language itself is perfectly adaptable to expressing new concepts, it must be taught in order to be used. In Greenland the

language is thriving, likely, the author suggests, because Greenlanders have used their political autonomy to develop legal, cultural, and educational means to reinforce their identity, of which their language is a major part.

The book ends with four appendices. The first three deal with grammar, using Nunavik Inuktitut as an example, and will be useful to those learning or studying Inuktitut. The fourth presents statistical data on Inuit first and home languages in Canada.

Excellent organization and clear writing help the reader absorb and keep track of the enormous amount of information this book presents. Topics follow an orderly progression, the very informative endnotes are keyed to page as well as reference number making them easy to find, and the author provides a summary at the end of each chapter. A glossary would have been a welcome addition for readers unfamiliar with linguistic terms, and the maps would have benefitted from more attention to readability and appearance.

*The Language of the Inuit: Syntax, Semantics, and Society in the Arctic* presents an encyclopaedic breadth of information in a concise and readable work that will have broad appeal. Most importantly, this very fine book will bring deeper understanding of the rich heritage and meaning of their language to Inuit working to preserve and revitalize it.

*John Bennett is editor of Meridian.*

## NEW BOOKS

***Polar Imperative: A History of Arctic Sovereignty In North America***, by Shelagh D. Grant. Douglas and McIntyre. ISBN 978-1-55365-418-6.

This book discusses the implications of major climate changes, the impact of resource exploitation on the indigenous peoples, issues regarding control over the adjacent waters of Alaska, Arctic Canada and Greenland, the history of claims to authority over the lands and waters of the North American Arctic, and compares the North America situation with others in the European and Asian Arctic.

***Inuit Education and Schools in the Eastern Arctic***, by Heather E. McGregor. University of British Columbia Press. ISBN 9780774817448.

"As the first history of education in the Eastern Arctic, this groundbreaking study provides the historical context needed to understand the educational challenges faced in Nunavut. With an emphasis on cultural negotiation, policy making, and the role of tradition, Heather McGregor assesses developments in the history of education in four periods – the traditional, the colonial (1945–70), the territorial (1971–81), and the local (1982–99)." (UBC Press)

## HORIZON



### 7th ArcticNet Annual Scientific Meeting (ASM 2010)

Ottawa, Ontario

December 14–17, 2010

[www.arcticnetmeetings.ca/  
index.php?url=11010](http://www.arcticnetmeetings.ca/index.php?url=11010)

### 12th North American Arctic Goose Conference and Workshop

Portland, Oregon

January 11–15, 2011

[www.naagconference.com](http://www.naagconference.com)

### Churchill Northern Studies Centre and Parks Canada Science Symposium

Winnipeg, Manitoba

January 19–20, 2011

[www.churchillscience.ca](http://www.churchillscience.ca)

### Arctic Science Summit Week 2011 The Arctic: The New Frontier for Global Science

Seoul, Korea

29 March – 2 April, 2011

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Canadian Polar Commission  
Suite 1710, Constitution Square  
360 Albert Street  
Ottawa, Ontario  
K1R 7X7

Tel.: (613) 943-8605

Toll-free: 1-888-765-2701

Fax: (613) 943-8607

E-mail: [mail@polarcom.gc.ca](mailto:mail@polarcom.gc.ca)

[www.polarcom.gc.ca](http://www.polarcom.gc.ca)

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