

**Ice, Through Inuit Eyes:  
Characterizing the importance of sea ice processes, use, and change  
around three Nunavut communities**

by

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A thesis submitted in conformity with the requirements

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Graduate Department of Geography

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**Abstract**

Sea ice is an integral component of life in Inuit communities. It has complex influences on economic, social, cultural, and subsistence activities. Also, due to its influential role in regulating energy exchanges between the ocean and the atmosphere, sea ice is often used as an indicator of climate change in arctic regions. Significant scientific research effort has been focused on determining the potential impacts of global climate change on arctic ice seasonal patterns. Recently, interest in the impacts of climate change on arctic communities, and resulting societal adaptations, has emerged. Sea ice is thus an essential component to include in vulnerability assessments designed to evaluate community-specific implications of climate change. However, in order to undertake such an assessment, we must first understand Inuit characterizations of sea ice and the attributes of ice that most affect their livelihoods and lifestyles.

Inuit have developed an intimate relationship with the sea ice and marine ecosystem through generations of observation and experience. While they have long been able to harvest wildlife and forecast changes linked to ice conditions, little of this detailed knowledge has been documented to appropriately represent this expertise. Therefore, working with Inuit sea ice experts in Cape Dorset, Igloolik, and Pangnirtung, Nunavut, this thesis characterizes the local importance of sea ice processes, use, and change. Employing a collaborative research approach, a combination of participatory methods (i.e. semi-directed interviews, experiential sea ice trips, focus groups) were undertaken in four field seasons between 2003 and 2005.

Results from each community include descriptions of: i) freezing and melting processes; ii) the influences of winds and currents on sea ice; iii) sea ice uses for travel, hunting, and wildlife habitat; and, iv) observations of sea ice change. These results facilitate a comparative regional analysis, with an emphasis on Inuktitut terminology and implications of a changing sea ice environment. Experiences in a cross-cultural, community-based, collaborative research setting also enable an evaluation of the effectiveness of the research approach. This thesis lays the foundation for knowledge-sharing between Inuit and scientists. It is a starting point for attempts to link local and scientific knowledge in a complementary manner.

## Dedication

*This work is dedicated to the Inuit elders who shared their wisdom and contributed to this project, but who passed away before seeing the results.*



*In memory of Mosesee Nuvaqiq, Paulassie Pootoogook, Etidlouie Petaulassie, and Iqadluq Nunguisuituq, this work is also dedicated to the future generations of Inuit with whom they wanted to communicate.*



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# **Chapter 1 – Introduction**

## ***Learning about ice, through Inuit eyes***

I clung to the back of a speeding snowmobile as we trailed an arctic fox across the sea ice. I treaded lightly – nervously – at the ice edge, a few inches separating me from the fast-moving water underneath and beyond the ice extent. I flailed to grab on to the *kamotik* (sled) lines as the dog team was off and running without me, despite several warnings that “go!” means “go right now!!” I hung on with clenched teeth as we manoeuvred an ice ledge attached to a steep cliff, with open water flanking the other side. These are just a few of the experiences I was privileged to have learned from during my time in Cape Dorset, Igloodik, and Pangnirtung, Nunavut. Facilitated by Andrew Dialla, Pootoogoo Elee, Eric Joamie, and Theo Ikummaq I was provided a small taste of the experiential and practical learning that is so critical in the development of Inuit sea ice expertise. They helped me to contextualize the depth and complexity of elders’ explanations of sea ice conditions, dangers, and terminology. It is challenging to adequately describe this research journey in words. I was led from books, to communities, to snowmobiles, to sea ice, to myself, and back again. As such, this thesis is my initial contribution to learning about sea ice, through Inuit eyes.

### **1.1 Inuit, sea ice, and scientists**

Sea ice is an integral component of Inuit life, and is the preeminent focus of numerous types of scientific research (Norton, 2002; George *et al.*, 2004; Nichols *et al.*, 2004; Laidler, 2006a). This dynamic, cyclical component of the arctic marine system has sustained Inuit for centuries, while also influencing regional climates around the world. The sea ice is of utmost importance to Inuit communities in the Canadian north as it: i) enables smooth, efficient travel; ii) creates habitat for marine mammals; and, iii) provides a hunting platform from which to access marine mammals (i.e. used for food, clothing, heat, light, and equipment). For most of the year, Inuit life is tied directly to the ice on the ocean (Nickels *et al.*, 2005). Therefore, knowledge of ice and

ice conditions are critical to survival, whereby sea ice use is a means of maintaining, and transmitting, Inuit culture and language. Meanwhile, sea ice formation and decay processes, sea ice influences on atmospheric and oceanic systems, and the advent of climate change has increasingly peaked scientific interest over the past century. The far-reaching implications of changing sea ice thickness, distribution, and extent also render this dynamic environment a primary target in efforts to model or project future scenarios of ice or climatic conditions. While the sea ice is a common focal point for both Inuit and scientists, there has conventionally been little interaction between the two, and thus minimal understanding of their differing perspectives on sea ice. So in a history of northern research where scientists often relied on Inuit, but where relationships were not always reciprocal in their benefits, the topic of sea ice continues to bring the two cultures together. Scientists are now having to respond to community, political, and institutional pressures to consult with, involve, and/or report their findings to Inuit in communities across Canada (Section 1.3.3). Furthermore, with an explosion of sea ice and climate change observations, investigations, and politics in the last few decades, scientific and Inuit interests have become increasingly intertwined.

## **1.2 Global to local and back again, the politics of sea ice and climate change**

A shrinking sea ice extent, or thinning ice cover, not only responds to warming but also contributes to enhanced change through positive climate feedback loops (e.g. surface albedo, and thermohaline circulation). Specifically, feedback mechanisms related to changes in sea ice extent, distribution, and thickness contribute to the projected amplification of warming trends – and thus environmental sensitivity – at high latitudes (Ledley, 1988; Ingram *et al.*, 1989; Bintanja and Oerlemans, 1995; Curry *et al.*, 1995; Lohmenn and Gerdes, 1998; Lemke *et al.*, 2000; Holland and Bitz, 2003). While this type of research has raised the global profile of circumpolar regions, it has also sparked investigations into the human dimensions of climate change (Ford, 2000; Cruikshank, 2001; Fenge, 2001; Riedlinger and Berkes, 2001; Berkes, 2002;

Berkes and Jolly, 2002; Fox, 2002; Huntington, 2002; Duerden, 2004; Ford, 2005). Comparatively little is known about the vitality of sea ice extent, distribution, and thickness to daily life in arctic communities, much less how community members perceive climate change as it relates to their local environs. Therefore, scientific assessments of sea ice change and simulations of climate scenarios are inevitably related to Inuit concerns for their lifestyles, livelihoods, travel safety, and marine mammal health.

Sea ice and climate change are intimately linked within the realm of environmental investigation, but they are also becoming forefront in political arenas. Physical changes are being observed and experienced from global to community scales, and are occurring within the context of: i) global policy decisions; ii) federal politics; and, iii) Inuit asserting their rights through increased political control of their lands and people. Scientific evidence of human influences on the global climate system emerged in the international public sphere in 1979, at the First World Climate Conference (UNFCCC, 2005). Public awareness of environmental issues increased throughout the 1980s, as did government concerns with climate issues (UNFCCC, 2005). Therefore, by 1988 the governing bodies of the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) established the Intergovernmental Panel on Climate Change (IPCC) (IPCC, 2004; UNFCCC, 2005). The IPCC provides a forum for interaction between scientists and decision-makers, aiming for policy relevance but leaving policy decisions/implementation to national government discretion (IPCC, 2004). Through three assessment reports (1990, 1995, 2001), the IPCC has confirmed that climatic changes are underway – as influenced by human activities – and provided comprehensive assessments of scientific research on a myriad of related subjects (IPCC, 2004).

Adopted in 1992 at the Rio de Janeiro Earth Summit, the United Nations Framework Convention on Climate Change (UNFCCC) works closely with the IPCC. The UNFCCC came into force in 1994, and is one of the most universally supported international environmental

agreements (including Canada) (UNFCCC, 2005). Under the UNFCCC, the Conference of the Parties (COP) has convened member countries annually since 1995 (UNFCCC, 2005). These COP meetings also enable the IPCC and UNFCCC to share advice, findings, and proposals for future assessments or areas of investigation (IPCC, 2004). Such interactions led to discussions of commitments for industrialized countries to curtail greenhouse gas emissions, whereby the Kyoto Protocol was adopted in 1997 at COP3 in Japan (UNFCCC, 2005). However, it was only in 2005 that the protocol had sufficient ratifications to come into force (UNFCCC, 2005).

As a member of the UNFCCC, and a contributor to the IPCC, the Canadian government developed a *Climate Change Plan for Canada* that sets out specific targets for reducing greenhouse gas emissions to reach its Kyoto commitments (i.e. 6% below 1990 levels, between 2008 – 2012) (GC, 2002). The target area focusing on “Canadians, communities, and governments” specifies a national commitment to “ongoing **collaboration with Aboriginal and northern communities** to build capacity to address their particular priorities” (GC, 2002, 4 [emphasis in original]). As part of this effort, a Memorandum of Understanding (MOU) was reached between the Government of Canada and the Government of Nunavut in 2003. This MOU outlined interests to cooperate on climate change priorities and to link the Canadian action plan with the Nunavut climate change strategy, for a five-year period (GC and GN, 2003). The predominant focus of the Nunavut climate change strategy is the documentation of change, according to *Inuit Qaujimajatuqangit* (IQ - Inuit knowledge), around the territory (refer to DE 2005a, 2005b, 2005c, 2005d) (Section 1.3.1).

Concurrent with international and governmental efforts to address climatic change, Inuit groups and organizations have rallied their own efforts to influence national and international decision-making. Northern community members, especially elders who have a longer timeframe for comparison, have been observing and experiencing changes that they consider indicative of climatic change, including: i) different weather patterns; ii) altered

season durations; iii) diminished sea, lake, and glacier ice; iv) increased sun intensity; v) new species of birds and wildlife; vi) more skin conditions; vii) increased land, water, and animal contamination; viii) lower water levels; ix) heavier winds; and, x) more ships traveling in surrounding waters (NTI, 2001). As an advocate for Inuit rights, the Inuit Circumpolar Conference (ICC) has been championing these local concerns on the international stage for over a decade. Sheila Watt-Cloutier (ICC Chair) has been the main proponent for Inuit rights in the international climate change context. She has been fighting to highlight the regional and local implications of international actions, policies, and protocols for years. With the United States' resistance to ratifying the Kyoto Protocol, she embarked on a campaign to communicate Inuit perspectives to the COP held in Milan in 2003 (ICC press release, 2003), among other gatherings of national leaders. Because of the dangers of travel related to changing sea ice conditions, the decreased ability for hunters' environmental knowledge to evaluate weather or seasonal patterns, and altered wildlife habitat, Watt-Cloutier used the issue of human rights to:

“...prompt a dialogue with Arctic states, particularly the United States of America. It is our intent to educate not criticize, and to inform, not complain. By defending our human rights we will help the world achieve the unity and clarity of purpose it needs to tackle global climate change.” (Watt-Cloutier in ICC Press Release, 2003).

With little active response from the USA, she followed up with a formal petition to the Inter American Commission on Human Rights, on behalf of Inuit in Canada and the USA (Watt-Cloutier, 2005). This effort contested that the refusal of the USA to ratify the Kyoto Protocol – as the world's largest emitter of greenhouse gases – is a violation of the human and subsistence rights of Inuit to maintain their culture and lifestyle (Watt-Cloutier, 2005). Without seasonal ice formation, the reliability of local expertise, and the health of northern wildlife, Inuit health, livelihoods, and culture may be irreversibly altered (Watt-Cloutier, 2005). “The culture, economy, and identity of the Inuit as an indigenous people depend upon the ice and snow. Nowhere on Earth has global warming had a more severe impact than the Arctic.” (Watt-

Cloutier, 2005, 1). Therefore, since 1992 Watt-Cloutier's efforts, along with other local, territorial, and national Inuit leaders, have heightened the importance of the circumpolar Arctic in global environmental and political affairs (Fenge, 2001). Through political and scientific developments that support these endeavours (e.g. the Arctic Council, the International Arctic Science Committee (IASC), and the Arctic Climate Impact Assessment (ACIA)), northern Indigenous Peoples are thus in a position to exert significant influence in future global debates, including those on climate change (Fenge, 2001).

Through this overview of the political and scientific context within which climate change research is undertaken, it becomes clear that both scientists and Inuit play an essential role in improving our understanding of the relationships between sea ice, climate change, and northern communities. As scientific assessments of change move from documentation to exploration of adaptive and mitigative strategies (from environmental, economic, and cultural perspectives), both scientific and Inuit expertise are increasingly being considered alongside one another (Ford, 2000; Ford and Smit, 2004; Symon *et al.*, 2005). This is necessary to adequately incorporate the multiple stressors of northern life into assessments of resilience, or vulnerability, to climate change (McCarthy *et al.*, 2005). Indeed, Inuit want to be involved in this process in order to: i) share their own observations; ii) have their voices heard; and, iii) be taken seriously (Ashford and Castleden, 2001; Kusugak, 2002; ITK, 2005; Nickels *et al.*, 2005; NTI, 2005; Laidler, 2006b). This, along with my interest in working collaboratively and linking different forms of expertise, contribute to the formation of the rationale for my thesis research.

### **1.3 Rationale**

This project is driven by an interest to learn from Inuit about what sea ice means to them, how it is important in their lives. This links to how northern community members understand sea ice processes, and how they are experiencing sea ice and related changes around their communities. Beginning at the community level is imperative to pursue my other

interests of learning how to effectively work across cultures, and beginning the process of practically linking different knowledge systems. These personal interests are also tied to three broader issues that provide the rationale for conducting this research: i) Inuit knowledge (*Inuit Qaujimajatuqangit*) is a priority for inclusion in territorial and community government systems in Nunavut; ii) there is a need for increased understanding of local expertise on topics of sea ice and climate change; and, iii) the value of employing Inuit and scientific knowledge in complement is recognized, but more effort is required to understand the best processes for undertaking collaborative research.

### **1.3.1 Inuit Qaujimajatuqangit as a Nunavut priority**

Inuit efforts to gain recognition and consideration of their expert knowledge evolved along with negotiations for the Nunavut Land Claim Agreement (NLCA) and the Territory of Nunavut. While there is no mention of Inuit traditional knowledge (or *Inuit Qaujimajatuqangit*) in the NLCA, the agreement (finalized in 1993) was based on extensive studies to document Inuit land use and occupancy (i.e. Freeman, 1976) to solidify Inuit claims to land, ocean, and sub-surface rights (NTI, 2004). This traditional knowledge (also reflecting Inuit values) was to become the cornerstone of the programs, services, policies, and legislation to be developed under the new Government of Nunavut (GN) (NSDC, 1998). In these discussions, it is important to remember that the NLCA and the Territory of Nunavut are two different entities. The NLCA recognizes Inuit title to a large area of the former Northwest Territories (NWT), and provides Inuit with the right to use and make decisions about lands within the Nunavut settlement area (Wenzel, 2004). The Territory of Nunavut was negotiated between political bodies (i.e. the federal government, Inuit organizations, and the land claims organization Nunavut Tunngavik Incorporated (NTI)) later in the land claims process (Wenzel, 2004). These negotiations aimed to satisfy Inuit desires for political separation from the NWT. Through the establishment of a public government and administration, the GN would deliver services

formerly provided by the Government of the NWT, as well as alleviate some federal government responsibilities (Merritt *et al.*, 1989; Hicks and White, 2000).

Although the GN represents all Nunavut residents, with over 85% Inuit population the territorial government is empowered to address many of the issues where Inuit seek political responsibility and control (Wenzel, 2004). The GN is structured similarly to the non-native dominated NWT and Yukon Territory, but it has also made concerted efforts to incorporate traditional knowledge (TK) into its political mandate and operational approach (refer to Wenzel, 2004 for a more detailed account). A strategic outcome of a traditional knowledge conference held in Igloolik, Nunavut in 1998 (NSDC, 1998) was the conception of the terminology *Inuit Qaujimajatuqangit* (IQ) – actually a translation of “traditional knowledge” into Inuktitut (the language of the Inuit). Since then, the *Inuit Qaujimajatuqangit Katimajiit* (IQ committee) was convened and IQ has been formally included as part of every GN departmental mandate (CLEY, 2003). Of course the degree to which IQ can, or has been, incorporated into government operations varies between departments; it is a conceptual and practical work in progress (Wenzel, 2004). Nevertheless, attempts to incorporate the guiding principles of IQ (Table 1-1) into government structures and systems is a GN priority (CLEY, 2003; GN, 2004). As such, these efforts provide impetus and support for research that seeks to better understand particular aspects of IQ. By focusing on Inuit knowledge of the sea ice environment I cannot respectfully claim to be researching IQ (Section 2.1.1), but I can state that

**Table 1-1:** Guiding principles of *Inuit Qaujimajatuqangit*.

Source: GN (2004)

Guiding principle	Description
<i>Inuuqatigiitsiarniq</i>	Respecting others, relationships, and caring for people
<i>Tunnganarniq</i>	Fostering good spirit by being open, welcoming, and inclusive
<i>Pijitsirniq</i>	Serving and providing for family and/or community
<i>Aajiiqatigiinni</i>	Decision making through discussion and consensus
<i>Pilimmaksarniq/Pijariuqsarniq</i>	Developing skills through practice, effort, and action
<i>Piliriqatigiinni/Ikajuqtiigiinni</i>	Working together for a common cause
<i>Qanuqtuurniq</i>	Being innovative and resourceful in seeking solutions
<i>Avatittinnik Kamatsiarniq</i>	Respecting and caring for the land, animals, and environment



this work contributes to GN efforts to learn about, promote, document, and apply IQ. Efforts to incorporate such principles into a public government also necessitate the exploration of effective methods of linking science and IQ in order to reflect, and possibly develop, GN policies and mandates.

### 1.3.2 Addressing research gaps

Several recently identified gaps in arctic climate change research were compiled and highlighted in reports by Thorpe *et al.* (2000), NCE (2000), and NRI (2002), such as:

- a) The state of documented traditional and local knowledge of climate change does not adequately reflect the state of traditional and local knowledge of climate change;
- b) There is an extensive body of literature on climate change trends and impacts based on Western science research, but climate change as observed, experienced, and explained through traditional and local knowledge has received less attention;
- c) Many documented sources of traditional and local knowledge are incidental and components of larger sources;
- d) In order to move towards a more comprehensive understanding of the impacts of change in the North substantial progress must be made in linking Western science-based climate change research with local knowledge;
- e) There is an imbalance in regional documentation of climate change from local perspectives;
- f) There is a lack of specificity in the descriptions of observations and impacts of change at the community level;
- g) Community-based research to document climate change focuses mostly on current observations rather than on historical context; and,
- h) There is a lack of identified specificity of observations of change as related to a particular community or region.

These gap analyses all provide important justification for additional, in-depth investigations of environmental and socio-economic issues related to community life, as understood and experienced by community members themselves. Sea ice is one of the most frequently referenced indicators of sea ice change by both scientists and Inuit (Johannessen *et al.*, 1999; Copley, 2000; Krajick, 2001; Nichols *et al.*, 2004; DE, 2005a; DE, 2005b; DE, 2005d; Nickels *et al.*, 2005); therefore, it became a valuable focus with which to expand our collective knowledge base while refining research methodologies.

### 1.3.3 Moving towards research partnerships

It is increasingly recognized that in order to address complex problems it is desirable to work collaboratively to incorporate different knowledge systems (Riedlinger and Berkes, 2001; Ford and Smit, 2004; Nichols *et al.*, 2004; NTI, 2005). To do so, ethical and effective means of working together must be explored. This requires the development of positive working relationships between scientists and communities so that both forms of knowledge can equally inform investigations (Thorpe *et al.*, 2000; ITK and NRI, in press). Creative methods, along with revisiting previously used methods, are necessary to more effectively communicate across cultures and across disciplines (NCE, 2000; Furgal *et al.*, 2005). It is imperative that Inuit knowledge be incorporated in sea ice studies in order to gain a truly *in situ* understanding of the role that ice plays in community dynamics, and daily life in the North. This inclusion has great potential for mutual learning, and thus for an improved comprehension of the importance of sea ice not simply in physical terms, but also in relation to community dynamics, identity, economy, tradition, communication, and safety. More efforts are needed to ensure the transition from simple recognition of local Inuit expertise, to substantive research partnerships (Krupnik, 2002; ITK and NRI, in press). Without such co-operative investigations, it will be difficult to develop adaptive strategies to projected climatic change that reflect community-specific socio-economic and ecological systems (Smit *et al.*, 2000).

## **1.4 Thesis statement**

I argue that community-based, collaborative research efforts to combine various forms of sea ice expertise could enhance ocean and climate research in the Canadian Arctic.

## **1.5 Thesis goals**

Within the scientific community there is a limited understanding of sea ice at local scales, especially in relation to Inuit culture, lifestyle, and socio-economic practices. As such, this thesis aims to:

- a) expand the current state of knowledge on sea ice and marine systems;
- b) provide a foundation from which to develop discussions, and knowledge-exchanges, between Inuit and scientists; and,
- c) establish joint local and scientific research priorities.

Therefore, this thesis furthers our understanding of the importance of sea ice processes, use, and change at the local level by characterizing these aspects based on Inuit expertise.

## **1.6 Thesis objectives**

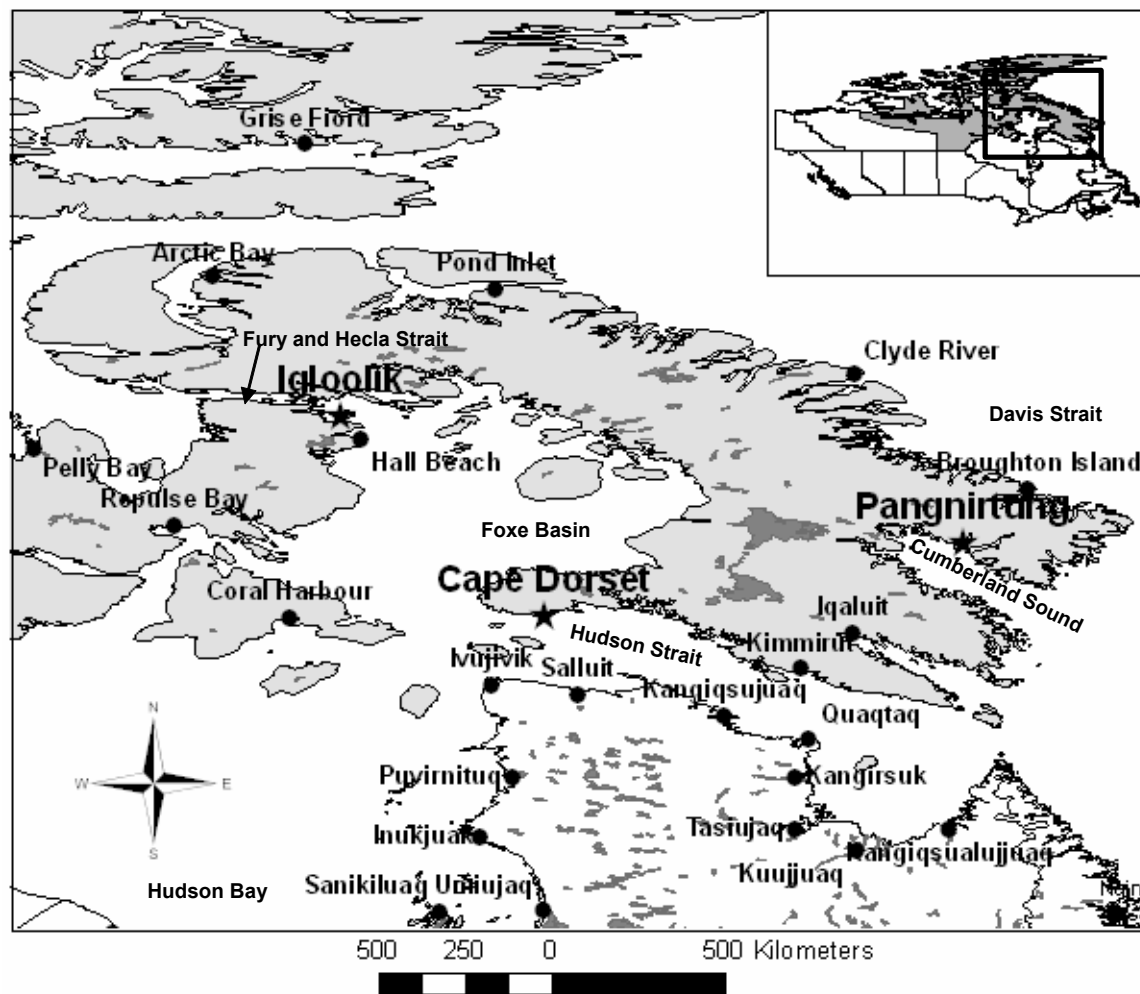
In order to achieve the goals listed above, this thesis has four objectives:

1. gain a better understanding of the importance of sea ice to Inuit by learning about their terminology and descriptions regarding ice conditions/cycles;
2. better comprehend the traditional and contemporary Inuit means of characterizing sea ice variability, and its relevance to human and animal activity, in the surrounding coastal environment (e.g. ice thickness, floe edge, seasonal extent, break-up timing, etc.);
3. evaluate a collaborative research approach for collecting, analyzing, and reporting Inuit knowledge to facilitate practical linkages with scientific knowledge; and,
4. identify future collaborative research/monitoring needs based upon the issues of greatest importance to Nunavut communities.

## **1.7 Communities involved**

Through discussions with northern and Inuit organizations (Section 3.1.1.2), the Nunavut communities of Cape Dorset, Igloolik, and Pangnirtung were selected to collaborate in this project because: i) they each have unique ice conditions and uses due to their geographic locations around Baffin Island; and ii) there was potential for collaboration with another researcher working in those communities. It was seen as beneficial to collaborate with someone who had already established a working relationship with community members. It would be easier to introduce my project idea to the community and may have eased logistical considerations. Despite the fact that the other researcher did not end up expanding into all three communities, I felt it was important to continue to pursue support from these communities. By involving multiple communities, there was also fascinating potential for regional comparisons of ice conditions, importance, uses, and change.

Cape Dorset is located on a small island of the same name off the southwestern tip of Baffin Island (i.e. Foxe Peninsula), in Hudson Strait ( $64^{\circ}14'N$ ,  $76^{\circ}40'W$ ) (Figure 1-1). This area was named by Luke Foxe who explored parts of Hudson Bay and Foxe Basin in 1631, with the cape being named after the Earle of Dorset (Freeman, 1976). However, in Inuktitut Cape Dorset is known as *Kinngait* (meaning “mountains”) (Milne *et al.*, 1995; Laird, 2004). In the past it has also been referred to as *Sikusilaaq* (meaning “where there is no ice”) because of the nearby presence of open water throughout the winter (Walk, 1999). A Hudson Bay Company (HBC) trading post was established in this area in 1913, which became the basis of community



**Figure 1-1:** Map showing the location of communities involved in this research project (i.e. Cape Dorset, Igloolik, and Pangnirtung, Nunavut are indicated with the stars).

**Where:** Nunavut is highlighted in grey in inset, and the square indicates the Baffin Island region shown in the larger map.

settlement in the 1950s (Freeman, 1976; Laird, 2004). Now with a population around 1148 (93% Inuit) (StatsCan, 2002), Cape Dorset is renowned for its art, cultural history, and proliferation of marine wildlife (Blodgett, 1991; Milne *et al.*, 1995; Walk, 1999; Doubleday *et al.*, 2004).

Igloolik is located on a small island of the same name, near the eastern entry of Fury and Hecla Strait, in Foxe Basin (70°35'N, 84°54'W) (Figure 1-1). Based on archaeological evidence, this island has always been an important Inuit settlement area due to abundant wildlife and fertile surrounding seas (Freeman, 1976; MacDonald *et al.*, 2004). The first contact with Europeans in this area occurred in 1822 – 1823 when the ships “Fury” and “Hecla” wintered in Turnton Bay, at Igloolik Island (Freeman, 1976; MacDonald *et al.*, 2004). In the 20<sup>th</sup> Century Igloolik people traded at posts in northern Baffin Island and Repulse Bay to the south, until the HBC opened a post in Igloolik in 1939 (Freeman, 1976). The present community of Igloolik was established in the late 1950s under increased federal administrative interest in the Arctic (MacDonald *et al.*, 2004). It now has a population of approximately 1286 (95% Inuit) (StatsCan, 2002) and maintains strong links to traditional cultural activities as well as being an important regional hub for the decentralized GN (MacDonald *et al.*, 2004).

Pangnirtung is located on the southeastern shore of Pangnirtung Fiord (on Cumberland Peninsula), off the northern shore of Cumberland Sound (66°7'N, 65°55'W) (Figure 1-1). Cumberland Sound was visited by John Davis in 1585, and the land north of the Sound was named Cumberland Island (later found to be a peninsula) by William Baffin in 1616 (Freeman, 1976). The community name of Pangnirtung is actually a poor spelling of the Inuktitut name *Panniqtuuq* (meaning “place of the bull caribou”) (Harper, 2004). Cumberland Sound has been home to Inuit for over 1000 years, with seals, walrus, beluga whales, and bowhead whales frequenting the waters<sup>1</sup> (Harper, 2004). Since 1818, this area has been the focus of organized

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<sup>1</sup> The common names of wildlife species are used throughout this thesis. However, Appendix 1 provides a list of both the scientific and Inuktitut names for each species mentioned.

whaling activities (attracting Inuit and European whalers alike) (Freeman, 1976; Harper, 2004). An HBC post was opened in Pangnirtung in 1921, followed shortly by a detachment of the Royal Canadian Mounted Police (RCMP) (Freeman, 1976; Harper, 2004). From the mid-1950s to early-1960s the federal government began establishing a schooling and administrative presence, encouraging families in outlying camps to move into the community (Harper, 2004). Currently with a population of approximately 1276 (95% Inuit) (StatsCan, 2002), Pangnirtung is known for its commercial turbot fishery (Pangnirtung Fisheries), the nearby National Park (Auyuittuq National Park), and its unique weaving artistry (based at the Uqqurmiut Centre for Arts and Crafts) (Harper, 2004; Scott, 2004).

## **1.8 Thesis outline**

This introductory chapter is intended to provide the background context within which the research was conducted, as well as to present the rationale and objectives for undertaking this research. The dissertation is divided into nine chapters to adequately reflect literature and methodological descriptions, community-based results, and different foci for analyses.

Chapter 2 provides a background for interpreting and understanding subsequent chapters. It aims to familiarize the reader with current literature, and topics, related to both Inuit and scientific sea ice knowledge. An overview of Inuit sea ice expertise, use, and observations of change is provided in Section 2.1. The relationship between sea ice and climate is then presented from scientific perspectives (Section 2.2). This begins with a basic description of sea ice formation and decay processes, as well as an introduction to ice conditions around Baffin Island. This is followed by a summary of monitoring and modeling efforts undertaken to assess sea ice change (Section 2.3). Then, a theoretical discussion of ways to link Inuit and scientific expertise is used to highlight important considerations for addressing these issues more practically (Section 2.4).

Chapter 3 provides a detailed account of the methods employed in this project. Beginning with an outline of the collaborative research approach, the seven main research phases are described in Section 3.1. This is followed by a discussion of critical realism as the philosophy underlying my research (Section 3.2). Specific qualitative research methods are then explained in terms of how they were employed to ensure rigorous and representative research results in each of Cape Dorset, Igloolik, and Pangnirtung (Section 3.3). Preliminary community visits were undertaken first (Section 3.3.1), followed by several field research trips (Section 3.3.2) where semi-directed interviews, experiential sea ice trips, and focus groups were conducted. The description of data analysis stages includes details on transcript analysis, map analysis, focus group/terminology review, and methodological analysis (Section 3.3.3). Furthermore, the full communication strategy is outlined in Section 3.4, and issues of knowledge representation are highlighted in Section 3.5.

Results chapters were separated to present findings from Cape Dorset (Chapter 4), Igloolik (Chapter 5), and Pangnirtung (Chapter 6) individually – although section delineations mirror one another. There are four main parts to each of these chapters, with the first one providing community context on the local importance of sea ice (Sections 4.1, 5.1, 6.1). Secondly, sea ice processes are characterized according to local expert descriptions of freezing processes, melting processes, and wind and current influences on sea ice (Sections 4.2, 5.2, 6.2). These are accompanied by conceptual models to highlight the interactions between sea ice terminology and process descriptions for each community. Third are the sections that describe localized sea ice uses for travel or hunting purposes, along with wildlife habitat descriptions (Sections 4.3, 5.3, 6.3). Each of the results chapters are concluded with sections on observations of change, according to local indicators (Sections 4.4, 5.4, 6.4).

The analysis chapters are split in two, each with a unique focus. Chapter 7 compares the findings of Chapters 4 – 6 to evaluate the overlap or differences between community

descriptions of sea ice processes, use, and change. Therefore, sections in Chapter 7 follow the general format of those employed in the results chapters. Section 7.1 looks at the importance of sea ice in each community. Section 7.2 provides inter-community comparisons of sea ice processes (including freezing, melting, and wind/current influences on sea ice), with a focus on Inuktitut terminology and regional variations in ice conditions. Sea ice uses are then contrasted between communities, according to differences and similarities in sea ice travel and hunting (Section 7.3). A similar process is undertaken for observations of sea ice change around each community, in terms of: i) indicators of change; ii) implications of change; and, iii) considerations for assessments of change (Section 7.4).

Chapter 8 analyzes the opportunities and challenges involved in collaborative research. This begins with an evaluation of the collaborative approach employed to conduct this research (Section 8.1), including reflections on the utility of: i) preliminary research visits; ii) semi-directed interviews; iii) participatory mapping; iv) experiential sea ice trips; v) focus groups; and, vi) the communication strategy. Sections outlining community perspectives on working with researchers then highlight: i) previous community experiences with researchers; ii) life experiences that differentiate Inuit and scientific expertise; iii) methods of sea ice investigation and knowledge acquisition; and, iv) goals in investigating or using sea ice (Section 8.2). Finally, Section 8.3 provides some recommendations for linking Inuit and scientific expertise.

Chapter 9 is the concluding chapter, and the sections mirror the original thesis objectives. This chapter emphasizes opportunities for moving forward to build upon the research presented here. A summary of the local characterizations of sea ice processes, use, and change from each community is provided (Section 9.1). This is followed by a synopsis of the relevance of sea ice to human and animal activity around the communities (Section 9.2). The collaborative research approach is then synthesized to describe lessons learned in an effort to improve community-researcher relationships (Section 9.3). There are many ways in which



this research could expand, or be built upon, which provides numerous avenues for future research (Section 9.4). Finally, I conclude with a discussion of considerations in assessing community vulnerability and/or resilience to sea ice/climate change (Section 9.5).

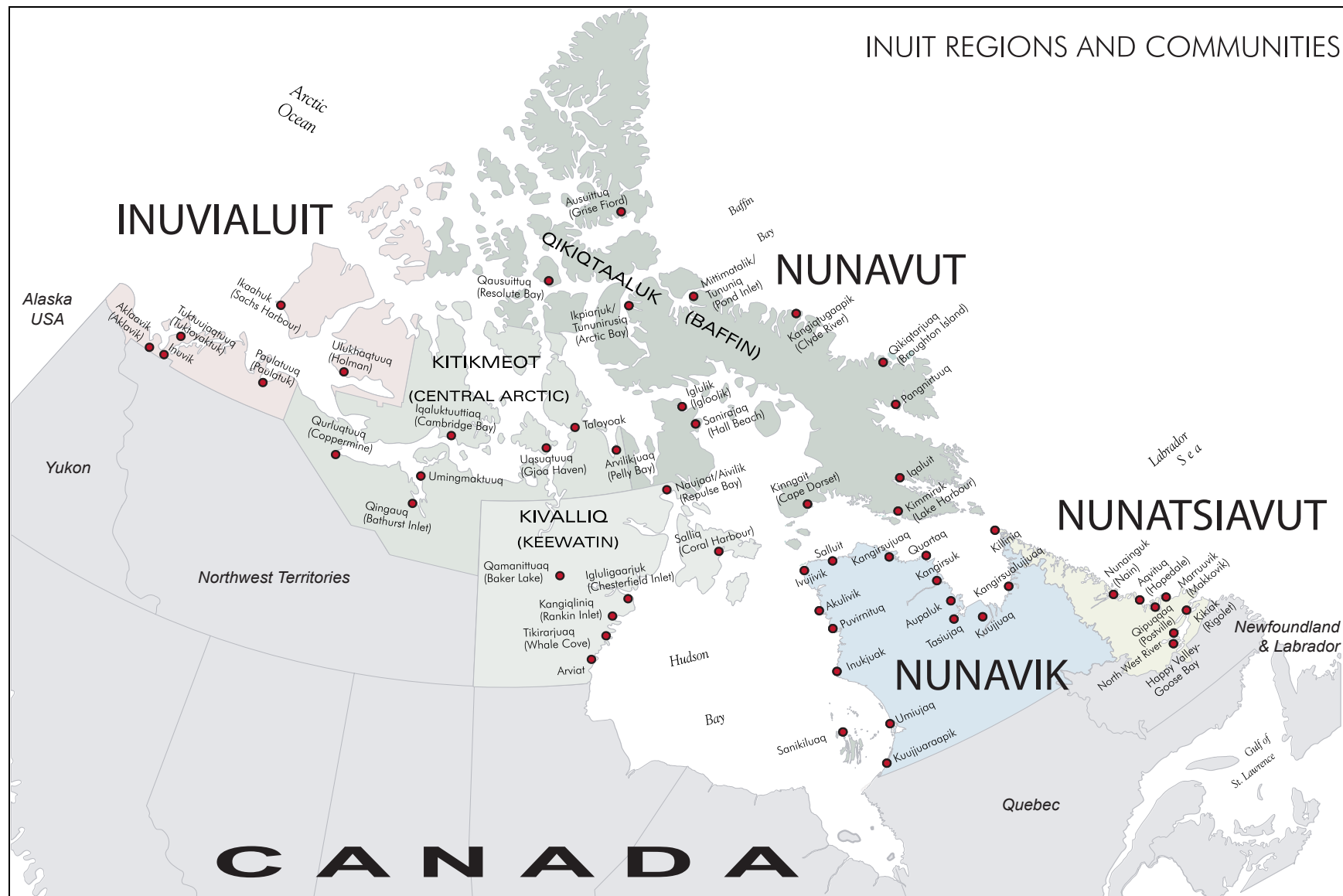
## **Chapter 2 – Literature Review**

### ***Inuit and scientific perspectives on sea ice, a starting point***

A review of current and relevant literature discussing Inuit and scientific knowledge of sea ice provides a baseline understanding of sea ice, and its relationship to climate change. This is important background, as it informs the results and analysis found in Chapters 4 – 8. The literature review is also the first step in the process of drawing together different conceptions of sea ice conditions and dynamics, an effort that will extend beyond this thesis.

Inuit are, among other Indigenous groups in the circumpolar Arctic, year-round inhabitants of northern communities and environments. The International Circumpolar Conference (ICC) definition of Inuit is used throughout this thesis to refer to Indigenous members of the Inuit homeland (i.e. arctic and sub-arctic areas where, presently or traditionally, Inuit have Aboriginal rights and interests) including the: Inuit and Inuvialuit in Canada, the Inupiat and Yupik in Alaska, the Kalaallit in Greenland, and the Yupik in Russia (ICC, 1998). While my own research occurs within the Qikiqtaaluk (Baffin) region of Nunavut, literature discussing Inuit knowledge and observations of sea ice by the Inuit of northern Canada (i.e. Inuit in northern Labrador (Nunatsiavut), northern Québec (Nunavik), the Territory of Nunavut, and Inuvialuit in the Northwest Territories (NWT)) (Figure 2-1) and Alaska (i.e. Yupik and Inupiat) are incorporated in this chapter.

The reference to scientists throughout this thesis means those who work directly with sea ice and/or climate phenomena to better understand their intrinsic and combined functioning (e.g. climatologists, oceanographers, climate modelers, remote sensing specialists). While there are other scientists (e.g. biologists, zoologists, ecologists, anthropologists, archaeologists, geographers) with an interest in sea ice and/or climate change, and overlapping interests with Inuit community members, only those with a specific sea ice or climate system focus are included within the scope of this chapter.



**Figure 2-1:** Map of Inuit regions and communities in Canada. Courtesy of Inuit Tapiriit Kanatami.

## 2.1 Inuit and sea ice

Sea ice is an important platform upon which Inuit have been traveling, hunting, gathering, and living for at least 5000 years (Riewe, 1991). While many Inuit are now settled in coastal communities, sea ice continues to form an integral social, economic, and traditional component of their lives. The knowledge they have developed of the ice, its nature, and its processes is embedded within their culture and identity (Aporta, 2002). Inuit are astute observers of the sea ice edge (Nakashima, 1993) as their harvesting practices, livelihoods, and/or personal safety depend on their knowledge and perception of changing ice, sea, and weather conditions.

### 2.1.1 Inuit sea ice expertise

Inuit have interacted with, and lived from, the unique environmental resources of the arctic oceans and coastal zones for generations. Therefore, it is important to provide a brief overview of Inuit knowledge characteristics and acquisition processes prior to presenting examples of Inuit knowledge that relate sea ice properties with weather/climate conditions.

Traditional knowledge (TK) is one of many labels used to refer to the knowledge held by various Aboriginal peoples. In much contemporary literature TK is interchangeable with other descriptors of Aboriginal knowledge and expertise such as traditional ecological knowledge (TEK) or indigenous knowledge (IK) (e.g. Stevenson, 1996; Collings, 1997; Duerden and Kuhn, 1998; Wenzel, 1999; McGregor, 2000; Riedlinger and Berkes, 2001). In the Canadian North the term *Inuit Qaujimajatuqangit* (IQ) is now commonly used to refer to Inuit knowledge and acquired ways of knowing (Thorpe *et al.*, 2001; Aporta, 2002; Thorpe *et al.*, 2002; McGrath, 2003; Wenzel, 2004). However, due to the multitude of interpretations this term can undergo depending on the Inuit community or Inuktitut dialect, 'Inuit knowledge' will be used throughout this thesis to refer to the expertise acquired by Inuit through extensive interaction with sea ice environments. Inuit knowledge is more encompassing of socio-cultural content

(and importance) than TK or TEK alone (Wenzel, 2004). However, within this thesis only a portion of Inuit knowledge is discussed and explored – as related to sea ice importance, use, and change. As highlighted in Laidler (2006a), no matter what term is used to identify Inuit knowledge (or other forms of Indigenous knowledge), it must be remembered that this is just a label – a term mainly used by academics and governments. This type of labeling is useful because it allows us to refer to the epistemology, knowledge system, and characteristics often implied (or explicitly defined) with the use of ‘indigenous knowledge’. However, as McGregor (2000) discusses, whatever term is used it is most often: i) an external (usually Western) construct, a non-native term created to identify another culture’s knowledge; ii) hard to define because the meaning varies from person to person and culture to culture; and, iii) a reflection of the knowledge that non-Aboriginal researchers think Aboriginal people possess, rather than the knowledge itself (McGregor, 2000). Despite numerous debates on which is the most appropriate term, definition, or method of applying Indigenous knowledge, there is increasing consensus on the value of respecting – and learning from – the knowledge to which all these debates refer (Kuhn and Duerden, 1996; Nuttall, 1998; Burgess, 1999; Wenzel, 1999; Riedlinger and Berkes, 2001; Nichols *et al.*, 2004).

Inuit knowledge comprises a worldview that shares some key characteristics with other Aboriginal peoples (e.g. Deloria, 1995). An important aspect is the consideration of humans as an intrinsic, yet not dominant, part of the natural environment. People, animals, plants, non-living entities, and spiritual entities are all highly interconnected because only in cyclical, reciprocal, and mutual relationships can natural systems be maintained (Kuhn and Duerden, 1996; Collings, 1997; Feit, 1998; Angmalik *et al.*, 1999; Berkes, 1999; Stevenson, 1999; Pierotti and Wildcat, 2000). Inuit knowledge is a way of life, where ethical codes of conduct inform not only social relationships, but also relations with natural resources. Pierotti and Wildcat (2000, 1335) suggest that TEK can be considered “...an intellectual foundation for an Indigenous

theory and practice of politics and ethics, centered on natural places and connection to the natural world, which is capable of generating a conservation ethic on the part of those who follow its principles.” This *knowledge-practice-belief* complex (Berkes, 1999) comprises an ethic of non-dominant, respectful human-nature relationships, and a sacred ecology belief component. However, this emphasis on environmental ethics and a holistic perspective must not be confused with a romantic notion of Indigenous harmony with the land (Pierotti and Wildcat, 2000) or with conservationist perspectives that dichotomize humans and the environment (Willems-Braun, 1997). Not all human-environment interactions have avoided negative consequences, but generally Indigenous/Inuit ethics are maintained through principles of taking only what is necessary as well as practicing rituals of respect and thanks for what is provided (Nelson, 1969; Usher and Bankes, 1986; Johnson and Ruttan, 1992; Nakashima, 1993; Collings, 1997; McDonald *et al.*, 1997; Thorpe, 1998; Angmalik *et al.*, 1999; Berkes, 1999; Pierotti and Wildcat, 2000; Sejerson, 2002). Fulfilling one’s relationships and responsibilities preserves harmony within the world, and allows knowledge to be transmitted between generations, ensuring sustainability and survival.

The depth, specificity, and content of Inuit knowledge is highly variable depending on the individual, their upbringing and experiences, the community where they reside, and the environmental factors influencing harvesting activities (Laidler, 2006a). However, Laidler (2006a) summarizes some general characteristics of knowledge acquisition which transcend individual, cultural, and regional differences within, and between, Inuit communities:

1. Inuit knowledge, insight, and wisdom is gained through experience, and incorporates a finely tuned awareness and respect for the dynamic and evolving relationship between Inuit and the land, weather, wildlife, and spirit worlds – this experiential and repetitive learning contributes to the development of an intimate and reliable understanding of an environment over the long term (McDonald Fleming, 1992; Zamporo, 1996; Nuttall,

1998; Immaruittuk *et al.*, 2000; Riedlinger and Berkes, 2001; Thorpe *et al.*, 2001; Aporta, 2002; Furgal *et al.*, 2002a; Furgal *et al.*, 2002b; Oozeva *et al.*, 2004);

2. Inuit knowledge, insight, and wisdom is shared in many forms of orality, and more recently in written form, and is passed on over generations through a set of complex social, economic, and ecological relationships (McDonald Fleming, 1992; Zamporo, 1996; Nuttall, 1998; Thorpe, 1998; Huntington, 1999; Immaruittuk *et al.*, 2000; Riedlinger and Berkes, 2001; Thorpe *et al.*, 2001; Furgal *et al.*, 2002a; Nichols *et al.*, 2004);
3. Inuit knowledge is dynamic, continually accumulating and evolving depending on the person and personal experiences, it is inclusive of new information and encompasses a way of life within a collective and experiential context – there is both rigour and confidence incorporated in local understandings of complex systems due to extensive, repeated, and verified observations within a broader social context (Bielawski, 1992; McDonald Fleming, 1992; Zamporo, 1996; Wenzel, 1999; Thorpe *et al.*, 2001; Nichols *et al.*, 2004)

These general aspects of knowledge acquisition underlie the more specific presentation of Inuit sea ice knowledge, and links to weather conditions and patterns, in the following sections and chapters.

### **2.1.2 Inuit sea ice use**

Inuit identity, knowledge, livelihoods, and survival are still strongly linked to the seasonal cycles of sea ice and wildlife harvesting despite growing community populations, shifting demographics, and the adoption of various aspects of southern lifestyles and technologies over the past fifty years, (Wenzel, 1991; Pelly, 2000; Poirier and Brooke, 2000; Aporta, 2004; Robards and Alessa, 2004). Specialized skills such as reading the ocean ice or recognizing changing weather conditions are still highly valued, although they may no longer be essential for survival in the strict sense of the word (i.e. the provision of food, clothing, heat,

light, and equipment) (Stern, 1999). However, such skills remain critical for safe sea ice travel for subsistence or commercial hunting/harvesting, as well as personal leisure. Hunting and harvesting can contribute economically and socially to household and community networks (e.g. Furgal *et al.*, 2005), as well as instill a sense of personal fulfillment (Laidler, 2006a). Weather is a key driver in the ecological dynamics of subsistence resources as it impacts local access to, and availability of, marine mammals (Kofinas *et al.*, 2002). Local weather influences hunting and travel conditions, thus Inuit have developed a rich tradition of understanding, interpreting, and forecasting weather patterns that forms an integral aspect of community life (Jolly *et al.*, 2002; Oozeva *et al.*, 2004).

Active hunters are typically the community members who know the most about sea ice conditions because successful hunting and travel relies on an understanding of the reciprocal influences of winds and currents on ice formation and dynamics (Nelson, 1969; Freeman, 1984; Krupnik, 2002). Because the sea ice is constantly shifting it can be extremely treacherous to navigate. Traversing moving ice especially requires an understanding of a vast array of interrelated factors such as: i) crystalline formation; ii) temperature; iii) salinity; iv) wind; v) currents; and, vi) shoreline and sea bed topography (Riewe, 1991; Jolly *et al.*, 2002). Hunters demonstrate a detailed understanding of the ocean and weather conditions that may cause sudden and dangerously changed ice conditions by their general avoidance of unnecessary risks when traveling on the sea ice (Nelson, 1969; Freeman, 1984; Aporta, 2002). In order to avoid dangers, they use external indicators as well as applying their understanding of processes working invisibly underneath the ice cover (Aporta, 2002). Therefore, by accounting for the peculiarities of varying types of wind and current flows, for an assortment of wind/current combinations, Inuit can reliably forecast ice safety (Nelson, 1969; Krupnik, 2002). This allows hunters to travel in the desired direction to avoid dangerous circumstances (MacDonald, 1998). Some sea ice conditions are inherently more risky to traverse (e.g. moving



ice, polynyas, floe edge, etc.), but often their importance as wildlife habitat and the desire or need for a successful hunt may be worth the risk to a confident and experienced hunter. Nevertheless, hunters are continually revising their personal guidelines for making correct (i.e. life-sparing) risk-versus-reward decisions (Norton, 2002; George *et al.*, 2004). Localized knowledge of, and previous experience with, thin ice conditions, strong currents, animal behaviour, tidal stages, and navigational aids (e.g. snowdrifts) contributes to enhanced safety during sea ice travel (McDonald *et al.*, 1997; MacDonald, 1998; Aporta 2002; Bennett and Rowley, 2004). Assessments of weather and ice conditions/stability can occur in a variety of ways: i) from the kitchen window; ii) standing outside the house; iii) standing at the shoreline; or, iv) while in the midst of traveling (Jolly *et al.*, 2002, Oozeva *et al.*, 2004). Safety assessments can also occur in a collective context through discussions with other hunters in town, on the move (Oozeva *et al.*, 2004), or over shortwave radio (Aporta, 2004; George *et al.*, 2004).

An essential component of Inuit prediction of sea ice movement and fragmentation includes wind forecasting. Wind influences on sea ice conditions are highly emphasized, and in so doing the effects of precipitation, temperature, or clouds are considered as secondary, or of minor importance (Nelson, 1969, Aporta, 2002). Nelson (1969) noted that during winter months some Inuit are able to foresee weather with impressive accuracy; however, in summer their forecasts may not be as reliable. Wind direction, combined with knowledge of local shoreline topography, and tests of current direction and strength, are all crucial in determining:

- i) whether the ice is moving, and if so, in what direction;
  - ii) the safety of ice (i.e. thickness and stability);
  - iii) where leads and cracks will form, and the safety of crossing such openings;
  - iv) what survival options are available in emergency conditions;
  - v) where marine wildlife may be found and whether it is safe to hunt wildlife that has been located; and,
  - vi) the moon phase, coupled with the strength of tides
- (Nelson, 1969; Freeman, 1984; Aporta, 2002; George *et al.*, 2004).

Inuit hunters have essentially “decoded” sea ice behaviour through their understanding of lunar phases, tidal currents, and winds (Aporta, 2002, 352). The intricate and extensive Inuit knowledge of the sea ice environment cannot be adequately generalized outside of a particular community, and even sometimes outside a group of individuals. Localized weather patterns, ice conditions, movements, and sea ice uses are all specialized according to different physical and social contexts within the Arctic. Understandably, the accuracy of weather or sea ice safety prediction will vary with the experience of the individual, the route they are traveling, the mode of travel, and the time of year (Laidler, 2006a). In addition, weather shifts have become more abrupt and weather patterns more unpredictable in the past few decades, which renders it more challenging for hunters to accurately interpret indicators/predict shifts in wind or weather conditions. Before presenting some of the changes noted in the communities where I conducted primary research (Sections 4.4, 5.4, and 6.4), it is helpful to get a general sense of the changes (related to sea ice) being experienced around the Baffin Island region.

### 2.1.3 Inuit observations of sea ice/climate change

Inuit have recently been observing changes in ice and weather patterns that may indicate long term climatic trends and increasing climate variability (McDonald *et al.*, 1997; Ford, 2000; Riedlinger and Berkes, 2001; Fox, 2002; Furgal *et al.*, 2002b; Huntington, 2002; Jolly *et al.*, 2002; Kofinas *et al.*, 2002; Krupnik, 2002; Nickels *et al.*, 2002; Thorpe *et al.*, 2002; Nichols *et al.*, 2004; Ford, 2005; Nickels *et al.*, 2005). The shrinking, thinning, and/or disappearance of Arctic sea ice could not only exacerbate long-term climate warming, but it could also severely impact the social, economic, and cultural practices of Inuit communities in the circumpolar Arctic. The impacts are already beginning to be felt, thus Inuit are increasingly expressing their concerns regarding the possible implications of global warming in polar latitudes. These experiences have expanded their characterization of the relationship between sea ice and climate change due to the outcome(s) it may have on their communities (e.g. alteration of travel

routes, access to hunting grounds, marine mammal distribution and behaviour, weather or sea ice forecasting accuracy, etc.) (Laidler, 2006a). Because Inuit perceptions of sea ice and climate change develop from place-based knowledge, and personal interaction with local marine environments, most studies focusing on local observations of change are necessarily community-based. The type, degree, and importance of change will vary based on geography, culture, economy, and community dynamics (Duerden, 2004). Some examples of climate-related changes experienced by Inuit in the North American Arctic are presented in Laidler (2006a). In addition, several key observations of change – and related implications – are summarized in Table 2-1 for communities on, or within the vicinity of, Baffin Island. Important sea ice/climate change-related research has been conducted in Alaska (Krupnik, 2002; Norton, 2002; George *et al.*, 2004; Oozeva *et al.*, 2004) and in the Western Canadian Arctic (Riedlinger and Berkes, 2001; Jolly *et al.*, 2002; Nickels *et al.*, 2002; Nichols *et al.*, 2004). However, the eastern arctic focus is maintained here as it is most relevant to the context of my research.

It is challenging to find direct statements linking Inuit knowledge of sea ice to climatic conditions or trends. However, the relationships between sea ice and weather are reinforced as predominant Inuit concerns because of their important local implications for hunting success and personal safety (Laidler, 2006a). In addition, environmental changes such as weather, and sea ice thickness or distribution, can also be linked to changes in climate (Riedlinger and Berkes, 2001; Nichols *et al.*, 2004). Therefore, because various daily activities and safety factors in and around Inuit communities depend on local weather and ice conditions, it seems that Inuit formulate an indirect relationship between sea ice and climate (Laidler, 2006a). These elements of personal safety and harvesting success render sea ice changes, and increased variability of weather and ice conditions, of great concern. However, it is the unpredictable nature of such circumstances that is most worrisome for community members (Ford and Smit, 2004; Ford, 2005). The unreliability of previously effective forecasting techniques can

**Table 2-1:** Summary of observed sea ice changes, and related implications, from communities around the Baffin Island region.

Community	Observations of change	Implications	References
Arctic Bay, Nunavut	Ice is thinner; earlier break-up; later freeze-up; permanent snow packs/ice packs/glaciers are melting	More dangerous travel; delayed ice travel; more accidents occurring; hampers access to hunting area; more potential for break-off events at the floe edge	Ford, 2005; Nickels <i>et al.</i> , 2005
Igloolik, Nunavut	Earlier break-up; later freeze-up	Hampers access to hunting areas; delayed ice travel, people are stuck in town for longer periods during transitional stages	Ford, 2005
Clyde River, Nunavut	Usual leads are not forming, and new ones are opening in different areas; ice is thinner; more icebergs	Dangerous for travel in some areas	Fox, 2002
Iqaluit, Nunavut	Ice conditions are becoming more unpredictable	Several accidents in the last few years	Fox, 2002
Repulse Bay, Nunavut	Ice is thinner; earlier break-up (used to be still traveling on the ice in June); permanent snow packs/ice packs/glaciers are melting	More dangerous travel; delayed ice travel	Nickels <i>et al.</i> , 2005
Cape Dorset, Nunavut	Freezes faster; poorer quality; landfast ice extends farther offshore; polynyas freeze floe edge melts before breaking up	More dangerous travel	McDonald <i>et al.</i> , 1997
Kimmitut, Nunavut	Freezes faster; poorer quality; landfast ice extends farther offshore; polynyas freeze floe edge melts before breaking up	Cannot access seals and walrus as easily	McDonald <i>et al.</i> , 1997
Ivujivik, Nunavik	Ice is thinner; earlier break-up; later freeze-up (forming in December instead of November); permanent snow packs/ice packs/glaciers are melting; Freezes faster; poorer quality; landfast ice extends farther offshore; polynyas freeze floe edge melts before breaking up; fewer ice packs coming in	More dangerous travel; delayed ice travel; can't access seals and walrus as easily; fewer polar bears in the area	Nickels <i>et al.</i> , 2005; McDonald <i>et al.</i> , 1997
Kuujuak, Nunavik	Earlier break-up; thinner winter ice; ice breaks up faster	Seals are gone earlier in the spring; changing travel times and ice safety	Furgal <i>et al.</i> , 2002b
Kangiqsujaq, Nunavik	Ice is thinner; earlier break-up; later freeze-up (forming in December instead of November); permanent snow packs/ice packs/glaciers are melting; Freezes faster; poorer quality; landfast ice extends farther offshore; polynyas freeze floe edge melts before breaking up	More dangerous travel; delayed ice travel	Nickels <i>et al.</i> , 2005; McDonald <i>et al.</i> , 1997
Salluit, Nunavik	Freezes faster; poorer quality; landfast ice extends farther offshore; polynyas freeze floe edge melts before breaking up	Cannot access seals and walrus as easily	McDonald <i>et al.</i> , 1997
Nain, Labrador	Less snow on the ice; pack ice (multi-year ice) not coming from the north anymore; goes out of the bay earlier; later freeze-up (late December); break-up takes longer to occur (temperature fluctuations in April); ice is not as solid/thick; takes longer to solidify; cracks form earlier; ice seems to be saltier;	Harder for seals to create dens and breathing holes; ships come in earlier; can go to fishing camps earlier; harder to travel on the ice; more dangerous spring travel; stuck in the community longer during break-up	Furgal <i>et al.</i> , 2002b

undermine the relationships Inuit have formed with the sea ice environment and marine mammals, and can thus drastically affect their lifestyle, safety, and identity (Norton, 2002; George *et al.*, 2004). Some of these factors, along with a changing context within which northern research is conducted, has led to increased interest in collaborative research and efforts to link disparate types of expertise on sea ice and climate change. In order to move in this direction, it is important to first gain some insights into scientific perspectives on sea ice.

## **2.2 Sea ice and climate**

Scientists are also interested in understanding sea ice because it is recognized as an indicator of (Vinnikov *et al.*, 1999), and influence on (Copley, 2000), the climate system. Covering approximately 13 000 000 km<sup>2</sup> of the Arctic oceans in the winter, and extending nearly 7 000 000 km<sup>2</sup> during the summer (Lemke *et al.*, 2000), the high albedo and insulating effects of sea ice can substantially alter: i) surface radiation balance; ii) momentum, heat, and matter exchanges between atmosphere and ocean; and iii) ocean circulation patterns (Copley, 2000; Lemke *et al.*, 2000; Grunet *et al.*, 2001). Therefore, considerable research effort has been expended on refining scientific understanding of the role ice plays in global climate regulation, as well as determining the potential impacts of climate change on arctic seasonal ice patterns (DeAbreu *et al.*, 2001). As anthropogenic CO<sub>2</sub> emissions are increasingly tied to observed, and predicted, rises in global mean temperature, sea ice monitoring and modeling efforts are being intensified. Arctic latitudes are thought to be especially sensitive to global warming trends, as impacts may be amplified in polar regions due to the plausible retreat, and perhaps even disappearance, of ocean ice cover (Curry *et al.*, 1995). Therefore, sea ice is considered an effective indicator of warming trends due to its sensitivity to changes in the air above, and ocean below (Kerr, 1999). In order to better comprehend the links between sea ice and climate, it is helpful to first describe the general processes of sea ice formation and decay.

### 2.2.1 Sea ice formation and decay

By investigating the thermodynamics and dynamics of ocean ice formation and movement, scientists have characterized some of the physical – and internal – processes that influence changes in ice extent, distribution, and thickness. One of the key properties of ice is that it floats. Therefore, it is one of the few substances where the solid form is less dense than its liquid state. The crystalline structure of water molecules in this solid form causes ice to maintain complex physical and mechanical properties (for a detailed description refer to Wadhams, 2000). To understand the thermodynamic processes influencing sea ice formation or decay it is important to note that sea ice is a mixture of ice, liquid brine (the concentration of salt in water), air bubbles, and solid salts. The interplay of these elements impacts the processes of ice formation because the porosity (i.e. air bubble content) and salt content of ice influences its ability to conduct heat (Wadhams, 2000; Davis, 2000). Sea ice dynamics also determine the motion and growth/decay of sea ice, where winds or currents create stress on the sea ice and may result in the formation of leads, pressure ridges, or polynyas (Davis, 2000). Figure 2-2, and the following sections, provide a summary of the general process of sea ice formation and decay based on five key sources: WMO (1970), Lock (1990), Wadhams (2000), Eicken (2003), Thomas and Dieckmann (2003). A glossary of scientific sea ice terms is also found in Appendix 2.

#### *2.2.1.1 Freezing processes*

As a water body is cooled from above, its density increases with decreasing temperature. The cold surface water will then begin to sink, being replaced by warmer water from below. This replacement water is cooled, causing a pattern of convection to set in, allowing the whole water body to cool gradually. The maximum density of fresh water occurs at 4°C, where further cooling of the water causes a decrease in density that allows colder water to remain at the surface (Wadhams, 2000). Once this occurs, the thin cold layer is rapidly

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**Figure 2-2:** Scientific characterization of sea ice formation, decay, and dynamic processes.

Source: Laidler (2006a, 420)

Based on: WMO (1970), Lock (1990), Wadhams (2000), Eicken (2003),  
Thomas and Dieckmann (2003)

Where: ----- = divergence creating areas of open water that will likely begin freezing again

cooled to the freezing point, allowing ice to form even though underlying water temperatures may still be near 4°C.

Sea water has a lower temperature of maximum density, as well as a lower freezing point, due to its salt content. With a salinity exceeding 24.7psu, the temperature of maximum

density disappears, so cooling of an ocean by a cold atmosphere always makes the surface water more dense. As convection continues, the freezing point for typical sea water is depressed to  $-1.8^{\circ}\text{C}$  (Wadhams, 2000). A density jump occurs at the pycnocline (zone of surface-water/deep bottom water separation in the ocean), allowing ice to form without the whole ocean having to cool to the freezing point (Wadhams, 2000).

#### *2.2.1.2 Ice formation*

In calm water, ice formation begins with frazil or grease ice, which consists of random-shaped small crystals that are suspended in the water (Figure 2-2). These increase in density with cooling, and will freeze around  $-1.8^{\circ}\text{C}$ , coagulating to form a soupy layer on the surface. Where the water is especially calm, or has lower salinity, ice rind can form (i.e. a brittle crust) (Figure 2-2). Nilas, crystals that form on a thin sheet of young ice, can follow from ice rind or grease ice (Figure 2-2). Water molecules then continue to freeze to the bottom of the existing ice sheet, creating congelation growth that leads to young/grey ice (Figure 2-2).

In open water, where the environment is more turbulent, frazil ice can still form but the edges cannot transform into nilas because of the energy exerted by wave action (Figure 2-2). This motion can also create pancake ice where a cyclic compression allows ice crystals to freeze together into small “cakes” of slush with a raised rim of frazil ice (Figure 2-2). If snow falls on pancake or grease ice it can create a mixture of ice and water, just referred to as slush (Figure 2-2). This snowfall, or wind action on grease ice alone, can then create shuga – an accumulation of grease ice or slush (Figure 2-2). As the conditions cool, and shuga begins to freeze again, it would reform either as grease ice or pancake ice, then progress along the cycle of ice formation. When multiple pieces of pancake ice freeze together they become consolidated, leading to the formation of young/grey ice (Figure 2-2).

As sea ice thickens, it becomes classified as first year ice (FYI), or white ice, and is distinguished in age based on thickness (thin, medium, or thick) (Figure 2-2). FYI is the



maximum thickness (approximately 1.5 – 2m thick) reached within a single season. Usually this ice melts fully in the summer, but in areas where it lasts more than one season – and maintains year-to-year growth – it is then referred to as multi-year ice (MYI) (i.e. can reach up to 3m thickness). This MYI can be distinguished from FYI based on its characteristics of: i) lower salinity (salt drains with subsequent freezing years, and can become freshwater ice); ii) lower conductivity; iii) a rougher surface; and, iv) distinct microwave penetration properties.

As the ice thickens and solidifies further, it becomes landfast (i.e. fast ice is attached to the land or other fixed objects). The edge of the fast ice is commonly referred to as the floe edge, but the more specific term would be ‘ice edge’ because it relates to any boundary between the ice-free ocean and ice-covered ocean. In areas where water motion or wind stress preclude the stability of fast ice it is referred to as compact ice, because it is continuously moving but it is compacted to the point where little open water is visible.

#### *2.2.1.3 Sea ice dynamics*

There are several divergent and convergent processes that also affect ice conditions or movement. Divergent processes exert forces that pull sea ice apart, or create breaks in the ice. For example, if there is a fracture in the ice that is not too wide, it is referred to as a crack (Figure 2-2). A flaw would be used to describe a separation zone between drifting ice and landfast ice (Figure 2-2). A lead is more of a linear feature with open water between pack ice and ice floes, but this can also be covered with thin ice as the opening begins to refreeze (Figure 2-2). Leads tend to widen as melt processes begin, and can cause parts of the fast ice to break off. Frost smoke will often preside over newly formed leads, whereby the heat lost through cracked ice appears to be steam. This evaporation and condensation of surface water is caused by the difference in atmosphere (colder) and ocean (warmer) temperatures. In contrast, a polynya is an open, non-linear feature that is surrounded by sea ice (i.e. can only form within landfast ice) (Figure 2-2). There are several types of polynyas (Table 2-2), and their persistence

throughout the winter distinguishes them from leads. Polynyas play an important role in the marine ecosystem because they are: a) Inuit winter hunting grounds; b) polar desert oases allowing biological activity to continue throughout winter; c) habitats for large mammals and birds; d) areas that maintain the heat balance of Arctic Ocean; e) areas that allow large fluxes of heat and moisture to the atmosphere (Wadhams, 2000).

**Table 2-2:** Polynya types and descriptions.

Source: Wadhams, 2000

<b>Polynya Type</b>	<b>Description</b>
Latent heat polynyas	formed when ice is continually removed from region in which it forms, by winds or ocean currents; the heat needed to balance the loss to the atmosphere is provided by latent heat of fusion of ice which is continually forming
Sensible heat polynyas	formed when a continued source of heat from the ocean prevents ice formation
Coastal polynyas	common feature of continental shelves and are believed to be primarily latent heat polynyas (heat loss from ocean surface is balanced by latent heat of new ice formation and the polynya is maintained by wind or current removal of new ice)
Flaw lead polynyas	develop just off the edge of fast ice under an offshore wind
Land water polynyas	effect whereby a continuous narrow strip of open water is formed against the fast ice edge, caused by offshore winds

Compacting processes force sea ice together, sometimes creating collisions that cause distinct ice deformations. A fracture is any break or rupture that results from this type of collision, and it usually re-freezes quickly (Figure 2-2). An ice ridge is a line of broken ice (sometimes referred to as pressure ridge) that was forced upwards through pressure (Figure 2-2). Pressure ridges result from weaknesses in young ice cover, typically formed after lead creation. These are easily crushed into heaps of broken ice blocks under subsequent wind stress. The so-called ice “pile-ups” maintain above water (sail) and below water (keel) portions. Underwater keels can be up to four times deeper than the sail height, and around two or three times wider (Wadhams, 2000). Once formed, these ridges are consolidated through ice blocks freezing together, becoming permanent features of the winter pack ice with strength equal to, or greater than, surrounding un-deformed ice. An ice raft is created where

one piece of ice is forced onto another (Figure 2-2). In addition, shearing (breaking off) may create distinct ice floes that are relatively flat, floating loosely, and highly variable in size (Figure 2-2).

Sea ice dynamics are influenced by external forces such as winds or currents (i.e. ocean circulation and tidal cycles). The importance of diurnal and semidiurnal tidal variations on sea ice conditions are emphasized in northern communities, especially as related to lunar phases (Section 2.1.2 and Chapters 4, 5, and 6). However, in the scientific literature this is described not only according to the moon, rather it is linked to the Earth-Sun-Moon alignment (i.e. syzygy) that can exert maximum influence on tidal height (Camuffo, 2001). Daily, the semidiurnal tides in the Arctic Ocean are caused by the Atlantic tides, while the diurnal tides are generated internally by astronomical forces (Wadhams, 2000). At the higher latitudes the largest tides occur when the Sun and the Moon are both at their greatest declination (i.e. at the solar solstices) (Camuffo, 2001). The orbital motion of the Earth-Moon pair also generates cycles in ocean tides that contribute to variations in: i) mean sea level; ii) tidal currents; iii) tidal flooding; iv) currents in sub-marine canyons; v) sea ice conditions and extent; and vi) sea surface temperature (Wadhams, 2000; Camuffo, 2001; Yndestad, 2006).

#### *2.2.1.4 Melting processes*

As temperature increases, spring/summer melt processes initiate a variety of ice conditions. Meltwater pools, or puddles, comprise melted overlying snow that typically begins to accumulate on the sea ice (Figure 2-2). As these pools drain brine flushing is promoted and under-ice melt pools can form. Where these puddles melt through the ice, they form thaw holes (Figure 2-2). The water on the ice can then drain into the ocean, leading to a temporary dried ice condition (Figure 2-2). Once the ice reaches an advanced state of disintegration it is termed “rotten”, as it is full of holes (Figure 2-2). Often near shore, where there is freshwater influence from river outlets, shore melt will occur before the fast ice is breaking up (Figure 2-2).

The generalized seasonal cycle of sea ice comprises various properties and thicknesses of sea ice. These are important elements to consider as scientists undertake sophisticated efforts to monitor sea ice variability and change, as well as to model sea ice links to – and influences on – the climate system.

### **2.2.2 Sea ice around Baffin Island**

There are actually few long-term time series within the literature reporting on sea ice trends and variability in northern Canada. Where they are available, they are typically included within an overview of northern hemisphere circumpolar ice monitoring results with large regions used to distinguish geographic areas (e.g. Seas of Okhotsk and Japan, Bering Sea, Hudson Bay, Baffin Bay/Labrador Sea, Gulf of St. Lawrence, Greenland Sea, Kara and Barents Sea, Arctic Ocean, and Canadian Archipelago – or similar variations) (Mysak and Manak, 1989; Parkinson *et al.*, 1999). There is ample raw data (i.e. typically satellite or ice chart data – refer to Section 2.3.1) available through the different national ice centres, but most researchers investigate more specific questions than general ice monitoring or trend evaluation. However, I would like to summarize a few key articles discussing sea ice extent and variability in order to provide a general background on sea ice conditions in the geographic areas related to this thesis (i.e. Hudson Bay and Baffin Bay/Labrador Sea).

Cape Dorset (within Hudson Strait) and Igloolik (within Foxe Basin) (Figure 1-1) are both found within the regional delineation of Hudson Bay, as discussed by Mysak and Manak (1989), Wang *et al.* (1994a), and Parkinson *et al.* (1999). Gagnon and Gough (2005) provide a more detailed regional analysis of Hudson Bay freeze-up and break-up trends, but with the increased resolution Hudson Strait and Foxe Basin are not directly incorporated. Therefore, generally speaking this region is fully ice-covered from January through to April. Early melting occurring from April to May, increased melting from May to June, and rapid ice decay from June to August (Mysak and Manak, 1989; Wang *et al.*, 1994a; Parkinson *et al.*, 1999). The

land-locked nature of Hudson Bay has a marked influence on sea ice extent (i.e. allowing greater ice coverage and leading to lower inter-annual variability in ice conditions) (Wang *et al.*, 1994a; Parkinson *et al.*, 1999; Gagnon and Gough, 2005). However, the representation of Hudson Bay at this coarse scale does not adequately capture the dynamics of Foxe Basin and Hudson Strait. Even in the summer/fall (August to October), when there is minimum ice coverage, some ice remains in this region – mostly concentrated in Foxe Basin (Mysak and Manak, 1989; Parkinson *et al.*, 1999). Ice begins to form again in October, and grows rapidly until December when the region is nearing complete ice cover – minimal ice growth occurs from December to January (Wang *et al.*, 1994a; Parkinson *et al.*, 1999).

Some localized Cape Dorset ice conditions (Appendix 3) are described in Higgins (1968). An important influence on sea ice conditions in this area are the strong tidal currents, whereby Hudson Strait tides are among the highest in the world. Tides vary approximately 20 feet between high and low tide (Higgins, 1968). The strongest currents actually occur around Cape Dorset, likely due to the sea bottom topography and the geography of the larger islands, creating faster water movement (Higgins, 1968). Seasonal freeze-up and break-up of the sea ice is significant in the delineation of seasons. For about seven months of the year fast ice conditions prevail along the southern Baffin Island coastline. It begins to freeze in mid-October, although the timing varies annually depending on weather and current conditions (Higgins, 1968). It advances rapidly and ice fast to the shoreline is travelable by mid-November. This ice extends from the land outwards, to varying distances depending on the shoreline configuration and current strength (Higgins, 1968). This ice begins to erode at the seaward edge by May. Furthermore, surrounding each island and some parts of the shoreline is a belt of rough ice, again with varying widths, caused by the action of tides moving the fast ice vertically along the shore (Higgins, 1968). Around mid-June water collects on the ice surface, turning it dark, and shore leads begin to open which causes accelerated erosion of the

ice cover. Open water usually predominates by mid-July, with minor amounts of pack ice present (Higgins, 1968). The winds, currents, and the amount of floating pack ice all contribute to the position of the floe edge (Higgins, 1968).

Some localized Igloolik ice conditions (Appendix 4) are described in Anders (1965). An important factor in local ice conditions is a slight counter-clockwise “whirl” formed by the waters entering through Fury and Hecla Strait (Anders, 1965, 22). Waters moving east and southeast through the strait flow into Hudson Strait, although waters moving more southwards are re-directed northwards when they hit Foxe Peninsula. However, tides and winds often drive sea ice against this light current, whereby tidal variations range from 2 - 5 feet (Anders, 1965). Freeze-up was described as beginning in early October, while break-up began around mid-May and originates at the mouth of Fury and Hecla Strait. A shore lead is present along Melville Peninsula in June and July, whereby its width varies depending on wind direction and strength (i.e. easterly winds push ice inwards and decrease the size of the opening) (Anders, 1965). In addition, fast ice along the shore may remain until late July or early August. Fast ice completely covers large bays in the winter, but strong tidal currents in the centre of Fury and Hecla Strait can cause open leads in mid-winter (Anders, 1965).

Pangnirtung (within Cumberland Sound) (Figure 1-1) is found within the regional delineation of Baffin Bay/Labrador Sea, as discussed by Mysak and Manak (1989), Wang *et al.* (1994a), and Parkinson *et al.* (1999). Tang *et al.* (2004) provide a more detailed regional analysis of annual and interannual sea ice variations in Baffin Bay, but the northern part of the Bay is the primary focus and thus conditions in Cumberland Sound are not specifically described. However, ice extent in Baffin Bay/Labrador Sea is generally much more dynamic than for Hudson Bay (Parkinson *et al.*, 1999). In this region there is considerable water exchange with the North Atlantic, and strong currents keep the ice moving throughout the year (Mysak and Manak, 1989). This leads to greater winter interannual variability in ice conditions (Parkinson

*et al.*, 1999). However, the region is still considered fully ice-covered in the winter and spring (Wang *et al.*, 1994a). The growth and decay periods are also more evenly paced. Modest sea ice growth occurs from September to October, with maximum growth between October and November, and slower growth from November to March (Mysak and Manak, 1989; Wang *et al.*, 1994a; Parkinson *et al.*, 1999). Sea ice decay begins in March and April, gradually melting until June and August when minimal ice extent is reached (and maintained from August to September) (Mysak and Manak, 1989; Wang *et al.*, 1994a; Parkinson *et al.*, 1999).

Some localized Pangnirtung ice conditions (Appendix 5) are described in Anders (1966). Similar to Cape Dorset, the tidal movements in Cumberland Sound are highly influential on ice conditions (varying between 23 and 25 feet) (Anders, 1966). Currents are channeled through islands and are thus strengthened, creating a dangerous funneling effect and preventing ice formation in some areas. Tidal movements also create a lot of broken ice, which forms and collects along the tidal flats, especially around the wider flats (e.g. around Pangnirtung) (Anders, 1966). Ice begins to form in late September and early October, in the shallow bays and sheltered coves and inlets. Freeze-up within Cumberland Sound is delayed as young ice is broken up by winds and currents, so solid ice cover in this larger water body does not occur until November, with continuous ice cover by December (Anders, 1966). The middle of the Sound is covered by a collection of polar ice, local rafted ice pans, and icebergs. This causes cracks to occur within the fast ice cover when winds or currents move this ice – although the head of the Sound has stationary ice (Anders, 1966). The position of the floe edge is thus dependent on the stability of this central ice. Break-up in the Sound begins deep in the larger fiords, and by June many fiords are open, while ice in the Sound is present until mid-July (Anders, 1966). Where strong currents prevail, break-up can occur much earlier than other areas, as well as where tidal movements wear away shoreline ice (Anders, 1966).

## 2.3 Monitoring and modeling

### 2.3.1 Monitoring sea ice variability and change

Satellite passive-microwave sensors have been the most effective scientific means of monitoring sea ice extent and characteristics since their introduction in the early 1970s (Johannessen *et al.*, 1999; Vinnikov *et al.*, 1999). Some of the most commonly employed sensors to monitor coarse resolution sea ice extent, area, and trends include the scanning multichannel microwave radiometer (SMMR) (on board the Nimbus 7 satellite) and special sensor microwave imager (SSMI) (on board the Defense Meteorological Satellite Program's F8, F11, and F13 satellites) (Zabel and Jezek, 1994; Derksen *et al.*, 1997; Parkinson *et al.*, 1999; Heide-Jorgensen and Laidre, 2004; Laidre and Heide-Jorgensen, 2005). The detailed specifications of this remote sensing technology are not of direct relevance to this thesis, but it is important to note that the data are acquired at a 25km grid cell resolution. These data are generally supplied by the National Snow and Ice Data Centre (NSIDC) in the US, although they can also be acquired through other national ice centres or space agencies (e.g. Canadian Ice Service (CIS)). SSMI data is presented as ice concentration in a percentage format, which can then be used to calculate ice extent (Parkinson *et al.*, 1999; Heide-Jorgensen and Laidre, 2004). Furthermore, sea ice observations or charts that are used to develop time series are often based on remotely sensed satellite data of similar or coarser resolution (e.g. up to 100km grid cells); these can also be used to develop and analyze sea ice concentration and extent (Mysak and Manak, 1989; Wang *et al.*, 1994a; Mysak *et al.*, 1996).

Remote sensing records for the circumpolar northern hemisphere Arctic indicate that over the past three decades the ice pack has been not only shrinking, but thinning as well (Kerr, 1999). It is estimated that between 1978 and 1998, the circumpolar Arctic sea ice extent shrank nearly 7% per decade (Johannessen *et al.*, 1999). Furthermore, mean ice thickness in 1990 (i.e. 1.8m) is estimated at nearly half the mean thickness measured between 1958 and 1976 (Copley,



2000). In the Hudson Bay region, between 1978 and 1996, there is a slight negative trend in yearly ice extent (i.e. decreasing approximately 2000km<sup>2</sup>/year), but this change is mostly derived from anomalous autumn ice conditions, and to some degree spring/summer ice conditions (Parkinson *et al.*, 1999). In contrast, in the Baffin Bay/Labrador Sea region the cyclical nature of seasonal, interannual variability means that trends of change are difficult to detect. However, overall the ice extent seems to be increasing in this region (derived mainly from winter trends, with autumn trends actually showing a decrease in ice extent from 1978 – 1996) (Parkinson *et al.*, 1999). Such potentially devastating hemispheric observations – along with evaluations of seasonal and long-term trends and variability mentioned above – have sparked fervent research to refine global scale general circulation models (GCMs) that depict future climate scenarios. These have been used not only to simulate future change, but also to expand current understanding of the relationship between sea ice and climate change.

### 2.3.2 Modeling sea ice in climate scenarios

Scientific understanding of the links between sea ice and climate have evolved mainly from the development of computer models. Such models have been used to evaluate, or postulate, the potential impacts of climate change on sea ice (e.g. Ingram *et al.*, 1989; Mysak and Manak, 1989; Vinnikov *et al.*, 1999; Lemke *et al.*, 2000; Holloway and Sou, 2002; Saenko *et al.*, 2002; Colman, 2003; Holland and Bitz, 2003). The empirical models are developed to re-create the complexities of nature and they use simulated atmospheric and oceanic processes to represent climatic variables in a theoretical fashion. The climate system is thus divided into a three-dimensional global grid (typically with a resolution ranging from 2.5° to 5° latitude/longitude), whereby supercomputers are employed to solve mathematical representations of matter and energy exchanges between grid points (Curry *et al.*, 1995; Demeritt, 2001a). Laidler (2004) outlines some of the most important considerations to take into account when interpreting the results of climate models. While models do provide

valuable insight into the range of potential impacts of climate change on arctic sea ice (e.g. sea ice extent, distribution, concentration, and thickness), there are various modeling constraints that prevent an exact representation of reality. In addition, readers are referred to Vinnikov *et al.* (1999) and Walsh and Timlin (2003) for reviews of some of the most popular GCMs used in sea ice/climate change research efforts. Climate models have enabled further exploration and understanding of the relationship between sea ice and climate, and the various potential feedbacks that could dampen or exacerbate global warming trends (Laidler, 2006a). The two most commonly discussed feedbacks include the surface albedo/temperature feedback and the thermohaline circulation (THC) feedback.

The albedo-temperature feedback (or snow/ice-albedo feedback) is one of the most well-known possible climatic responses to reduced sea ice extent or thickness, and is an important process relating to hypotheses (and observations) of amplified warming trends at the poles (Bintanja and Oerlemans, 1995; Curry *et al.*, 1995; Holland *et al.*, 1997; Grunet *et al.*, 2001). Albedo is the amount of incident radiation reflected from a surface without heating the receiving surface (Wadhams, 2000). It is very important in determining the spectral characteristics of sea ice. The rate of absorption and scattering depends on the angle of incidence of radiation, the wavelength, and the properties of the material, and is generally measured on a scale from zero to one (e.g. open water albedo = 0.06 – 0.3 (i.e. low) while bare ice albedo = 0.52 – 0.7 (i.e. high), with new snow albedo = 0.87 (i.e. highest)) (Wadhams, 2000, 89). The basic chain of events for temperature/sea ice/albedo change would suggest a positive feedback whereby: i) surface temperature rises; ii) sea ice extent decreases; iii) more open water allows an increased absorption of solar radiation; and, iv) surface temperature increases further (Holland *et al.*, 1997). The albedo-temperature feedback is also influenced by changes in ice thickness, movement, and dynamics (Laidler, 2006a).

Potential sea ice-climate-thermohaline circulation (THC) feedbacks can also be accounted for by including an interactive atmosphere component in a GCM (Lohmenn and Gerdes, 1998). The THC has important implications for salinity profiles and contributions to deep water formation in polar regions as it carries heat around the globe with ocean circulation patterns – an influence on climatic conditions worldwide (Copley, 2000; Lemke *et al.*, 2000; Vellinga and Wood, 2002).

Periodic cyclical or quasi-cyclical forces such as El Nino-Southern Oscillation (ENSO) or the North Atlantic Oscillation (NAO) also affect the arctic climate. These have been discussed briefly in Laidler (2006a), and more details are found in Mysak and Manak (1989), Wang *et al.* (1994a), Mysak *et al.* (1996), Parkinson *et al.*, (1999), Wadhams (2000), and Weller (2000), among others. While such atmospheric pressure gradients certainly do impact annual variations in sea ice conditions and distribution, there is general consensus in the scientific community that long-term trends in sea ice change are not solely related to atmospheric oscillations (Houghton *et al.*, 2001; Symon *et al.*, 2005). Overall, Northern Hemisphere results show a tendency towards declining sea ice extents, and decreasing thickness (Johannessen *et al.*, 1999; Kerr, 1999; Copley, 2000); therefore, evidence is accumulating to indicate that climate change is affecting sea ice in a unidirectional manner not characterized by typical inter-annual, or even decadal, variability (Vinnikov *et al.*, 1999).

The results and outputs from GCM research and satellite monitoring are presumed to enable human populations to better predict, and thus prepare for or adapt to, foreseeable changes resulting from alterations in sea ice extent, distribution, and/or thickness. In the Canadian Arctic, Inuit communities are the populations who are the most likely to be directly impacted by such ecological shifts. The Inuit have adapted to, and thrived in, the harsh Arctic tundra and marine environments that are now among the ecosystems most threatened by climatic change. Due to the coarse scale of GCMs it is difficult to relate model results to

potential impacts at the community level (Duerden, 2004). Therefore, model outputs are not easily translated into meaningful projections that the Inuit could use to help develop responses to foreseeable change. While climate and oceanographic sciences have been established over the past five decades, academic and research interests in the impacts of global warming on Arctic communities, and resulting societal adaptations, have only recently emerged (e.g. Berkes and Jolly, 2002; Duerden, 2004; Ford, 2005). To the Inuit of northern communities, observing and adapting to variations in sea ice and climate has been a daily practice for generations. It would seem reasonable to attempt to incorporate local scale expertise (such as that held by Inuit hunters and elders) into model simulations to enhance the local and regional accuracy of results. While model capabilities have simply not evolved to the point where this is possible, Inuit expertise is also not well understood or easily accessible as it is held in oral histories and experiential teachings that are only gained by living in the arctic and using the sea ice. The generations of expertise derived from living on, and with, the sea ice renders Inuit potentially significant contributors to climate and sea ice research. However, efforts must be expended to explore appropriate ways of linking Inuit and scientific expertise to further our collective understanding of the links between climate, sea ice, wildlife, and humans.

## **2.4 Linking expertise**

The current and potential effects of climate change in the north are not all negative, but with regards to sea ice they are of great concern (Kusugak, 2002). Inuit are well aware of the local implications of altered sea ice conditions or timing, but they also want to be informed of the outside influences and implications of a warming climate (Kusugak, 2002). Therefore, in deriving assessments of their vulnerability, and developing viable adaptive strategies, Inuit want their voices to be heard, consulted, and incorporated (Kusugak, 2002). As most quantitative scientific research regarding observations or modeling of sea ice/climate change occur on global or regional scales, and most qualitative scientific research regarding

observations or community experiences of change occur on local scales, there is great impetus for linking disparate forms of expertise. It is increasingly recognized, by Inuit and researchers alike, that there is a critical need to find new ways for Inuit and southern scientists to work together to set priorities and establish idea, information, and skill exchanges (Weetaluktuk, 1981; Collings, 1997; Nuttall, 1998; Riedlinger and Berkes, 2001; Jolly *et al.*, 2002; Kormso and Graham, 2002; Kusugak, 2002; Huebert *et al.*, 2005; Nickels *et al.*, 2005; Laidler, 2006b).

Inuit have all too often been victims of indifference, arrogance, and off-hand information from southern researchers (Weetaluktuk, 1981; Laidler, 2006b). Conventionally they have experienced little control over how their knowledge was interpreted and applied by outsiders (NRI and ITC, 1998; Laidler, 2006b). However, through the refinement of research protocols and the development of ethical guidelines researchers are more accountable to communities, and community members have more say in how research is conducted (NRI and ITC, 1998). In order to pursue cooperative ventures, Inuit must be considered as equal research partners, and Inuit knowledge can no longer be dismissed as anecdotal, compromised by spiritual beliefs, or superstitious (Collings, 1997). In fact, detailed local Inuit expertise, and their personal or communal connections to sea ice environments, often address spatial (i.e. fine) and temporal (i.e. coarse) scales that scientific investigations cannot hope to represent with coarse resolutions and short time series (Duerden and Kuhn, 1998; Copley, 2000; Riedlinger and Berkes 2001). While Inuit and scientific knowledge bases are each important and useful in their own right, neither approach is sufficient, in isolation, to address the complexities of global climate change (Jolly *et al.*, 2002; Nichols *et al.*, 2004). When considered in tandem, these two perspectives can provide a more comprehensive vision of past, present, and current sea ice trends (Laidler, 2006a). The current challenge is how to appropriately bridge these scales, and perspectives, on sea ice to effectively link different forms of knowledge.

One of the fundamental challenges in linking Inuit and scientific expertise on sea ice is the distinctive epistemologies with which knowledge is acquired, interpreted, and applied. Scientific ways of knowing are reductionist by nature, aiming for objective isolation of experiments that elucidate causal relationships, consequences, or the intersection of variables (Freeman, 1992; Deloria, 1995; Kuhn and Duerden, 1996; Nadasdy, 1999; Usher, 2000; Cruikshank, 2001). Remaining distanced from experiments is important in order to ensure replicability, comparability, and standardization across various contexts, free of actor interference (Laidler, 2006a). However, the embedded assumptions and institutional factors that influence scientific practices are rarely acknowledged (Deloria, 1995; Zamporo, 1996; Cruikshank, 2001). Objectivity and generalization may be the aim and intent of an experiment, yet scientists cannot operate outside the influence of professional (e.g. funding and promotion) and societal structures (Deloria, 1992; Agrawal, 1995; Deloria, 1995). Furthermore, results must still be manipulated and interpreted, which inevitably involves some degree of subjectivity (Deloria, 1992; Agrawal, 1995; Demeritt, 2001a). Inuit knowledge is often contrasted with scientific knowledge (see Section 2.1.1 and Laidler, 2006a) as being part of a holistic understanding that is inherently subjective because it includes a physical, mental, emotional, and spiritual awareness (Kuhn and Duerden, 1996; Zamporo, 1996; Nadasdy, 1999; Berkes *et al.*, 2000; Usher, 2000). Yet, what this assumed dichotomy can overlook is that both Inuit and scientific understandings of sea ice develop within a specific social and cultural context. Therefore, it is perhaps more accurate to contrast Inuit and scientific knowledge in terms of the specific goals, social relations, experiences, and methods that (sometimes implicitly) condition Inuit and scientific means of understanding sea ice processes (refer to Laidler (2006a) for a more detailed discussion). Scientists tend to focus on understanding the physical processes, while Inuit communities are more interested in understanding the implications of sea ice change for travel safety and wildlife habitat/availability (Laidler, 2006a). Scientific

perspectives tend to be based primarily on remotely acquired data, or modeled empirical relationships, while local Inuit perspectives derive from daily interactions with the sea ice environment. It must be acknowledged here that the labels of 'Inuit knowledge' and 'scientific knowledge' do not adequately capture the diversity of perspectives nor the power relations between individuals within each 'grouping' (Agrawal, 1995; Deloria, 1995; Agrawal, 2002). However, by providing a specific focus on three Baffin Island communities, and identifying the particular type of 'scientists' being referred to, I attempt to clarify some of the important context that informs my results interpretations. Certainly, many cultural and societal influences affect the production of knowledge and the evaluation of its utility for both Inuit and scientific communities. However, the distinctive nature of these influences filters into different perspectives on sea ice and climate change phenomena. Thus they inform the knowledge and practices of both scientists and Inuit in culturally and socially moderated ways. These same distinguishing characteristics, along with a strong mutual interest in sea ice and resulting climatic changes, are also what render Inuit and scientific sea ice expertise potentially so complementary (Laidler, 2006a).

Many studies presenting Inuit observations of climate change, uses of the sea ice, or Inuit knowledge of weather, climate, sea ice, and related factors have been conducted collaboratively (e.g. McDonald *et al.*, 1997; Riedlinger, 1999; Aporta, 2002; Krupnik and Jolly, 2002; Berman and Kofinas, 2004; George *et al.*, 2004; Nichols *et al.*, 2004; Ford, 2005; Nickels *et al.*, 2005). Indeed, to document or incorporate Inuit knowledge into research, policy, or management/monitoring applications necessitates the involvement of community members themselves – especially local experts. Within a community setting, researchers have spent weeks, months, or even years working with community members to learn from them, and to help give voice to local concerns/expert opinions (Laidler, 2006a). However, because of the effort required to build relationships, to effectively work with community members, and to

accurately represent their knowledge and perspectives, few of these studies have succeeded in practically linking disparate knowledge types. The exceptions usually come in the realms of community-based monitoring (e.g. Kofinas *et al.*, 2002; Krupnik, 2002), wildlife/natural resource management (e.g. Berman and Kofinas, 2004; Berman *et al.*, 2004; Cobb *et al.*, 2005; Manseau *et al.*, 2005), or when the focus is placed on a specific event (e.g. Norton, 2002; George *et al.*, 2004). However, insights and examples of how to move towards practical inclusion, specifically in relation to sea ice, are forthcoming (e.g. Meier *et al.*, in press; Tremblay *et al.*, in press). Nevertheless, it seems that the complexity involved in understanding both Inuit and scientific perspectives on sea ice and/or climate change are so challenging in their own right that much more effort is required to bring the two together. In contrast, with a case such as community wildlife monitoring, the specific focus is more clearly understood by both sides. This facilitates expansion into modeling and evaluations on a shorter time scale than is the case with climate modeling.

Based on a broad review of literature, Laidler (2006a) outlines five main areas where conceptual or practical links between scientific and Inuit sea ice expertise could expand our collective understanding of sea ice characteristics, importance, and change. First, climate models are an important means of characterizing and investigating the relationship between sea ice and climate, as well as global projections of change (Demeritt, 2001a), but they cannot capture or represent the local sea ice geographies of northern communities using sea ice in various ways each day (Demeritt, 2001a; Duerden, 2004; Nichols *et al.*, 2004). Climate models can help us understand the physical impacts of climate change on sea ice, as well as physical process feedbacks and coarse resolution global trends. However, Inuit expertise can provide a detailed local understanding of physical sea ice processes as well as the potential implications of sea ice change on social, economic, and cultural aspects of distinct communities (Duerden, 2004). Using both together we can expand our combined understanding of the complexities of



the sea ice environment, which contributes to the enhancement of science because it expands human knowledge (Bielawski, 1984).

Second, attempting to incorporate Inuit and scientific methods within research projects mirrors debates between natural and social scientific disciplines. It provides an opportunity to explore the complementary nature of quantitative and qualitative data, along with challenges of addressing issues of subjectivity, validity, and credibility (Bielawski, 1984; Baxter and Eyles, 1997; Collings, 1997; Nuttall, 1998; Wenzel, 1999; Demeritt, 2001a; Ellerby, 2001; Searles, 2001; Davis and Wagner, 2003). While these elements of evaluation are more advanced in the natural sciences, social scientists are being encouraged to (re)consider these notions, and both types of disciplines are having to reflect on the validity of different means of knowledge generation (Baxter and Eyles, 1997; Huntington, 1998; Wenzel, 1999; Huntington, 2000; Duerden, 2004). In either case, it most often comes down to the individual people involved, as well as detailed and transparent accounts of research methodology (Laidler, 2006a), both of which have important implications for the effectiveness of linking expertise.

Third, with an evolution towards more extensive and integrative collaborative research in the north (Bielawski, 1984; Huntington, 1998; Wenzel, 1999; Duerden, 2004), both natural and social scientists will increasingly be asked to convince community members of the importance and relevance of the investigation to local interests and concerns (Nuttall, 1998; Wenzel, 1999; Furgal *et al.*, 2005; Laidler, 2006a). This move towards interdisciplinarity for both natural and social scientists may elicit new efforts to: i) investigate the effectiveness of research methods; ii) re-evaluate disciplinary barriers; and, iii) re-consider means of communicating and applying research results (Furgal *et al.*, 2005; ITK and NRI, in press; Laidler, 2006a).

Fourth, linking different expertise requires more in-depth analysis of terminology, the construction of meaning, and the communication of a message (Demeritt, 2001a, Demeritt, 2001b; Schneider, 2001; Manning, 2003; Nichols *et al.*, 2004). This is evident in any specialized

discipline (Schneider, 2001; Manning, 2003), including local sea ice experts with highly tailored local sea ice lexicons (Nichols *et al.*, 2004). In order to more effectively work across disciplines and cultures, it is imperative to first have a good sense of what the other is “talking” about.

Finally, any knowledge that expands collective understanding is a contributor to the advancement of knowledge (Bielawski, 1984), whether that be scientific or Inuit knowledge. Linking different types of expertise is challenging, time-consuming, and tedious. However, especially where there are direct connections between environmental change and local social, economic, environmental, and cultural change, there exists an imperative to bring together diverse expertise to address a complex problem. The challenges of linking different knowledge systems that have been identified above all inform my own research process, and provide an important impetus for reflection and methods evaluation in Chapter 8.

## **Chapter 3 – Methods**

### ***Undertaking cross-cultural, collaborative, community-based research***

#### **3.1 Collaborative research approach**

This project follows the new spirit of partnership between northerners and researchers described by ACUNS (2003), whereby the process of high quality research is dependent upon researchers understanding the needs and concerns of communities, and vice versa. Therefore, the research methodology has been designed using a collaborative approach. It is difficult to separate community collaboration and participation, but within this project I use collaboration to refer to working together to develop and refine research directions, questions, plans, and results. Inherent in collaboration is the participation of community members, which varies with the role of an individual, and the research stage (ITK and NRI, in press). The collaborative approach was selected in recognition of the importance of establishing a community-researcher partnership to ensure: i) commitment and participation from community members; ii) some local benefits to the research; and, iii) the generation of meaningful and accurate project results (Thorpe, 1998; Jolly *et al.*, 2002). It is an approach to research that is becoming more common in the northern context (Ferguson and Messier, 1997; Thorpe, 1998; Huntington, 1999; Thorpe *et al.*, 2001; Krupnik and Jolly, 2002; Nichols *et al.*, 2004), as well as within broader paradigm shifts to the consideration of culture and people when researching places (Cosgrove, 1987; Chambers 1994a; Mathewson, 1996; McGregor, 1999; Burgess, 2000; Calheiros *et al.*, 2000; Marcus, 2000; Usher, 2000; Corburn, 2002; Kormso and Graham, 2002; Austin, 2003; Austin, 2004; Berkes, 2004). This is even more evident in applied research that seeks to address issues of relevance to local communities (Nakashima, 1993; Berardi and Donnelly, 1999; Enting *et al.*, 1999; Smith, 2003; George *et al.*, 2004; Natcher, 2004). Within Inuit communities, this collaborative approach to research is increasingly required by: i) northern research licensing agencies (e.g. Nunavut Research Institute (NRI) and Aurora

Research Institute (ARI)); ii) northern communities (in response to previously exploitative research relationships); and, iii) Inuit, who are (re)gaining control over local and territorial legislation through land claims and government (Nuttall, 1998; Wenzel, 1999; Kormso and Graham, 2002; ACUNS, 2003; ITK and NRI, in press). While several researchers/research teams have successfully established collaborative research partnerships with northern communities there are still many concerns expressed about research conduct, local involvement, and results reporting (by communities, Inuit organizations, and different levels of government) that suggest there is room for improvement (Kormso and Graham, 2002; Furgal *et al.*, 2005; ITK and NRI, in press; Laidler, 2006b).

In selecting a research approach, it was important that some criteria were met to satisfy my goals for how the research would be undertaken. The criteria include:

- ❖ addressing an issue of interest and/or concern to northern communities;
- ❖ understanding local perspectives and expertise on the issue of interest and/or concern;
- ❖ involving Inuit community members in as many aspects of the research as possible;
- ❖ learning from community members about research practices that are appropriate in a local context; and,
- ❖ exploring the linkages between Inuit and scientific research methods and findings.

Sea ice provided an important focus for this research as it is a topic of great interest, and concern, to many northern communities. Furthermore, a collaborative research approach would facilitate adherence to all the criteria mentioned above. Therefore, I adapted the cross-cultural collaborative research approach outlined in Gibbs (2001), aiming to:

- a) allow Inuit community members to negotiate the research agenda and questions, while also proposing alternative research methods with which they were most comfortable;
- b) ensure that research questions were relevant in order to gain meaningful answers;
- c) enable the researcher to make different kinds of epistemological claims;
- d) allow the co-construction of a text, or joint interpretation of data, to enhance the reliability and meaning of information shared between different worldviews;
- e) facilitate the development of relationships that mirrored the form of relationships in the research participants' culture (i.e. minimize researcher imposition);
- f) promote connectedness, engagement, and participatory consciousness to regulate the "distance" between the researcher and the researched;
- g) allow the researcher to remain critical of her role in the participatory process, while maintaining academic freedom;

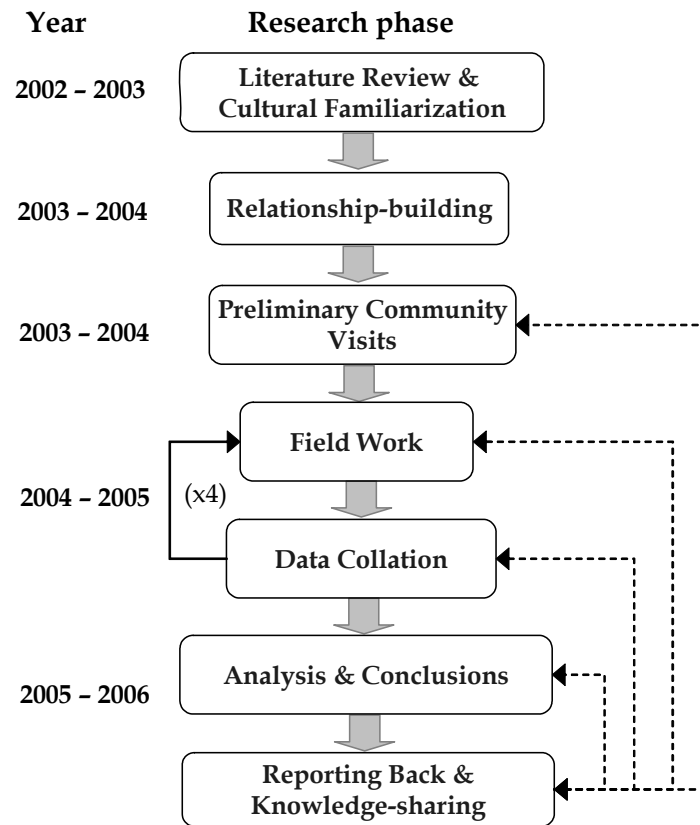
- h) be, at least partially, participant-driven; and,
- i) allow participants to maintain some influence over the dissemination of Inuit knowledge and research results.

All these features increase the likelihood of research benefits flowing back to participants through knowledge-sharing networks and the relationships created by the research process. Furthermore, a research approach that is responsive to the time, place, and situation at hand has proven invaluable in providing the flexibility necessary to conduct successful, respectful, and meaningful research in Nunavut communities (Fox, 2002). In order to be responsive in this manner, participants and local organizations were provided ongoing opportunities to examine scientific findings, ask questions, and provide feedback throughout the various research phases undertaken in this project. Therefore, the collaborative approach used to engage community members and undertake participatory methods comprised seven (7) research phases: i) literature review and familiarization; ii) relationship-building; iii) preliminary community visits; iv) field work; v) data collation; vi) analysis and conclusions; vii) reporting back and knowledge-sharing (Figure 3-1). They are presented separately to highlight the general research chronology, but it must be noted that these steps are not exclusive; they are ongoing, cumulative, and iterative throughout the research process.

### **3.1.1 Research phases**

#### *3.1.1.1 Literature review and familiarization*

The first year of this project (i.e. 2002/2003) was used to familiarize myself with the various literature sources (Figure 3-1). Before being able to select communities, establish local contacts, or plan preliminary visits, it was imperative to review all relevant literature related to sea ice and Inuit culture, from a variety of disciplines and perspectives. This provided background on the processes of sea ice formation/decay, recent seasonal trends, and insights into previous research investigating the relationships between Inuit and the sea ice environment. Furthermore, it was imperative that I familiarize myself with some Inuit cultural



**Figure 3-1:** Overview of the collaborative research approach, employed in this project, including the various research phases and the general timeline of research.

Where:  $\longrightarrow$  = repeated sequentially for each field work trip  
 $\longleftrightarrow$  = ongoing throughout phases, two-way information flow

traditions and perspectives in order to appropriately, and respectfully, approach communities with the proposition of a collaborative research project. These efforts were an important beginning, but they were also ongoing, taking place throughout the duration of the project. Sources used in this phase included journal articles, books, news/media articles, government and educational websites, northern archives, research reports, research gaps/needs analyses, and personal communications with those engaged in similar work. Literature was selected using keyword electronic index searches (journal and library) to identify research dealing with: i) Inuit knowledge, observations, or uses of sea ice; ii) Inuit observations of weather and/or climate change; iii) sea ice and climate change; iv) sea ice parameters in climate models; v) scientific methods of monitoring sea ice change; and, vi) linking Inuit/traditional/local

knowledge with scientific knowledge. This provided an important conceptual foundation for this research, and contributed significantly to the drafting of Chapter 2.

### *3.1.1.2 Relationship-building*

I initiated verbal and written contact with northern, Inuit, and research representatives prior to selecting communities to work with or making preliminary community visits (i.e. during the summer of 2003) (Figure 3-1). This involved personal exchanges with the Arctic Institute of North America (AINA), ArcticNet, Canadian Climate Impacts and Adaptation Research Network (C-CIARN) North, Canadian Ice Service (CIS), CRYSYS (Cryosphere System in Canada), Department of Fisheries and Oceans (DFO), Environment Canada (EC), the Global Environmental Change Group at the University of Guelph, the Government of Nunavut (GN), Indian and Northern Affairs Canada (INAC), Inuit Heritage Trust Incorporated (IHTI), Inuit Tapiriit Kanatami (ITK), Nunavut Arctic College (NAC), the NRI, the Nunavut Wildlife Management Board (NWMB), Nunavut Tunngavik Incorporated (NTI), and the Qikiqtani Inuit Association (QIA) along with research scientists in academic institutions or independent consulting firms. Through these interactions and multiple discussions about my project ideas, there were consistent indications that nearly any Nunavut community would be interested in the topic of sea ice (and would likely be supportive of a community-based sea ice project). Therefore, the three Nunavut communities of Cape Dorset, Igloolik, and Pangnirtung were approached to be a part of this research project because of their ice conditions as well as the potential for local and academic/organizational collaboration (Section 1.7).

The first interactions with community leaders and organizations (e.g. the Mayor, Hamlet Council, and Senior Administrative Officer (SAO), the wildlife officer, Hunters and Trappers Associations (HTAs), local GN departments, local schools, etc.) were initiated by fax and followed up with phone calls in the late summer and early fall of 2003. Early interest was

expressed from all three communities so a preliminary visit was arranged to meet respected Inuit elders, renewable resource users, Hamlet Council and SAOs, and other local organizations that might support or facilitate my proposed research. These trips helped to follow up on local interest, and refine research plans. This initial relationship-building phase overlaps with all other research phases, as establishing and maintaining contacts requires continued effort. This is especially important in the cultural context of Inuit as an oral society (preferring face-to-face verbal contact), and in the northern government/organizational context of high employment turnover rates.

#### *3.1.1.3 Preliminary community visits*

Preliminary community visits were undertaken in the fall and winter of 2003/2004 (Section 3.3.1) (Figure 3-1). This phase facilitated the establishment of valuable local and institutional contacts, and helped build interpersonal relationships with community representatives and individuals. Suggestions from community organizations were also solicited regarding my proposed research approach and direction. Therefore, these trips were used to evaluate project feasibility, continuity, and commitment from all involved. They also provided a forum for discussion to identify any current community concerns or trend observations that could refine research proposals, timelines, protocols, and/or analysis procedures. Such community visits enabled an assessment of community willingness and/or comfort in sharing their expertise on sea ice, while also affording them the opportunity to assess the project's value or applicability to community needs. These interactions took place in formal and informal meetings, as well as everyday conversations. Face-to-face discussions provided interested community members the chance to voice their opinions, questions, or concerns. Field work timing and duration was also re-assessed based on feedback from these initial visits.



#### *3.1.1.4 Field work trips*

Multiple field work trips, at different times in the cycle of sea ice freeze/thaw processes, were undertaken between April, 2004 and June, 2005 (Figure 3-1) in order to address the thesis objectives (Section 1.6). Methods used in this research phase included semi-directed interviews (Section 3.3.2.1), participatory mapping (Section 3.3.2.1.3), participant observation/experiential sea ice trips (Section 3.3.2.2), and focus groups (Section 3.3.2.3). In the majority of circumstances, the aid of an interpreter was required to effectively communicate with Inuit elders, and other community members, who were most comfortable speaking Inuktitut.

#### *3.1.1.5 Data collation*

Between field campaigns substantial amounts of information collation and analysis was performed (Figure 3-1). This involved the transcription of audio and video tapes, the digitization of hand-drawn maps, and the development of document analysis and geographic information system (GIS) databases to house the information.

#### *3.1.1.6 Analysis and conclusions*

Similar to the data collation phase (Section 3.1.1.5), interpreting field work and analyzing the findings was an ongoing process (Figure 3-1). However, writing and finalizing these thesis chapters constituted a discrete phase in the last year of the research process (2005/2006). Bringing together the Inuit expertise on sea ice, comparing the three communities in terms of sea ice conditions, uses, and change, evaluating the success and validity of the research approach employed, and addressing the challenges of linking scientific and Inuit expertise comprise my contributions to academia. These efforts culminated in the completion of this project, but they also identified several directions for future research (Section 9.4).

### *3.1.1.7 Reporting back and knowledge-sharing*

This stage happened concurrently with phases three (3) – six (6), but it will also extend beyond the completion of this project (Figure 3-1). So, while this phase is shown as the final stage – and is important in terms of results reporting – it is an ongoing, iterative process that attempts to maintain a two-way flow of information sharing. Therefore, interim trip/results summaries were provided to community members and organizations between each field work trip. I also sought feedback on my analyses and interpretations throughout the process. This helped community members stay informed, and share their evaluations of the research process and the scientific perspectives they had learned about. Several other means of maintaining contact were used as part of a general communication strategy (Section 3.4). In addition, a results reporting trip was arranged in May, 2006 to present key findings in person (in the form of results summaries and an open meeting). This may be seen as the project termination phase, but it is in fact the starting point for new or ongoing collaborative research efforts that build upon the foundation created through this research.

## **3.2 Philosophical underpinnings**

I sought to collaborate with northern community members, and to learn about Inuit expertise of sea ice, based on the premise that those who live in – and use – the sea ice environment in daily life are most knowledgeable within a local context. Inuit understandings and uses of sea ice are most applicable to community life. Through centuries of experience travel, hunting, and safety methods have evolved, and been refined, for practical and cultural purposes. Therefore, empirically-driven scientific means of understanding the sea ice environment cannot capture the local expertise derived from experience, nor can it elucidate the importance of sea ice to Inuit communities. Scientific evaluations can provide both broad and micro-scale understandings of sea ice, as it links to global ocean and atmospheric circulation down to the chemical properties of ocean water. Neither local or scientific expertise

is deemed superior, they each provide important insights into the dynamic nature of the sea ice environment, and its influence on humans, wildlife, and climate around the world. However, neither can they provide the entire picture on their own. Indeed, sea ice maintains complex, multi-scale, open system influences (i.e. with the ocean, atmosphere, wildlife, and people) that are infinitely variable in combination, magnitude, and strength. Yet, both scientists and Inuit have found ways to characterize the sea ice environment to the point where processes are generally understood, both in abstract and empirical/practical terms. Therefore, while undertaking research to better comprehend Inuit expertise on this subject, it was imperative that: i) I learn from the most knowledgeable, respected Inuit in each community; ii) community members be involved in all aspects of the project (i.e. to collaborate); and, iii) there be room for consideration and inclusion of scientific understandings of sea ice where possible, and in future research. In so doing, my philosophical approach to the research includes a consideration of: i) different types of knowledge; ii) quantitative and qualitative methods; and, iii) limitations to the understanding of a complex environment.

Studying sea ice, as well as Inuit relationships with their environment, places my research within the scope of both cultural and environmental geography. Admittedly my focus is more on the applied and methodological realm of research than the theoretical or philosophical. But, of the various philosophies of science intertwined with paradigm shifts in geographic thought and practice, I identify most with critical realism. Debates prevail over the definitions of critical realism, its epistemological position, and its implications for methodological practice and theoretical claims (Lawson and Staeheli, 1990; Chappell, 1991; Lawson and Staeheli, 1991; Yeung, 1997; Brown, 2004; Maki and Oinas, 2004; Sayer, 2004). Yet there are underlying conceptions of realism which are sustained throughout – despite different interpretations – as most descriptions of realism have Roy Bhaskar's work (i.e. transcendental realism) at their roots (e.g. Chappell, 1991; Lawson and Staeheli, 1991; Gregory, 1994; Yeung,

1997; Brown, 2004; Sayer, 2004). Within realism, reality is considered independent of human consciousness, whereby physical and human processes will continue to exist regardless of whether we understand them or the way we investigate them (Yeung, 1997; Sayer, 2004). Therefore, what people understand to exist is a combination of related levels of real processes, actual events, and the ways people experience these processes/events (Huckle and Martin, 2001; Sayer, 2004). As such, realism provides a philosophical basis for developing an understanding of the empirical (outcomes – what we see and what others see), actual (decisions – what people do/did and their reasoning for action), and real (mechanisms – the structures that enable and constrain action) worlds of experience (Johnston, 1988). Realism accounts for the world as an open system, stratified into multiple layers of events, mechanisms, and structures (Lawson and Staeheli, 1990; Gregory, 1994; Sayer, 2004). Therefore, while people – Inuit and scientists alike – are actively engaged in interpreting events and making decisions accordingly, their actions are constrained or enabled by (and have reciprocal effects on) the overarching societal structures within which they live (Johnston, 1986). Therefore, the empirical world (i.e. what we see and experience) is a combined result of the tendencies of broader mechanisms that cannot be directly observed except within particular contingent circumstances (Johnston, 1986). Critical realism differentiates between, but is also able to accommodate, research that is intensive (seeking causal mechanisms) and extensive (seeking empirical regularity) (Lawson and Staeheli, 1990; Gregory, 1994). While positivism or empiricism is sometimes associated with realism, Sayer (2004) denotes this as a ‘thin’ form of realism, whereas, critical realism is a ‘thick’ form. It is highlighted that since social – and most natural – systems are open, there are not always regular associations that elucidate causal laws; it depends on the nature of the structures and associated internal power relations (Sayer, 2004). Within realism, abstract and concrete research can both be incorporated, provided the adequate delineation of concepts and time-space relations is specified according to the context and

questions at hand (Gregory, 1994). Furthermore, explanations within a realist epistemology can be based on criteria that go beyond empirical testing (e.g. practical usefulness, consistency with moral or political values, or aesthetic merit), since interpretive understanding is considered complementary to external explanation (Sarre, 1987). This is particularly pertinent when working with Indigenous communities, where the interpretive elements linked to cultural context and practical application are often more revered than the posited “objective truth” put forward by scientists (Deloria, 1995). In addition, while critical realism allows for the adjudication of better or worse arguments, inferences are always in some measure tentative because they are shaped by the broader social and cultural context.

One of the characteristics of realism that I appreciate is the allowance for inclusion of different forms of data, as well as different types of knowledge (Gregory, 1994; Yeung, 1997). Bielawski (1992, 6) explains that philosophical realism is appropriate within the context of community-based arctic research because:

“...both science and Inuit knowledge contribute to understanding the Arctic. A realist approach requires that one accept the natural world as real and amenable to explanation. It holds that the objects of nature exist in and of themselves, were here before science, and will remain regardless of the activities of inquiry directed toward them.”

Conventional arctic science separates culture from nature, emphasizing a division between social and natural science. This results in a denial of the synergy between people and nature in Inuit interpretations of the world, as well as their strategies for living in it (Bielawski, 1992). One of the challenges in my research is attempting to bridge this disparity between culture and the physical environment in a manner that accounts for Inuit conceptualizations of this intimate relationship. Realism supports the notion that the elusive nature of social “facts” means that knowledge must be evaluated in a given social context – not in relation to an “objective truth” (Lawson and Staeheli, 1990, 14). This is critical to my research process, since “[l]ike all knowledge (including that of science), indigenous knowledge is acquired, nurtured,

and shaped within particular social situations and social contexts...[and] can only make sense within local contexts of social relationships and productive activities" (Nuttall, 1998, 21). As Sayer (1984) highlights, knowledge (true or false) does not develop in a vacuum, it is always embedded in social practices. This view is valuable within a collaborative context as it opens up the possibility for productive, reciprocal relationships to develop between Inuit and scientists. This way, efforts to work together are based on more open and honest attempts to come to terms with, but also to disclose, the highly situated character of knowledge production in each culture. Therefore, realism provides a middle ground between humanist and structuralist philosophies of social science (Johnston, 1988), whereby the interdependence of knowledge and practice are reciprocally confirming (Sayer, 1984). By understanding more about some of the social practices in which knowledge is created, we can better comprehend the knowledge itself. As such, critical realism supports efforts to tease out causal chains and connections between different dimensions of human/physical relations (Gregory, 1994), whether that be from Inuit or scientific perspectives.

The adoption of a philosophical research guide capable of meshing practical and theoretical methods was deemed necessary to accommodate the unique aspects of Inuit communities and arctic ecosystems. As Yeung (1997) argues, critical realism is a philosophy, and does not specify a theoretical or methodological prescription for research. By accepting a realist standpoint, scientific (natural or social) and Inuit epistemologies can inform my research process through a variety of techniques including: i) semi-directed interviews; ii) focus groups; iii) participant observation/experiential field excursions; iii) participatory mapping and spatial analysis; iv) map/remote sensing image interpretation; v) scientific data interpretation (in this case based on results published in books or journal articles); vi) audio/visual/textual interpretation; and, vii) conceptual modeling. These methods combine elements of iterative abstraction and triangulation as described by Yeung (1997), and yet adhere to the flexibility of

methodological practice necessitated in collaborative research. Furthermore, realism allows the utility of qualitative and quantitative methods to be maximized in order to better comprehend both the abstract and concrete realms of research (Sarre, 1987; Johnston, 1988). Generalization is not treated as an important goal within critical realism; therefore, quantitative methods alone do not have much to contribute because the relationships identified reflect the nature of the experiments conducted (Sayer, 1984; Johnston, 1986). However, incorporating quantitative elements can help to link abstract and concrete research by providing information at the level of appearances (Sayer, 1984; Johnston, 1986). When this is complemented with qualitative investigations that consider the social/physical structures which provide the necessary conditions for activity, then it is possible to move towards synthesis (Sayer, 1984; Johnston, 1986). From this standpoint, critical realism accommodates, and even requires, both extensive and intensive research as a synergistic means of generating and testing inferential hypotheses. As Huckle and Martin (2001, 38) suggest, “Realism offers a unified approach to the natural and social sciences while recognizing real but different structures and processes within the physical, biological and social worlds.” While there is potential for direct inclusion of quantitative/empirical methods in sea ice monitoring and assessment, this is a minor component of my current research due to the scope of the qualitative aspects. However, it is important to mention because these are areas for expansion when building upon this project in future community-based research efforts. Consideration for different types of expertise, and inclusion of different methods, can promote collaboration and lead to more practical linkages between Inuit and scientific understandings of sea ice.

Although my research is not dictated by a strict adherence to critical realism, it does inform my overall philosophical position as I incorporate: i) a focus on process – of research, Inuit expertise, and the physical sea ice environment; ii) abstraction, through conceptual models of sea ice interactions with seasonal, wind, and current influences; and, iii) a

combination of methods, to unveil environmental, cultural, spatial, and temporal aspects of sea ice. With the ultimate goal of being able to intersect both Inuit and scientific knowledge of sea ice – to enhance a collective understanding of the complexity of human relationships with this environment – it is imperative to consider differing expertise on this topic. However, in order to adequately represent Inuit perspectives the majority of time had to be spent learning from Inuit themselves; their local expertise is not readily accessible in literary forms. Admittedly, I can never fully overcome issues of positionality in this research. I cannot alter the compositional (i.e. what sort of person I am) and contextual (i.e. where I come from) (Johnston, 1997) elements that I have learned from, and become accustomed to. No matter how I conduct the research, I am still a white, female, ‘southerner’ researching a topic in a northern community where sea ice is mainly in the realm of male experience and expertise (Inuit and scientific). These personal relationships also take place in an underlying context of colonial and research relationships that have not always been positive (Gibbs, 2001; McNaughton and Rock, 2003; ITK and NRI, in press). However, I wanted to learn about Inuit ‘positions’ as much as possible in attempts to better understand and represent their ‘voices’ in my research. This is also essential to minimize any misrepresentation which may arise from our different life circumstances and experiences (Laidler, 2006a). Therefore, the research methods employed reflect efforts to: i) work collaboratively with community members; ii) consider various perspectives; iii) link to other research efforts; iv) conceptualize elements of Inuit expertise; and, v) evaluate the methods undertaken through a collaborative approach.

### **3.3 Research methods**

The methods employed in this study fall generally within two of the three major types of qualitative research in geography and social science: oral and participation/ethnography (Winchester, 2000; Esterberg, 2002). An inductive, intensive research strategy facilitated exploration and interpretation of information shared within the research context without



imposing pre-existing expectations (Patton, 1980; Lindsay, 1997). Therefore, I used individual observations and explanations to build towards a more general understanding of sea ice processes, uses, and change in each participating community. Furthermore, a diverse set of participatory methods were incorporated to move towards a collaborative research partnership. I say ‘move towards a partnership’ because this is inherently a long-term process; at the outset I was not sure what was feasibly achievable within three years. However, the methods incorporated in this research aim to involve community members in all components of the project (e.g. planning, design, implementation, analysis, and reporting). In addition, an important consideration in methods selection was that they be flexible, adaptable, and responsive to feedback as the project progressed.

The collaborative research approach (Section 3.1) has been successful in incorporating a variety of participatory methods including: i) background literature reviews; ii) preliminary meetings; iii) collaborative research design and implementation; iv) follow-up interviews and meetings; and, v) focus groups to review results and outline reporting strategies (Austin, 2003). Within the context of northern research, working with Inuit communities, the use of such participatory methods is common and generally accepted as appropriate for engaging community members (Table 3-1). Therefore, I undertook a combination of preliminary community visits, field research visits, and data analysis stages that included a variety of qualitative data collection (i.e. semi-directed interviews, participatory mapping, experiential sea ice trips, and focus groups) and analysis (i.e. transcript analysis, map analysis, conceptual modeling, and methodological analysis) techniques.

### **3.3.1 Preliminary community visits**

Preliminary trips were arranged to visit each community (Table 3-2), prior to conducting any research, in order to: i) propose the project to community groups and organizations; ii) assess community interest in the project; iii) establish research priorities; iv)

**Table 3-1:** Summary of participatory methods employed in northern research involving Inuit communities.

<b>Participatory research method</b>	<b>Examples of studies that have employed the method</b>
<b>community monitoring</b>	Gilchrist and Robertson, 2000; Kofinas <i>et al.</i> , 2002; Krupnik, 2002; Oozeva <i>et al.</i> , 2004
<b>experiential travel and learning</b>	Nelson, 1969; Gilchrist and Robertson, 2000; Aporta, 2002; Furgal <i>et al.</i> , 2002a; Aporta, 2004; George <i>et al.</i> , 2004
<b>focus groups</b>	Furgal <i>et al.</i> , 2002b; Berman and Kofinas, 2004
<b>jointly directed research projects</b>	McDonald <i>et al.</i> , 1997; Thorpe <i>et al.</i> , 2002
<b>map biographies or participatory mapping</b>	Freeman, 1976; Nakashima, 1993; Ferguson and Messier, 1997; Huntington, 1998; Huntington, 1999; Fox, 2002; Norton, 2002; Aporta, 2004
<b>narratives</b>	Nakashima, 1993; Cruikshank, 2001; Oozeva <i>et al.</i> , 2004
<b>participant observation</b>	Nelson, 1969; Fox, 2002; Furgal <i>et al.</i> , 2002a; Jolly <i>et al.</i> , 2002
<b>participatory rural appraisal</b>	Berardi and Donnelly, 1999; Ford, 2000
<b>participatory action research</b>	Thorpe, 1998
<b>structured or semi-directed interviews</b>	Nakashima, 1993; Ferguson and Messier, 1997; Huntington, 1998; Huntington, 1999; Berardi and Donnelly, 1999; Ford, 2000; Gilchrist and Robertson, 2000; Aporta, 2002; Fox, 2002; Furgal <i>et al.</i> , 2002a; Furgal <i>et al.</i> , 2002b; Jolly <i>et al.</i> , 2002; Thorpe <i>et al.</i> , 2002; Aporta, 2004; George <i>et al.</i> , 2004; Nichols <i>et al.</i> , 2004
<b>videography</b>	Ford, 2000; Fox, 2002; Jolly <i>et al.</i> , 2002
<b>workshops for research planning, implementation, or reporting</b>	McDonald <i>et al.</i> , 1997; Berardi and Donnelly, 1999; Ford, 2000; Huntington <i>et al.</i> , 2002; Jolly <i>et al.</i> , 2002; Krupnik, 2002; Nickels <i>et al.</i> , 2002; Norton, 2002; Berman and Kofinas, 2004; George <i>et al.</i> , 2004; Nichols <i>et al.</i> , 2004; Nickels <i>et al.</i> , 2005

**Table 3-2:** Outline of research visit timing, and duration, in each community.

<b>Visit</b>	<b>Pangnirtung</b>	<b>Cape Dorset</b>	<b>Igloolik</b>
<b>Preliminary</b>	Sep 24 – Oct 5, 2003	Oct 5 – 15, 2003	Feb 13 – 21, 2004
<b>Community visit</b>	1.5 weeks	1.5 weeks	1 week
<b>Research Trip #1</b>	Apr 29 – May 19, 2004	Apr 12 – 29, 2004	Oct 27 – Nov 15, 2004
	3 weeks	2.5 weeks	3 weeks
<b>Research Trip #2</b>	Dec 2 – 17, 2004	Nov 19 – Dec 2, 2004	Jun 6 – 27, 2005
	2 weeks	2 weeks	3 weeks
<b>Research Trip #3</b>	Feb 1 – 21, 2005	Jan 10 – Feb 1, 2005	N/A
	3 weeks	3 weeks	
<b>Research Trip #4</b>	Apr 26 – May 11, 2005	May 11 – 24, 2005	N/A
	2 weeks	2 weeks	
<b>Total # of weeks</b>	<b>11.5 WEEKS</b>	<b>11 WEEKS</b>	<b>7 WEEKS</b>

answer questions or concerns; v) assess project feasibility; and, vi) gain feedback on field work timing and duration. This type of preliminary research is essential within the northern context to ensure that there is community interest and support for the proposed project. Without this, my project could not have proceeded since it was highly contingent on local involvement and

expertise. Such preliminary trips have been undertaken in other projects in order to conduct preparatory/planning workshops (Table 3-1), and has proven essential to the successful development the project. I opted for informal and formal meetings with various community groups and organizations in each community since it is difficult to organize a workshop without previous local contacts or working relationships. The following sections outline the groups that I met with, and the activities undertaken, during the initial community visits.

#### *3.3.1.1 Cape Dorset*

A preliminary visit to Cape Dorset was arranged in October, 2003 (Table 3-2, Figure 3-2a). During this trip I met with local organizations and representatives including: the Hamlet Council (including Mayor and SAO), the Aiviq HTA board, the NAC coordinator, the Peter Pitseolak High School Principal and teachers, the QIA community liaison officer (CLO) and Lands Committee, the owners of Huit Huit Tours, and many community members along the way. I met Pootoogoo Elee on this first trip, and he played an important role in arranging, facilitating, and interpreting the meetings mentioned above. Elee and I also hosted a call-in radio show to present the project and to solicit broad community feedback (Figure 3-2b). There was a lot of support for, and interest in, the proposed sea ice project, whereby general comments and recommendations are summarized in Appendix 6. Therefore, several research trips were planned and conducted in response to community suggestions to return during various sea ice stages from freeze-up to break-up (Table 3-2).

#### *3.3.1.2 Igloolik*

A preliminary visit to Igloolik was arranged in February, 2004 (Table 3-2, Figure 3-3a). During this trip I met with local organizations and representatives including: the Hamlet Council (SAO), the HTA board, the QIA CLO, the Ataguttaaluk High School Principal and teachers, the NAC interim coordinator, the NRI coordinator and researchers, Isuma Productions director and employees, and GN Department of Environment employees. I met



a) View of downtown Cape Dorset in October, 2003



b) Timi Mikigak (left) and Pootoogoo Elee (right) on the local community radio, just before our radio show to describe the proposed sea ice project to the broader community, October, 2003

**Figure 3-2:** Preliminary community visit to Cape Dorset. (photos: Gita Laidler)

Germaine Immaroitok and André Uttak on this first trip, and they played an important role in arranging, facilitating, and interpreting the meetings mentioned above. Immaroitok also helped me to host a call-in radio show to present the project and to solicit broad community feedback (Figure 3-3b). There was a lot of support for, and interest in, the proposed sea ice project, whereby general comments and recommendations are summarized in Appendix 7. Therefore, several research trips were planned and conducted in response to community suggestions to return during various sea ice stages from freeze-up to break-up (Table 3-2).



a) View of downtown Igloolik in February, 2004



b) Gita Laidler on the local community radio to describe the proposed sea ice project to the broader community, February, 2004

**Figure 3-3:** Preliminary community visit to Igloolik. (photos: a) Gita Laidler; b) Germaine Immaroitok)

### 3.3.1.3 Pangnirtung

A preliminary visit to Pangnirtung was arranged in September, 2003 (Table 3-2, Figure 3-4a). During this trip I met with local organizations and representatives including: the Hamlet Council (including the Mayor and SAO), the HTA board, the QIA CLO, the Attagoyuk High School Principal and teachers, the Angmarlik Visitor Centre coordinator, the NAC coordinator, Parks Canada employees, the owner of Alivaktak Outfitting, and GN Department of Environment and Education employees. I met Andrew Dialla on this first trip, and he played an important role in arranging, facilitating, and interpreting the meetings mentioned above. Dialla and I also hosted a call-in radio show to present the project and to solicit broad community feedback (Figure 3-4b). There was a lot of support for, and interest in, the proposed sea ice project, whereby general comments and recommendations are summarized in Appendix 8. Therefore, several research trips were planned and conducted in response to community suggestions to return during various sea ice stages from freeze-up to break-up (Table 3-2).



a) View of downtown Pangnirtung in September, 2003



b) Gita Laidler on the local community radio to describe the proposed sea ice project to the broader community, September, 2003

**Figure 3-4:** Preliminary community visit to Pangnirtung. (photos: a) Gita Laidler; b) Andrew Dialla)

### 3.3.2 Field research trips

Prior to conducting any field research trips involving interviews, participatory mapping, sea ice trips, or focus groups, the required ethical review and research licensing process had to be completed. Therefore, a Social Science and Traditional Knowledge Research License was acquired from the NRI (multi-year license #0100504N-M (January, 2004 - December, 2006)). University of Toronto ethical protocols (Protocol reference #10112 (2003/2004), #12316 (2004/2005), #14915 (2005/2006)) were also completed (and adhered to) for the duration of the research. These were essential elements to ensure ethical conduct of research, respect for individual and community rights, as well as compliance with northern and institutional procedures for research involving humans. In addition, guidelines provided by the NRI, the Association of Canadian Universities for Northern Studies (ACUNS), and the Tri-Council regarding ethical conduct for research involving humans were consulted in an ongoing fashion. With the document completion and approvals finalized, field work began in the spring of 2004.

As shown in Table 3-2, a total of approximately eight (8) months were spent in the three communities to initiate and conduct this research. Approximately three (3) months were spent in Cape Dorset and Pangnirtung, and two (2) months in Igloolik. Less time was spent in Igloolik because of the active branch of the NRI based in Igloolik, whereby considerably more research had already been undertaken in this community. To avoid duplication or research burden, it was believed to be appropriate to spend less time there, but still important to do research in Igloolik to build upon previous sea ice-related research. The amount of time spent, and the number of research visits in each community, was critical to developing the sea ice project based on community interest and commitment. The following sections describe the different research methods employed throughout the field work trips.

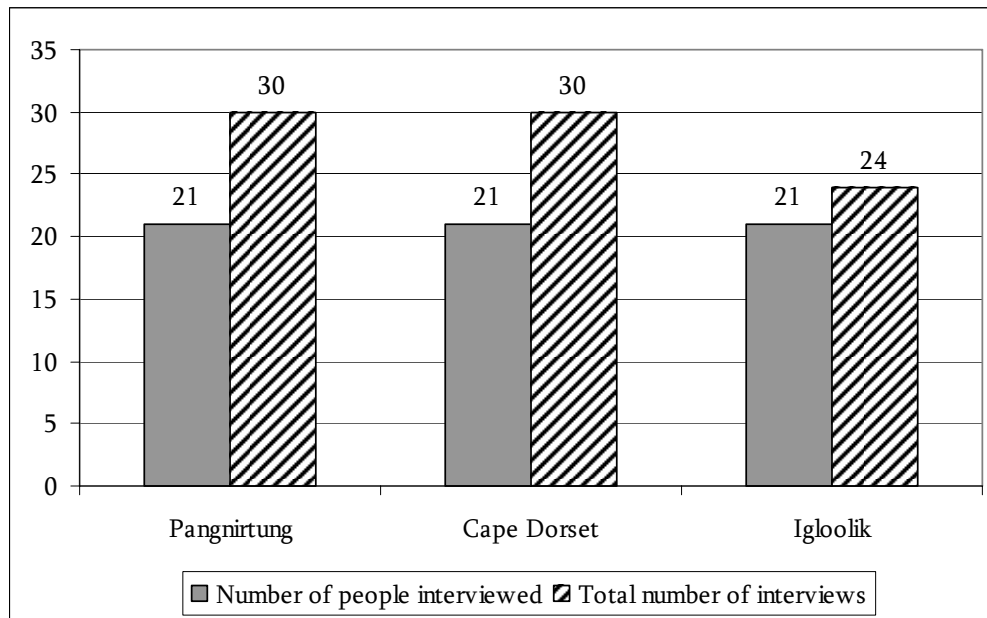
### 3.3.2.1 *Semi-directed interviews*

#### 3.3.2.1.1 Participant selection and numbers

Participants to be interviewed in a semi-structured format (Section 3.3.2.1.2) were selected through purposeful sampling (Patton, 1980; Bradshaw and Stratford, 2000; Esterberg, 2002) targeted to include community members that were deemed sea ice experts – key informants – in each community (Lindsay, 1997; Bradshaw and Stratford, 2000). Therefore, Inuit elders and active hunters were sought after based on endorsements provided by: i) community organizations; ii) interpreters; iii) elders or hunters who were already interviewed; and iv) other community members. There was no pre-determined gender or age criteria for inclusion in interviews, but in seeking Inuit experts on sea ice the majority of individuals recommended were middle-aged to elderly men. For this reason, there are fewer female participants (4 of 63 interviewees), and all of them were in Cape Dorset. There are strongly defined gender roles within Inuit culture (Ferguson and Messier, 1997; Thorpe, 1998) and it is typically a male role to be traveling on the sea ice for harvesting or hunting purposes (Nelson, 1969; Freeman, 1984; Riewe, 1991; Aporta, 2002; Furgal *et al.*, 2002a; Aporta, 2004). Thus, men were deemed most knowledgeable about sea ice and were most often recommended by their peers. Where women were asked for an interview, they would frequently defer to their husbands in the realm of sea ice knowledge. Where women were recommended to be interviewed it was because they were well-respected elders, honoured for their extensive experiences living more traditional lifestyles.

There was no pre-determined target for the number of interviews to be conducted. Within the total population of each community, the number of elders is proportionately very small, and the number of (regularly) active, experienced hunters is also relatively small (Chapter 2). Out of a suggested list of approximately 30 people in each of Cape Dorset, Igloolik, and Pangnirtung, 21 people from each community participated in the interview

process (63 people total). However, some elders or hunters had a lot that they wanted to share, so when one interview session was not adequate a follow-up interview was arranged. Therefore, a total of 84 interviews were conducted as part of this project (Figure 3-5). A list of interview participants, dates, and interview codes is provided in Appendix 9 – these interview codes will be used throughout the results (Chapters 4 – 6) and analysis (Chapters 7 – 8) chapters to reference sea ice experts.



**Figure 3-5:** The number of people interviewed, and the total number of interviews conducted, in each community.

#### 3.3.2.1.2 Interview protocol

Semi-directed interviews allow for more flexibility than a question and answer session or the administration of a questionnaire, and are useful when the goal is to understand individual ‘stories’ or explanations of a certain topic (Patton, 1980; Lindsay, 1997; Dunn, 2000; Bennett, 2002b; Esterberg, 2002). This is a standard open-ended, ethnographic technique that has been successfully used to gather information within the context of Inuit knowledge research (Table 3-1). This format was chosen to promote dialogue and not interrogation (Huntington, 2000; Bennett, 2002b). It was also important because it allowed detailed



documentation of responses (for accuracy, and depth of explanation) (Esterberg, 2002; Dunn, 2000). The semi-structured format allowed the participant to be guided in discussions, but the direction and scope could follow associations identified by the participant (Patton, 1980; Lindsay, 1997; Huntington, 1998; Dunn, 2000; Bennett, 2002b; Esterberg, 2002). No fixed questionnaire was administered, and no time limit was placed on discussions; however, an interview guide was used as a reference to help me cover important areas of interest (Appendix 10). The general line of questioning included topics such as:

- Personal background and past research experiences
- Inuktitut sea ice terminology and descriptions of freeze/thaw processes
- Wind and current influences on sea ice formation or movement
- The importance and uses of sea ice (for humans and wildlife)
- Rare or notable sea ice events
- Inuit perspectives on working with scientists, or scientific methods of studying sea ice
- The meaning of *Inuit Qaujimajatuqangit*

Interviews were arranged by the interpreters that I worked with in each community (i.e. Pootoogoo Elee in Cape Dorset, Theo Ikummaq in Igloolik, and Andrew Dialla and Eric Joamie in Pangnirtung). They called people on the list of potential interviewees (that we had developed together, according to recommendations as described in Section 3.3.2.1.1), to explain the project and to ask if the elder or hunter would be willing to be interviewed. The response rate was high (i.e. 21 people in each community, from a list of approximately 30 people identified as sea ice experts), and often the reason people on the list were not interviewed was because they were out of town, sick, or too busy (i.e. only one person refused, because the honorarium was not considered enough). Interviews were scheduled according to what was best for the participant, and were held in places agreed upon by all involved. Therefore, interviews were conducted in places where participants felt comfortable, and wherever possible in a quiet atmosphere with few distractions. This meant that in each community interviews were conducted in a variety of locations:

- in **Cape Dorset** → interviewee's homes, the Hamlet Council Chamber, and the Malikjuaq Visitor's Centre (Figure 3-6a)
- in **Igloolik** → the Polar Bear Biology Research Laboratory (run by the GN Environment Department), and a meeting room in the GN building (Figure 3-6b)
- in **Pangnirtung** → interviewee's homes, the Hamlet Council Chamber, the Parks Canada meeting room, the Angmarlik Visitor Centre meeting room, the HTA board room (Figure 3-6c)



a) Interview in the Community Learning Centre library in Cape Dorset, with Etulu Etidlouie (left) and Pootogoo Elee interpreting (right), January, 2005.



b) Interview in the polar bear biology research lab in Igloolik, with Maurice Arnatsiaq (left) and Theo Ikummaq interpreting (right), November, 2004.



c) Interview in the Hamlet Council Chambers in Pangnirtung, with Jamesie Mike (left) and Andrew Dialla interpreting (right), February, 2005.

**Figure 3-6:** The interview setup in Cape Dorset (a), Igloolik (b), and Pangnirtung (c). (photos: Gita Laidler)

Interviews began with personal introductions, a brief explanation of the project, and going through the information pamphlet (Appendix 11) and consent form (Appendix 12). Where consent was provided the full interview was recorded with a digital audio recording

device to facilitate later transcription. In addition, where consent was provided the participant was filmed with a digital video camera in order to capture body language, gestures, and a visual reference of the participants; however, recording only took place when the participant was speaking (and not the interviewer or interpreter) due to time limitations on the video tape. Where people were not comfortable with being filmed, they consented to a photograph being taken in order to link a face to the name (for my benefit, but also for the benefit of those who may consult the interview transcripts at a later date). All but one participant consented to being identified in research results, and all participants wanted their information shared with others (i.e. released for others to access). Therefore, all the raw data (i.e. original transcripts, audio tapes, video tapes, and digital files where possible) was deposited in local community repositories so that community members can access this information at any time. Each community has a different facility that can house this information. In Cape Dorset it is stored at the Community Learning Centre, in Igloolik at the Nunavut Research Institute, and in Pangnirtung at the Angmarlik Visitor Centre. In addition, all this data is securely stored on my computer, on two remote computers (i.e. back-up), and in institutional filing cabinets. No data will be destroyed upon the completion of this project because participants want this information available, and it provides a historical sea ice legacy for each community.

The majority of interviews lasted approximately 2 hours, with 45 minutes being the minimum time, and 3 hours being the maximum time. As seen in Appendix 9, several people were interviewed more than once if we ran out of time, or if they had more that they wanted to share. Every effort was made to learn and understand the Inuktitut terminology most applicable to sea ice conditions and characteristics in order to best contextualize interpretation; however, interpreters were present in every interview where the participant was most comfortable speaking Inuktitut. In many cases the interpreter was essential for communication between unilingual elders and myself.

Upon the conclusion of each interview the participant was given an honorarium (\$60/interview) as a gesture of appreciation. This is a commonly accepted, and expected, means of compensating participants in Nunavut. The amount was determined in consultation with NRI as well as with reference to our budget. It must be made clear that this money was in no way intended to pay for knowledge, which will always remain the intellectual property of the experts interviewed. This honorarium was for peoples' time out of their daily schedule and other responsibilities. It was also accompanied with a small gift package of tea, chocolate, gum, and apple cider as a token of appreciation. In addition, interpreters were paid \$40/hour for their translation services, and \$20/hour for any research assistance (e.g. time arranging interviews, reviewing questions, discussing results, etc.).

#### 3.3.2.1.3 Participatory mapping

Maps act as important communication tools within interactive sessions (Huntington, 1998; Fox, 2002), they aid in understanding relationships between culture and the environment (Herlihy and Knapp, 2003; Smith, 2003), and they have been used to defend the interests of marginalized groups (Berkes, 1999; Smith, 2003). Combining elements of participatory research and cognitive mapping (Herlihy and Knapp, 2003), maps are also postulated to be effective means of enhancing scientists' comprehension or acceptance of local expertise. Maps are commonly used within the context of Inuit knowledge research (Table 3-1) because they are deemed effective conversation pieces, as well as appropriate tools for synthesizing diverse observations. Therefore, several National Topographic Service (NTS) maps sheets were incorporated in interviews to: i) facilitate knowledge-sharing; ii) enhance explanations of sea ice conditions or uses; iii) enable visual identification of key sea ice conditions or uses; and, iv) promote discussion and spark memories/experiences. For each community a combination of three to five 1:250 000 scale NTS map sheets (generally 3' x 3') were employed to represent the surrounding coastline and ocean areas (Table 3-3, Appendices 2 - 4). This scale was selected as

**Table 3-3:** Summary of map sheets used in interviews in each community.

Community	NTS Map Sheets	UTM Zones	Datum
Cape Dorset	36B, C, D and 35N	17 and 18	NAD1983
Igloolik	47A, C, D, E, F	16 and 17	NAD1983
Pangnirtung	26 G, H, I, J	19 and 20	NAD1983

a viable middle ground between the coarse scale maps employed in regional land use and occupancy studies (e.g. 1:500 000 in Freeman *et al.*, 1976) and fine scale maps employed in placename and local harvesting studies (e.g. 1:50 000 in Brice-Bennett, 1977). This selection was thought to provide adequate regional coverage as well as sufficient detail to identify key land or sea ice features (this selection is evaluated in Section 8.1.3). A clear plastic overlay (similar to mylar) was placed on top of each map and registered using a three-hole punch system (created by the Cartography Office in the Department of Geography at the University of Toronto) to ensure that the overlays could be re-placed on the maps in the exact same position (essential for accurate digitizing). These maps were taped onto the table in front of the participant, and were used as reference whenever necessary (Figure 3-6a, b, c). Permanent markers were provided to each interviewee and different colours were used, wherever possible, to indicate different sea ice features of interest. Common features drawn on the maps included: i) travel routes; ii) floe edge positions; iii) tidal cracks; iv) polynyas; v) areas that melt early in the spring; vi) wildlife harvesting areas; and, vii) traditional or current camps. Such features were indicated whenever the participant felt it was necessary, or in response to a question posed as part of the interview.

In addition, black and white printouts of remotely sensed imagery (RADARSAT-1, Scansar wide - 100m resolution - copyright to the Canadian Space Agency and provided through CRYSYS by CIS, EC) were incorporated near the end of interviews to discuss scientific methods of ice monitoring (Appendix 13). Satellite imagery has been shown to spark discussions of observations or changes in overall ice conditions (Jolly *et al.*, 2002; Norton, 2002),

and they were also helpful in soliciting local perspectives on the utility and/or meaning of satellite data.

### 3.3.2.2 *Experiential sea ice trips*

Participant observation is one of the principal qualitative methods for conducting research on a particular group in a particular locality (Kearns, 2000; Fox, 2002), and is a central feature of many northern research projects (Table 3-1). With its roots in social anthropology (Lindsay, 1997; Kearns, 2000), participant observation is an attempt to understand the everyday lives of other people, from their perspective (Kearns, 2000; Bennett, 2002a). While observation is implicit in qualitative research involving other people, it is also consciously undertaken to better understand processes or relationships within a particular project focus (Kearns, 2000). This activity provides both complementary and contextual understanding to that gleaned within interviews (Section 3.3.2.1) and focus groups (Section 3.3.2.3) (Kearns, 2000). To really begin to understand or contextualize Inuit expertise, it was imperative that I experience, and participate in, Inuit routines or practices. Therefore, I prefer to refer to this method as experiential sea ice trips because the experiential aspect was very prominent – it was more than simple observation. Such trips were suggested by elders during interviews as an important way to learn about sea ice from an Inuit perspective. It is more traditional to convey knowledge, and to teach Inuit youth, through personal experience and observation (Thorpe, 1998). These were also part of the original research methods plan. However, they were prioritized upon receiving feedback from interview participants. In order to partake in such trips I was actively engaged in sea ice travel, testing the sea ice, observing ice conditions, and watching others. I was fortunate to participate in 14 experiential sea ice trips to learn about sea ice navigation, conditions, and terminology first-hand (Table 3-4). The length, timing, and destination of each trip was highly dependent on the availability of transportation (i.e. snowmobiles) and guides, as well as weather conditions. Guides were hired at rates mutually

agreed upon (ranging from \$150 – \$600/trip, depending on duration, number of people involved, mode of transportation, etc). I also covered the costs of snowmobile rentals, gas, oil, and food for each trip, for each person.

All of the sea ice trips (Table 3-4) were documented with photographic and video footage of various ice conditions and explanations from guides or elders. In addition, a global positioning system (GPS) was used to track our travel routes (set to automatically record a location point every 30 seconds) in order to locate the trip after the fact, and with the idea of linking routes to satellite imagery of sea ice conditions (Figure 3-7).

**Table 3-4:** Overview of experiential sea ice trips undertaken in each community, whereby the research trip # refers to the research trip numbers and dates outlined in Table 3-2.

Community	Trip type	Means of travel	Research trip #	Destination	Guide(s)
Cape Dorset	Day trip	Dog team	1	Floe edge	Huit Huit Tours
Cape Dorset	Day trip	Walking	2	Tellik Inlet	Atsiaq Alasuaq, Pootoogoo Elee
Cape Dorset	Day trip	Snowmobile	3	Floe edge	Atsiaq Alasuaq, Pootoogoo Elee
Cape Dorset	Day trip	Snowmobile	3	Polynya	Quvianaqtuliaq Tapaungai, Pootoogoo Elee
Cape Dorset	Multi-day trip	Snowmobile	4	Fishing lakes, hunting cabin, goose hunting grounds	Huit Huit Tours
Igloolik	Day trip	Snowmobile	1	Floe edge	Theo Ikummaq
Igloolik	Day trip	Snowmobile	1	Polynya	Theo Ikummaq
Igloolik	Day trip	Snowmobile	2	Melville Peninsula and floe edge	Theo Ikummaq
Igloolik	Multi-day trip	Snowmobile	2	Baffin Island, polynya, seal hunting	Theo Ikummaq and met up with others
Pangnirtung	Day trip	Snowmobile	1	Floe edge and Nasauya point	Eric Joamie, Joanasie Maniapik, Andrew Dialla
Pangnirtung	Day trip	Walking	2	Pangnirtung Fiord	Joavee Alivaktuk
Pangnirtung	Day trip	Snowmobile	3	Northeastern end of Cumberland Sound	Andrew Dialla
Pangnirtung	Day trip	Snowmobile	4	Fishing lakes	Donald Mearns and family
Pangnirtung	Day trip	Snowmobile	4	Fishing lakes	Eric Joamie and family



**Figure 3-7:** Garmin GPSMap 60C was used to track the sea ice routes traveled throughout all research trips (left). In order to maintain effective AA battery life the GPS was kept inside my parka for warmth, and an external antenna was attached to the top of my hood (right) to ensure clear reception. (photos: Gita Laidler (left) and Kristiina Alariaq (right))

### 3.3.2.3 *Focus groups*

Combining elements of both interviews and participant observation (Lindsay, 1997; Fox, 2002), incorporating a focus group format into the field research allowed me to explore Inuit knowledge of sea ice environments through observation of, and participation in, group dynamics (Cameron, 2000; Bennett, 2002b). These group sessions aimed to link Inuktitut terminology for various ice conditions to pictures taken on sea ice trips. They were also organized to help me develop and verify terminology links within a sequential order of sea ice formation and decay processes (based on information compiled from interviews). I facilitated these sessions with the help of an interpreter, whereby 3-5 elders participated in each one (Figure 3-8). Elders were selected based on the depth of their previous interview sessions, their interest in the project, and recommendations from the interpreters as to who was most knowledgeable about the nuances of Inuktitut sea ice terminology. These sessions lasted approximately 4 hours each, with guided but relatively un-structured discussions. Participants were free to interact and ask each other questions or clarify trends and details amongst themselves, while my own experiences and learning through the group dynamics was an important element of these sessions (Lindsay, 1997; Cameron, 2000; Bennett, 2002b).



Two focus groups were conducted in each of Cape Dorset (Figure 3-8a, b) and Pangnirtung (Figure 3-8c, d), one in each of the third and fourth research trips (Table 3-5). Participants were each given an honorarium of \$100 - \$120 for their time, depending on the duration and purpose of the group session. Interpreters were paid the same \$40/hour rate as for interviews. Snacks and refreshments were also provided, as these sessions typically lasted



a) Focus group in Cape Dorset, Jan., 2005  
clockwise from left: Pootoogoo Elee, Paulassie Pootoogook, Atsiaq Alasuaq, Mangitak Kellypalik.



b) Focus group in Cape Dorset, Apr., 2005  
clockwise from left: Adamie Nuna, Ashevak Ezekiel, Atsiaq Alasuaq, Oqutaq Mikigak, Pootoogoo Elee.



c) Focus group in Pangnirtung, Feb., 2005  
clockwise from left: Gita Laidler, Andrew Dialla, Joanasie Maniapik, Enoosie Nashalik, Peterosie Qappik.



d) Focus group in Pangnirtung, May, 2005  
clockwise from bottom left: Manasie Noah (red hat), Mosesee Keyuajuk, Jamesie Mike, Eric Joamie, Gita Laidler, Peterosie Qappik, Michael Kisa, Enoosie Nashalik.

**Figure 3-8:** Focus groups held in Cape Dorset (a, b) and Pangnirtung (c, d).  
(photos: a, b, c) Gita Laidler; d) Ame Papatsie)

4 hours. In both communities, the first focus group concentrated on linking terminology to photographs of local and regional sea ice conditions, while the second focus group aimed to verify terminology and maps, as well as link sea ice processes into a seasonal order of freeze/thaw processes (Table 3-5). These second focus groups were each set up as drop-in sessions, but in Pangnirtung it ended up being nearly a full day focus group, while in Cape Dorset it ended up being a half-day focus group.

**Table 3-5:** Outline of focus groups participants, timing, and location in Cape Dorset and Pangnirtung, whereby the research trip # refers to the research trip numbers and dates outlined in Table 3-2.

Community	Research trip#	Duration	Participants	Interpreter	Location
Cape Dorset	3	4 hrs	Atsiaq Alasuaq, Mangitak Kellypalik, Paulassie Pootoogook	Pootoogoo Elee	Community Learning Centre library
Cape Dorset	4	4 hrs	Atsiaq Alasuaq, Oqutaq Mikigak, Adamie Nuna, Ashevak Ezekiel	Pootoogoo Elee	Community Learning Centre classroom
Pangnirtung	3	4 hrs	Peterosie Qappik, Enoosie Nashalik, Joanasie Maniapik	Andrew Dialla	Hamlet Council Chambers
Pangnirtung	4	7 hrs (2 separate sessions)	Peterosie Qappik, Jamesie Mike, Michael Kisa, Manasie Noah, Mosesee Keyuajuk, Enoosie Nashalik	Eric Joamie	Angmarlik Visitor Centre meeting room

No focus groups were conducted in Igloolik because of timing constraints, with only two research trips to this community. However, extensive revisions were undertaken with Theo Ikummaq based on terminology and the maps drawn by participants. In addition, the independent revisions undertaken by groups within each community (Section 3.3.3.3) was also conducted in Igloolik.

Photographs were taken of these sessions to document the general setup, and discussions were recorded with the same digital audio recording device as used in semi-

directed interviews. This audio recording allowed the possibility of re-visiting discussions to clarify aspects that may have been confusing or unclear.

### 3.3.3 Data analysis

The participatory nature of diverse components within this research approach promotes a multi-faceted, qualitative analysis of the knowledge-sharing results and processes. The major components of the analyses include transcript, map, and focus group interpretation. These then contribute to community comparisons and an evaluation of the overall methodological approach taken.

#### *3.3.3.1 Transcript analysis*

I transcribed the audio recordings of semi-directed interviews by listening to the audio playback at a slightly slower speed, and typing simultaneously. Transcripts were documented as word-for-word accounts of the English discussions during interviews. When explanations occurred in Inuktitut, transcription was not possible. In these instances the speaker was indicated in the transcript, but only the subsequent English translation was recorded as text. Therefore, it is important to note that all analyses are based on the English translations and transcriptions of the statements made by interviewees. Thorough content analysis was then conducted on each of the interview transcripts. The process of coding and analysis was the same for each community, although the participants and the context informing analyses varied by community.

Content analysis began by coding transcript statements into key themes/topics (Patton, 1980; Dunn, 2000, Esterberg, 2002) that were used as the basis for developing conceptual models, explanations, descriptions, and synthesis analyses based on the local expertise in each community. This process was essential in order to incorporate the depth and detail of individual interviews, and to highlight nuances that facilitate interpretation. Codes were created to reflect the questions asked in interviews, as well as to capture concepts/theories that

were identified through the interview process. The coding process was facilitated by the qualitative analysis software Atlas.ti (version 5.0.66). While all coding was performed manually, the software eased the retrieval and compilation of statements by code (or combination of codes) to expedite subsequent analyses. Therefore, every statement made in interviews was coded to belong to one or more of the following themes (shown in alphabetical order):

- |  |  |
|--|--|
| 1. anything to add                             | 2. birth place                             |
| 3. change                                      | 4. concerns                                |
| 5. cracks                                      | 6. currents and ice                        |
| 7. experience with scientists                  | 8. family travel                           |
| 9. first hand experience                       | 10. floe edge                              |
| 11. freezing processes                         | 12. hunting                                |
| 13. ice uses                                   | 14. importance of sea ice                  |
| 15. Inuktitut terminology                      | 16. landfast ice                           |
| 17. language                                   | 18. learning from each other               |
| 19. learning in Inuit culture                  | 20. length of time living in the community |
| 21. map features                               | 22. melting processes                      |
| 23. moving ice                                 | 24. multi-year ice                         |
| 25. placenames                                 | 26. polynyas                               |
| 27. questions                                  | 28. rare events                            |
| 29. reporting of research results              | 30. safety                                 |
| 31. scientific methods                         | 32. sea ice experience                     |
| 33. snow influences on sea ice                 | 34. stories                                |
| 35. thoughts on <i>Inuit Qaujimajatuqangit</i> | 36. travel                                 |
| 37. unusual temperatures                       | 38. weather prediction                     |
| 39. wildlife                                   | 40. winds and ice                          |
| 41. working with scientists                    |  |

Personal field notes and videography taken during sea ice trips were not formally analyzed, but they were used to provide important context along with reminders of personal interactions and community situations that occurred throughout the course of the research. Furthermore, some of the codes were used more prominently, while others provided important background information on the participants or were supplementary information that went beyond the intended scope of the interview. In order to systematically analyze the coded themes only the most relevant were used in developing conceptual models, explanations, or syntheses of information based on what was shared through interview sessions (identified throughout the

following sections). This coding method is an important first step in organizing/simplifying the complexity of the transcripts and explanations into a manageable format to facilitate analysis (Patton, 1980; Peace, 2000). Although this was understood to be a lengthy and time-consuming process (Patton, 1980) it was important to have this detailed level of information identification because it allowed related statements to be easily retrieved and compiled throughout the analysis stages (Dunn, 2000; Peace, 2000; Esterberg, 2002).

#### 3.3.3.1.1 Conceptual modeling

The development of a conceptual model of sea ice freeze-thaw processes in each community was deemed important in order to illustrate the linkages between Inuktitut terminology and local expert descriptions of seasonal sea ice cycles. In addition, a similar type of representation was developed to explain the influences of winds and currents on sea ice conditions and movement around each community. These emerged from inductive analysis (using components of manifest, latent, and semiotic content analysis as described by Dunn (2000) and Esterberg (2002)) whereby the patterns, themes, and categories employed came from the interview responses (Patton, 1980). While the general sea ice focus and broad topics were established at the outset, the way that the models developed, and the subsequent descriptions of sea ice use and change, were generated based on interview outcomes (i.e. frequently mentioned topics/descriptions) thus comprising a type of indigenous typology (Patton, 1980). This format for presentation was selected because it more appropriately reflects the complexity and non-linear nature of sea ice processes, and Inuit understandings of sea ice processes, than a process/outcome matrix (Patton, 1980) or an alphabetical listing of terminology, for example. These models are a form of iterative abstraction (Yeung, 1997), serving to highlight the relationships between sea ice conditions, processes, and external influences (i.e. winds and currents) as described by elders and hunters. Therefore, three conceptual models were

developed for each community, as shown in Sections 4.2, 5.2, and 6.2, all using a similar process.

The conceptual model of freeze-thaw processes for each community was created by systematically analyzing select transcript analysis codes (i.e. cracks, floe edge, freezing, landfast ice, melting, moving ice, multi-year ice, polynyas, and snow). Codes were analyzed one at a time in order to develop a synthesized view of local ice processes and conditions. Within the codes, each interview was analyzed individually, statement by statement, in order to identify and define key terminology, and to develop explanations of the processes of interest to community members. Each new term and explanation identified was included in the model and the text, and put in approximate order in relation to seasonal chronology of sea ice formation and decay. As additional transcripts were analyzed the terms and explanations were refined to incorporate more details or to clarify concepts, and the ordering of terms within the conceptual model were shifted as more details and terms became available. All interviewees who described a particular condition, process, or sea ice term are cited with each reference to the conceptual model in the text, as well as in the accompanying glossaries (Appendix 14 - 16). Where only one person mentioned a term, it was still included if the description was clear enough to be adequately interpreted. There are a few cases where a term is mentioned but not fully explained, and thus these were omitted from the current presentation of results until further clarification can be obtained.

The conceptual models for wind and current influences on sea ice conditions and movement were created using the same systematic transcript analysis code interpretation method as for the sea ice terminology and cycles (using the codes: currents and ice, moving ice, polynyas, and winds and ice). However, these models are more explanatory by nature, and are used to illustrate interacting environmental factors that affect ice conditions, as described by local sea ice experts. These help to highlight local and regional ice conditions, and also enabled

the description of other sea ice terms that relate more to sea ice dynamics influenced by external forces.

#### 3.3.3.1.2 Explanation/synthesis

Results for each community discussing sea ice use (including travel, hunting, and wildlife habitat) and observations of change were derived through the interpretation and synthesis of relevant transcript codes (i.e. change, hunting, safety, travel, and wildlife). These too were analyzed code by code, person by person, in order to develop an overview of critical factors involved with sea ice travel safety, hunting conditions and techniques, and wildlife habitat. Therefore, Sections 4.3 – 4.4, 5.3 – 5.4, and 6.3 – 6.4 include the synthesized interpretation of interview transcripts in order to present local explanations of sea ice use, danger, hunting, and change. All indicators and processes that were clearly described by interviewees, and were relevant to each section, were included in the explanatory/synthesis parts of the results chapters. In most cases the frequency with which a condition or activity was mentioned mirrored its importance to interviewees (as indicated by the number of cited interviews in the text). However, some experts have uniquely specialized knowledge, and thus distinct comments or explanations regarding travel safety, hunting techniques, or wildlife habitat were incorporated to refine the detail of explanations.

#### 3.3.3.1.3 Community comparisons

Inter-community analysis was conducted to critically compare results from each community in order to better understand: i) local and regional similarities/differences in ice conditions and processes; ii) variations in sea ice use and importance; iii) local assessments and indicators of travel safety; and, iv) local assessments and indicators of sea ice change. Similar sections from each of the three community results chapters were used to draw comparisons between the communities based on physical sea ice processes, cultural importance, and community characteristics. This exercise was also employed to interpret the potential

implications of changing sea ice conditions for each community, based on the results and explanations presented in Chapters 4 – 6.

### 3.3.3.2 *Map analysis*

The maps drawn by participants, using NTS basemaps (Section 3.3.2.1.3), were digitized using ArcMap (version 9.0) and a large format digitizing table. This enabled the provision of a digital map representation to be used as part of the analyses. Maps were digitized manually by myself, whereby separate features, uses, and conditions were saved as separate spatial entities (points or lines) within a GIS database. These unique entities were identified by colours or labels indicated on the maps. Attributes were also added where additional descriptive information was provided on the maps. Each NTS mapsheet had to be digitized separately because the combined maps to form a regional overview of community shorelines did not match up perfectly. An additional complication was that in all communities the selected basemaps crossed two UTM zones, and thus they required separate parameter specifications when digitizing (Table 3-3). The four corners of the maps were first digitized to specified UTM coordinates in order to register the hard copy map to electronic NTS shapefiles. A maximum root mean square (RMS) error of 0.005 inches was established as the standard for spatial accuracy in order to proceed (i.e. approximately 30m in map units) (ESRI, 2000-2004). File naming conventions reflected the person interviewed and the specific feature digitized to facilitate identification and interpretation later on.

Once all the maps were successfully digitized the individual shapefiles, including digital NTS baseline data (e.g. ocean shorelines, NTS map limits, rivers, and toponyms (placenames)), were re-projected into Lambert Conformal Conic, NAD1927. This projection and datum was selected because it enabled the viewing of all map sheets for one community in a single data layer (with the different UTM zones this was not possible), and it is also the spatial reference standard used by the CIS (i.e. it would allow for accurate spatial overlay of



digitized features on CIS standard RADARSAT images). Once re-projected, some slight mismatches were identified along the border areas of the different UTM zones. Therefore, particular features were edited to ensure smooth continuous lines. These small errors were due to manual digitizing inaccuracy, the thickness of the lines drawn, and UTM parameter differences. However, because no spatial analyses requiring absolute measurements of distance or area were planned within the context of this study, and because in most cases the lines or points drawn are approximations to begin with, there is little consequence for this minor manual editing. Visually though, it is important because it renders the features more easily identifiable and facilitates interpretation.

Similar spatial features (e.g. travel routes, tidal cracks, floe edge, polynyas, etc.) were then edited to ensure that the same symbol represented like features. Where appropriate, symbols or colours were also used to delineate specific attributes (e.g. different time frames, different modes of travel). The final products provide visual spatial representations of Inuit expertise shared in interviews. These maps were then used as a visual complement to explanations based on interviews, and were also interpreted visually to contribute to results and community comparison chapters (Chapters 4 – 7).

### *3.3.3.3 Focus groups and terminology review*

Focus groups (Section 3.3.2.3) were undertaken mainly as a form of verification. These group sessions were used to link pictures to Inuktitut terms, and to clarify the order of sea ice freeze/thaw processes around each community. These sessions allowed me to ask questions, and gain feedback on my transcript interpretations to date. They were important not as a validation of other peoples' information according to a few select experts, but rather to clarify misunderstandings in an effort to improve the quality, accuracy, and credibility of my results (locally and academically). These group sessions were complemented with an independent terminology review undertaken by one interpreter/coordinator and three elders/experts in

each community. These were initiated based on the last focus groups in Cape Dorset and Pangnirtung, where community members felt that not enough time had been spent on linking terminology and sea ice stages. Therefore, the fall and winter of 2005/2006 were spent on these revisions, by each group in each community. These revisions were completed with varying degrees of timeliness, but wherever possible they have been used to verify the interpretations presented in Chapters 4 – 6, and have helped to refine explanations, Inuktitut spelling, glossary definitions, and conceptual models.

#### *3.3.3.4 Methodological analysis*

Finally, I undertook an analysis of the methodological approach used to conduct this research. Many of the methods employed are commonly accepted social science methods, but I felt it was important to better understand the way that community members felt about research in general, and my own research approach in particular. Therefore, in Chapter 8 I present a critical evaluation of the effectiveness of the methods explained in Section 3.3. This is essential self-reflection and analytical evaluation of my collaborative research approach in order to move towards linking Inuit and scientific sea ice expertise.

The methods analysis also reflects upon ways in which we can link different knowledge systems in a complementary fashion. This can help to broaden our comprehension of complex environmental processes like sea ice, especially when considering the important relationship between Inuit communities and sea ice. For this, additional content analysis of transcripts is introduced to better understand how Inuit feel about working with scientists, and how they perceive the methods that scientists currently employ to study sea ice (using the codes: experiences with scientists, learning from each other, reporting research results, scientific methods, and working with scientists). This analysis, combined with community insights, is used to identify some practical ways forward in working towards a true research partnership.

### **3.4 Communication Strategy**

Developing a communication strategy from the outset, and continuing to refine it throughout the research process, was essential to the success of this project. Although a communication strategy may not be considered a method per se, it is important to mention because it is critical to undertaking research methods effectively. Communication helps to incite the community interest, participation, and commitment that is necessary to proceed with a project of this nature.

The relationship-building phase (Section 3.1.1.2), and especially the preliminary community visits (Section 3.1.1.3 and 3.3.1), were the first element of communication with each of the communities. Here, various forms of communication such as written faxes, emails, informal meetings, classroom visits, and radio shows were all included as ways to propose the project and solicit feedback. Subsequent to these processes for initiating the project, it quickly became clear that interim results and regular updates were important to keep the community (and especially individual participants) informed of project progress throughout all stages. The following sections provide a brief overview of various communication methods used to facilitate this research.

#### **3.4.1 Interim reports**

Interim reports, or trip summary reports, were mailed to local organizations, and to individual participants in interviews, after each preliminary and field research trip (Appendix 17). These simply summarized what I did on the trip, the purpose of the trip, who I spoke with, some preliminary results, and an outline of future plans. These documents were translated into Inuktitut, and both the English and Inuktitut versions were distributed.

#### **3.4.2 Informal meetings**

During each field work trip I met with local organizations whenever possible, to provide an update on the project, to answer questions, or to address any new or ongoing

concerns. This usually involved the Hamlet Council and HTA, but informal meetings were also arranged with nearly all the organizations contacted at the outset of the project (Section 3.3.1). Wherever people had expressed interest, I tried to keep them informed about the project progress (using an interpreter when necessary).

#### **3.4.3 Radio shows**

In northern communities local radio is the primary means of communication and news information, both formally and informally. It is predominantly used by Inuit community members, and thus an effective way to reach a broad community audience. I conducted a call-in radio show in each community during preliminary visits (Section 3.3.1) to present the project and to solicit feedback. A radio show was also employed to provide updates on project progress in subsequent research trips, and to highlight key results on reporting trips (with variable frequency in each community depending on access to the radio station or available air time). In each case an interpreter was employed to ensure bilingual presentation of information.

#### **3.4.4 Posters**

Posters were created for each community and distributed on the second research trip in order to highlight and summarize the results of preliminary community visits. All posters were translated into Inuktitut, so there are two versions of each poster (English and Inuktitut).

#### **3.4.5 Information pamphlets**

A one-page folded bilingual information pamphlet was created from the outset of the project to provide a brief introduction and overview of the project. This pamphlet was distributed throughout the course of the research as an information source in preliminary community visits and as the information form that accompanied the consent form in interviews. An additional information pamphlet was created for, and distributed during, the reporting trips. This second pamphlet summarizes the project progress, highlights where

detailed results can be found, thanks participants, and presents the potential for future project development through the International Polar Year (2007/2008).

#### **3.4.6 Results summary reports**

In order to report to community members regarding the results of this research, prior to the release or publication of project findings, I summarized each of the results chapters (Chapters 4 – 6). These summaries consisted of point-form accounts of the full descriptions, providing all the conceptual models and associated terminology, most of the quotes, and the key points in the travel safety, hunting, wildlife, and change assessment sections. The documents were translated into Inuktitut, and both the English and Inuktitut versions were distributed. They were then mailed to each participant prior to the research reporting visits undertaken in May, 2006.

#### **3.4.7 Public meetings**

Public meetings were held in Igloolik and Pangnirtung to present research results to the broader community. These were meant as additional means of encouraging feedback and verification of information, as well as to communicate study results to community members who were not directly involved in the project. The open presentation and gathering was advertised over the local radio, and refreshments were provided (including country food). They were also conducted jointly with an interpreter in each community, to ensure bilingual presentation of results. Open, informal discussion and question periods were also provided as part of these meetings. Due to long weather delays and personal illness I was unable to conduct the public meeting in Cape Dorset; however, all reporting materials were mailed to community members and organizations in my absence, and I explained the circumstances to key individuals by phone.

### 3.4.8 Maps

Compilation maps based on all the maps drawn in interviews were created and printed in large format (3' x 3') to leave in each community. Therefore, in each community they have two laminated copies of maps showing: i) travel routes and camps; ii) tidal cracks and floe edges; iii) polynyas and areas that melt early; and, iv) a compilation of all the features. These map copies are available at the local HTA and high school. Maps were of great interest in the community and these large printouts were thought to be of interest and potential use to those frequently using the sea ice, as well as for educational purposes.

### 3.4.9 Copies of audio/video tapes and transcripts

All original transcripts, audio/video tapes, and digital files where possible, were deposited in local community repositories (Section 3.3.2.1.2). This ensures that all the information collected as part of the project is available to community members in an un-altered form, along with results summaries and research findings.

### 3.4.10 Website

I created a personal website in 2002 (<http://eratos.erin.utoronto.ca/grad/laidler/>). As field work began, I posted summary information about the project on my website, as well as making trip summaries and pictures available online for each trip. This was undertaken with the intention that it would be a tool to allow community members access to updated project information. It was also to serve the function of keeping project partners (i.e. community groups, Inuit organizations, funding agencies, research collaborators) informed about project progress.

### 3.4.4 Informal communication

I made several local contacts with whom I kept in touch while away from the community. These consisted mainly of people who allowed me to stay in their homes, as well as key individuals in local organizations. Most importantly though, I maintained ongoing

communication by phone, fax, and/or email with the interpreters with whom I had worked on each research trip. They acted as an important local liaison to deal with ongoing project issues, or planning future field trips. Furthermore, while in the communities informal conversations on the street, or visiting people at their homes, enabled me to gain additional feedback on the project, to discuss the project, and to learn more about community dynamics – as well as aiding community members to get to know me (and the project) a bit better.

### **3.5 Knowledge representation**

I want to make a specific note on knowledge representation, because it is such an important and challenging issue in writing up the results. What is found in the following chapters is based on what individual sea ice experts shared with me during semi-directed interviews (Section 3.3.2.1). I have attempted to synthesize the results in a way that brings together topics to form explanations and detailed descriptions of sea ice importance, processes, use, and change in each community. I use select quotes wherever possible to support the points presented – a selection based on the articulation of the information, much like using academic references to support an argument in a journal article. Square brackets [ ] are employed within the quotes to replace third person references used by the interpreter with the first person references and tenses implied by the interviewee. I have shaped the results in terms of how I brought themes together, and the way in which things are presented, requiring considerable analysis in itself. However, I have made every effort to present only what was shared with me, and have refrained from inserting my own comments or critical interpretation in the main results chapters (Chapters 4 – 6). An important aspect of this research is to learn about, and communicate with others, “ice, through Inuit eyes”, which is the reason I have presented the initial results in this manner. However, the analysis and interpretations in Chapters 7 – 8 are based on my own ideas, observations, and experiences throughout the process of this research. Therefore, it must be made clear that any errors of interpretation in

Chapters 4 – 6 are my own, based on the challenges of working through translated interviews with a limited knowledge of Inuktitut. In addition, it must be clarified that the points presented in Chapters 7 – 8 are my own, and not those of the local sea ice experts – unless explicitly stated.

Another important note to highlight is the accuracy of the Inuktitut in this study. I took an introductory Inuktitut course at the University of Toronto (in the fall of 2003) to familiarize myself with the written syllabics, basic grammar, and elementary words. Through the course of the interviews I was able to expand my language comprehension, but I still have minimal capabilities in using Inuktitut. The Inuktitut sea ice terminology employed and described in the results chapters is based on explanations that were communicated in interviews, clarified in focus groups, and verified in independent community revisions of the terms. These interactive sessions were imperative to ensure that the Inuktitut terminology is as accurate as possible. In general, I have used a plural, singular, or verb format where it seemed most appropriate, depending on the concept being described. In the terminology glossaries I have also noted alternative versions of a word (i.e. there may be dialect differences in the community, or there may be a more traditional word). In the text I have incorporated Inuktitut to the best of my ability, and wherever possible, in order to present the Inuit expertise in a manner that closely resembles the way in which it was shared with me.



## Chapter 4 – Results

### *The importance of sea ice processes, use, and change around Cape Dorset*

“[I]n the winter [the sea ice] is very useful. We rely on it, that’s why we have to know the conditions so much because we [use] it from beginning to the end. It was so much so in the past, but not as much now. We don’t rely as much on country food, like it’s only a percentage now of our daily diet. [B]ut still we use that information. [It] is good for as long as we live here because we’re still going to use [the ice]. I don’t see any highways out on the land, so it’s still going to be our highway. The kids still have to learn the points, the fall and the spring and the winter, the conditions, they will have to learn that. [A] big part of our life is spent on the ice, especially here where our name is, where our regional name is so much recognizable as people who live ‘where there’s water’, not just ice, but where there’s water. It’s very important to know [about the sea ice].” (Joanasie, 2004)

#### 4.1 Importance of sea ice

“[The] way this island is built, around the Hudson [Strait], because of the way it’s shaped around here, that’s why the ice never goes any further than where it goes. That’s why it’s called *Sikusilaaq*, but if you go further southeast of here, like 100 miles from here, it could take you a whole day’s trip to get to the floe edge from the edge of the mainland. But over here it’s not like that, it’s only like a 10 minute drive from this town.” (Peter, 2004)

Strong Hudson Strait currents prevent solid ice formation from extending far offshore, creating a dynamic sea ice environment. Despite the lack of extensive ice cover around Cape Dorset, sea ice remains an important part of life for this island community (Etidlouie, 2005b (EE2); Suvega (2004) (SS1)). Sea ice was described as being as important for local travel as highways are in southern Canada (Joanasie, 2004 (MJ1)). Without ice formation people would not be able to access Baffin Island (often referred to as the mainland) to reach their fishing lakes, caribou hunting grounds, soap stone mines, cabins, and other communities (there are strong links to Kimmirut, formerly known as Lake Harbour) (Ezekiel, 2005 (AE1); Parr, 2004 (AP1); Nunguisuituq, 2004 (IN1); Manning, 2005b (JM2); Solomonie, 2004 (KS1); Mikigak, 2004b (OM2); Tapaungai, 2004 (QT1)). Community members are stranded on the island in the summer if they do not have access to a boat, which mainly older hunters or families with more financial resources are able to afford (Alasuaq, 2004 (AA1); AE1). Ice travel is smoother and

faster than on land (AA1; Nuna, 2004 (AN1); EE2; Mangitak, 2004 (EM1); JM2; MJ1; Kellypalik, 2004a (MK1); Ottokie, 2004 (OO1); QT1; Kelly; 2004 (SK1); SS1). Sea ice provides a shortcut (SK1), allowing people to save time by crossing inlets instead of following the windy coastline (AA1).

“We go out hunting on sea ice. We go seal hunting, walrus hunting. And if you’re going on land you’re going to take a ‘longcut’, going through the ice you’re taking shortcuts all the time. You get to where you want to go faster on the ice than by land.” (Kelly, 2004)

Sea ice is also a valuable hunting platform and provides essential habitat for a host of marine mammals (EE2; Petaulassie, 2004b (QP1); SK1; AN1; SS1). Sea ice travel and hunting allows people access to country foods (e.g. Arctic char, caribou, seals, walrus) which are still an important part of northern diets (AA1; AE1; AN1; AP1; EE2; Petaulassie, 2004a (EP1); IN1; KS1; MJ1; MK1; Saila, 2004 (MS1); NP1; OM2; OO1; QP1; QT1; SK1; SS1). The main purpose of sea ice travel is often hunting (AN1; MK1), whereby seals and walrus are a mainstay for the community, along with caribou (when available) and Arctic char (AP1; NP1; OM2; QT1; SK1; OO1). In addition, old sea ice, grounded icebergs, or the surface of certain ice formations, are a source of drinking water that is much preferred to tap water (EE2; OO1; NP1).

“[To me the sea ice] is part of life, [I] can go hunting on it, walk on it, and it will give you peace of mind if you’re out there doing your thing. It provides for the families that use it.” (Etidlouie, 2005b)

In using sea ice for travel and hunting purposes, Inuit elders and hunters have developed an understanding of freezing and melting processes. Specific Inuktitut terms are used to describe ice conditions and transition stages that occur throughout the annual sea ice cycle of formation and decay. These also link to the floe edge, tidal cracks, and polynyas, as influenced by wind and current conditions. Local characterizations of these freeze/thaw and dynamic processes (Section 4.2) will thus be presented prior to discussing sea ice use (Section 4.3). These terms and processes are critical to the presentation of sea ice travel safety (Section

4.3.1) and marine wildlife hunting and habitat descriptions (Sections 4.3.2 and 4.3.3). It is also essential to describe the formation and decay processes as a background to the changes that are currently being experienced by elders and hunters in Cape Dorset (Section 4.4).

## 4.2 Sea ice processes

The general order of freezing and melting processes in Cape Dorset, as well as links to the floe edge and tidal cracks, is shown in Figure 4-1. The processes are described to follow the diagram, so the reader is encouraged to refer to Figure 4-1 and Appendix 14 frequently to better understand the links and terminology presented in the following sections. Furthermore, Appendix 3 acts as a map index for figures that show subset areas around Cape Dorset and in other parts of Hudson Strait.

### 4.2.1 Freezing processes

#### 4.2.1.1 Near shore freezing

When sea ice begins freezing around Cape Dorset it is referred to as *sikuvaliajuq*, it is just starting to harden (IN1; Mikigak, 2004a (OM1); Pootoogook, 2004 (PP1); QP1) (Figure 4-1). The earliest ice formation is *qinnu*, a slush-like consistency which begins to form with the colder temperatures (AA1; AE1; MJ1; OO1; SK1) (Figure 4-2a). However, as freezing progresses different terms are used whether the ice is extending from the shoreline or forming more in open water.

Along the shore, the process of *ilaupalia* (OM1) contributes to the formation of *ilu*, where ice has frozen to the ground when the tide was low (AP1; Etidlouie, 2005a (EE1); MK1; MS1; OM1; QP1; QT1).

“[The] beginning stage of freezing up, that is when it’s low tide, rocks or the sand will start freezing when it’s low tide and it starts to be cold. But [when] high tide comes that ice will float up from the frozen part, and then it will keep freezing until then, unless it’s windy. [W]hen it starts freezing, *ilaupalia*, is the first stage. Sometimes [there] will be chunks forming where it’s freezing, that’s kind of where it’s shallow, you will see [ice] that has formed where there was a rock right under it, but actually the rock is like 4 feet down under there.” (Mikigak, 2004a)



Ice then begins to freeze to the rocks in shallow areas (*kuiviniq*), but it will break off when the tide is high (EP1) (Figure 4-2b). This ice eventually freezes to the ground (*qaikut*), but it will pop up after several tides (AP1; NP1; QT1). Following this, as the ice extends past the low tide area it is referred to as *sikurtusijuq* (QT1). Once the shoreline ice has formed fully, and is attached to the land, it is then known as *sijja* (AN1; EE1; MK1; QT1) (Figure 4-2c). From the *sijja* ice tends to extend further outwards as it freezes, thus coming together with other ice formations that have evolved in open water (Figure 4-1).



a) *qinnu*, early slush-like ice formations



b) *kuiviniq*, ice freezing to the rocks



c) early formation of *sijja*, shoreline ice



d) *sikuliaq*, new ice forming in open water

**Figure 4-2:** Photos of early near-shore freezing, including: *qinnu* (a), *kuiviniq* (b), *sijja* (c), and *sikuliaq* (d).

(photos: Gita Laidler)

#### 4.2.1.2 Open water freezing

Away from shore, after *qinnu* there are different terms used to describe the freezing process of sea ice (Figure 4-1). Chunks of ice form in open water (*qaikuin*), or at the floe edge after it has been established.

“[*Q*]aikuin the next stage after *qinnu*, that’s when chunks of ice will form on top of the slushy water. After that stage it will [stay] like that for a few days until it either gets colder or warmer. *Qaikuin* is the word that’s used when the ice is still kind of wavy.” (Ezekiel, 2005)

These *qaikuin* are usually created by winds and thus form patches of rough ice, which move with the currents (AE1; OM2; SK1). Similarly, when ice is freezing in open water, especially with the influence of winds or currents moving it around, ice tends to thicken as it is pushed together or onto other pieces of ice. This process is referred to as *qalligirtuq* (EE1). Following this, newly formed, relatively flat ice that freezes in open water is called *sikuliaq* (AE1; AN1; IN1; QT1) (Figure 4-2d). From there, early ice formations in open water tend to begin joining up with ice formations that have extended from the shoreline (Figures 4-1 and 4-3).



**Figure 4-3:** The freezing process, gradually extending away from shore, November 23, 2004, Cape Dorset. (photo: Gita Laidler)

#### 4.2.1.3 Sea ice thickening

“[The] first layer of freezing ice is called *sikuaq*. Also, depending on the ice thickness you can say *sikuaqtuq* or *sikuaq* depending on what sentences you use or what subjects you use on the ice. [The] first night when it freezes it’s usually very shiny, after one night it could be maybe a ¼ inch thick or so.” (AA1)

The first layer of frozen ice is *sikuaq*, whereby *sikuaqtuq* is the action of *sikuaq* forming (AA1; MJ1; SS1) (Figure 4-4a). It is possible to walk on *sikuaq* if a person is carefully testing it with a harpoon.

“In terms of freezing up, *sikuaq* is very thin, you can puncture a hole [with a harpoon] in one or two strokes into the same spot...Usually [by the] second day if it’s the same coldness or colder when it was freezing, you can go on it, but you have to [travel] with a harpoon...[I]f you strike the same spot twice and it goes through that’s too dangerous, once very dangerous.” (Joanasie, 2004)



a) *sikuaq*, thin, newly formed ice (note that although *sikuaq* is described as thin, it is also sometimes described as being capable of supporting a person’s weight; therefore, *sikuaq* can be within a range of thin ice conditions, not necessarily only the thin film of ice shown here)

b) *nigajutaq*, an area in the ice that freezes over later than others.

**Figure 4-4:** Photos of sea ice thickening, including: *sikuaq* (a) and *nigajutaq* (b). (photos: Gita Laidler)

Because ice formation is not completely uniform, there could be some areas where water remains on top of the ice (*qamittu*) (MK1) or where certain small patches remain open (*nigajutaq*) (Figure 4-4b) (EE2). For either *sikuaq* or *sikuliaq*, snowfall on this newly formed thin



ice could lead to a thinning of the sea ice (*sallivaliajuq*) (MS1; QP1). Snow acts as an insulator and melts the new ice (EP1). When it snows on the first layers of thin ice the snow sinks down and the ice softens (AA1).

“[U]*qurusirtuqsimajuq* means like when you have a jacket, you know down-filled jackets that have feathers in them? When it has snowed in some areas where ice usually forms, in that area if it isn’t that cold and the snow is thickening, the snow won’t harden and acts as insulation.” (Etidlouie, 2005a)

If this occurs, the freezing process would begin again anew (Figure 4-1).

Furthermore, *millutsiniq* is a specific condition where a patch of ice remains mushy after snowfall has accumulated on thin ice (Figure 4-1) (EE1; EP1; QP1). For example, this could occur if snow had fallen over a crack, where the ice is thinner than either side of the crack. The snow would melt the ice underneath, leading to a slushy consistency (EE1; EP1; QP1). An additional condition called *qanguti* may form on *sikuaq*, or on ice at the floe edge (Figure 4-1, 4-5a). The process of *qangutaituq* leads to the ice condition of *qanguti*. This condition is identifiable when the ice is covered with what looks like little snowflakes or little flowers growing out of the ice (Figure 4-5b) (AA1; EE1).



a) *qanguti* forms on thin ice, or at the floe edge, due to the temperature differences between the air and the ocean



b) a closeup view of *qanguti*, showing the crystal- or snowflake-like formations.

**Figure 4-5:** Photos of *qanguti* on the ice surface (a), and close up (b). (photos: Gita Laidler)



“The second part of freezing ice is called *qangutaituq*. It is called that because sometimes in a few days when the ice is freezing, if it hasn’t been snowing or anything, even though if it hasn’t snow crystals start growing from the ice. It’s like plants are growing on the ice, that’s when it starts getting freezing.” (Alasuaq, 2004)

The formation of *qanguti* is also used as an indicator of areas where the ice will form smoothly once it has thickened (AA1; EE1).

As the ice gradually thickens it moves from *sikuqaq* to *sikujuq* and finally to *siku* (Figure 4-1). Generally the ice thickens first in inlets, where it stops moving as it becomes more solid (*sikuqaq*) (AE1; EE1; EP1; NP1; OM2). At this point seals are making breathing holes (*atluan*) through the ice, it is a few weeks old, and it is possible to walk on the ice. Then, having thickened past a few inches *sikujuq* can be used for seal breathing hole hunting (NP1) and careful traveling (Figure 4-6a) (EE1; MK1; OO1). Any thicker than *sikujuq* is referred to as *siku* – a general term for sea ice – which also implies that any kind of sea ice travel is now possible (AE1; AN1; EP1; MJ1; NP1; QT1; SK1; SS1). After *siku*, *tuvaq* is used to refer to landfast ice which is older and more solid (thicker) than *siku* (Figure 4-1, 4-6b) (AE1; EP1; MJ1; QT1; SK1).



a) *sikujuq*, the ice is thickening and will soon become *siku*

**Figure 4-6:** Photos of ice that is becoming landfast, including: *sikujuq* (a) and *tuvaq* (b). (photos: Gita Laidler)



b) *tuvaq*, solid ice that is attached to land, here *tuvaq* is shown in Tellik Inlet, and *sijja* is shown in the foreground

“[S]*iku* is like loose ice, but *tuvaq* is land locked ice, it’s part of the land. But *siku* is more loose, could be part of the sea ice if it’s broken off, *siku*. But a lot of people will use *siku* now [to refer to] *tuvaq*.” (Joanasie, 2004)

When the *tuvaq* thickens and snow accumulates it then becomes *tuvaluqaq* (old, mid-winter ice) (EP1; NP1). It must be noted that once the ice becomes *siku* or thicker, snowfall no longer contributes to melting when the temperatures remain cold. Furthermore, from *sikujuq* onwards in the landfast ice freezing process it can be considered *kuvvilukajuq*, where the ice will not be breaking off anymore (Figure 4-1) (OM1).

#### 4.2.1.4 Tidal cracks

Cracks are usually formed by the movement of the sea ice, from contraction or expansion in the freeze-thaw process, or from the force exerted by winds and/or currents. Tidal cracks form often in the same location annually, and go through cycles of cracking, opening, and re-freezing through the winter in synchronization with the lunar cycle (Section 4.2.3.4) (MS1; NP1; QP1; Tapaungai, 2005 (QT2)). They are also affected by the diurnal tidal cycle, where the difference in daily high and low tides causes ice movement and cracking (MK1; SS1). When these form in the winter they are referred to as *nagguti*, which means tidal crack but implies that it refreezes after it opens (Figure 4-1, 4-7a) (AA1; AE1; AN1; AP1; EE2; Manning, 2005a (JM1); MK1; NP1; OM2; QT1; SK1). This same crack in the spring time would be called *ajuraq* because after it opens it does not re-freeze (Figure 4-1, 4-7b) (Section 4.2.2.4) (AE1; AN1; AP1; EE2; JM1; NP1; MJ1; MK1; OM2; OO1; PP1; QP1; QT1; SS1; SK1). The term *qullupiarniq* is also used to refer to a crack that opens, re-freezes, and then opens again in the same spot (Figure 4-1, 4-7c) (QP1).

Cracks were frequently drawn on the maps as occurring near *Aupaluktuk* Point (Apalooktook Point on the map), near *Igluakjuak* Point, as well as between islands or in narrow areas (Figure 4-8).



a) *nagguti*, a tidal crack that forms in *tuvaq* in the winter, and re-freezes

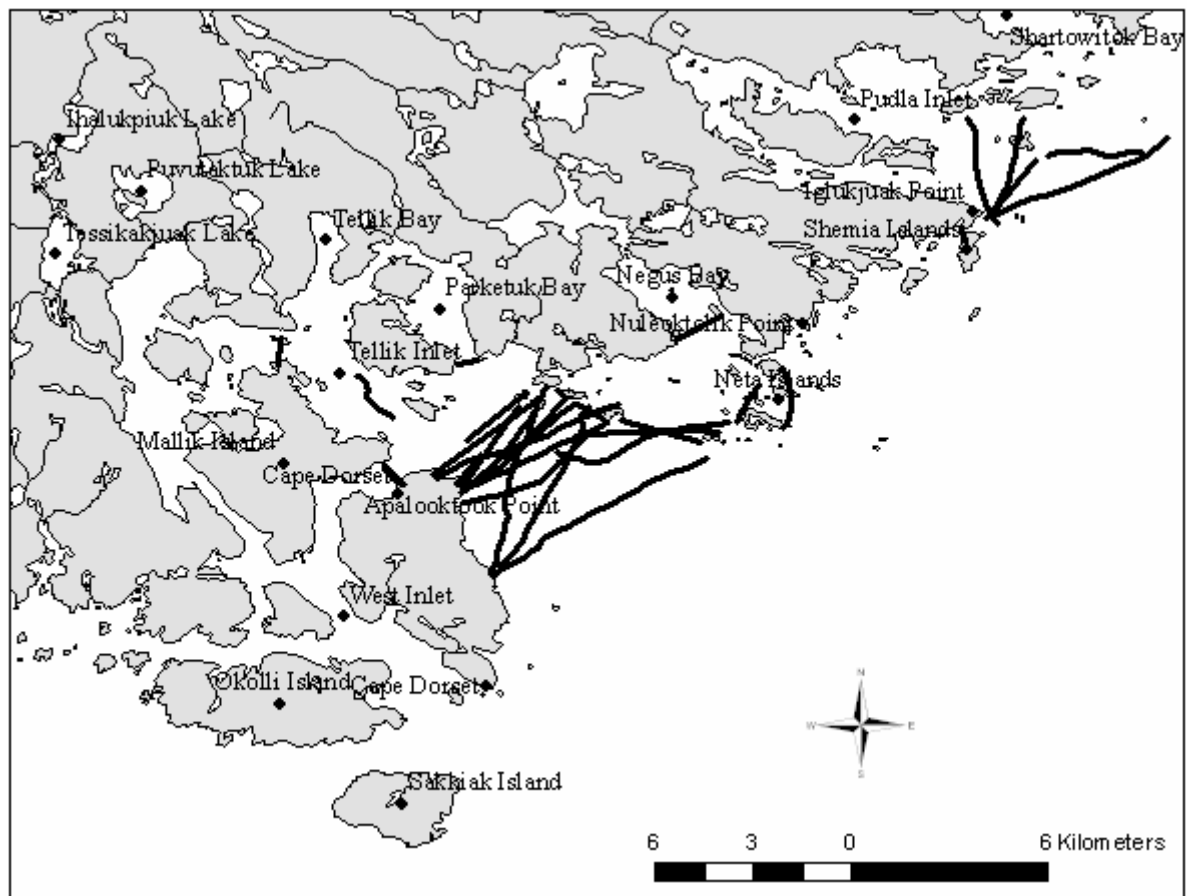


b) *ajuraq*, occurs in the spring and does not re-freeze after opening



c) *qullupiarniq*, a crack that opens, re-freezes, and opens in the same spot (it can become peaked over where the crack has formed)

**Figure 4-7:** Photos of different types of tidal cracks, including: *nagguti* (a), *ajuraq* (c), and *qullupiarniq* (c). (photos: Gita Laidler)



**Figure 4-8:** Key *naggutiit* (plural for *nagguti*) in the Cape Dorset area.

Sources: AE1; AP1; EE1; JM1; MJ1; OM2; OO1; Pootogook, 2005 (PP2); SK1

“[P]retty much where there are islands, closer to the islands it will usually form these cracks, except for the mainland area. Usually around the small islands it forms these kinds of cracks. Every little island that you see there’s some kind of crack that’s going to form.” (Tapaungai, 2004)

Cracks typically form from land to land (usually points, or between islands) (AE1; EE1; EP1; JM1; QT1; SS1), and are thus identified by the nearest placenames on each shore (AP1). Where cracks form by tidal action is also where the ice tends to break off (*uqaq* or *aukaaq*) with the influence of winds (EP1; MJ1; MS1; OM2). Essentially, cracks form when stress is placed on the sea ice cover, such as when: i) ice collides or pushes onto, or into, each other; ii) tides or currents move the ice up or down; and, iii) winds force the ice together or apart (Sections 4.2.3.2, 4.2.3.4). There can be little cracks all over the ice surface, but *naggutiit* are both important hunting destinations and potentially dangerous areas where the ice may break off.

#### 4.2.1.5 Floe edge

The floe edge is the edge of landfast ice (*tuvaq*), and is referred to as *sinaaq* in Inuktitut (Figure 4-9a, b) (SK1; SS1). At the *sinaaq*, any new ice that forms is termed *wiguaq* (literally “an addition”), whether it is extending the edge of the *tuvaq* or it is re-freezing after ice has broken off (Figure 4-9c) (AN1; EE1; JM1; MJ1; MK1; NP1). When ice breaks off from the *sinaaq* the action is termed *uqaqtuq* (Figure 4-9d) (JM1; MK1; OO1). The piece of ice that breaks off – while it is usually *tuvaq* when attached – becomes *uqakuti* once it becomes detached (MK1).

“[W]e would call that *uqaq*, *uqaqtuq*, when a big pan of ice breaks off from a good floe edge. That happens when we have solid ice, and then we have like *nagguti* or *ajuraq*, that’s when the strong tide comes it’ll start to move a bit more, and it’s not frozen anymore so it breaks off. We call that *uqaqtuq*.” (Manning, 2005a)

The *sinaaq*, and peoples’ experience of the *sinaaq*, varies within and between years. Therefore, while the *sinaaq* positions drawn on the map sheets vary, they are consistently close to the Baffin Island coastline (Appendix 18). Hudson Strait is ice-free, or full of moving ice, throughout the year due to the strong currents funneling from Foxe Basin and Hudson Bay into the Atlantic Ocean, or vice versa. Along the eastern map portion the greatest ice extent is

found in Andrew Gordon Bay (Figure 4-10a). Whereas, nearer to Cape Dorset in the western map portion the sea ice does not extend very far offshore in any area (Figure 4-10b). However, solid ice does form consistently in Tellik Inlet, and between some of the islands northwest of Cape Dorset.



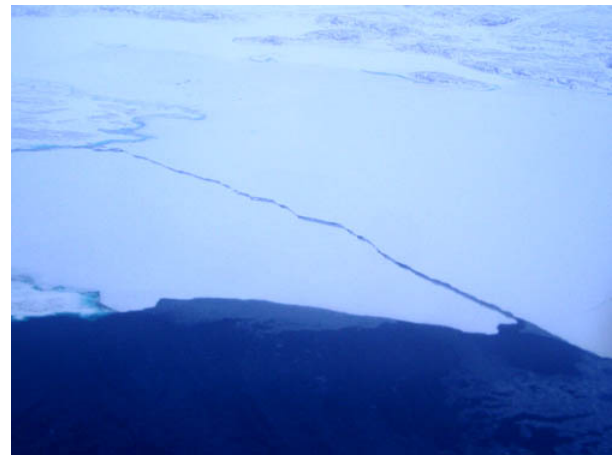
a) the winter floe edge (*sinaaq*) is continually in flux, freezing, breaking off, re-freezing, depending on current and wind conditions



b) the spring floe edge (*sinaaq*) is more defined, as the ice is thicker and it is no longer re-freezing at the edge



c) *uiguaq* is the new ice that forms at the *sinaaq*, shown here to the right, where Pootoogoo Elee is about to walk



d) *uqaqtuq* is the action of ice breaking off, usually where a *nagguti* has formed.

**Figure 4-9:** Photos of the floe edge, and ice formations/dynamics along the floe edge, including: *sinaaq* (a, b), *uiguaq* (c), and *uqaqtuq* (d). (photos: Gita Laidler)



### 4.2.2 Melting processes

In the melting process, the ice can deteriorate unevenly based on a number of factors: current strength, snow cover, water accumulation or drainage, ice thickness, wind direction or strength, air temperature, water depth, etc.

“[A]round March time, where there are currents...those areas will probably start to get dangerous to travel on. If there are currents in that area, then around March those areas start getting [unsafe] to be traveling on.” (Saila, 2004)

An *aukaaniq* is an area that opens up earlier than others, usually located near areas of stronger currents (Figure 4-1) (AE1; EE2; NP1). Around Cape Dorset these tend to concentrate in the areas where polynyas occur (Section 4.2.3.4). This happens because the ice around polynyas wears out faster than where there is ice cover all winter, due to thinner ice as well as the strength of currents that wear away the ice<sup>1</sup>. These *aukaaniit* (plural for *aukaaniq*) may also be found along the coast where *sinaaq* dynamics affect ice thickness and stability (Figure 4-11).

#### 4.2.2.1 Snowmelt

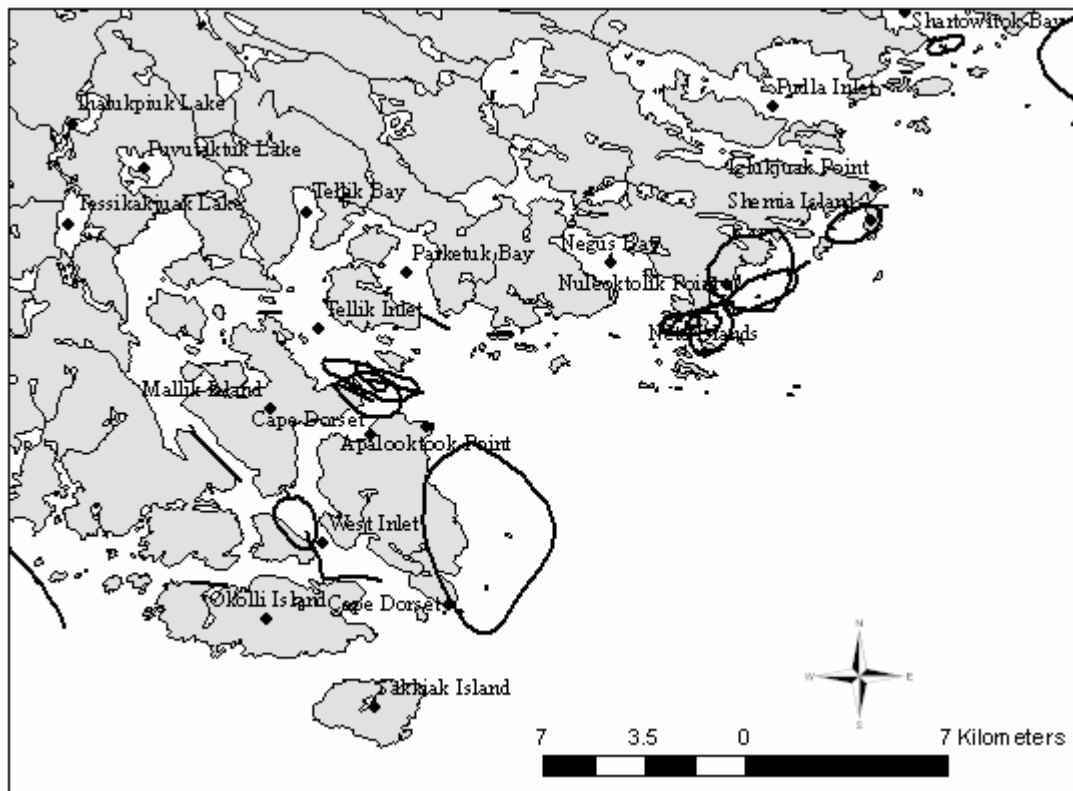
“[T]his time of year [April], thinning of the ice usually starts from the bottom, and also this time of year it’s where there are usually currents...that are not safe to be traveling on anymore. And our inlet areas will be safe until the ice actually gets out of the inlet.” (Alasuaq, 2004)

Because ice thinning begins underneath, and cannot be easily detected, early melt stages are mainly assessed by snowmelt along with different snow conditions on top of the ice. (Figure 4-1) Therefore, the early melt stage is identified as *aukajuq* (AA1; JM1; MK1; OO1). Snowfall around April and May contributes to ice melting (*aputlariq*) (EE2; MS1). The snow begins to get soft and wet, but if the ice underneath is still solid it is termed *qinningijjuq* (EE2). The process of *manguqtuq* covers a few melt stages, as it is a general descriptor for the onset of ice melt beginning with snowmelt and then influencing the ice underneath (AA1; PP2; QP1).

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<sup>1</sup> This description of ice being “worn away” by currents is mentioned frequently in all three communities. The “wear” aspect was employed by interpreters by way of explanation, but it may not capture the full nuances of the Inuktitut explanation. Therefore, the “wearing” of ice may be likened to the scientific concept of ablation (i.e. related to thermal exchanges) and not necessarily limited to the implied frictional effect.





**Figure 4-11:** Key *aukaaniit* around the Cape Dorset area. These areas wear out earlier than others in the melt process, and can thus be dangerous to travel near or around. Sources: EE1; JM1; Kellypalik, 2004b (MK2); MJ1; MS1; QT1

“[W]hen [I] check to see if the ice is melting, [I] will go on the ice if [I] can’t tell from looking at it. [I] will get a handful [of snow], if it makes a snowball, if it sticks together, [I] know it’s melting now. But if [I] do that and it doesn’t stick, it just crumbles off, [I] know it’s not melting then.” (Alasuaq, 2004)

Furthermore, *sallivaliajuq* also extends over several melt stages, where the ice is thinning as influenced by snow, rain, or wind. In the spring this stage also refers to a period where the seals are having their pups (around April or May) (Figure 4-1) (MS1; QP1).

#### 4.2.2.2 Water accumulation and drainage

Once the snowmelt is underway, water begins to form on top of the sea ice, a process called *immaqtuqtuq* (QT1).

“[I]mmaqtuqtuq mean[s] water is starting to form on top of the ice, that’s one of the beginning stages of melting ice. And then *immatinniq* is where water is staying on there, [until] the end of the month or something, until it starts draining down. And then [you can also] say *tasiaruq* meaning pretty much the same thing as *immatinniq*.” (Tapaungai, 2004)



This leads to melt rivers (*quginiit*) (AA1; NP1) and melt ponds (*immatinniit*) (Figure 4-1, 4-12a) (EE2; NP1; QT1) forming before there is sufficient drainage to decrease the water accumulation. These *immatinniit* can also be caused by *qalluit*, holes formed into the ice by seaweed (or other material) which has melted downwards (because it was deposited on the ice and it absorbs more heat than the ice surface, thus forming puddles around it) (Figure 4-12b) (EE2; OM2). Finally, water begins draining through *qillait* (meltholes) once the ice has melted all the way through in areas (Figure 4-12c) (Figure 4-1) (EE2). Drainage (*matsaaq*) (EP1) also occurs through



a) *immatinniit* refers to the accumulation of meltwater on the sea ice, either puddles or substantial water cover



b) *qalluit* form when seaweed or other material has melted into the ice



c) *qillait* act as drainage outlets for meltwater

**Figure 4-12:** Photos of early melt processes, including: *immatinniit* (a), *qalluit* (b), and *qillait* (c). (photos: Gita Laidler)

seal breathing holes and open leads (*ajuraq*) (Figure 4-7b). After substantial water drainage the ice actually pops up from where it was frozen to the ground, and remains floating on the water without breaking up (*qangitarniq*) (Figure 4-1) (AA1; OM2).

#### 4.2.2.3 Break-up

After *qangitarniq*, *pattituaq* is when there is no longer ice along the tidal zone (Figure 4-1) (OM2). The sea ice tends to melt faster along shore, just as it also freezes faster along shore. Once all the shoreline ice (*sijja*) breaks off, it becomes *sijjaviniq* when it is floating around (EE2).

Away from the shore the ice tends to begin breaking off where the cracks are widest (*ajuqpaliajuq*) (EE2).

“The ice that breaks off first, usually comes almost from the point here, there’s a point just over here where it breaks off first. And then next point up it will form a crack where the other point is, and then next point it will break off, and then a big chunk usually comes off all at once.” (EP1)

Ice breaking off in the spring time, usually caused by winds, is referred to as *aukaaq* (EP1). When the ice is breaking up (*siggia*) (MS1; QT1; OO1) *qullupiaqtuaq* may occur (when ice collides and is pushed on top of other ice as it breaks) (AA1). Finally, once the landfast ice breaks into floating pieces, *siku* and *tuvaq* become *sikuviniq* and *tuvaaviniq*, respectively (Figure 4-1) (MJ1).

#### 4.2.2.4 Cracks/leads

As mentioned previously, an *ajuraq* is a *nagguti* that remains open in the spring time. This crack then widens (*ikiqtusijuq*) to become jumping distance (*nipittupaliajuq*). As it widens further an open lead forms, requiring a boat to cross the opening (*ikiqtuaq*) (OM2).

### 4.2.3 Wind and current influences on sea ice

“Both wind and currents, when they stop at a certain time, like in the fall time, that’s when it’s time to freeze. [W]hen the wind stops, the water will freeze, and when the current stops, it will freeze.” (Kellypalik, 2004a)

Mentioned briefly throughout Sections 4.2.1 and 4.2.2, winds and currents greatly influence how and when ice forms, moves, or deteriorates. For both winds and currents, the

general conditions around Cape Dorset are described, followed by a characterization of their influence on sea ice.

#### 4.2.3.1 Prevailing winds

There is little consensus on a predominant wind direction around Cape Dorset, and the related sea ice conditions (Table 4-1). The predominant wind direction was identified as being somewhere between West and northeast, with northerly winds being the most commonly cited as prevailing (Table 4-1). In contrast, southerly and southwesterly winds were most often mentioned as being influential on ice conditions – mainly by causing break-off events or keeping moving ice near town (Table 4-1).

**Table 4-1:** Summary of predominant directional and seasonal winds around Cape Dorset, and their related influences on sea ice.

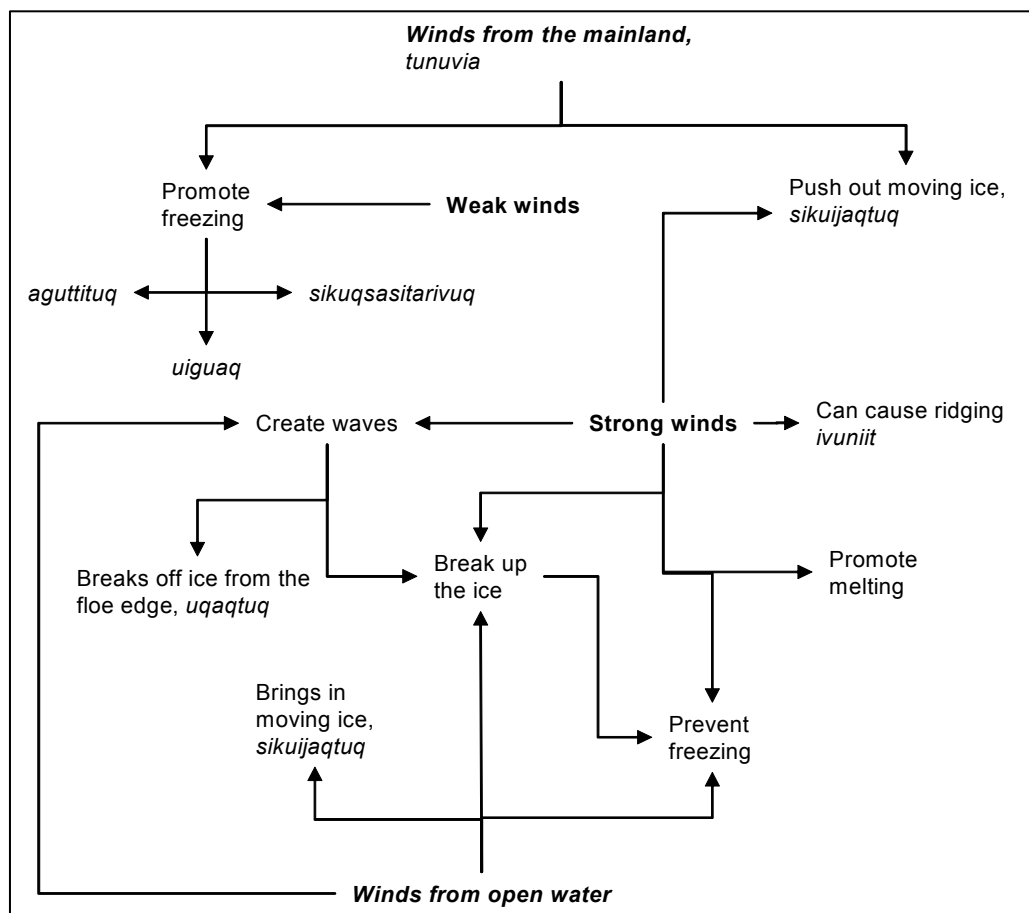
Direction	Season	Ice influence	Source
<b>West</b>	<ul style="list-style-type: none"> <li>Fall</li> <li>Predominant</li> </ul>	<ul style="list-style-type: none"> <li>Break up the ice</li> <li>Less = MYI closer to town</li> </ul>	AE1, AN1, MK1
<b>NW</b>	<ul style="list-style-type: none"> <li>Predominant</li> </ul>		MJ1, SK1
<b>North</b>	<ul style="list-style-type: none"> <li>Fall and winter</li> <li>Predominant</li> </ul>	<ul style="list-style-type: none"> <li>Promotes freezing</li> <li>More = MYI far from town</li> </ul>	AE1, AN1, AP1, EE2, EM1, OO1, QP1, QT1
<b>NE</b>	<ul style="list-style-type: none"> <li>Predominant</li> <li>Fall</li> </ul>	<ul style="list-style-type: none"> <li>Nice weather</li> <li>Promotes freezing</li> </ul>	AA1, EP1, PP1
<b>East</b>		<ul style="list-style-type: none"> <li>More = MYI far from town</li> </ul>	AN1
<b>SE</b>	<ul style="list-style-type: none"> <li>Fall</li> </ul>		NP1
<b>South</b>	<ul style="list-style-type: none"> <li>Fall</li> <li>Winter</li> <li>At full and new moons</li> </ul>	<ul style="list-style-type: none"> <li>Break up the ice</li> <li>Prevents freezing</li> <li>Less = MYI closer to town</li> <li>Lots of ice near town</li> </ul>	AA1, AE1, AN1, AP1, EM1, KS1, NP1
<b>SW</b>	<ul style="list-style-type: none"> <li>Spring</li> <li>Fall</li> </ul>	<ul style="list-style-type: none"> <li>Less = ice stays longer</li> <li>More = ice will leave sooner</li> <li>More = breaks off the ice</li> </ul>	AE1, NP1

There are a few possible explanations for this variation among respondents:

- the interviewee, or the interpreter, was unclear about which direction they were referring to (e.g. mixed up the directions, or said one and meant another);
- wind directions are not easily translated into English, which can lead to confusion or misinterpretation after translation (e.g. NW is the most commonly cited predominant wind, but in popular media the Inuktitut term for NW is often translated into English as North (Ikummaq, personal communication); and/or,

- c) the wind directions have noticeably changed in recent years, and respondents had a hard time separating 'usual' conditions from 'recent' conditions (Section 4.4).

Having said this, it is not feasible to focus on absolute directions in reporting wind-related results and analysis. However, it is useful to discuss influences of winds on sea ice in relation to the general direction from which they originate. While referring to particular directions, interviewees often mentioned winds coming from the mainland (i.e. Baffin Island) in comparison to the open water. Generally, the more northerly winds constitute winds coming from the mainland and the more southerly winds originate from the open waters of Hudson Strait. So, for the purposes of the remaining discussion, the directions between West and East towards the North are 'from the mainland', and the directions between West and East towards the South are 'from open waters' (Figure 4-13).



**Figure 4-13:** Conceptual model of the influences of winds on sea ice formation, movement, or decay based on interviews conducted in Cape Dorset.

#### 4.2.3.2 Influence of wind on ice conditions or movement

“When it’s time for the ice to freeze, it will usually freeze from the north side, from the mainland side going down. But if it’s been windy from the south side for a bit of time, the ice usually won’t freeze up for a while. Like [I] said, winds are part of breaking [the] ice.” (Alasuaq, 2004)

Winds from the mainland tend to bring pleasant (and cold) weather (AA1; PP1), and if sustained within mild to moderate speeds they promote the freezing of sea ice in the fall (AE1; EP1) (Figure 4-13). Therefore, with *tunuvia* – weather coming from the mainland – the ice will begin to form outward from the edge of the land (*sikuqsasitarivug*) (OO1). Winds from the mainland can also drive moving or multi-year ice away from the community, allowing for conditions that are more conducive to boat travel (AN1).

In contrast, winds coming from the open water are said to have greater influence on ice conditions (SS1), usually in a destructive manner (Figure 4-13). In any season, winds coming from the open water are likely to break up the sea ice (*uqaq* or *aukaaq*) (AA1, AE1, AN1, EP1, KS1, JM1, MJ1, MK1, MS1). This is caused by wave action or by pushing moving ice into the *sinaaq*. Such actions prevent freezing in the fall (AA1, AE1) and promote break-up in the spring (AE1). Winds from the open water also bring moving ice close to town, and keep it there (EM1, AN1).

“[S]ometimes the ice has broken off from [another] area, it will go right up to around Cape Dorset, and sometimes it will be stuck up [here] for a while. A lot of our hunters will say that there is no floe edge close by because of the ice that has broken off and kind of settled up [here] for either a few days, or weeks at a time.” (Saila, 2004)

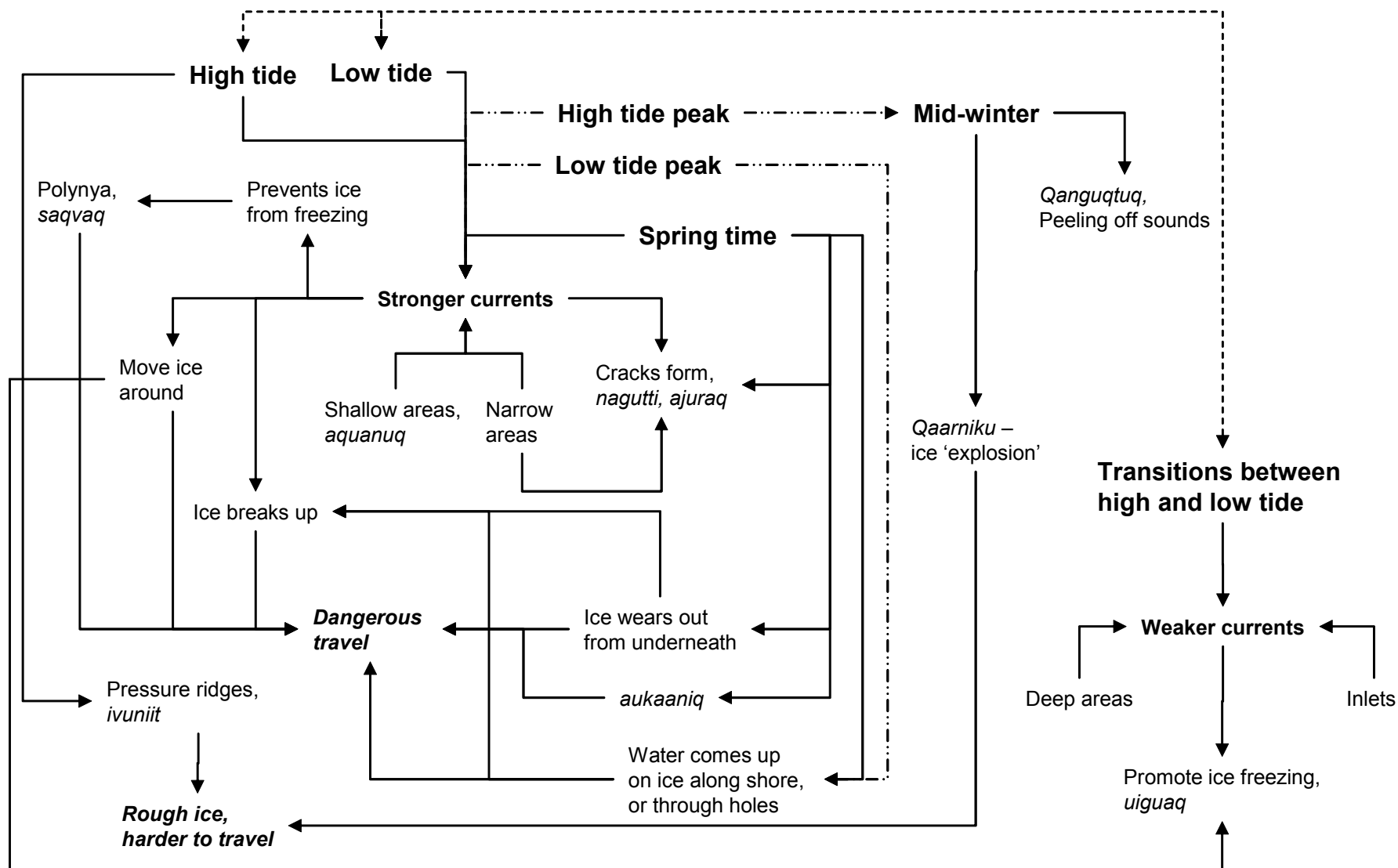
Light winds, or calm conditions promote ice formation (EM1, EP1, MK1), whereby the term *aguttituq* describes ice forming with the direction the wind (Figure 4-13) (MK1). In contrast, strong winds from any direction can affect ice stability and condition. Ice deformation such as ridging (*ivuniit*) can be caused when winds push ice on top of other ice causing it to pile and refreeze into rough ice (AA1, AN1).

“Another ice is called *ivuniit*...it’s like a bulldozer coming from the water side pushing [thick ice] to the islands or the mainland. When it’s windy from the south side that happens, or around current areas...” (Alasuaq, 2004)

Winds also create wave action, which prevents ice from forming (AP1, MK1), and may cause the *sinaaq* to open up or break off (KS1, SS1). Seasonally, a windy fall means that broken pieces of ice will freeze together, rendering spring ice travel dangerous because the ice might break off little by little (Figure 4-13) (MJ1). Windy conditions seem more prevalent in the spring (EM1) and they promote ice melting, causing faster ice deterioration than the influence of sun or rain (MJ1). Winds also cause ice movement (SK1), whereby *sikuijaqtuq* refers to ice moving with the wind (Figure 4-13) (OO1). Furthermore, sustained strong winds will cause the formation of *naggutiit* in the sea ice (NP1).

#### 4.2.3.3 Tidal cycles and currents

Currents play an important role in the unique ice conditions around Cape Dorset. The strength of the currents are related to different water depths, whereby shallower water promotes the faster movement of water, keeping many areas ice-free year-round (AN1; EP1; JM1) (Figure 4-14). For example, an *aquanaq* is described as a shallow area (somewhat like a reef) that creates stronger currents and prevents ice from freezing solid (EM1). Due to relatively shallow waters around Cape Dorset, tidal variations are large (SS1). The cycle of high and low tides determine the direction of currents, as they go back and forth typically in a north/south alternating pattern (AA1, EE2, MK1, OO1). The water is described as moving towards the north (up/in) at high tide, and towards the south (down/out) at low tide, approximately every 12 hours. Beyond the daily high and low tide cycles, the monthly new and full moons are especially influential on current strength (i.e. peak high and low tides), and thus ice conditions (Figure 4-14) (AN1, EE1, EE2, MS1, NP1, PP2, SS1, QT2, SK1).



**Figure 4-14:** Conceptual model depicting the influences of currents and tides on sea ice formation, movement, or decay based on interviews conducted in Cape Dorset.

Where: — = general process direction    - - - - = daily cycle    - · - · - = monthly cycle

#### 4.2.3.4 Current and tidal influence on ice conditions or movement

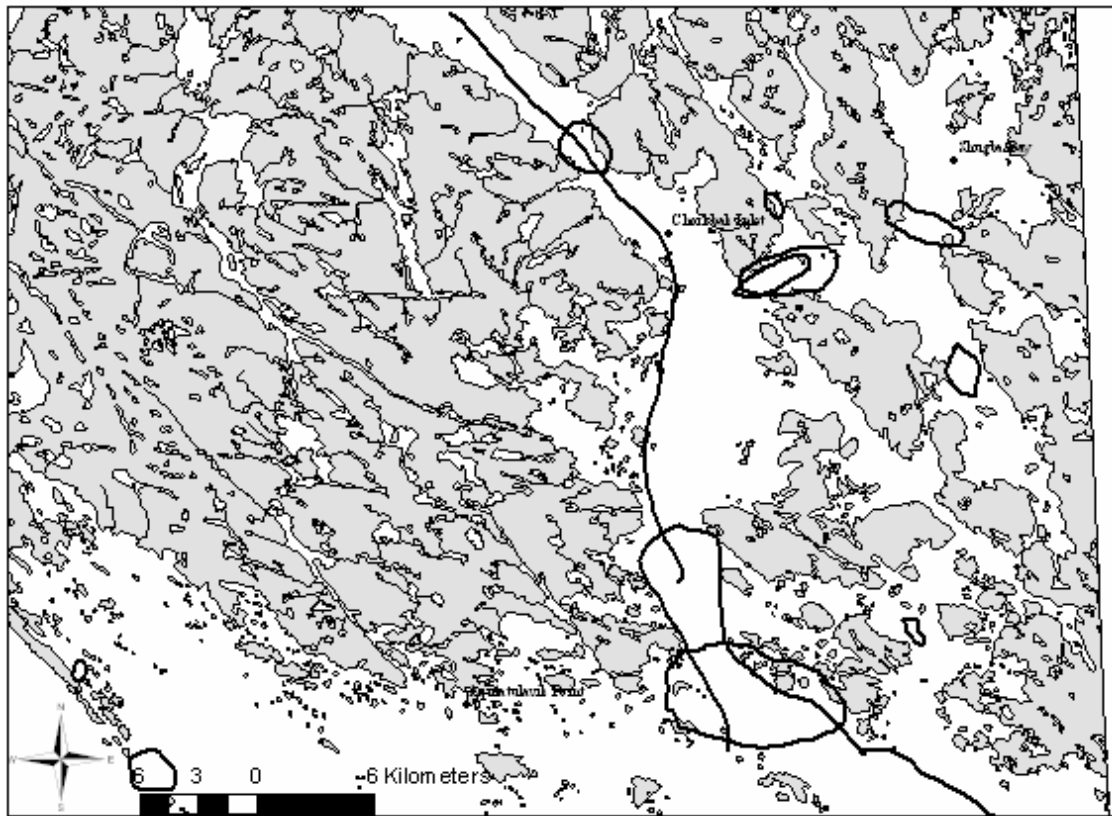
Generally, the stronger the currents the harder it is for ice to form (Figure 4-14). The Hudson Strait currents are significant contributors to the maintenance of the *sinaaq* close to town throughout the winter, and the annual creation of polynyas (*saqvaq*, *saqvait* is the plural form) (AA1; EM1; EP1; MS1; OO1; PP1; PP2; QT1; SK1). Ice is more likely to form in inlets, but not usually up to the points of land as that is where currents are often strongest (EP1, PP1, PP2, QT1) (Figure 4-14).

“The ice will form mainly around the edges, because it’s all currents on [the West] side. Mainly around the edges...in between these two islands it doesn’t usually ice in between there. So mainly close to the mainland here, it will form only mainly in inlets because there’s too much currents...It doesn’t go, even most places it doesn’t go right up to the points, just the little inlets will be ice.” (Petaulassie, 2004a)

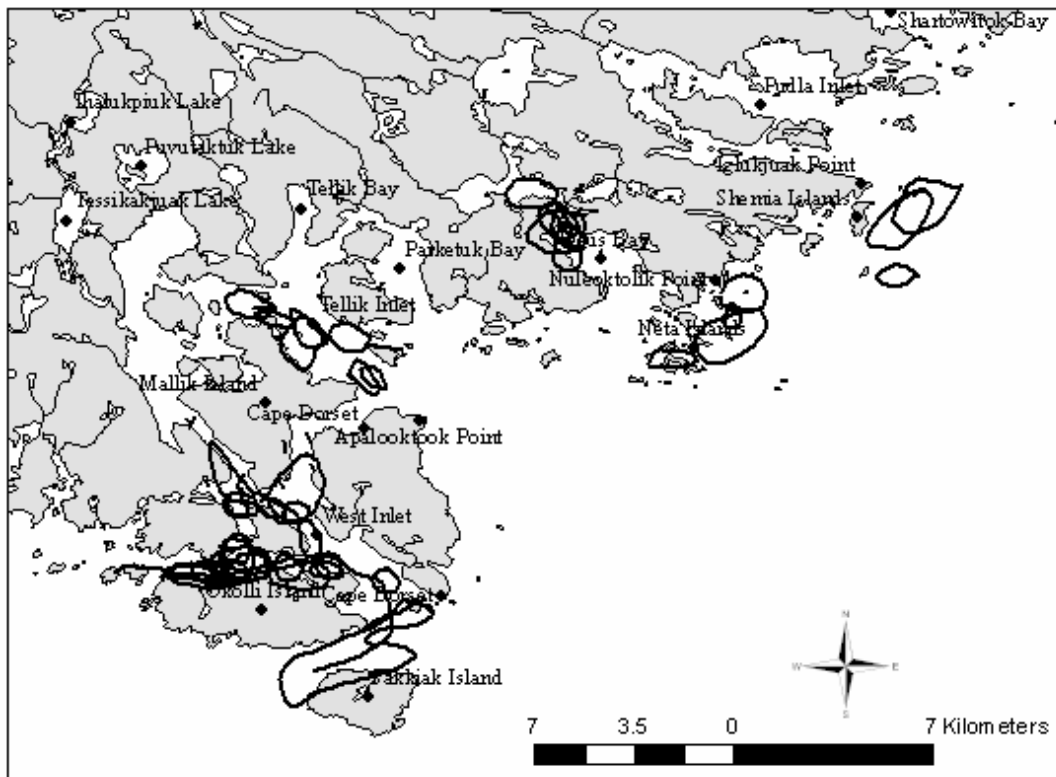
Between islands the currents are also very strong, as they are funneled through narrower areas (PP2, SS1). This funneling action results in thinner ice or more frequent formation of *nagguitiit* (EP1, SS1) (Figure 4-14). In addition, strong currents cause ice ridging (*ivuniit*) along the coastline, along the ice edge, or in areas where tidal cycles cause ice to collide or break off (AA1, AN1, MK1) (Figure 4-14).

The Inuktitut term for polynya, *saqvaq*, actually refers to areas “where there are currents” (not necessarily areas that never freeze over). It is well understood around Cape Dorset that areas of strong currents prevent ice formation, and keep certain areas ice-free throughout the winter, although they are surrounded by ice. However, along with the varying strength of currents during a month, varying degrees of ice cover may form over a *saqvaq*. A notoriously dangerous area for *saqvait*, or thin ice conditions, is *Saqvaq* Inlet (Chorkbak Inlet on the map) (Figure 4-15a). Areas of open water were indicated throughout the inlet, and between the myriad of islands in the area. Therefore, this inlet tends to be avoided when traveling to Kimmirut. There is one small area near the mouth of the inlet that does freeze over at times (*nunniq*), and thus becomes travelable (PP2). But elders warn that this part is still very





a) Key *saqvait* in the Chorkbak Inlet area. Sources: AA1; EE1; JM1; MJ1; MK2; MS1; OM2; QP1



b) Key *saqvait* in the Cape Dorset area.  
Sources: AA1; AN1; EE1; EP1; JM1; MJ1; MS2; MK2; OM2; PP1; QT1; SK1

**Figure 4-15:** Maps showing prominent *saqvait* around Chorkbak Inlet (a) and Cape Dorset (b).

dangerous if the person is not familiar with the conditions around the inlet (PP2). Other than that, *saqvait* are scattered throughout the region predominantly between islands and in narrow areas where currents are perpetually strong. Interviewees indicated several important *saqvait* near Cape Dorset, known as both dangerous for sea ice travel and popular for seal hunting (Figure 4-15b). To identify a particular *saqvaq*, the closest placename on the land is used and added to the term *saqvaq* to refer to a specific area of open water (QT1).

“[E]specially when it’s full moon season, that’s when the currents start moving a lot, that’s when [certain] areas are no longer safe to be traveling through, full moon season. And the new moon season is same as, almost like a full moon, cause the tide is not as low as it would be when it’s regular low tide.” (Saila, 2004)

The monthly new and full moons create peak tidal stages where stronger currents contribute to: i) ice thinning (EE2); ii) more dangerous sea ice travel (MS1, NP1); iii) the opening or creation of *naggutiit* (NP1, PP1, SS1); iv) the opening or formation of *savaqs* (PP2); v) ice break-off events (AN1, QT2, SK1) (Figure 4-14). Seasonally, in mid-winter a full moon can create such tidal pressure under the ice that an explosion of sorts (*qaarniku*) may occur, but not on a regular basis (EE1). Also, at the end of a very strong water tide currents can lift up ice that was frozen to the ground, making loud ‘peeling off’ sounds (*qanguqtuq*) (JM2) – likened to the sound of loud snoring (Figure 4-14) (AA1). Furthermore, full moon effects in the spring contribute to enhanced ice thinning from underneath the ice surface, and cause water to come up through holes in the ice (EE2). Currents may also be stronger in the spring, which can expedite melt processes and/or break-up (AN1).

Currents also influence sea ice movement. Usually movement delays ice formation in the fall (QT1). However, currents may also promote freezing if they deposit ice in areas with weaker currents, where they can freeze (*uiguaq* – newly formed ice) (JM1, MJ1, MK1, QT1) (Figure 4-14).

“[W]hen it comes to icing in the fall time, currents have something to do with ice forming in some areas, where it would not ice right away the current has moved a chunk of ice into that area and now it’s permanent in that area. The currents have something to do with ice forming in areas where it wouldn’t have frozen right away because there’s currents in the area. But sometimes the currents take ice to [where] it will stick...That’s why some areas are a lot thicker than [other] areas.” (Tapaungai, 2004)

Currents can take frozen piled ice to another area where it will stay (*sikuliaqta*), if the winds are not strong (MK1). Furthermore, in the spring currents can speed up the melting processes, and create *aukaaniit* (Section 4.2.2) (Figure 4-11, 4-14).

In addition, floating ice tends to follow the currents, as associated with the tidal cycle (EM1). A few key terms associated with moving ice include:

- *aniqsai* → sea ice that moves with the ebb and flow of the current, without breaking up or melting (MK1)
- *asaluaan* → sea ice formed into a ball-like shape, in open water (OM2)
- *aulaniq* → moving ice in general (OM2)
- *marruluin* → when there is a lot of broken ice from different areas, with seaweed or other ocean debris on top (MS1)
- *puktaan* → small pieces of floating ice moving in open water (MK1)
- *qaikut* → ice that moves with currents (OM2)
- *qapvaq* → large moving ice that comes from far away, usually from the north, considered like multi-year ice (OM1; JM2; MS1; NP1; PP2;)
- *qunni* → ice that will not crack, floating in open water (MK1)
- *savittuq* → a small piece of ice that broke off and is floating away (OO1)
- *sikurasaan* → small pieces of ice gathered in one area, moving as one (MK1)

Specifically, *qapvaq* is associated with hampering sea ice or boat travel.

“[Q]apvaq, they’re big, like Hudson Strait polar ice, they’re really clear white blue colours ...when people see that say ‘oh oh, we’re going to get trapped’. Because when they start to see that *qapvaq* [it] means a big area of ice like that can move into your area and block off all the shoreline. That has happened here, we got stranded out right here one time, with *qapvaq*. And then it stayed there over almost two weeks.” (Manning, 2005b)

Both the currents and winds clearly influence sea ice movement, formation, decay, and distribution. Their strength or direction varies with the weather and lunar cycles, enhancing the complexity of understanding sea ice freezing and melting processes. They are also very

important factors that are continually considered when traveling or hunting on the sea ice, as they can greatly enhance the danger of sea ice navigation.

### 4.3 Sea ice use

Sea ice travel and hunting are nearly inseparable components of Inuit sea ice use because travel on the sea ice is mainly for the purpose of hunting/accessing hunting grounds. However, travel and hunting will be discussed separately to provide some specific highlights regarding sea ice conditions that relate to travel safety and hunting practices, respectively.

#### 4.3.1 Travel

Sea ice travel is inherently dangerous. The frozen ocean surface is dynamic and unforgiving. Hunters are exposed to various types of conditions as they travel on the ice, many of which have been described in Sections 4.2. In this section, some of these exposures and associated risks (Table 4-2), along with the ways in which community members often minimize these risks, will be discussed.

##### *4.3.1.1 Dangers in sea ice travel*

Current strength, especially as associated with tidal and lunar stages, comprise a cyclical exposure that varies in influence depending on the time of day and month. Thus, currents can make sea ice travel very dangerous, and even more so in the spring time (March/April) (AA1; MS1; QT2). They wear away the ice from underneath, which is not always visually identifiable (AA1, MJ1, MS1, QT2) (Table 4-2). In areas that are *aquanaq* the currents are stronger and the ice is prevented from freezing solidly (EM1). Such narrow areas, or straits, are also the areas that tend to begin eroding first, from underneath, in the spring time (MJ1). Furthermore, at points of lands the currents tend to be stronger, and these areas will be avoided as much as possible during travel, as they are always dangerous (MJ1). Currents are also influential in the creation and maintenance of *saqvait*. Therefore, *saqvait* have continually

changing ice cover and conditions with different current strengths, making them very dangerous to travel on or near (Table 4-2).

**Table 4-2:** Summary of sea ice-related exposure and associated risks for community members in Cape Dorset, including some methods of minimizing these risks.

Sources: AN1; EE1; EE2; EP1; IN1; JM2; KS1; MJ1; MK1; MS1; NP1; OM1; PP1; QT2)

Type of Exposure	Associated Risks	Actions to minimize risk
<b>Tidal stages, strongest currents associated with new and full moons</b>	<ul style="list-style-type: none"> <li>➤ Early January, new moon may cause flooding along shoreline</li> <li>➤ Wear out the ice from underneath, or prevent ice formation</li> <li>➤ Dangerous to travel in narrow areas, straits, or between islands</li> </ul>	<ul style="list-style-type: none"> <li>➤ Avoid ice travel when shorelines are flooded</li> <li>➤ Bring or use boats to travel on open water</li> <li>➤ Be alert when traveling near areas with strong currents – conditions can change overnight</li> <li>➤ Listen for (thunderous) cracks to indicate instability</li> <li>➤ Know where currents are strongest, avoid those areas</li> </ul>
<b>Polynyas (<i>saqvait</i>)</b>	<ul style="list-style-type: none"> <li>➤ Changing size and extent of freezing, depending on current or wind strength (i.e. most ice cover at weakest currents and winds)</li> </ul>	<ul style="list-style-type: none"> <li>➤ Avoid traveling over these areas despite whole or partial freezing</li> <li>➤ Avoid traveling near <i>saqvait</i> during windy conditions or peak tides</li> </ul>
<b>Floe edge (<i>sinaaq</i>)</b>	<ul style="list-style-type: none"> <li>➤ Changing position due to ice bumping into the edge, making it hard to determine the edge delineation</li> <li>➤ Potential break off events when currents or winds are strong</li> </ul>	<ul style="list-style-type: none"> <li>➤ Avoid travel near the <i>sinaaq</i> where the currents are the strongest</li> <li>➤ Avoid travel near the <i>sinaaq</i> when winds are strong</li> <li>➤ Bring or use boats to travel on open water</li> <li>➤ If broken off on the ice, note wind and current directions, as there are predictable landing locations depending on wind and current conditions</li> </ul>
<b>Broken, moving ice near town (<i>aulaniq</i>)</b>	<ul style="list-style-type: none"> <li>➤ Southerly winds or high tides can bring the ice towards the <i>sinaaq</i></li> </ul>	<ul style="list-style-type: none"> <li>➤ Hunters will not go too far from town by boat in the winter when moving ice is near by – if it is broken up and blown in it could be hard to get back to town</li> </ul>
<b>Snowfall</b>	<ul style="list-style-type: none"> <li>➤ Snowfall on newly formed ice insulates the ice, causing it to soften or melt</li> <li>➤ Snowfall covers the ice conditions underneath, making it hard to evaluate the ice thickness and safety</li> </ul>	<ul style="list-style-type: none"> <li>➤ Avoid travel right after a new snowfall</li> <li>➤ Use dog teams to detect safe ice conditions</li> </ul>
<b>Freeze-up</b>	<ul style="list-style-type: none"> <li>➤ Thin ice conditions and non-uniform freezing</li> </ul>	<ul style="list-style-type: none"> <li>➤ Avoid travel until ice has thickened, unless tested with a harpoon</li> </ul>
<b>Break-up</b>	<ul style="list-style-type: none"> <li>➤ Deteriorating ice conditions</li> <li>➤ Some areas open up 2 – 3 weeks earlier than others</li> <li>➤ Dangerous when water accumulates on the ice and is starting to drain</li> </ul>	<ul style="list-style-type: none"> <li>➤ Travel closer to town to avoid being stranded on land away from town when ice is no longer travelable</li> <li>➤ Stay away from areas with stronger currents</li> </ul>

Traveling near the *sinaaq* potential danger is imminent. Changing wind strength and direction, as well as daily or monthly tidal cycles, are an ongoing threat for break-off events. Traveling near islands, or *naggutiit*, located close to the *sinaaq* are most dangerous (IN1). If ice happens to break off (*ukaqtuq*) from the *sinaaq* with someone still on it, it is called *saataviniq* (MJ1). They can become *ukuarujaq* (stranded on the ice that broke off) (OO1) if currents or winds do not bring the ice back to shore. For these reasons, a small boat is often brought along on the sled (*kamotik*) as a means to retrieve wildlife but also as a safety precaution in case the ice breaks off (IN1; NP1).

Ice conditions are considered dangerous in the fall and spring time during the early stages of freeze-up and late stages of break-up (Table 4-2). But transition conditions are checked more frequently, and so are somewhat safer because they are evaluated more often. For example, in the fall the ice is being checked constantly (MJ1), and once safe conditions are determined it is possible to evaluate nearby areas by sight (OO1). However, this knowledge must be renewed each year, because it is conditioned with use.

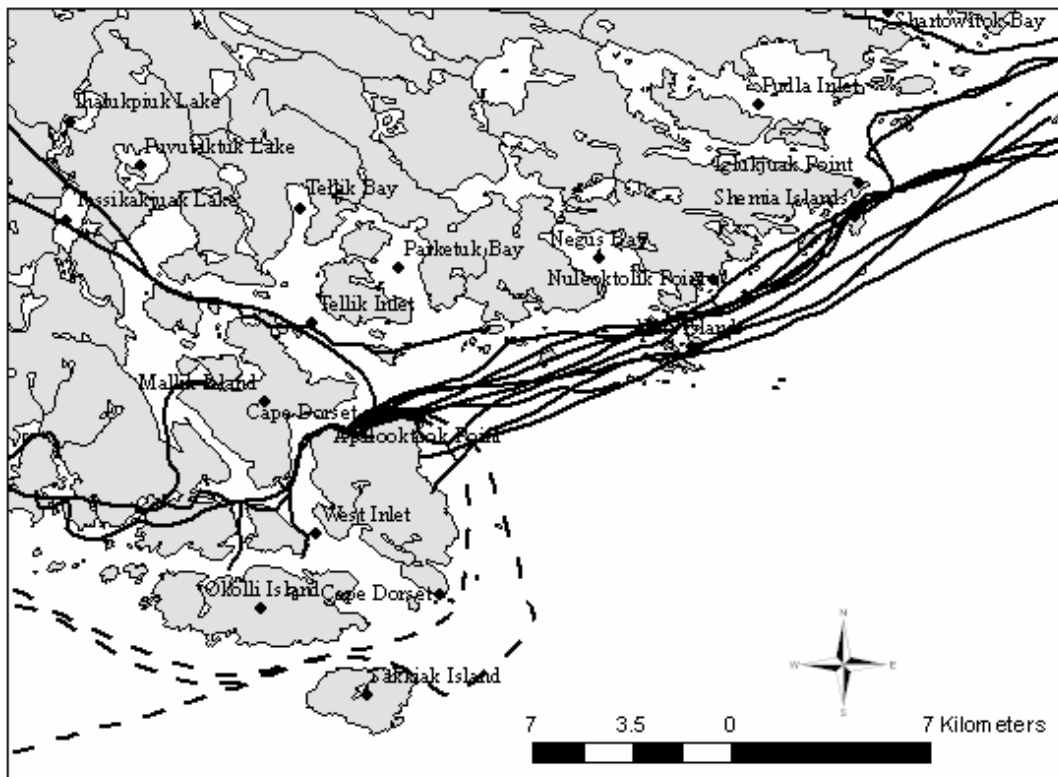
“Once you know your checking, then you can see with your eyes the rest of the good [areas], and the rest of the fresh ones. [T]hat you have to renew every year almost, like anything. Once you stop using it you forget certain parts, but like riding a bicycle once you get back into it you’re right back there. It’s the use.”  
(Joanasie, 2004)

Once someone stops using the ice there is a tendency to forget certain subtleties (MJ1). When the ice has reached a thickness of approximately 4 or 5 inches, people can start walking on the sea ice if it is snow-free (AA1). If snow falls on newly formed ice, it will no longer be safe for travel even if it was safe the day before (Section 4.2.1.3) (EE1). The term *sikuliaqsirtuq* refers to the first people to walk on the ice, using their harpoons to continually check the thickness (EE1). Similarly, *atuksavuk* is used to refer to a man walking on the ice with a harpoon, when the ice is not yet thick enough for dog team travel (PP1). *Ijjusijuq* or *nangianaituq* mean that the ice is now safe for travel on foot, by snowmobile, or by dog team (AA1; PP1).

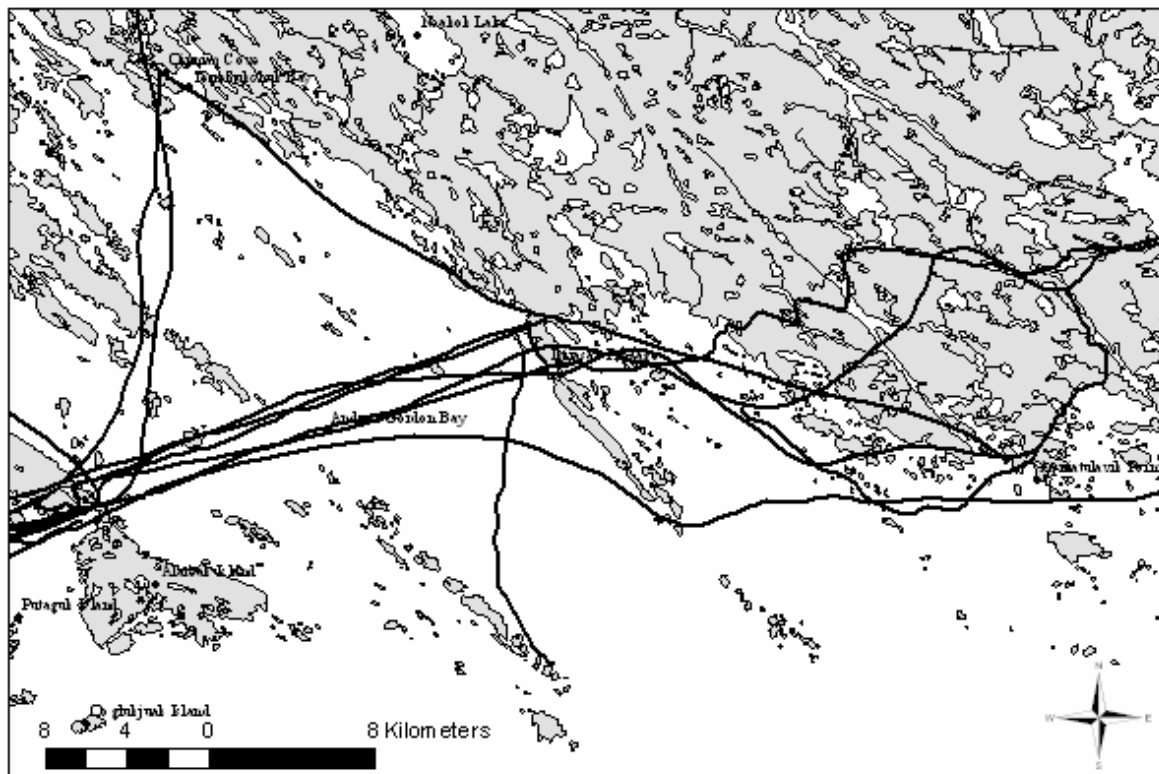
In the spring, although late stages of break-up are dangerous and can change abruptly, earlier melt stages can be safe because: i) where there is a lot of water it is evident and easy to avoid (MJ1, MS1, SK1); ii) there is less snow, so you can see where the cracks are (MK1); and, iii) after the water has drained the ice is usually hardest on top and good for traveling – easy to see where holes have formed all the way through the ice (AA1). However, as the ice deteriorates so too do many travel routes, which forces people to move closer to the coastline in order to be on solid ice (EE2). Once certain areas are no longer safe to be traveling through, they are deemed *nangiarnaqisuq* (QP1).

#### 4.3.1.2 Evaluating sea ice safety

The most common practice to minimize risks involved in sea ice travel seems to be an exercise of caution, and avoidance of dangerous areas as much as possible (Table 4-2). However, many of these hazardous ice conditions or areas are also key travel destinations because they are on a main travel route or they support desirable hunting conditions (SK1). Appendix 19 provides an overview of regional travel routes, while Figure 4-16a highlights that around Cape Dorset sea ice cover is maximized to enhance the efficiency and speed of travel. The main travel routes hug the coastline going east or westward of the community, having to be altered depending on the distance to the *sinaaq* (Figure 4-10a, b). In many cases, even *saqvaq* areas cannot or are not completely avoided, travel is just slower and more cautious to navigate near or around such areas. Further east the ice cover in Andrew Gordon Bay provides an important travel route, essentially a shortcut to inland or coastline travel (Figure 4-16b). Going even further east towards the soap stone mine, or Kimmirut, the routes become more circuitous as they wind between islands, or inland and onto frozen lakes. Only people knowledgeable and confident in traveling across the Chorkbak Inlet sea ice will attempt the sea ice crossing, and some of these routes are no longer used at all.



a) Key sea ice (solid line) and boat (dashed line) travel routes used around Cape Dorset.  
Sources: AA1; EE1; IN1; JM1; MK2; MS1; PP1; QP1; QT1; SK1



b) Key sea ice travel routes used around Andrew Gordon Bay.  
Sources: AA1; EE1; IN1; JM1; MS1; PP1; QP1; QT1; SK1

**Figure 4-16:** Maps of common travel routes near Cape Dorset (a) and Andrew Gordon Bay (b).



“Yes, going down the coast, like where they get their soap stone, there would be a trail that has to be taken because once you hit the *Saqvaq* [Chorkbak] Inlet, that’s one of the very difficult areas to travel on ice. [B]ecause that’s where most of the currents are going in and out. And a lot of the area is really broken up and packed and so a certain route would have to be taken.” (Manning, 2005a)

Of course another important reason for all these routes so near the *sinaaq* and *saqvait* is that marine mammals (e.g. seals, walrus, beluga, narwhal, and polar bears) tend to be found in open water, or at the ice edge. Therefore, important hunting locations would be accessed by foot after driving as closely as deemed safe to the feature.

Elders and hunters continually reiterate the importance of bringing an ice tester of some sort, typically a harpoon (*unaaq*) to manually test the ice thickness (AA1, EE1, EM1, EP1, IN1, MJ1, MK1, MS1, NP1, OM2, OO1, PP1).

“The main tool, if you want to know about the condition of the ice, if a person doesn’t know anything about the ice you can use the harpoon to check the thickness of the ice. That’s one way of using the harpoon. If you’re going to be a hunter you should know all these things, even the smallest things about the ice. If you don’t, you’re going to go through the ice.” (Kellypalik, 2004a)

With a harpoon you can be very certain of the ice safety, but it is essential to angle the harpoon away from you when testing the ice (Figure 4-17) (EE1).

“[T]he best way to be traveling through the ice is with a harpoon...like not completely going down like that, you have to have it at an angle going out a little bit when you poke [the ice] to see if it’s safe to be traveling on...[I]t has to be at an angle outwards a little bit from the guy [who] is holding a harpoon. You don’t do it straight down because if you go straight down you might go right through, and the person that’s holding the harpoon might go right down with it. So they do it like at an angle.” (Etidlouie, 2005a)

A person can walk anywhere that passes the harpoon test (MJ1) – on much thinner ice than it would be possible to drive. It was indicated that no matter what a person’s confidence with the ice, it should always be tested (IN1). It can be useful to observe ice or trail conditions from a hill before traversing a particular route (EM1), but it is still difficult to evaluate ice safety from a distance or when driving a snowmobile (IN1). Colour (i.e. light is generally safer and dark is generally more dangerous) is often a good



**Figure 4-17:** Atsiahq Alasuaq uses his harpoon to test the *uiguaq* at the *sinaaq*. It is the most important tool to ensure that the ice is thick and stable enough to support travel (either on foot or by snowmobile).  
(photo: Gita Laidler)

indication of ice safety, but it is no substitute for the use of a harpoon (JM2; MK1; SK1). For these reasons it is also prudent to avoid sea ice travel in high winds because: i) visibility can be impaired by blowing snow; ii) varying sea ice colours or textures cannot be discerned; and, iii) there is an increased probability of ice cracking or breaking off (AN1; MS1; OM1).

“[W]hen you’re traveling, especially if it’s a windy day, kind of blizzard day, the ice looks all the same. Even the *saqvait* seem to all look the same when there’s a little bit of wind when you’re traveling through it. So it’s dangerous to be traveling when it’s a semi-blizzard.” (Saila, 2004)

Some additional conditions that are particularly hazardous include:

- *aukaan* → starts melting early, and not safe to travel through (AE1)
- *aukaaq* → starts getting dangerous on the ice, breaking away (EP1)
- *millutsiniq* → when snow has fallen over a recent opening in the ice, so you can’t see the water and people will fall through if not careful, usually occurs close to the *sinaaq* (EE1)
- *nigajutaq* → safe to travel on even shortly after it has opened up (EE2)
- *qalligirtuq* → when ice is forming and pieces start to break off and go on top of one another, once it refreezes it’s safe to travel on (AA1; EE1)
- *qangitarniq* → may be mistaken for safe ice, but it is really floating (AA1)

- *qangutaituq* → where *qanguti* is forming may all look the same, but some areas won't be safe (EE1)
- *qinnu* → cannot always be identified by sight, hunters will just fall right through (AA1)

Respondents' assessments of ice safety often revolved around how well they knew a particular route. It was the use of the ice, and the frequency of sea ice travel in certain areas, that were identified as contributing to a person's assessment of the safety of ice conditions in a particular area. By knowing the route well a hunter knows where dangerous areas are, and can thus avoid them. Consequently, it is hard to predict ice safety when the route is not familiar (JM2, MJ1). For example, by knowing where the strongest currents are these areas can be avoided, and it is possible to travel around them where the ice is thicker (EP1). Even where some of the smaller *saqvait* might freeze over, they would not be considered travelable as they can rapidly become unsafe, or snow cover may conceal open water underneath (PP1). Extra caution must be taken when traveling through narrow areas between islands, or near the *sinaaq*. Hunters always need to be aware of changing ice conditions, crack formations, or thunderous sounds of ice breaking off or piling up at the *sinaaq* (EP1; PP1; QT2).

"[U]sually when it's new moon or full moon time that's when usually a lot of chunks of ice will usually break off...But even though it's usually around that time you always have to make sure that even if it's not new moon or full moon you are still alert because you will hear a big thunder or sound. That usually means that the ice you're on is breaking off, if it's really loud like that. You won't hear a vibration or anything, you just hear loud thumping sound or cracking sound. But a lot of time you hear it and you try to cross over to where you thought it had cracked, usually it's too late to be going through the ice. So usually if they hear a big crack or anything like that they try to get on their machines and get off the ice right away. But usually it's usually too late by the time they try and cross it." (Tapaungai, 2005)

Understanding the direction and timing of currents is important if a hunter is caught on ice that has broken off the *sinaaq*, as it will determine where the ice might come ashore (MJ1).

"[There was] an incident that happened years ago when somebody floated away from here. And that person wasn't seen for days, and then they found him at a place called, close to *Aqiatulaulavik* [Aqiatlaulavik on the map], it's exactly what Matthew [Joanasie] was saying too, something about somebody floating away on

the ice and having to reach another camp days later. [I]f we were to break off on an ice today right here, we would end up, no matter how long it takes you would end up in that camp area *Aqiatulaulavik*.” (Peter, 2004)

Furthermore, by remembering what the weather and conditions were like during freeze-up, it can help inform sea ice safety assessments in the spring in terms of where to expect early ice rotting (JM2).

Long-term experience and continuous use of the sea ice are critical in evaluating ice safety, and this is why some elders suggested that younger people are more frequently getting lost or having accidents on the sea ice. The younger generation of Inuit are not as experienced and are not using the ice as often as they might have in the past (JM2). People who do not use the ice that much will rely on people who do, especially in a particular year and in terms assessing spring travel safety (MJ1, OO1). More experienced hunters may be able to travel on thinner ice (MS1), but warnings were also expressed that no matter who you are it is important to be careful when traveling in the spring (OO1, QT2).

Some of the elders also referred to the use of dog teams as a much safer mode of travel than the snowmobiles that are predominantly used today (Figure 4-18) (MS1; NP1; OO1; QT1; QT2). The dogs were very helpful in identifying dangerous sea ice conditions, as well as the marine wildlife that hunters were seeking (NP1; OO1). In the early fall, the older more experienced dogs would be used, along with a few younger ones who would learn about thin ice navigation as they went (NP1; OO1).

“[When we] were traveling in the fall time, it is usually the most dangerous time to be traveling or to be out hunting, because a lot of time some of [our] dogs would go through the ice. [I]t’s not the lead dog that will usually fall down, [my] lead dog would usually take a different turn if there’s thin ice. It’s just that other dogs that are in the back they would usually [fall] first if they’re not familiar with the ice conditions that they’re traveling on. Usually [I] would take the older dogs that know where if it’s going to be safe or not to be traveling on the ice, in the fall time it’s usually older dogs that [we] would take out hunting.” (Peter, 2004)



**Figure 4-18:** Snowmobiles (left) are now the most common method of sea ice travel, but many elders expressed that they felt safer when they used to travel with dog teams (right). (photos: Gita Laidler)

Snowmobiles are certainly faster, they take hours to travel distances that used to take days and sometimes weeks (NP1; QT1). Yet, snowmobiles cannot tell the hunter about the condition of the ice. Even in poor visibility, good dog teams knew their route and could take a hunter to their desired camp without visual cues (NP1). More recently, someone who is unfamiliar with a particular route, and all the associated cracks or currents, is prone to getting lost or having an accident (NP1). There are even some routes that were used by dog team that cannot be used by snowmobile because they are too rough or too dangerous (NP1). Therefore, when driving a snowmobile the hunter has to be more alert to changing conditions, at higher speeds (QT2). The snowmobile does not know that it is falling, and cannot help you back out if it does (OO1). Furthermore, machines are expensive to maintain and you are stranded if they break down (NP1; OO1).

Beyond assessing ice safety, communicating ice conditions to other community members is also important. Notifying others of dangerous areas around town was deemed essential because even the best hunters can have accidents (QT2). The community radio, as well as short-wave radio that people bring with them or keep at their cabins, are also important means of communicating ice safety and notifying others of areas to avoid (IN1, OO1).

### 4.3.2 Hunting

“Seals, seals were the main food all the time. Even today it’s even the main food. After that when [we] had run out, [we] could have scrap food for dogs or something. Even when [we] were out of meat, [we] would still use seal skin clothing or blankets as food for the dogs, and even [ourselves]. It has been [our] main food since when [I] could start walking. Today the main use of seal skins would be mitts and *kamiks*, not that many parkas anymore.” (Kellypalik, 2004b)

Ringed seal (*natsiq*), bearded seal (*ujjuq*), and walrus (*aiviq*) are some of the most common marine mammals hunted around Cape Dorset, throughout the year (AN1; EE2; EM1; EP1; IN1; JM2; KS1; MJ1; MK1; MS1; NP1; OM2; OO1; QP1; QT1; SK1). Harp seals may also be hunted when they are found near the community (IN1). Polar bears (*nanuq*) are protected under a quota system, and can no longer be hunted freely (MJ1), but they are valuable in terms of their hide, meat, and sport hunt guiding opportunities. In the spring, Canada Geese and Snow Geese are important targets as they migrate northward (AN1; JM2; OM2). Beluga whales (*qilalugait*) and narwhals (*alanguait*) are sought from the spring to the fall along the ice edge or in open water (AN1; EP1; JM2; KS1; SS1). Therefore, sea ice is an essential platform for hunting many of the marine birds and mammals important to community members in Cape Dorset. However, it is also an important means of accessing other staple animals such as inland Arctic char fishing lakes, caribou feeding grounds or migration routes, and fox trapping trails (AN1; EP1; JM2; MK2; MS1; NP1; OM2; PP1; QT1; SK1).

#### 4.3.2.1 Conditions

Seals are hunted from the ice, or by boat in the open water (AN1; EP1; OO1). Around Cape Dorset it is common to set seal nets in annual *naggutiit* (AA1). Hunters also follow *naggutiit* looking for seal breathing holes (AE1; AP1; NP1; SK1), or they wait for seals to pop up in *ajurait* (AE1; EP1; OM2). Seals are also hunted in the open water of *saqvait* (Figure 4-19), where hunters wait at the *qullinaq*, the south side of a *saqvaq* (AA1).

“The word *qullinaq*, [I] use depending on where, let’s say me and you were standing outside of a *saqvaq*, and south side, usually hunters will wait on the south side no matter where the wind direction is coming from. Seals are popping up on the north side. If they pop up on the south side the currents are a little too strong in this area, so they pop up on the north side and kind of float down [to where] the hunters are waiting. They have either their hooks or their harpoons ready, [so they can] hook it or harpoon it right away or else it’s going to go right down the ice you’re just going to lose it.” (Alasuaq, 2004)

Boats are used to retrieve seals at *saqvait*, or at the *sinaaq*, where currents may be taking them away from the ice edge (Figure 4-19) (IN1; NP1). Some hunters wait for seals at their breathing holes in the winter (MK1; OM2), but this is no longer such a common practice as it is often easier to hunt seals with nets, at *saqvait*, or at the *sinaaq*. However, in the fall when the ice is still relatively new (*sikuaq*) it is easier to hunt seals (QT1). Their breathing holes are identifiable (even at a great distance, 1km or so) because of the little ‘tent’ that seals form as they poke through the ice (MJ1). This also makes travel and hunting more dangerous though, so hunters have to be careful at the same time (MJ1). In the spring, when the desirable seal pups (for their meat and skins) (KS1) are basking on the ice they are popular targets (MK1; SS1).



**Figure 4-19:** Hunters wait and watch for seals at a *saqvaq* nearby Cape Dorset (left). Boats are often used to retrieve seals from open water (right). (photos: Gita Laidler)

Walrus tend to be hunted by boat off the *sinaaq* in the winter, or in open water in the summer (AA1; AN1; EM1; EP1; IN1; MS1; OO1; PP1). A walrus (or a seal) sitting on top of either a rock, or more commonly the ice, is termed *uttuq* (EP1). However, if walrus are resting

on top of the ice it is usually on moving ice, and rarely on landfast ice. They are usually in the open water where the ice is broken up (EP1; MJ1; MS1). Therefore, going hunting for walrus (or seals) on ice is termed *uttuniaqtuq* (MJ1).

“Certain times of the year [the walrus] will be traveling some place else...Usually all winter-long [we] try and go there usually around full moon, full moon time, that’s when walrus are in that area. Other times there are some, but not as many as when it’s full moon time. So the moon has something to do with a lot of our movements and our animals.” (Petaulassie, 2004b)

#### 4.3.2.2 Locations

Seals can be hunted nearly anywhere there is sea ice present. However, some of the popular areas indicated for seal hunting were east of Cape Dorset off the *sinaaq* (Figure 4-20a); and in large expanses of Andrew Gordon Bay (near *Ikirasak* Passage, and offshore from *Aqiatulaulavik* Point (Aqiatulavik on the map)) (Figure 4-20b). Furthermore, the maps showing *naggutiit* (Figure 4-8) and *saqvait* (Figure 4-15, a, b) are also areas that are attractive for seal hunting.

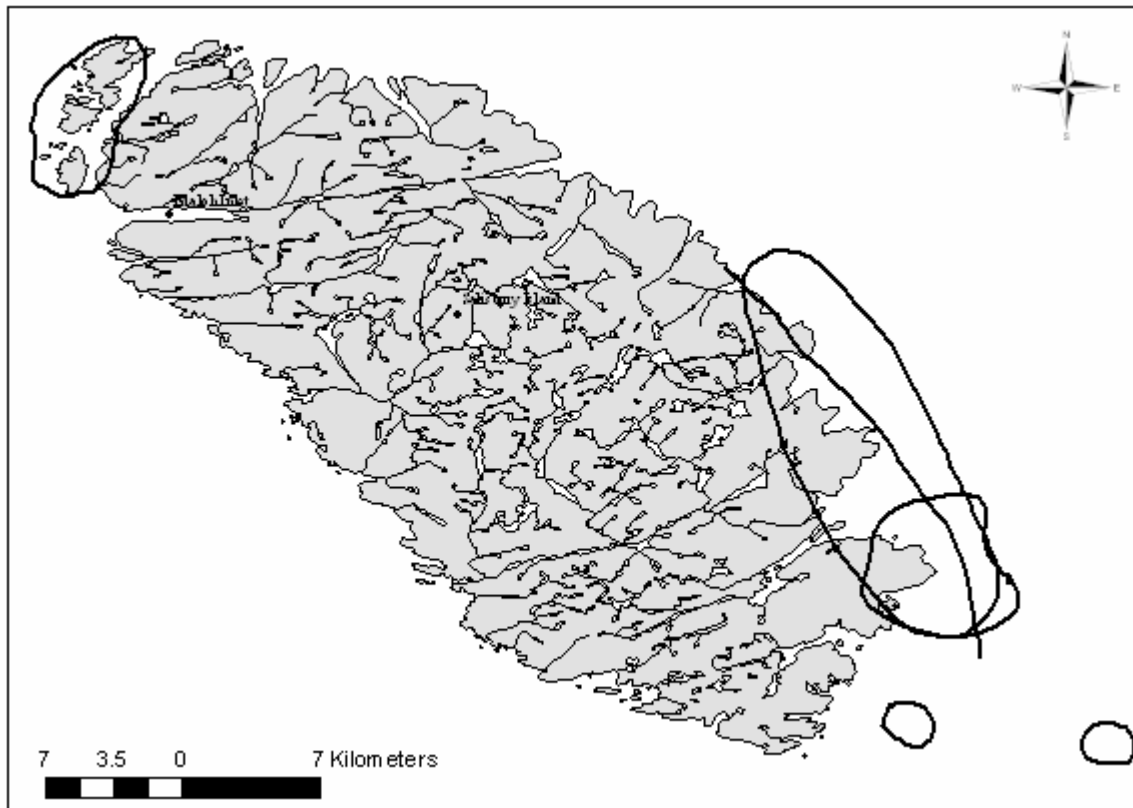
Walrus are mainly accessed using boats, in open water, winter or summer. Therefore, walrus hunting grounds follow the winter *sinaaq* closely, extending westward from Cape Dorset. The *sinaaq* and walrus hunting grounds are relatively near to the Baffin Island shoreline as the strong Hudson Strait currents keep ice formation within bays and inlets. Another popular walrus hunting ground is further south, on the east coast of Salisbury Island (Figure 4-21a). This area is accessed by boat and is thus predominantly a summer destination. Other walrus hunting grounds include the northwestern point of Salisbury Island and northeast of Cape Dorset just offshore between Negus Bay and Pudla Inlet (Figure 4-21b).

#### 4.3.3 Wildlife habitat

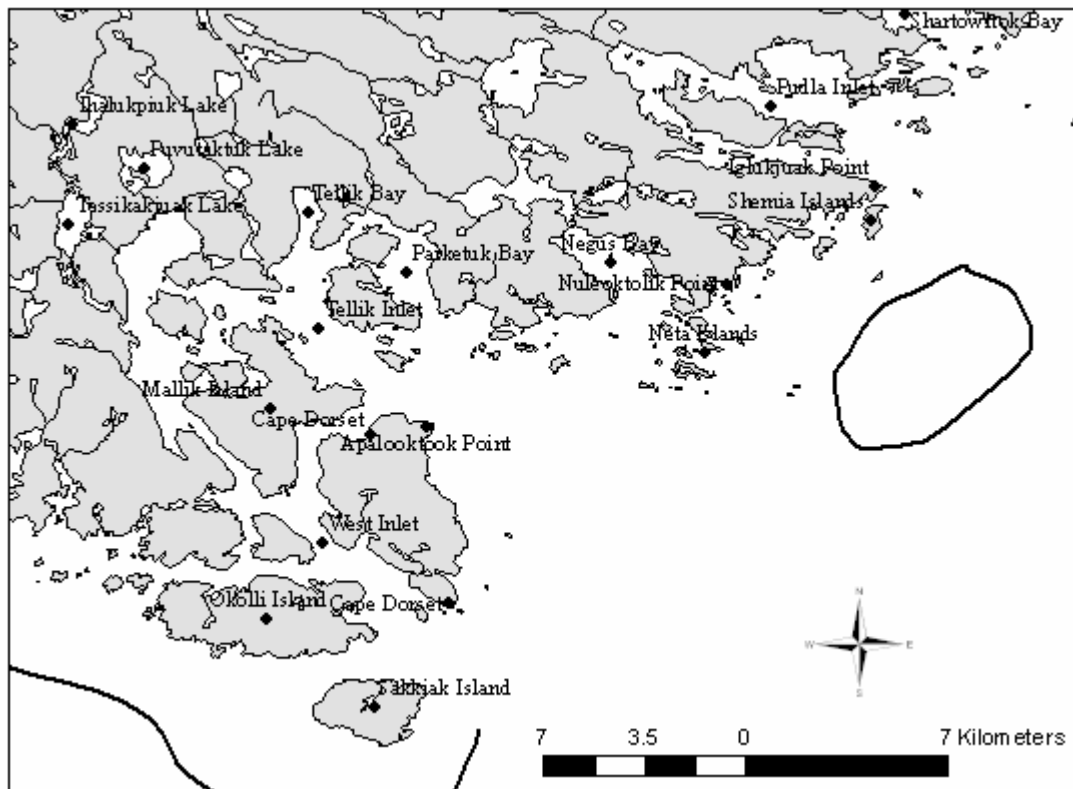
Beyond the importance of sea ice for travel and hunting, it is also habitat for many of the wildlife already mentioned. Arctic animals are uniquely adapted to the cold climate as well as to the cold and frozen seas. A full description of sea ice use by different species is beyond







a) Common walrus hunting areas around Salisbury Island. Sources: AA1; AE1; IN1; PP1



b) Common walrus hunting areas around Cape Dorset. Sources: AN1; EP1; OM2; QP1

**Figure 4-21:** Maps showing common walrus hunting areas around Salisbury Island (a) and Cape Dorset (b).

the scope of this thesis. However, Inuit and their use of the sea ice is intricately involved with wildlife use and habitat. Therefore, statements of sea ice as habitat frequently entered interview discussions and are thus included here.

“[E]ven animals they use the ice, pretty much like humans do. They use it to catch whatever meal is available on the ice. It’s also their travel route, sometimes they will, certain seals will sleep inside a hole that they had made. It’s also a home to some animals that live out there. And depending on how far the *sinaaq* is, fish will be traveling through there to certain areas like where there’s rivers.” (Mikigak, 2004b)

Habitat at the ice edge, mainly referring to the *sinaaq* but also to *saqvait*, is important to a variety of bird and mammal species, making it one of the more dynamic and biologically productive areas relating to sea ice. Ringed seals, bearded seals, and walrus are found on or near the ice all year round. In the spring time, marine birds such as eider ducks (*mitik*), guillemots (*pitseolak*), murrelets (*arqak*), seagulls (*naujaq*) and even Canada (*nirliq*) or Snow Geese (*qanguq*), congregate at the *sinaaq* or *saqvait* to access their food (AN1; JM1; MK2; MS1; PP1; SS1). Cod (*ugaq*) live under the ice (AN1; MK2), while beluga whales and narwhals migrate along the ice edge in spring and fall (AN1; KS1). So, even animals that do not live on, or cannot go on, the ice are dependent on the habitat created by the freeze/thaw cycle.

“And also caribous use [the sea ice] a lot to go from one island to another or take shortcuts through the ice. Some animals will also use the same travel routes like caribous, foxes, or wolves. Some areas it’s all the same traveling-wise for some animals.” (Mikigak, 2004b)

Without the sea ice, many of the species would not be around (MK2).

Seals use the sea ice in the most extensive, and versatile ways. Ringed seals in particular use many different ice conditions. Always needing to breathe air, seals will either seek out open water, or areas of thinner ice to make breathing holes (*atluan*) (which could mean thin ice that is easy to break through, or breathing holes that they have maintained throughout the winter in thick landfast ice) (AA1; AE1; MJ1; MK2; MS1; NP1; OM2; OO1; QP1; SK1). This means that seals can be found in areas of extensive ice cover, in *naggutiit*, or in open water such

as at the *sinaaq* or *saqvait* (AA1; EP1; MK2; SS1). Ringed seals also make their dens on the ice, under the snow, hidden from inexperienced eyes (AA1; MK2; OM2). They seek out areas with large snowdrifts, or rough ice (e.g. between islands), to make their dens (MJ1; MK2).

“In the fall time [seals] make a hole where there’s islands around, when the ice forms. They make a little hole, from that hole they keep it open, the seal keeps popping up to that same hole. Over time the ice will thicken, and the seal will be busy in that hole later in the months. And there’s pups, there are seal pups (*natsian*) right now at this time of the year.” (Kellypalik, 2004b)

These dens are where the seal pups are born and raised (EE2). In each den the seal maintains an associated breathing hole and escape hole into the water, but there is no hole through the snow to identify them on the surface (MJ1). However, they can be easily identified if a hunter is aligned with the sun. In looking towards the sun small ice crystals sparkle over the dens, indicating that there are seals breathing underneath (AA1). These can also be identified by a polar bear’s sense of smell or hearing. Ringed seal (especially pups) are prime prey for polar bears, who break through the dens to access the seals below (MJ1; MS1). Furthermore, seals enjoy basking on top of the ice in the long hours of spring sunshine (EP1; QP1; SK1), while using the ice to molt and change their fur (EE2).

Walrus mainly lie on top of the ice (EE2; SK1), and would have their young either on ice or on dry land, but not in the water (MK2). Walrus stick closer to open water, either at the *sinaaq* or on moving ice pans further offshore (AE1; EM1; EP1; IN1; KS1; MJ1; MS1; OO1; PP1; QP1). The odd time walrus will create a breathing hole by breaking through solid ice, but it is rare that they will maintain it (MJ1). They migrate northwards in the spring to access food. It is said that they move north to get away from the ducks, that they do not mix well because they fight for the same food (MK2).

Beluga feed under the ice, where they can stay underwater for up to half an hour (MK2). The beluga around Cape Dorset are also the same ones that migrate further north to Igloolik in the spring (May or June), and back in the fall (August or September) (a similar

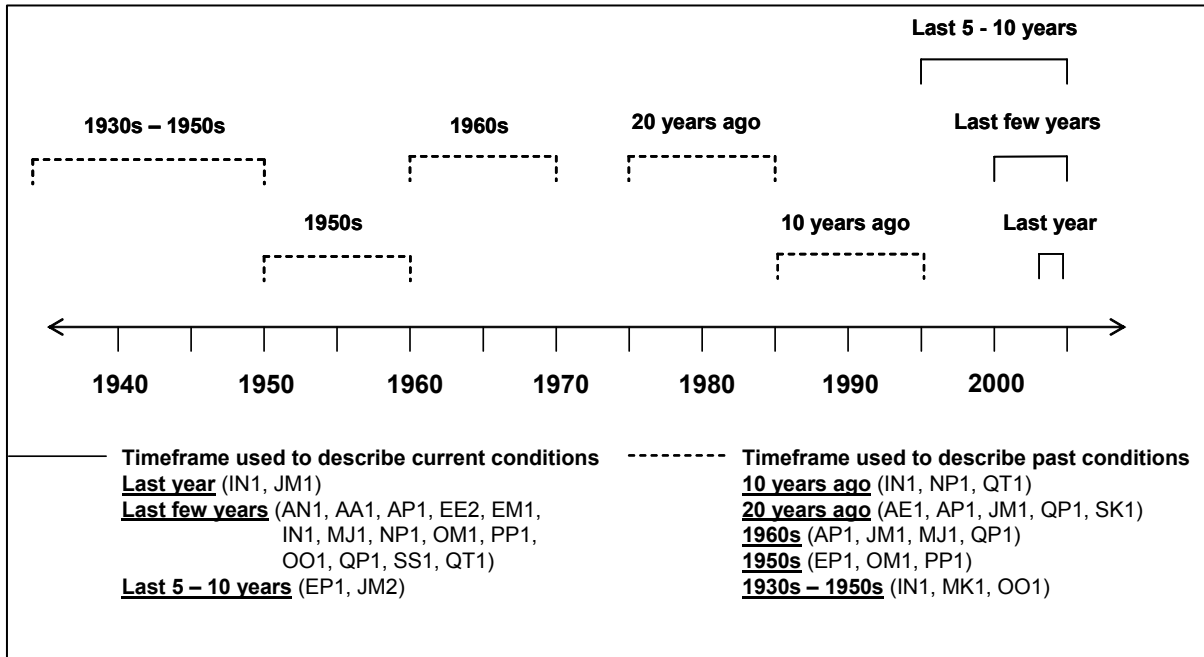
timeframe as the walrus) (MK2; OO1). They tend to stick along the *sinaaq*, or in areas of broken ice to enable easy breathing access (MJ1).

Sea ice is used extensively by humans and wildlife alike. People are accustomed to yearly variations in ice conditions and timing, and yet increasingly consistent shifts are being noted that are affecting both sea ice use and safety.

#### 4.4 Observations of change

Community members in Cape Dorset have observed, and are experiencing, considerable change in their local climatic and sea ice conditions. When discussing change it is important to be aware of the timeframes used to assess change as they vary depending on the individual and the phenomenon in question. Figure 4-22 summarizes the timeframes referred to within the interviews conducted. Observations of change have been noted mainly in the last few years (indicated as approximately 2000 – present), but some indications of change were discussed as early as ten years ago (Figure 4-22). Most recent changes included increased snowfall, ice thinning, more break-off events at the *sinaaq*, increased presence of open water, closer *sinaaq* position, altered freezing processes and timing, and different wind directions. In contrast, the time periods of comparison (i.e. expected conditions) vary from ten to seventy years ago (Figure 4-22). However, in general, the 1960s are used as a baseline reference for expected freeze-up timing and processes, as well as *sinaaq* location. Furthermore, several elders used their childhood and adolescent years as an important reference point (i.e. 1950s and earlier – estimated based on their birth dates).

“[T]oday’s weather is not even close to same as what it was when [I] was growing up. Nowadays [I] listen to a lot of radio, there’s more accidents that have to do with ice nowadays. But [I] also hear that it’s getting warmer up north. [I] don’t think it’s getting warmer up north, it’s just the ice is not freezing when it’s supposed to, and it’s breaking up a lot earlier than it used to. [To me] it doesn’t seem to be getting any warmer, it’s just that the ice is not freezing at the time [it is expected to] and not breaking up at that certain time of the year, it’s a lot sooner than that now.” (Mangitak, 2004a)



**Figure 4-22:** Summary of the timeframes used in interviews when discussing observations of sea ice change.

There are a variety of indicators that elders and hunters use to gauge change. The most commonly referenced include: i) the position of the floe edge (*sinaaq*); ii) weather/seasonal temperature or predictability; iii) freeze-up processes and timing; iv) break-up processes and timing; and v) ice thickness. The predominant changes observed according to these indicators are summarized in Table 4-3, and additional changes are noted in Section 4.4.6.

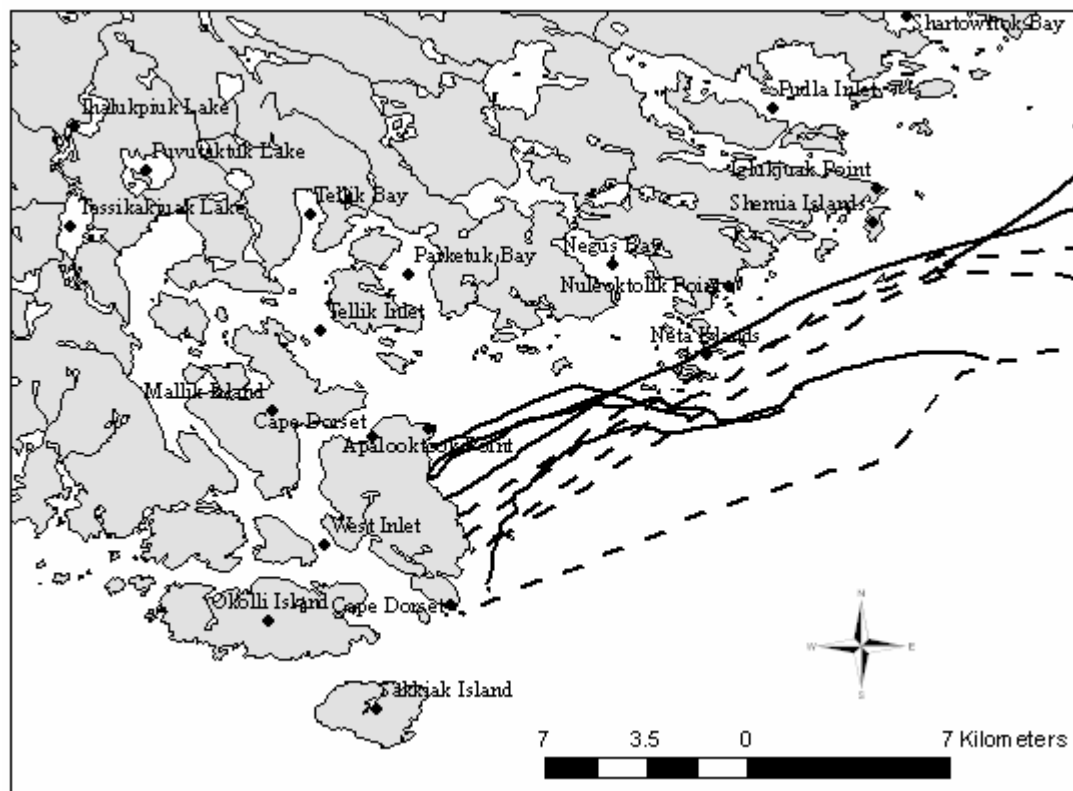
#### 4.4.1 Floe edge

The location of the *sinaaq* is gauged based on the distance from town that it has formed. Inuit elders and hunters consistently mention the *sinaaq* as being closer to town (Table 4-3), often using *Aupaluqtuq* Point (Apalooktook on the map) as a reference (Figure 4-23). *Naggutiit* normally formed at this nearby point (Figure 4-8), but more recently it is where the *sinaaq* is located (EP1; MS1; NP1; OM2).

**Table 4-3:** Summary of observed indicators and associated changes around Cape Dorset. The number of observations refers to the number of interviewees that mentioned this change.

Sources: AA1; AE1; AN1; AP1; EE1; EE2; EM1; EP1; IN1; JM1; JM2; KS1; MJ1; MK1; MK2; MP1; OM1; OM2; OO1; PP1; PP2; QP1; QT1; QT2; SK1; SS1

Indicator	Change	# of Observations
<b>Floe edge (<i>sinaaq</i>)</b>	a) Closer to town	a) 14
<b>Weather</b>	a) More unpredictable b) Different c) Warmer	a) 5 b) 6 c) 6
<b>Freeze-up</b>	a) Takes longer/freezes slower b) Occurring later c) More watery d) Not as solid	a) 4 b) 8 c) 1 d) 3
<b>Break-up</b>	a) Melts/breaks up earlier b) Melt stages happen faster	a) 10 b) 1
<b>Ice thickness</b>	a) thinner	a) 12



**Figure 4-23:** Delineation of the changes observed in *sinaaq* location over the past ten years.

Sources: AA1; IN1; MS1; PP1; QP1

Where: - - - = previous *sinaaq*      — = recent *sinaaq*

“[T]he ice from years ago, the ice would form all the way down almost to the point, but if it was still like that today the cracks would start from *Aupaluqtuq*, if the ice was still in there. But since the ice hasn’t formed all the way down there anymore the ice will be, the floe edge will be around *Aupaluqtuq* area, and then just before that is where cracks would be forming, depending on the month. Like full moon month, we have seven months that are winter here, about that many times it will start breaking off in that area and will freeze over again. But this area here, it doesn’t go that far anymore, but it used to.” (Saila, 2004)

Ice at the edge was also noted to break off more frequently in recent years, without warning (SK1).

#### 4.4.2 Weather

Elders and hunters find weather to be more unpredictable and generally warmer (Table 4-3). Traditional weather prediction skills and indicators (e.g. winds and clouds) are no longer considered reliable (AE1). Some people even feel like they would be lying if they tried to predict weather variations over a few hours or days (QT1).

“As far back as [I] can remember winds usually came in from the north. But today it’s even in the fall, summer, spring time winds are coming from all directions not from one direction anymore. If there was a whole bunch of students that asked [me] for advice on what kind of weather it would be tomorrow, if [I] was to look to out there at the weather now and if it was 20 years ago [I] would predict what kind of weather it would be in the next couple days. But if [you] were to ask [me] what weather we’re going to have like next couple days, and if [I] tell [you] [I] would probably be lying because the weather changes in a matter of more like minutes than days now.” (Tapaungai, 2004)

Even weather forecasts received over the local radio are not deemed reliable. They are often opposite to the current conditions, leading to some people being stranded on the land when relying on weather forecasts (AE1, QT1).

“[I] could predict weather a few years back, but today [I] wouldn’t be able to predict. [I] can guess if [you] were to ask [me] what it would be like tomorrow, [I] can only guess because even weather forecaster people are announcing weather changes. Usually it’s the other way around now, even though the radio is telling us it’s going to be nice today, it’s a blizzard, or it’s going to be a blizzard it’s nice, usually the opposite of what the radio says now. So even our weather people are making mistakes now, even though they’re using computers to see what the weather is going to be like.” (Tapaungai, 2004)



In addition, the fall and winter seasons seem consistently warmer (AN1, OO1, QP1, QT1, SK1). This is partially indicated by the decrease in ice crystal formation on people's faces and parka hoods (AA1) but also perhaps because people are not spending as much time outside (AE1).

Despite some comments on general warming of the weather, there were also several postulations that it is the ocean – and not the air – that may in fact be warming (AE1; AP1; SK1). This increased water temperature may be a key contributor to closer *sinaaq* proximity, thinning sea ice, and alterations in freeze-up and break-up timing (IN1; QP1; SK1).

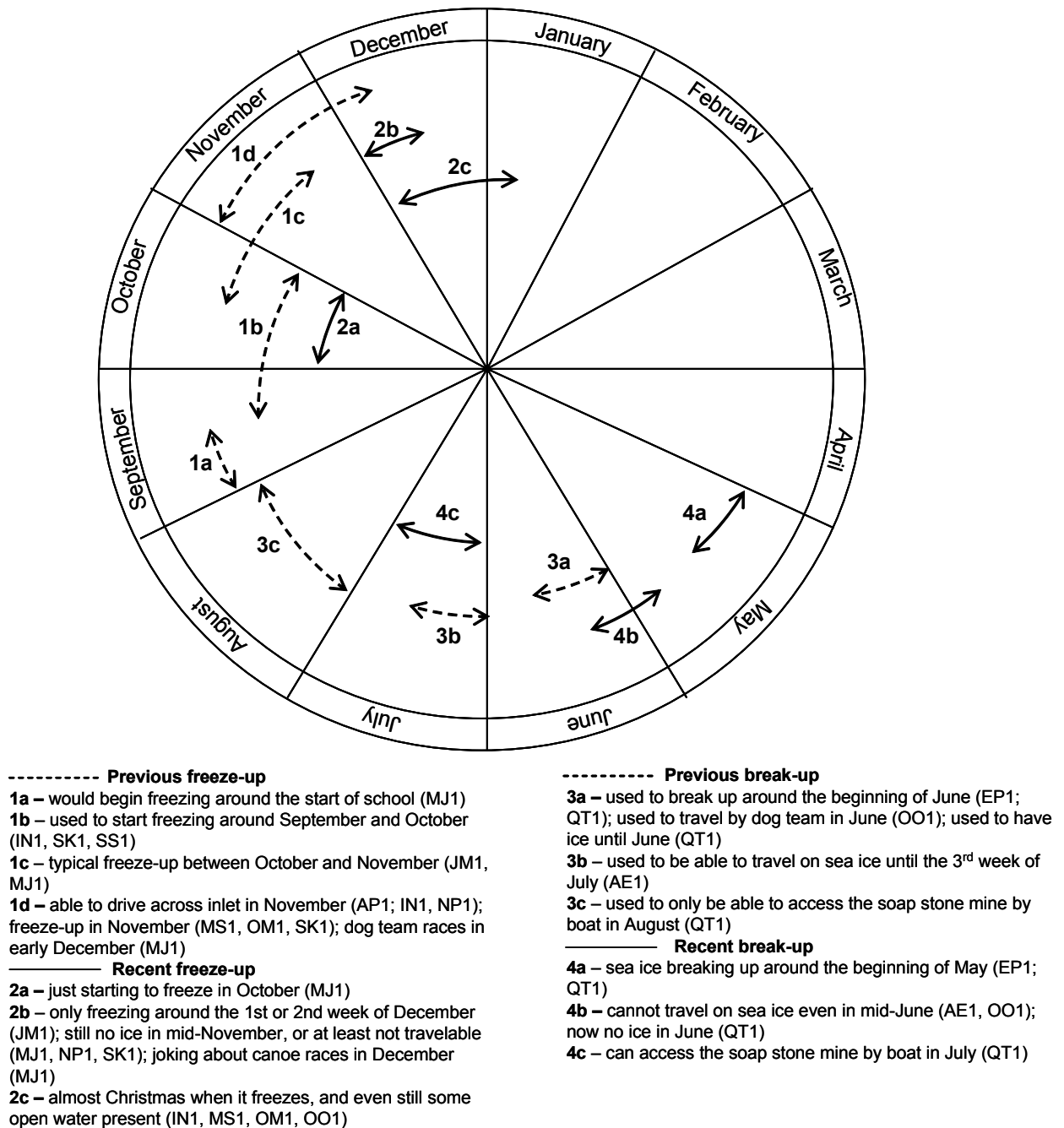
#### 4.4.3 Timing of freeze-up

“[I]t's definitely not the same nowadays, especially around Christmas time. [Just] this past Christmas we still had open water in our inlet. In November when [I] was growing up, November was the time when [we] could, everybody, anybody could go on a dog team in November.” (Ottokie, 2004)

Freeze-up is generally occurring later, taking longer to form travelable sea ice, and some of the expected freezing stages (and associated terms) are no longer happening (Table 4-3). Figure 4-24 provides a visual depiction of the temporal change in freeze-up timing, typically gauged according to when: i) sea ice first begins to form; and, ii) the sea ice travelable by dog team or snowmobile. To summarize the temporal change shown in Figure 4-24, the beginning of the freezing processes are occurring approximately one month later than in the past (i.e. October – December instead of September – November). Similarly, the ice is not formed solidly enough for travel until later in December in recent years, while previously people were traveling on the ice as early as late October. Changing winds are potentially linked to later freeze-up dates, as more unpredictable winds, and from different directions (shifting to more easterly and southerly winds), break up the ice and prevent solid formation (AN1; EP1; KS1; MJ1; MS1; NP1; OM1; OO1; QP1; QT1). More winds, especially from the southerly directions, also create rougher ice formations (e.g. *sikuliaq* forming more roughly in

recent years) (AN1; AP1; QP1; QT1) and affect the position of the *sinaaq* (SK1). Furthermore, some stages of the freezing processes seem to be skipped (AP1), such as:

- no *qanguqtuq* (AA1)
- no *qaikut* (AP1)
- *ilu* not happening anymore (AP1)



**Figure 4-24:** Summary of the changes in freeze-up and break-up timing observed in Cape Dorset.

The ice used to freeze from the bottom of the low tide area, but this process does not seem to happen anymore (AP1, IN1). Furthermore, when *naggutiit* used to open up they would refreeze smoothly and were thus important for hunting and travel. Now they are re-freezing more roughly but they are still used for hunting (AP1).

#### 4.4.4 Timing of break-up

[I]n June [we] used to go by dog team. But now [we] don't even snowmobile in this month of June, it doesn't look like it's going to happen again. Because [we] used to go by dog team, and snowmobiling in June, but now nobody goes dog teaming or snowmobiling in June." (OO1)

Break-up is generally occurring earlier in the spring than would have been expected in the past (Table 4-3). Break-up timing is often referred to as when the sea ice is no longer travelable, as well as when the ocean is ice-free (and boating is possible). Figure 4-24 summarizes the temporal change in break-up timing, alongside the freeze-up timing discussed above. The off-set in break-up timing is approximately one month, as well as for the ice-free season. It used to be possible to travel on the sea ice in June and into July, whereby boat travel (especially in relation to accessing a soap stone mine eastward along the coast) was not possible until August (Figure 4-24). However, in recent years the ice begins to break-up in May, is rarely travelable in June, and the ocean is ice-free in July (Figure 4-24). This allows earlier boat access to the soap stone mine. Some travel routes are no longer as safe because they are melting sooner and opening up earlier (AE1, QT1).

"[T]he ice that has formed around this coast, nowadays it's been melting a lot sooner. Even beginning of winter, or in the middle of winter, [we] have to be extra careful now traveling through ice, even though it's in the middle of winter. [We] have to be extra careful nowadays because there's a lot of dangerous spots now." (Tapaungai, 2004)

The deterioration process is noted to be occurring faster due to thinner sea ice (QT1), making it more unpredictable in terms of safety (OO1).

#### 4.4.5 Ice thickness

Sea ice was consistently described as being thinner than in the past (Table 4-3). These observations are based upon a few key indicators:

- seal breathing holes are no longer as deep or tunnel-like (AA1)
- ice at open cracks is no longer as deep (JM1, QP1)
- ice is thinner in comparison to personal height – usually gauged when drilling a fishing hole or setting seal nets (Figure 4-25) (PP1)
- travel routes are not as sturdy or solid as previous years (e.g. more open water on the winter soap stone mine route, which can also link Cape Dorset to the community of Kimmirut) (AE1, JM1; NP1)
- multi-year/moving ice are smaller and not present as frequently (AN1)

These methods of ice thickness evaluation make it difficult to determine an overall measurement of thickness change. They are comparative in nature, and the absolute change will depend on the area and related conditions.

“No, we don’t measure, like because we don’t fish in the salt water ice, but last year we’ve noticed, in the later part of the season the ice started to break off in big, very large chunks. Yeah, breaking away, and then you know closer to Dorset the ice never got very thick. But it was safe to travel, but not thick thick you know?” (Manning, 2005a)



**Figure 4-25:** Atsiaq Alasuaq checks his seal net in a *nagguti*. This is one way that hunters are always aware of, and evaluating, ice thickness.

Where comparisons of personal height were demonstrated, ice thickness changes of approximately 0.5m were indicated, while in other cases changes were more like 0.2m or less. Thinning ice is also indicated by the formation of new *saqvait*, and more open water seen during airplane flights between communities (JM1).

#### 4.4.6 Wildlife

In addition to the sea ice changes mentioned in Sections 4.4.1 – 4.4.5, wildlife are commonly used indicators of change in Inuit culture. Because of the important relationship between humans and animals, there were some changes noted about polar bears, seals, and beluga whales that may be linked to changing ice conditions.

First, polar bears are being spotted in and around the community much more frequently than the 1960s and 1970s (MJ1; PP1; OO1). One possibility for the larger number of bears in town is that they are traveling further north from Hudson Bay because of deteriorating ice conditions in the south (PP1). Another suggestion is that there are more bears around now due to the quota system. Previously, any polar bear seen would be hunted, especially due to the rarity of such a sighting in the past (OO1). However, with the quota system each bear spotted cannot necessarily be hunted, and perhaps this is either affecting the size of the population, or decreasing the bears' wariness of humans (OO1).

“[E]specially in the past few years there has been more bears. Men in those days rarely caught polar bears. But today there are more men that catch them, he thinks there are too many bears now.” (Pootoogook, 2004)

Second, seal behaviour seems to be changing as they have been observed popping up more in *saqvait* (NP1) and even basking on top of the ice in the winter (QP1). This could be an indicator of thinner ice or warmer air temperatures. In addition, less bearded seals are being caught these days (NP1; OM2; QP1), which may be linked to changing seal behaviour or simply to the fact that they are not being hunted as often.

Finally, beluga whales are not sighted as often and their fall migration seems to be occurring later in the year now (OO1).

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To the elders and hunters interviewed in Cape Dorset the sea ice is very important, for traveling, hunting, and wildlife. They understand the sea ice processes around their community, and have been keenly observing changes to expected conditions and timing of events.

[N]ot too many people that know about these changes [are] talking about it on the radio, so there's been more accidents than there would [otherwise] be. If there was more people that were letting the local people know about the difference of the ice from years ago, if somebody can do that everybody would be a lot safer." (OM1)

They want their knowledge shared with the younger generation of Inuit, and with scientists, to help educate people from the Inuit perspective. This chapter is a beginning in the sharing process. The means of learning across generations, and cultures, is discussed further in Chapter 8.

## Chapter 5 – Results

### *The importance of sea ice processes, use, and change around Igloolik*

“Sea ice, even though landfast, moving, free-floating, [I’m] constantly using it. If it wasn’t for ice anywhere [I] probably wouldn’t be where [I] am right now. It assists [me] in getting about, it assists [me] in hunting. [I] can be hunting either on landfast ice, moving ice, or free-floating ice, so [I] use all types of ice. Even in the summer, when [I] cannot get about on the landfast ice [I] still hunt on ice which is again free-floating ice.” (Palluq, 2005)

#### 5.1 Importance of sea ice

“[I]t’s very useful to [me]...[I] have used the ice in the past, [for] survival. [I] was born in 1943, the only source of heat was from what [we] caught, the only food source [we] got was from the sea. So therefore, [we] were using sea as much [we] did, as [we] do today. Again today [we] hunt constantly even though [we’re] not using seal fat as much for a heating source, [we’re] still using the meat to the same extent. So therefore, the use of the sea again, was always for hunting, and it’s still used for hunting.” (Arnatsiaq, 2004)

Sea ice is important because it is so useful (Qrunnut, 2004 (AQ1); Angutikjuaq, 2004 (Dan1); Aqiaruq, 2004a (DAq1); Irgnaut, 2004 (DI1); Qattalik, 2004 (DQ1); Ipkanak, 2004 (EI1); Kunuk, 2004b (EK2); Paniaq, 2004 (HP1); Palluq, 2005 (JaP1); Qaunaq, 2005 (LQ1); Uttak, 2004 (LU1); Arnatsiaq, 2004 (MA1); Qamaniq, 2004 (NQ1); Ammaq, 2004 (SA1)). Sea ice is an essential hunting platform, without which hunters cannot go hunting (AQ1; Taqqaugak, 2004 (AT1); DAq1; HP1; LQ1; Arnatsiaq, 2005 (JAn1); JaP1). For example, seal hunting is mainly conducted at polynyas, or through tidal cracks (AT1; DAq1). So as the ice progresses, the animals become accessible (LQ1). The frozen ocean surface also decreases travel time between destinations (Ikummaq, 2004a (TI1)). Once the ice has formed solidly it is like a shortcut (EI1), whereby following the coastline to get to camps would take much longer than the direct back-and-forth paths enabled by the sea ice (AT1). The land is rougher, requiring more detours and slower speeds; therefore sea ice travel can decrease travel time by hours or even days (TI1). But sea ice travel is not typically undertaken just for the sake of travel, it is mainly for the purpose of hunting, or reaching hunting grounds (JaP1; LQ1; LU1; MA1; Aqiaruq, 2004b

(ZA1)). Sea ice is used more often than the land for reaching important marine mammal hunting grounds (e.g. for polar bear, walrus, seals) (AT1; LU1), and it also enables travel across Fury and Hecla Strait (*Ikiq*) to access terrestrial hunting grounds (e.g. Baffin Island caribou hunting and fishing, Melville Peninsula fishing (DAn1; DI1; EI1; LU1).

“[I] term ice as useful in that [I’m] still learning about it, even though...[I’ve] been using it for about 50 years...[I’ve] been using it constantly for the last 50 years. And looking at that, the usage [I’ve] had for it, and the uses [I] have today, are pretty much the same, in that [I] use it for harvesting marine mammals, and then [I] still use it to get to places where [I] hunt which are non-marine. Example, caribou, fish, [I] have to go through, on the ice in order to get to hunting places. So [I’ve] been using it in the past and [I] still use it today to harvest the same animals [I] was harvesting then as [I’m] harvesting today.” (Irngaut, 2004)

Therefore, people are relatively stranded on the island of Igloolik during transition periods where the ice is too thick to boat, but not thick enough to travel on (DQ1; JAn1; NQ1). In these times hunting access is limited, and hunters look forward to its formation to enable key transportation (DQ1; LU1). Once the ice forms the island is no longer distinguishable, and the community becomes connected to all other islands, and the mainland (JAn1; NQ1).

“Sea ice is very useful, in that we are on an island. [When it freezes], now we’re not on an island anymore, we’re now connected to everywhere, and that’s how useful the sea ice is to [me]. In that, even though we’re on an island, [I] don’t feel we’re on an island anymore.” (Qamaniq, 2004)

In addition, the moving ice was frequently emphasized as being important to the community of Igloolik (Ulayuruluk, 2004 (AU1); JaP1).

“[The] ice is very useful in that, especially moving ice, that’s the only place where you can get walrus in the winter, and walrus is one of the mainstays of Igloolik, and Hall Beach as well. So therefore moving ice, travel on moving ice was practiced, and it’s still practiced today because it’s crucial for hunting walrus.” (Ulayuruluk, 2004)

Moving ice hunting was critical for the survival of families in the past (AU1; EK2; LU1; ZA1), yet marine mammals remain important in community diets and lifestyles today. Many people still use the ice the same way now as they did in the past (AT1; DI1; DQ1; EI1; JaP1; LU1; MA1).



Some people even described sea ice travel and hunting as enjoyable and fun (AU1; DAq1; EI1; EK2), rendering the pursuit of marine mammals more than simply a harvesting activity, but a type of leisure engagement as well. Shelters (e.g. an *igloo*) can be built on the sea ice, when the snow conditions are adequate (NQ1; SA1), making sea ice a place that people can also live. Furthermore, old, multi-year ice (MYI) is an excellent source of drinking water, and is preferred to tap water when making tea or coffee (LU1; TI1). This MYI is also important in providing shelter from the winds and waves during open water boat travel in the short summer (Ivalu, 2005 (AI1); JaP1). When travelling from Igloolik to Baffin Island by boat (e.g. for caribou hunting), hunters purposely navigate through large pans or chunks of floating ice because travel is smoother and safer than in open waters (AI1).

In using sea ice for travel and hunting purposes, Inuit elders and hunters have developed an understanding of freezing and melting processes. Specific Inuktitut terms are used to describe ice conditions and transition stages that occur throughout the annual sea ice cycle of formation and decay. These also link to the floe edge, tidal cracks, and polynyas, as influenced by wind and current conditions. Local characterizations of these freeze/thaw and dynamic processes (Section 5.2) will thus be presented prior to discussing sea ice use (Section 5.3). These terms and processes are critical to the presentation of sea ice travel safety (Section 5.3.1) and marine wildlife hunting and habitat descriptions (Sections 5.3.2 and 5.3.3). It is also essential to describe the formation and decay processes as a background to the changes that are currently being experienced by elders and hunters in Igloolik (Section 5.4).

## **5.2 Sea ice processes**

The general order of freezing and melting processes in Igloolik, as well as links to the floe edge and tidal cracks, is shown in Figure 5-1. The processes are described to follow the diagram, so the reader is encouraged to refer to Figure 5-1 and Appendix 15 frequently to better understand the links and terminology presented in the following sections. Furthermore,



Appendix 4 acts as a map index for figures that show subset areas around Igloolik and in other parts of Fury and Hecla Strait. The moving ice is also highlighted separately because of its unique importance and uses to Igloolik (Section 5.2.1.6).

### 5.2.1 Freezing processes

#### *5.2.1.1 Near shore freezing*

Around Igloolik in the fall, sea ice freezing is described as beginning with the freezing of the ground, followed by ice formation around the tidal zone (between high and low tide) (AI1; AT1; AU1; DAq1; DI1; DQ1; EI1; Kunuk, 2004a (EK1); HP1; JaP1; LQ1; MA1; NQ1; SA1). Once the tidal zone is covered by ice, this frozen area along the shoreline is termed *qaingu* (Figure 5-1) (DAq1; DI1; DQ1; EI1; EK1; JAn1; JaP1; LQ1; MA1; NQ1; SA1).

“The ground on the land freezes first, so therefore there’s going to be open water while the ground is frozen, when the ground is frozen on the land. And the ground being frozen on the land creates the tidal zone to freeze up first. And once, the tidal zone gets covered by ice...it doesn’t necessarily float up but it stays on the rocks. Once that forms then you know that freeze-up will be following afterwards. And that, that tidal zone when it’s freezing is called *qaingu*.” (Aqiaruq, 2004a)

It is also known that bays will freeze over earlier and faster than the ice in open water (AI1; AU1; DAn1; EK1; LQ1) due to the influence of freshwater (DI1; JAn1; SA1) or the accumulation of MYI (EI1; LQ1).

#### *5.2.1.2 Open water freezing*

When the ice is first forming, it is constantly moving and thus grinding against other new ice (AI1; EK1). This process forms *qinu*, ice that is broken and not solid (slush-like) (Figure 5-2a) (DI1; EK1). As it collects together it slowly becomes thicker (EK1). As the ice begins forming in open water there might be areas that look like smooth striations (visible when it is windy), and these are termed *quvviquat* (Section 5.2.3.2) (Figure 5-1) (AU1; DI1; EK1; NQ1).

### 5.2.1.3 Sea ice thickening

The process of freeze-up is called *sikuvalliajuq* (DI1), whereby different types of freezing would have different names (e.g. *aggurtipaliajuq* (Section 5.2.3.2) (AI1; DI1; EI1; EK1)). In the early stage of freezing, the ice that forms into thin sheets and is still moving around is called *sikuaq* (Figure 5-2b) (AI1; AQ1; AT1; AU1; DI1; DQ1; EI1; EK1; JaP1; LQ1; MA1; NQ1; SA1; TI1; ZA1). As ice formation progresses open pockets of water (*nigajutait*) may remain in the ice because of wind or current conditions (Figure 5-2c) (AT1; AU1; JaP1; SA1; TI1).



a) *qinu*, slush-like early ice formation that begins in open water



b) *sikuaq*, the first layer of thin sea ice



c) *nigajutaq*, kept open during early freezing by winds or currents



d) *nigajutaviniq*, a *nigajutaq* that has frozen over

**Figure 5-2:** Photos of early open water freezing and sea ice thickening, including: *qinu* (a), *sikuaq* (b), *nigajutaq* (c), and *nigajutaviniq* (d). (photos: Gita Laidler)

“When it starts freezing, like for example this is frozen, and you have open patches of water. Again, if there’s a bit of wind, those are kept open by the wind action, by the wave action, water is constantly moving so therefore it’s not freezing. Those we call *nigajutaq*, it’s a water, it’s not a polynya, it’s just water that’s staying open caused by the wind. And as it thickens, those can be open as everywhere else is thickening.” (Ammaq, 2004)

When these do freeze over they become *nigajutaviniq*, “it used to be a *nigajutaq*” (Figure 5-2c) (TI1). When the ice is frozen, but it is still flexible and moves with travel, it is *sikuriaq* (estimated at approximately 1 - 1 ½ inches, it is possible to walk on but not drive on) (AQ1; AT1; AU1; LU1; MA1). In general, young ice is termed *sikuqaq* (AT1; LQ1; SA1). When it is freezing smoothly without any snowfall it is known as *quasalimajuq* “it is slippery” (Figure 5-1) (LU1). However, there can also be patches of crystal formations that appear to be ‘puddles’ or blotches of crystallization where the ice has not formed as solidly (*niuma*, *niumakjuaq* if they are large) (Figure 5-3a, b) (AQ1; JAn1; JaP1; MA1; NQ1; SA1; TI1). These areas indicate that the ice will be thickening (NQ1).

“After the *sikuqaq* stage, if you see it’s starting to whiten, [I will] know for a fact that crystallization occurs in that you now have white patches that look like snow. But that’s more frost, frost, or crystallization of ice that’s forming and it looks like snow, and it comes out in patches, that is called *niuma*. And after that stage it progresses to even something bigger, it keeps adding on, and then it becomes *niumakjuaq*, in that *niuma*, *juaq* meaning “big”. So it progresses from *niuma* to *niumakjuaq*.” (Ammaq, 2004)



a) *niuma*, white patches of crystallization that look like snow      b) *niumakjuaq*, large *niuma*.

**Figure 5-3:** Photos of *niuma* (a) and *niumakjuaq* (b) on the ice surface. (photos: Gita Laidler)

If snow does accumulate on *sikuqaq*, or newer ice, it will cause thinning (DAq1; DI1; DQ1; EI1; EK1; HP1; JaP1; LQ1; LU1; MA1; NQ1; TI1; ZA1). The snow will insulate and melt the ice, causing *puimajuq* (a slush-like formation) and the freezing process will begin again from an earlier stage (Figure 5-1) (MA1; NQ1). But if it continues thickening without snow, it becomes *sikusaaq*, which is solid enough for travel (AQ1; LQ1). Sea ice progresses in thickness to become *tuvaruajjuqtuq* (“it is now partly *tuvaq*”) (AQ1; DI1). Thicker ice is then called *siku*, a general term for sea ice (DI1; EK1; NQ1; TI1), *sikuvik* (approximately 1 foot thick) (AQ1; EI1; LQ1), and finally *tuvaq* (thick landfast ice, anything thicker than *sikuvik*) (Figure 5-4a) (AQ1; AU1; DI1; EI1; Qulaut, 2005 (GQ1); LU1; MA1; NQ1; TI1). Once snow has accumulated on the ice it becomes *apulliq* (i.e. snow-covered) (Figure 5-4b) (DI1; MA1; TI1), although some people also refer to *tuvaq* as snow-covered (DI1). At this thickness, snow no longer contributes to thinning (DQ1; EI1; LQ1; MA1; TI1; ZA1). If no snow had accumulated, it would be *aputaittuq* “it does not have any snow” (Figure 5-1) (DI1). In general, as the ice progresses, the terminology moves with the formation of the ice. As the ice thickens it gets older and is referred to as *angajul/iq*, whereas any ice that is newer/thinner will be called *nuqaql/iq* (AT1; DQ1; MA1; SA1). These same terms are used to refer to relative age, older or younger, in people (AT1), so they are general descriptive terms. Similarly, *nutaq* and *nutaaviniq* are also used to refer to newer and older ice, respectively (AT1; DQ1).

#### 5.2.1.4 Tidal cracks

Cracks are usually formed by the movement of the sea ice, from contraction or expansion in the freeze-thaw process, or from the force exerted by winds and/or currents. Major tidal cracks often form in the same location annually, and go through cycles of cracking, opening, and re-freezing through the winter in synchronization with the lunar cycle (Section 5.2.3.4) (AQ1; AT1; DAn1; DAq1; DI1; DQ1; JaP1; LQ1; LU1; MA1; TI1). There are specific Inuktitut terms for cracks occurring in *tuvaq* or along the floe edge (Figure 5-1). Within the





a) *tuvaq*, solid, landfast ice

b) *apulliq*, ice with snow accumulation

**Figure 5-4:** Photos of ice that has become landfast (i.e. *tuvaq*) (a) and has snow accumulation (i.e. *apulliq*) (b). (photos: Gita Laidler)

solid *tuvaq* cracks tend to occur between points of land, running from land to land (AQ1; AT1; DAn1; DAq1; DQ1; HP1; JaP1; LU1; MA1; NQ1; SA1; TI1; ZA1). When these occur in the winter, in cycles of opening and re-freezing, they are *nagguti* (Figure 5-1, 5-5a, 5-6) (AQ1; AT1; DAn1; DAq1; DI1; EK2; HP1; LQ1; LU1; MA1; NQ1; TI1; ZA1). In contrast, cracks that originate in the *tuvaq* (e.g. a point of land or where MYI has anchored to the sea floor and become lodged in the new ice) and meet the floe edge (i.e. land/ice to water) they are termed *napakkuti* (Figure 5-6) (AQ1; AT1; DI1; EK2; GQ1; LU1; MA1; NQ1; ZA1). It is the same process of formation as the *nagguti*, but because they reach the floe edge they have a different name (AQ1). In addition, a crack that opens and then creates a peaked ice feature when it is pushed back closed is referred to as a *quglukniq* (Figure 5-1, 5-5b), and they form more commonly in the northwestern part of *Ikiq* before Labrador Narrows, and in Murray Maxwell Bay (Figure 5-6) (AQ1; AT1; DAq1; DQ1; EI1; EK2; HP1; JaP1; LQ1; LU1; TI1; ZA1). Sometimes a *nagguti* will even become a *quglukniq* over the winter depending on the forces acting on the ice (AT1; DAq1; EI1; EK2; HP1; JaP1; LQ1; LU1; ZA1).





“Moving onto cracks, the cracks that occur on landfast ice that are going from land to floe edge, those are called *napakkuti*...They break up pretty much the same time as [the *naggutiit*], where a new moon, full moon, creates them to open, but the name difference derives from being from land to sea, to the floe edge, whereas this is from point of land to point of land, and that would be called *nagguti*...And also, it goes for any crack be it the one going from land to sea, or from land to land, at high, the strength of the moon, when it's full moon or new moon it breaks. It breaks, and then all of a sudden it closes, and then it creates this action. It's open down here, underneath, but the ice is being pushed together, pushes it up. So therefore it is now called *quglukniq*, and again that's describing what has happened. It isn't named specifically, that describes what is happening...These can be *nagguti*, as long as they're open, flat, and then they freeze over. But at the point in time when the ice gets together and it creates that [peaked formation], then it changes name all together. It's the same crack mind you, but it changes name all together, from *nagguti* to *quglukniq*.” (Taqqaugak, 2004)

Sometimes a *nagguti* stops and then continues in a different location, this continuation is termed *pilagiatinniq* (AI1; DQ1; LQ1; LU1; NQ1; SA1). In the spring, a *nagguti* that opens and does not re-freeze is termed an *aajuraq* (Figure 5-1, 5-5c) (HP1; JaP1; NQ1; TI1; ZA1). Distinguished from cracks in solid ice, cracks along the floe edge – within moving ice – are usually created by the movement or grinding of ice against the *tuvaq*. For example, when the moving ice touches *tuvaq* a long, thin crack may be created outwards from the floe edge through the moving ice (*quppirniq*) (Figure 5-6) (AI1; AT1; DI1; DQ1; EK2; LQ1; NQ1; SA1; TI1;). These usually correspond to areas near land, or key reefs (Section 5.2.1.5), and refer to the ice “parting” or “opening” (DI1; DQ1; EK2; LQ1).

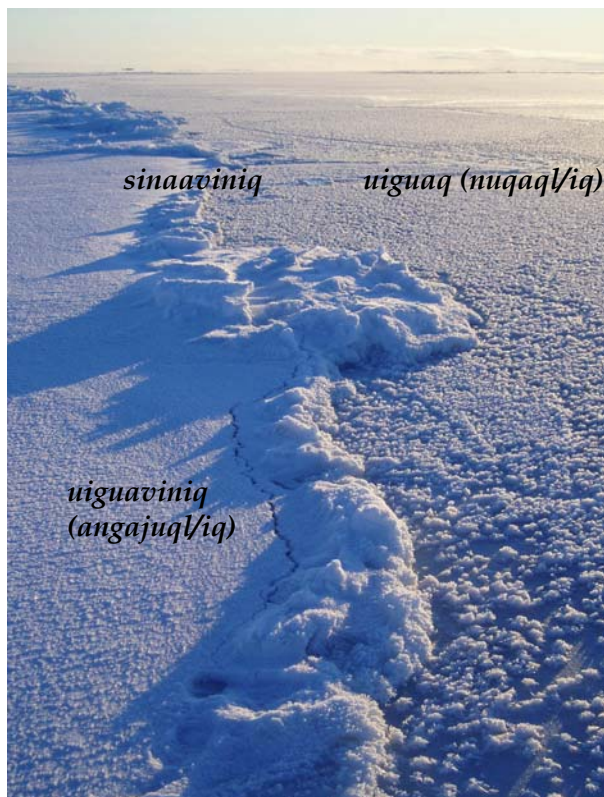
#### 5.2.1.5 Floe edge

The floe edge is termed *sinaaq*, and any addition to the floe edge is *uiguaq* (Figure 5-1, 5-7a, b) (AQ1; AT1; DAq1; DI1; DQ1; EI1; EK1; EK2; GQ1; JaP1; LQ1; LU1; MA1; TI1; ZA1). But just prior to the establishment of *uiguaq* is a lesser mentioned narrow portion along the floe edge where thin ice is just forming – the *atirriaruti* (AT1; DI1; EK2; LU1). As *uiguaq* progressively freezes away from the edge, the old floe edge will be delineated by an edge of rough ice (*sinaaviniq*) (Figure 5-1, 5-7a) (DAn1; DQ1). If the *uiguaq* were to break off, or if new

ice were to form beyond the *uiguaq*, the small part that is left behind (or the 'older' *uiguaq*) would become *uiguaviniq* "it used to be *uiguaq*" (Figure 5-1, 5-7a) (AQ1; DI1; GQ1; LQ1; ZA1).

"*Sinaaq* meaning the floe edge. *Uiguaq* meaning what's adding on from the existing floe edge to the new one, and that's called *uiguaq*, and it occurs right through the winter. It breaks off, it occurs, it adds on, it breaks off, it adds on. It doesn't add on very much, like the *sinaaq* that [I'm] referring to would probably be here [using map], and it stays here pretty much right through the winter. Ice forms, it breaks off, ice forms again... And every time it breaks off the new ice that had formed comes all out. But sometimes it leaves some behind, like this part might be left behind, [and it would be] called *uiguaviniq*. It was *uiguaq* at one point, now it's solid ice, and hunters know it by *uiguaviniq*." (Qaunaq, 2005)

Therefore *uiguaviniq* is also *angajuq/iq* in comparison to *uiguaq* (EK2; LU1; ZA1). If the new ice forms smoothly without any snow or crystallization it is *qangusirsimajuq*, but when seeming ice crystals have formed on the ice it is known as *qanguti* (Figure 5-1, 5-7) (DI1; SA1). This would be present around the floe edge or on moving ice (DI1; SA1). Similar to *qanguti*, *uiguaviniq* tends to have *niumakjuaq*, large crystallized ice formations caused by the condensation near the *sinaaq* (Figure 5-1, 5-7) (AQ1; JaP1).



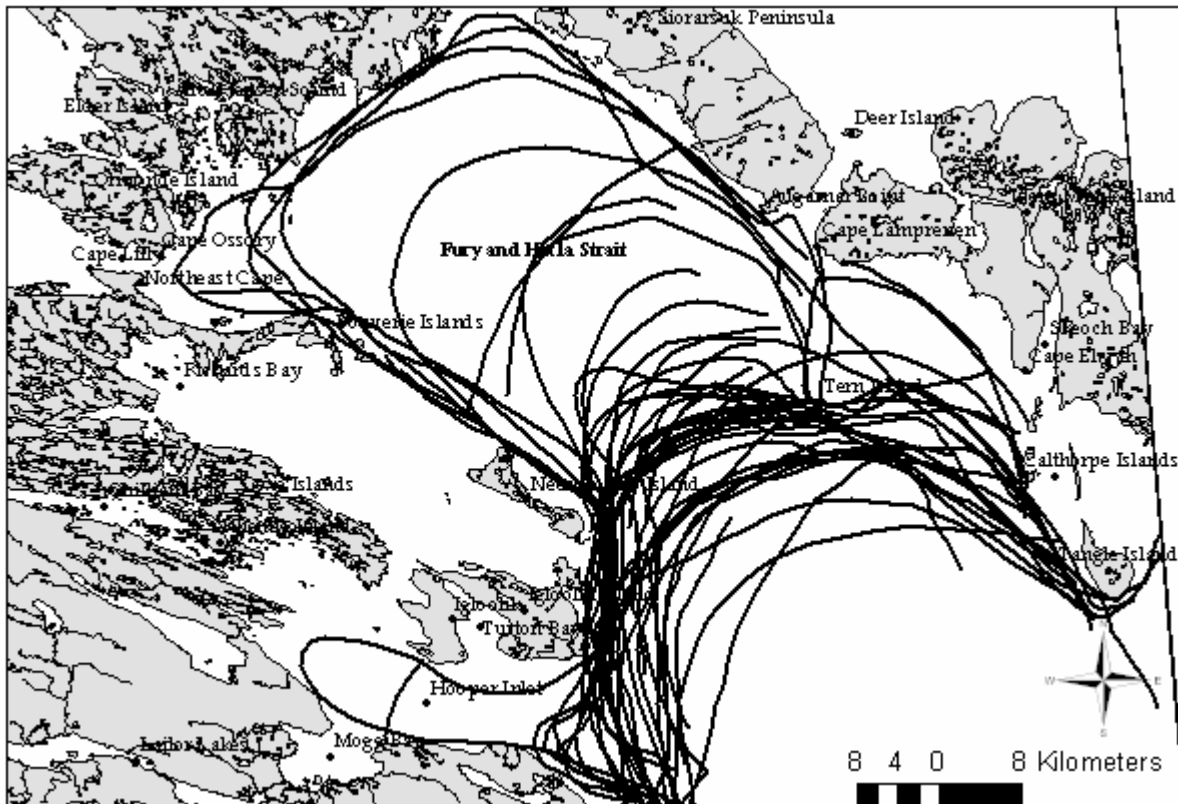
a) (left) *uiguaq* is the newest ice formation (i.e. *nuqaq/iq*, younger) and *uiguaviniq* is the previous *uiguaq* (i.e. *angajuq/iq*, older), with the *sinaaviniq* being the previous floe edge, delineated by its slightly rougher formation created by ice movement along the edge  
b) (above) the spring *sinaaq* is more defined, since new ice is no longer forming at the edge.

**Figure 5-7:** Photos showing a fall (a) and spring (b) floe edge. (photos: Gita Laidler)

There are three key reefs that influence the formation of the floe edge, and the distance from the community (Figure 5-8a, b) (AI1; EK1; TI1; ZA1). The southern one, off the northeast coast of Melville Peninsula is named *Ivunirarjuq*, and it acts as a *kikiak* (a nail) for the ice (Figure 5-8b) (EK1; TI1; ZA1). It stops the ice from moving out, so once it freezes on that reef the ice tends to stay there because the *kikiak* prevents it from breaking off (EK1; TI1).

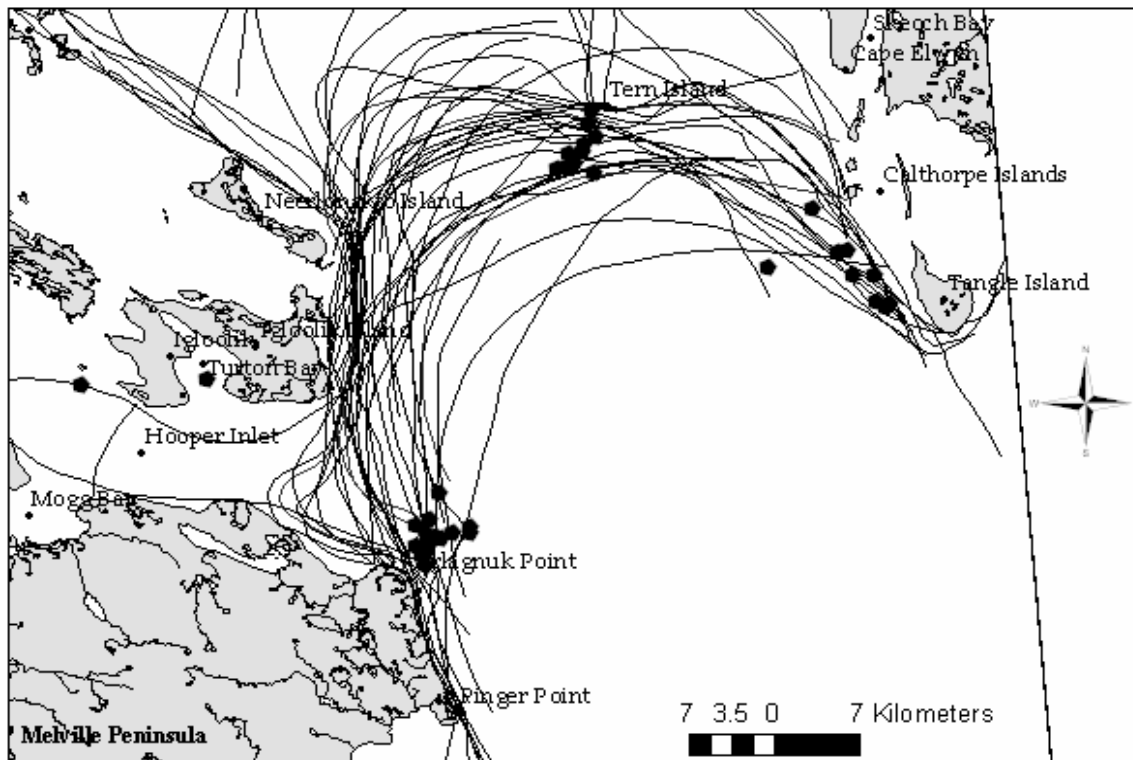
#### 5.2.1.6 Moving ice

Moving ice is very dynamic, and influential on the formation and condition of the floe edge. Any pieces of floating ice can be referred to as *puktaaq* (LQ1; SA1), whereby the collection/process of moving ice is named *aulajuq* (Figure 5-1) (AI1; DI1; JaP1; SA1; ZA1). The interface between moving ice and the *sinaaq* is so dynamic (*aulaniq*) that various specific processes are named (DI1; JaP1; LQ1; TI1; ZA1). The *aulaniq* touches *tuvaq* daily, where it will stay temporarily, but it will eventually move away from where the *sinaaq* had been, an action called *qaattuq* (Figure 5-1) (DAq1; DI1; DQ1; EK2; MA1; SA1). However, if the *uiguaq* or even part of the *tuvaq* were to break off, the action would then be termed *uukkaqtuq* (Figure 5-1) (DAq1; DI1; DQ1; MA1; SA1). The ice that breaks off due to *uukkaqtuq* then becomes *uukkaruti* (EK2; MA1; TI1), and parts that may remain along the floe edge are termed *nipititaaq* (Section 5.2.3.2) (AQ1; EK2; SA1). This is a reoccurring process over the winter as the ice forms, adds on, breaks off in a cyclical loop (*uukkaqtaqtuq*) (DI1; EK1). If, as the ice moves out, some of the ice along the *sinaaq* is dislodged, the process is referred to as *tatijaujuq* (EK2). As ice moves along the *sinaaq*, it can rotate whereby only a point of the ice pan is touching the edge (*ukkuartinniq*) (AT1; DI1). Also as the moving ice moves in, there can be a lot of grinding along the *sinaaq* where the ice is hitting (*sanimuangniq*) (AT1; DI1; DQ1), and if it stops at the edge long enough to freeze to the *sinaaq* it is *qaangajuq* (Section 5.2.3.2) (DQ1; JaP1). Furthermore, *Agiuppiniq* is a type of place name given to an important annually reoccurring ice feature just



a) floe edge variations in *Ikiq*, at various seasonal stages

Sources: AI1; AQ1; AT1; AU1; DI1; DQ1; EI1; EK2; GQ1; HP1; MA1; NQ1; SA1; TI1; ZA1



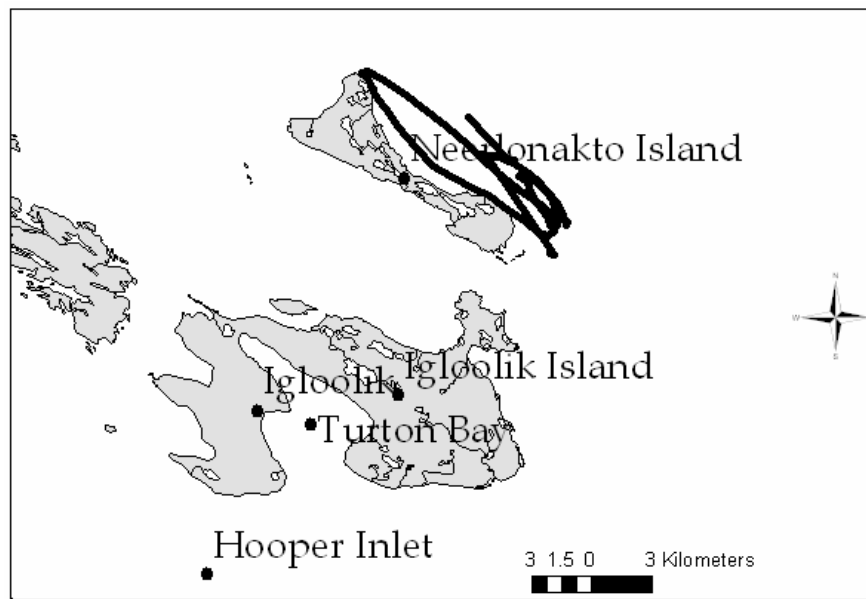
b) three key reefs (marked by the pentagons), *Ivunirarjuq* shown just north of Arlagnuk Point.

Sources: AI1; AT1; DAq1; DI1; DQ1; EI1; EK2; GQ1; HP1; MA1; NQ1; SA1; TI1

**Figure 5-8:** Maps showing floe edge variations (a) and approximate position of key reefs (b).

northeast of Neerlanakto Island, literally referring to “where it grinds” (DAq1; EK2; GQ1; HP1; LU1; MA1; TI1) (Figure 5-9a – c).

“*Agiuppiniq*, the term arriving from the ice having moved back and forth for so long, *Agiuppiniq* meaning it passes on there, it grinds. *Aggiuti* meaning filing, “it grinds away.” So *Agiuppiniq* is again just description of what’s happening, it’s the ice that’s grinding as it’s moving...And [I] have [fallen through the ice when I] tried to cross. And then what’s really characteristic about *Agiuppiniq*, is that...the ice is ground enough that it’s soft. It is now slush, or how would you say it, it’s ground? Some kind of, it’s ground enough that the particles don’t freeze over and it’s there, it can look solid, but you go right through.” (Kunuk, 2004b)



a) Position of *Agiuppiniq* as drawn by GQ1; HP1; MA; SA1; TI1.



b) *Agiuppiniq* in June, 2005 (looking NW)

c) *Agiuppiniq* in June, 2005 (looking NE)

**Figure 5-9:** Map (a) and photos (b, c) depicting the position and views of *Agiuppiniq*.

This is the location where a lot of ice movement occurs during freezing stages, and where the early floe edge forms in *Ikiq* (EK2). In general a lot of grinding occurs as the *aulaniq* is constantly moving along the *sinaaq* or the edge of land, and the ground ice that results from this process is termed *minuirniq* (AT1; HP1; JaP1; LU1; NQ1; SA1).

MYI lasts throughout the summer without fully melting; therefore, it is termed as old ice, *sikutuqaq* (Figure 5-1) (EI1; GQ1; HP1; LQ1; TI1). Such ice comes from elsewhere, it is not formed around Igloolik, but it flows through *Ikiq* coming from the north as well as the south (HP1). These are distinguished based on their coloration. One type is the yellowish-brownish ‘dirty’ ice coming from the sandy areas to the south and east, from Steensby Inlet and Cape Dorset (Figure 5-10a) (AI1; LQ1; LU1). The other type is clean and white, coming from the north through Labrador Narrows (Figure 5-10b) (AI1; GQ1; LQ1; LU1). While these are sometimes referred to as icebergs (*piqalujaaq*), it must be clarified that there are very few glacial icebergs coming through *Ikiq* (GQ1; TI1). Depending on the wind conditions (Section 5.2.3.2) the *sikutuqaq* can become lodged in the newly formed ice, creating rougher conditions (AQ1). Wherever they are grounded (e.g. on reefs), they can also influence the freezing processes by preventing the new ice from moving out (Figure 5-8b) (AI1; EI1; HP1; TI1).



a) ‘dirty’ *sikutuqaq* comes from the south



b) ‘clean’ *sikutuqaq* comes from the north

**Figure 5-10:** Photos showing ‘dirty’ (a) and ‘clean’ (b) *sikutaq*. (photos: Gita Laidler)



“There’s a reef that assists in getting this ice, or this part frozen over. A lot of years the floe edge is right there, from here to let’s say, to about here [referring to map]. And that’s a majority of the years. But some years when [it is not piled up at the reef], the floe edge tends to stay here, right along the shore. So therefore, this pretty much determines how this ice is going to form again. If it’s piled up here then the ice is going to stop, if it’s not so much of a pile then the ice doesn’t stop, around that area.” (Ivalu, 2005)

Such conditions also promote snow accumulation, and can lead to dangerous travel (Sections 5.2.3.4 and 5.3.1.1) (AQ1; DAq1; MA1; TI1). Furthermore, if they are blown into bays, the bays tend to freeze over earlier than if they were not present (EI1). Therefore, the presence of *sikutuqaq* in the summer can determine what the winter ice will be like (Figure 5-1) (AI1).

It is possible to identify MYI because of its weathered, smooth look from some melting over the summer (AQ1). They melt somewhat in the spring and summer, and then re-freeze in the fall and winter, so they are constantly alternating between larger and smaller sizes (TI1). But they are large chunks of ice floating in the water, and they are also noticeable due to their clear bluish complexion because the salt has drained out over time (AQ1; HP1; LU1). Ice that may have piled up over the winter may also become large, but it still has a very white look which indicates that it formed during the previous winter, and has not lasted through a summer yet (AQ1).

## **5.2.2 Melting processes**

### *5.2.2.1 Snowmelt*

When asked about the melting of the ice, many people began by mentioning the influence of currents wearing away the ice from underneath, before the snow even starts melting (Section 5.2.3.4). Therefore, melt stages happen from both sides, above and below the ice surface. However, the snow is visible and begins melting before the ice (AI1; AQ1; DAq1; DI1; EI1; LQ1; MA1); therefore, it is an important indicator of the onset of melt stages (Figure 5-1). The snow would begin by becoming smooth/shiny in certain places (SA1), and then getting soft and mushy – making travel difficult (DAq1; DI1; EI1; MA1). The first stage of snowmelt is

termed *qinallatut*, when the snow is softening and thinning (likened to crystallizing and compacting), whereby the process of shrinking is *nanirlijuk* (Figure 5-1) (AI1).

“Like if you have the snow, and the ice underneath, that would be the very first part of the melting stage, *qinallatut*...The melting starts from the snow. The *qinallatut* is the very first stage, and then the snow can be this deep, but then when it’s somewhat semi-melts, it’s not melting but it softens, it gets thinner as well, and that process being from that thick to this thin is called *nanirlijuk*.” (Ivalu, 2005)

As the snow melts it creates a crystallized film on top (*nilaruqtuq*) (Figure 5-11a) whereby little balls of ice form (*ijaruvauijat*) (Figure 5-11b) (AI1). The softening snow will then even out, and when the weather cools down it will harden again. So, *manguqtuq* is when the snow is evening out, and is somewhat melted (Figure 5-1) (AI1; EI1; LQ1; MA1; SA1). The surface will then become wet and slushy under the snow (*puimajuq*), but it has not completely melted, making it very difficult to pull a sled (MA1; NQ1). This is followed by *qirsuqqaq* where it freezes smooth again, which is good for traveling (AI1; EI1; SA1). Once it starts melting again, it will continue to the point where the ice becomes water-logged and breaks up (Figure 5-1) (AI1; EI1; SA1). The re-freezing does not occur again (SA1).



a) *nilaruqtuq*, the ice is somewhat crystallized as it melts



b) *ijaruvauijat*, the ice forms little balls (“like eyeballs”) in early melt stage

**Figure 5-11:** Photos of snowmelt conditions on the surface of the sea ice, including: *nilaruqtuq* (a) and *ijaruvauijat* (b). (photos: Gita Laidler)



### 5.2.2.2 Water accumulation and drainage

Where seaweed has been lodged in the ice, or swept on top of the ice, is where deep sections will be created during later stages of melting (AQ1; DI1). They are narrow and hair-like, and absorb the sun's heat, melting the ice faster and making dents in the ice surface (AQ1; DI1). Areas where rivers meet the ocean also tend to wear the ice out quickly because of the influence of freshwater (AT1), they are not as salty and thus wear out the ice faster (EK2). Where these areas open up they are called *aktinniq* (Figure 5-1) (AT1). These waters are thought to be warmer, and also the movement of the water contributes to the faster melting (AT1). In general, water will accumulate (*immaktittuq*) on the sea ice to the point that the ice is covered in water (*immaktinniit*) (Figure 5-12a) (AI1; DAq1; DI1; EI1; HP1; LQ1; MA1; SA1). However, where white sections of snow are still visible, they are termed *puktailaq* (Figure 5-12b) (HP1). In areas of strong currents, there may even be a process occurring called *patikjiuqtuq*, where the snow is melting but the water is seeping through the thin ice underneath, leaving only a layer of snow (JaP1).

"Like you're traveling and there's water under the snow constantly, when it first melts. You'll notice that again there's no more water under the snow, indicating the water is now seeping right through the ice, meaning that the ice is thin. And that's what you call *patikjiuq*, *patikjiuqtuq*, that's a term. Again, that's water seeping, fresh water seeping through the salt ice, in that it's not present, so therefore that's when you can tell that you are now getting onto dangerous ice...So therefore these can look like safer than anywhere else because it's got no water, but in fact the water has seeped right through the ice." (Palluq, 2005)

The water-logged ice may last for several days (JaP1; SA1), but once cracks and breathing holes (*aggluit*) get larger they provide drainage for the water (Figure 5-12c) (DAq1; DQ1; EI1; HP1; JaP1; MA1; SA1). Once water has drained off the ice becomes smooth again for a period of time – good for traveling (DAq1; DI1; EI1; JaP1; MA1). This condition where the snow has melted and drained away is called *tikpaqtuq* (Figure 5-1) (DAq1; EI1; HP1; MA1; SA1). Areas where the water has drained faster will leave a lot of ice visible, and this is termed *saluraq* (SA1).



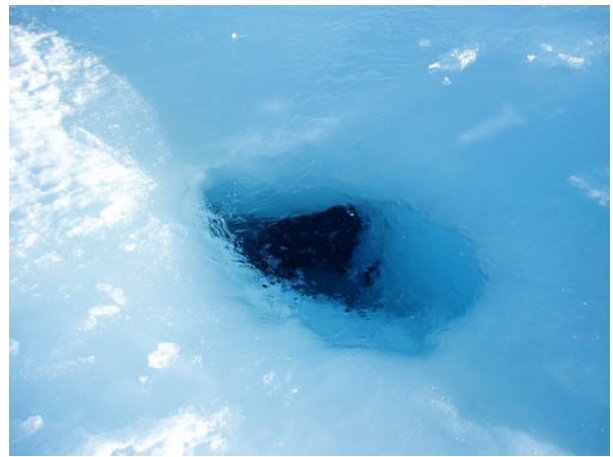
a) *immaktinniit*, melt ponds or water-logged sea ice



b) *puktailaq*, the areas where snow shows above the *immaktinniit*



c) water accumulates on the sea ice before the seal breathing holes and *naguttiit* open up to provide drainage



d) where water accumulates the ice will wear out, and once it wears all the way through a *killaq* is created (a melt hole)

**Figure 5-12:** Photos of water accumulation and drainage, beginning with *immaktinniit* (a) and *puktailaq* (b) and leading to water accumulation (c) before the formation of *killait* (d). (photos: Gita Laidler)

As the ice melts further, thinning in certain spots (*sagliurtuq*) (HP1), water accumulates again (*immaktipaliajuk*) and some sections get very deep (*itisiuraq*) (Figure 5-1) (AI1; DAq1; DQ1; DI1; EI1; JaP1; LQ1; MA1; SA1). This is especially prevalent around pressure ridges or the *sinaaviniq* (AI1). After this deep water stage, the ice becomes rougher and some areas wear out completely (AI1; DI1; EI1; MA1). Holes that have formed right through the ice are called (*killaq*) (Figure 5-1, 5-12d) (AI1; DAq1; LQ1; MA1; SA1). Soon after this stage the ice will be breaking up (DAq1; EI1; SA1).

### 5.2.2.3 Break-up

Break-up does not occur randomly, it will usually begin breaking *ajurait* or where the *killait* have become enlarged (DQ1; HP1; LQ1; MA1). It will break into large moving ice pans before it fully breaks up (DQ1; HP1; MA1). The *tuvaq* starts wearing out (*tuvarliqtuq*) (AI1), and then the ice starts breaking up (*siruttiq*) (MA1; SA1). Following this, the *tuvaq* starts to come off (*tuvaijaqtuq*) (MA1; SA1).

“And again, around when it’s melting all together and you have these holes [*killait*] now that are created on the ice, and ice has now, is now starting to break up, the wind with the current moves the ice back and forth. So therefore, it breaks it up even more...And then this process that’s happening to the ice is called *siruttiq*, “it’s breaking up”. And then if the ice is constantly breaking off here it’s *tuvaijaq*, “the *tuvaq* is coming off” so they would call it *tuvaijaqtuq*. Whereas here it would probably be more *siruttiq*, where it breaks up first and then it eventually goes out.” (Arnatsiaq, 2004)

Finally, once the landfast ice breaks into floating pieces, the *tuvaq* becomes *tuvajautiit* (Figure 5-1) (AQ1).

## 5.2.3 Wind and current influences on sea ice

Mentioned briefly throughout Sections 5.2.1 and 5.2.2, winds and currents greatly influence how and when ice forms, moves, or deteriorates. For both winds and currents, the general conditions around Igloolik are described, followed by a characterization of their influence on sea ice.

### 5.2.3.1 Prevailing winds

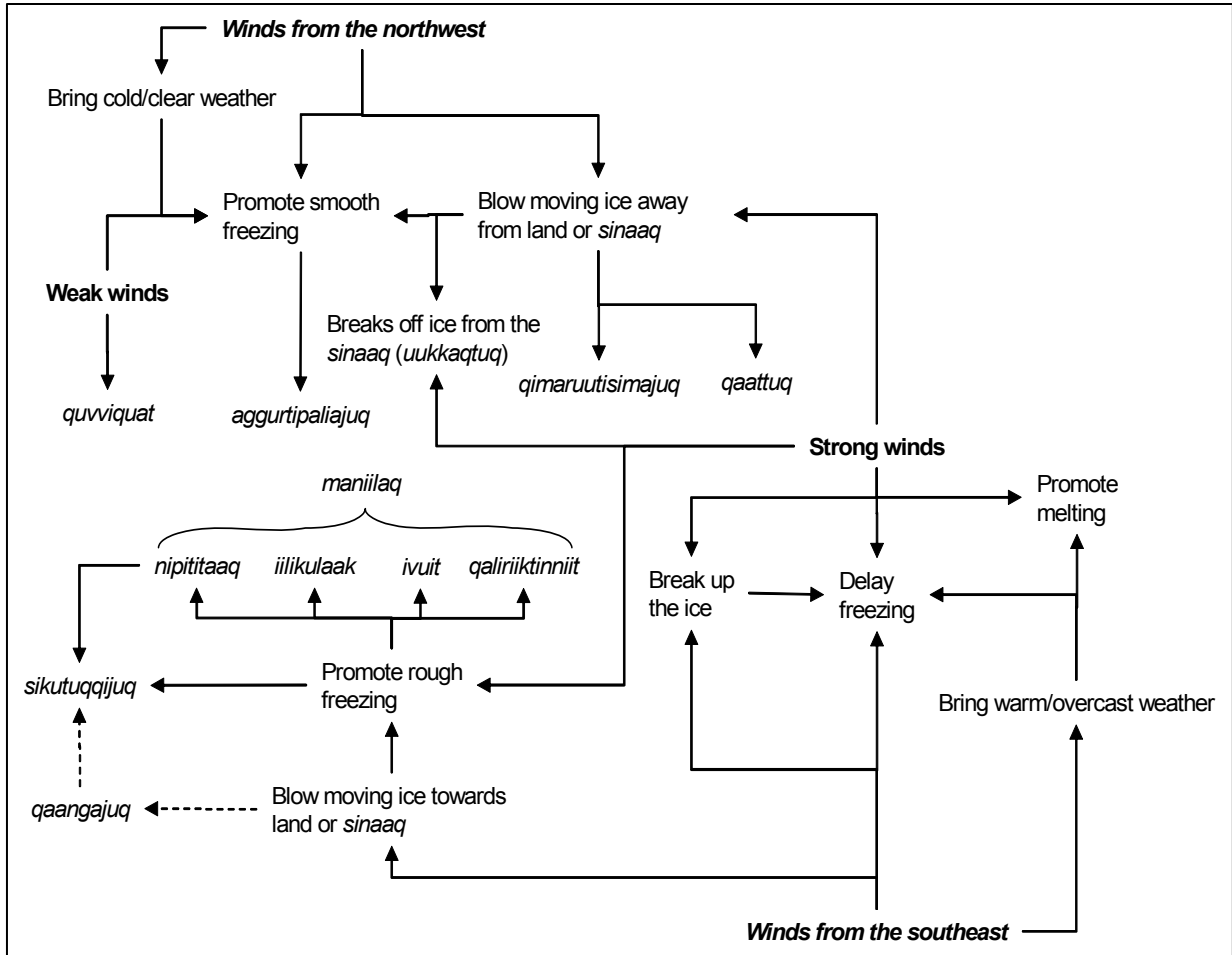
The predominant wind direction around Igloolik is most frequently cited as being from the northwest, with the southeast being the second most predominant (Table 5-1). A few people also mentioned the northeasterly winds as being prevailing, but more specifically in relation to areas further east along the Baffin Island coastline (Table 5-1). The influences of these two important winds (NW, and SE) on sea ice conditions or movement are summarized in the conceptual model shown in Figure 5-13.

**Table 5-1:** Summary of predominant directional and seasonal winds around Igloolik, and their related influences on sea ice.

Direction	Season	Ice influence	Source
<b>West</b>	<ul style="list-style-type: none"> <li>brings a change in weather</li> </ul>		LU1
<b>NW</b>	<ul style="list-style-type: none"> <li>predominant</li> <li>brings clear, cold weather</li> </ul>	<ul style="list-style-type: none"> <li>blows ice out</li> <li>contributes to smoother freezing</li> <li>ice breaks off at the floe edge</li> </ul>	AI1; AT1; DAn1; DAq1; DQ1; EI1; EK2; HP1; JaP1; LQ1; LU1; MA1; NQ1; SA1; TI1
<b>North</b>	<ul style="list-style-type: none"> <li>predominant</li> </ul>		JAn1
<b>NE</b>	<ul style="list-style-type: none"> <li>fall</li> <li>not common</li> </ul>	<ul style="list-style-type: none"> <li>blows ice out</li> <li>contributes to smoother freezing</li> <li>becomes stronger further east from Igloolik (pushes the ice into solid ice)</li> </ul>	AU1; AT1; DI1; NQ1; ZA1
<b>SE</b>	<ul style="list-style-type: none"> <li>opposes the NW wind</li> <li>second most predominant</li> <li>warmer, overcast weather</li> </ul>	<ul style="list-style-type: none"> <li>moving ice is blown towards land, or the floe edge</li> <li>ice temporarily sticks to the floe edge</li> <li>contributes to rougher freezing</li> </ul>	AI1; AQ1; AT1; DAq1; DAn1; DQ1; EI1; EK1; EK2; HP1; JaP1; LQ1; MA1; NQ1; TI1; ZA1
<b>SW</b>	<ul style="list-style-type: none"> <li>not common</li> <li>spring and summer</li> </ul>		NQ1; SA1

#### 5.2.3.2 Influence of wind on ice conditions or movement

The prevailing northwesterly winds are discussed as following the lines of glaciation (AI1; LQ1; SA1; TI1). They are credited with bringing clear, cold weather (Table 5-1, Figure 5-13) (DAq1; EI1; TI1). They also blow moving or unstable ice out, away from the land or floe edge (AT1; DAn1; HP1; LQ1). Therefore, as ice is blown away the open water tends to freeze over smoothly with NW winds (Figure 5-13) (AT1; DAn1; DQ1; EI1; HP1; TI1). This also means that with NW winds blowing there is increased likelihood of break-off events at the floe edge (Figure 5-13) (DAn1; DQ1; MA1; SA1). In addition, northwesterly winds can be even more influential in breaking off sea ice at the floe edge during very cold weather or with rougher ice conditions (DAq1; EK2).



**Figure 5-13:** Conceptual model of the influences of winds on sea ice formation, movement, or decay based on interviews conducted in Igloolik.

“[I]n January when it gets really cold, I mean really cold, the ice cracks easier in that it breaks up more often, cracks are created more frequently, so therefore when it’s colder the cracks occur and this tends to break off quite often. In that [I] was also instructed not to hunt in this area when it was too cold. In that the cold can crack the ice, or break the ice quite easily. If you have a little bit of wind, little bit of current, then more than likely the ice is going to break. [The ice] becomes brittle, and then when it does that it starts breaking off constantly...” (Kunuk, 2004b)

In the cold, the ice cracks more easily, and rougher ice means that there is more surface area for the wind to catch. When the moving ice has just moved away a bit, it is *qimaruitisimajuq* (DI1). When the moving ice is moving out, it is termed *qaattuq* (DAq1; EK2; MA1), in contrast to when part of the *sinaaq* broken off (*uukkaqtuq*) (Figure 5-13) (DAq1; MA1).

The southeasterly winds tend to counteract northwesterly winds (Table 5-1, Figure 5-13) (AT1; DQ1). After the NW wind blows, the SE wind usually follows (DQ1). Winds from the SE blow the moving ice inwards, towards land or the floe edge (AI1; AT1; EK1; HP1; LQ1; ZA1), whereby moving ice can become temporarily landfast (Table 5-1) (AQ1; DAq1; MA1). When the moving ice stops at the floe edge, and is maintained touching the floe edge for several days, the process is called *qaangajuq* (Figure 5-13) (DQ1). However, this is not a regular occurrence, usually the moving ice flows in and out. The SE winds need to be sustained to create *qaangajuq* (DQ1). Southeasterly winds also create rough ice conditions as the winds force ice to pile into, and onto, solid ice (Figure 5-13) (DAn1; DQ1; EI1; EK1; LQ1; SA1; TI1). When this happens the ice becomes impossible to travel on, it is too rough (*sikutuqqijuq*) (AQ1; DQ1; SA1). Furthermore, in between the rough ice some areas may not freeze uniformly, and are thus softer and thinner, especially where snow accumulates (HP1; MA1; TI1).

“And this year, the conditions are that the southeast wind has been blowing a lot in the last couple weeks, and due to that it might look like this is all safe, but there can be spots, let’s say in between the ice, the rough ice, in between that snow had accumulated very quickly, even before the ice had become solid. So therefore, the ice is not frozen, therefore you can get your harpoon shaft and just go through the snow and then it’s soft all the way through...If it had frozen over at the same time without the rough ice, all of it wouldn’t be dangerous at all, it would be solid all the way. And as long as snowfall hadn’t fallen, that ice would have been safe right through the winter, right through the forming stage to the end. But as it is right now with the snowfall having fallen, there’s some spots that are dangerous to travel on.” (Paniaq, 2004)

This can enhance the danger of nearby ice travel, as well as affect the melting process in the spring (Section 5.3.1.1) (TI1). When the ice moves out again, the rough ice that remains on the landfast ice at the floe edge is called *nipititaaq* (Figure 5-13) (AQ1; EK2).

“And then the ice would be temporarily stuck to the floe edge, that moving ice, and then if it breaks off, just with that rough ice remaining onto the landfast ice...[it would be called] *nipititaaq*, the ice, the rough ice that was created by the southeasterly wind. If some of it is left behind and it breaks off, that’s what they call *nipititaaq*.” (Qrunnut, 2004)

This ice can also be too rough to enable travel or access to the moving ice (EK2).

Seasonally, when the wind is not blowing, and the temperatures cool in the fall, the sea ice will freeze over quickly (Figure 5-13) (AI1; AQ1; JAn1).

“And also the wind plays a factor in the formation of ice in that whenever it’s windy, quite often the ice tends to be rougher than when there is no wind. If there is no wind, with just the current being the only factor then it would have frozen over smoothly, and it would have frozen over quite well. But with the wind it keeps breaking it and piling it so therefore it becomes rough and the ice forms at a later date.” (Qamaniq, 2004)

In the early stages of freezing, there are sometimes smooth, narrow sections that show up on the water despite the fact that the wind is blowing. They follow the direction of the wind, and they are called *quvviquat* (Figure 5-13) (AU1; DI1; EK1). In addition, the ice can freeze in the direction of the wind. When the ice freezes in an upwind direction (regardless of where the wind is coming from), it is termed *aggurtipaliajuq* “it’s progressing towards the wind” (Figure 5-13) (AI1; DI1; EI1; EK1). This process creates ice that is softer than *siku* (EK1). In addition, winds can also carry new ice to certain areas where it accumulates, and thus where freeze-up may begin earlier due to the higher ice concentration (HP1).

It is mainly when the sea ice is thin that the wind is influential on ice conditions (DAn1; AQ1; NQ1). Winds can more easily blow, or break, thinner ice. When the ice is still relatively thin, the wind can cause it to hit other ice (e.g. from *aggurtipaliajuq*), where it might break, pile, and even stand upright (DAn1; EI1). When this process occurs the ice forms more upright as opposed to horizontal, a condition termed *iilikulaak* (Figure 5-13) (DAn1; MA1). This type of roughness is noticeable, but it is still possible to travel through (EI1). A generic term for rough ice is *maniilaq* (EK1; SA1), whereby *ivuit* are pressure ridges (created by the process of *ivujuq*) (AI1; EK2; GQ1) and *qaliriiktinniit* are created where ice is overlapping (AI1; DQ1). Therefore, in general, windy conditions during freeze-up lead to rougher ice (Figure 5-13) (MA1; NQ1). Windy conditions can also expedite the break-up process (Figure 5-13). If it is a windy spring

the ice will break up faster, whereas if it is calm the ice will remain for longer (ZA1). In addition, warm spring winds wear out the ice faster than calm sunny conditions (JAn1; JaP1).

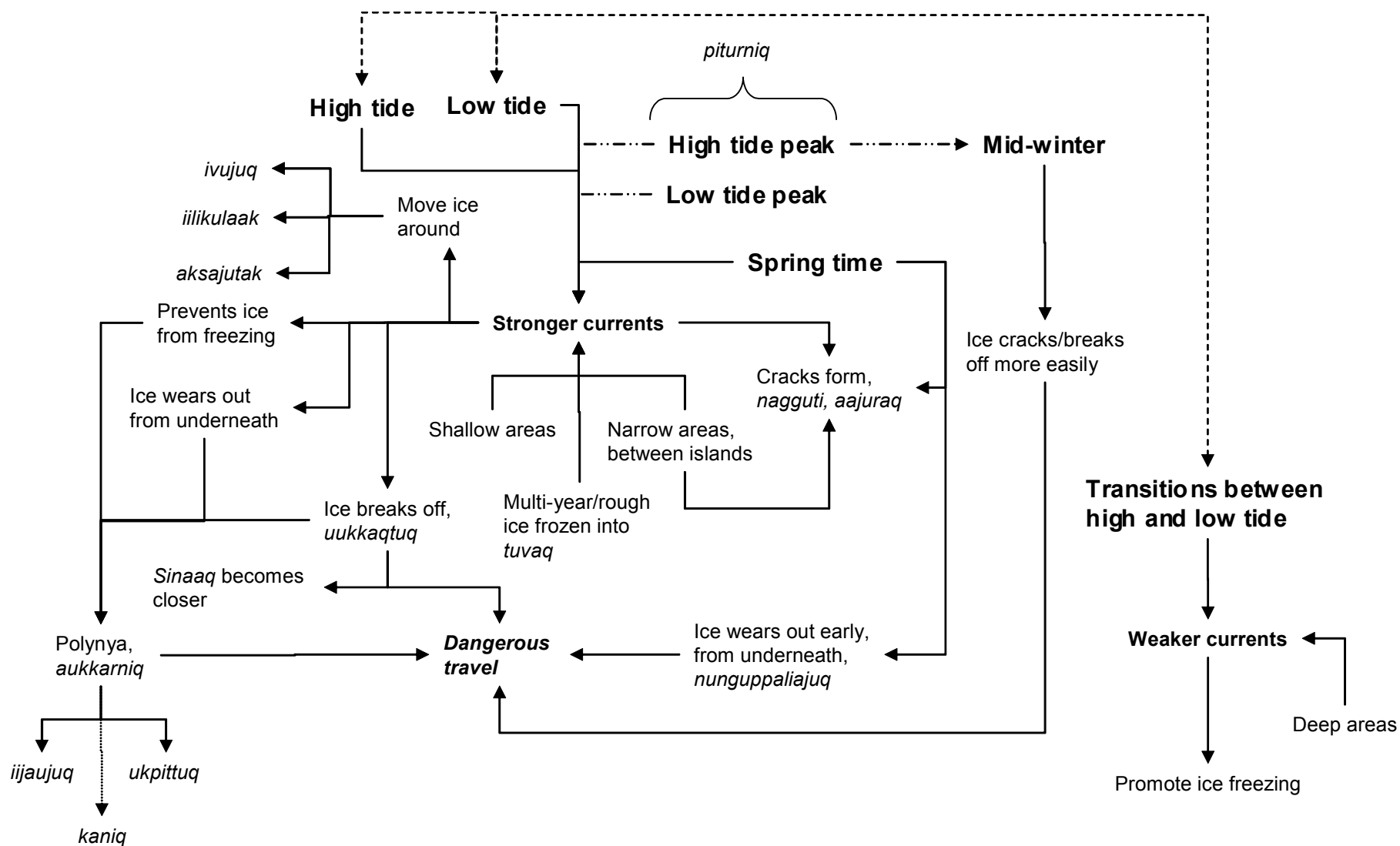
### 5.2.3.3 Tidal cycles and currents

The general ocean circulation around Igloolik is governed by the waters flowing through Labrador Narrows (AI1; AT1; AU1; Ikummaq, 2004b (TI2)). Therefore, the tides generally come in and out in an east/west alternating pattern, every six hours (AU1; DI1). However, over the course of a day it is noted that currents are stronger as they travel eastwards through the narrows, and not as much water will travel back in the opposite (westward) direction (AI1; AT1; EK2; MA1; TI2). Therefore, it seems that for approximately 14 hours (60% of the time) water is traveling eastward, and approximately 10 hours back west (40% of the time) (AI1; AT1; TI1). With the currents going in and out every six hours, they are influential on the direction that ice travels as well as the stability of ice conditions (AU1; TI1). Furthermore, the currents are strongest when the moon is new, or full – every two weeks (DAn1; DQ1; LU1; TI1). At these times of the month the tides peak at their highest and lowest, and are thus especially influential on ice conditions (Figure 5-14) (DAn1; DQ1; LQ1; TI1). This interaction, whereby the two key moon stages increase the strength of the currents, is referred to as *piturniq* (LU1).

“A full moon and a new moon creates these, when the current gets stronger the ice cracks because the ice moves a lot. It has to have a certain give, it can stretch, salt water ice can stretch so much and then it breaks. So therefore these cracks are created let’s say at a new moon and a full moon. So every two weeks, at about every 2 weeks a new crack, the same crack is opened up and then it adds, it opens up about that much and it freezes over.” (Ikummaq, 2004a)

Interestingly, the day after the full or new moon, just as it is starting to shift sizes, is actually when the currents are strongest, and not necessarily on the day of the full moon itself (DAq1). Furthermore, it was mentioned that the fall and spring equinox bring the strongest full/new moon effect (i.e. every six months) (SA1). In addition, the strength of currents is said





**Figure 5-14:** Conceptual model depicting the influences of currents and tides on sea ice formation, movement, or decay based on interviews conducted in Igloodik.

Where: — = general process direction    - - - - = daily cycle    - · - · = monthly cycle

to vary between years, where some years have stronger currents than others (AI1; JAn1; LQ1; TI1; ZA1).

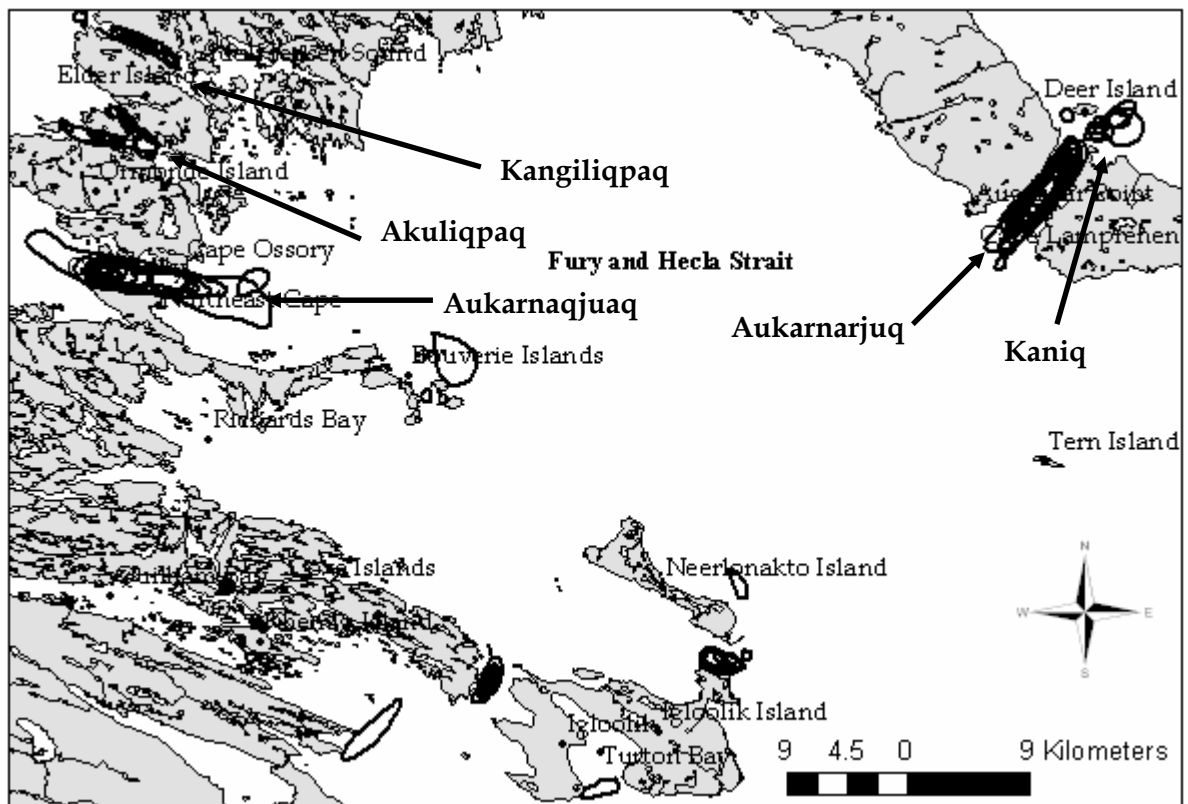
#### 5.2.3.4 Current and tidal influence on ice conditions or movement

Where currents are strong, the fast flowing waters prevent ice formation (Figure 5-14) (AU1; DAq1; EI1; LQ1; LU1). This is often the case between islands, or between islands and the mainland (AT1; AU1; DAq1; JaP1; NQ1; TI1; ZA1). Stronger currents also contribute to the formation of polynyas (*aukkarniit*) (DQ1; EI1; HP1; ZA1) and influence the position of the *sinaaq* (Figure 5-14) (AI1; ZA1). Current strength is also linked to water depth, where deeper areas have weaker currents than shallower areas (TI1). Currents can cause *ivujuq* (Section 5.2.3.2), or contribute to the formation of *iilikulaak* (Section 5.2.3.2), thus leading to rougher freezing (Figure 5-14) (AI1; EI1; EK2; GQ1). Furthermore, where currents are stronger the ice freezing in open water will move around more, leading to the formation of circular ice pans that are smooth in the middle and rougher around the edges (*aksajutak*) (Figure 5-14) (NQ1). Whereas, areas with weaker currents freeze over at an even pace and thickness, meaning that they are safer throughout the duration of the winter (DAq1).

The term *aukkarniit* is used to refer to areas of open water, where currents wear out the ice from underneath (Figure 5-14) (DQ1; HP1; MA1; NQ1; TI1). Whether or not these areas freeze in the winter, they are called *aukkarniq*, but specific names are used to refer to specific polynyas (attached to the names is an understanding of the possibility of freezing) (SA1). There are several key polynyas in the area of Labrador Narrows, *Aukarnaqjuaq* ("large polynya") being the largest and most centrally located in the narrows (Figure 5-15) (AU1; EI1; HP1; LQ1; SA1; ZA1). *Akuliqpaq* ("in the middle") and *Kangiliqpaq* ("furthest towards the mainland") also remain open for a while, but often freeze over at a certain point in the winter (Figure 5-15) (AU1; EI1; HP1; SA1; ZA1). *Aukarnarjuq* ("small polynya") is another important polynya near the mouth of Murray Maxwell Bay (Figure 5-15, 5-16a, b) (HP1; SA1; ZA1). The

rate of freezing is dependent on the strength of currents, where the stronger the currents the longer it will remain open (AI1; EK2; LQ1; TI1; ZA1). However, even if these, or similar, areas do freeze over, there is always danger traveling in such areas (Figure 5-14) (AI1; AU1; DI1; LQ1; ZA1). Any narrow channels tend to be dangerous because of the strong currents flowing through (AT1; AU1; NQ1). These same areas also tend to wear out earlier than others with more solid ice cover (AT1; JAn1; NQ1; SA1; TI1; ZA1).

The continual water movements in polynyas render them ever-changing, in size, shape, and stability. For example, there are always pieces of ice breaking off the edge of polynyas, being carried with the current, and then being pushed under the ice at the other end of the polynya (DI1; ZA1). The same term is used for this breaking off process as at the floe edge, *uukkaqtuq* (Figure 5-14) (DI1). So, there is a continual cycle of thin ice forming on the polynya, breaking off, being pushed under ice at the edge, ice reforming, etc. This can sometimes lead to



**Figure 5-15:** Map showing key *aukkarniit* around Igloolik and within *Ikiq*.

Sources: AI1; AT1; AU1; DAq1; DI1; DQ1; EI1; EK2; GQ1; HP1; JaP1; LQ1; LU1; MA1; NQ1; SA1; TI1; ZA1



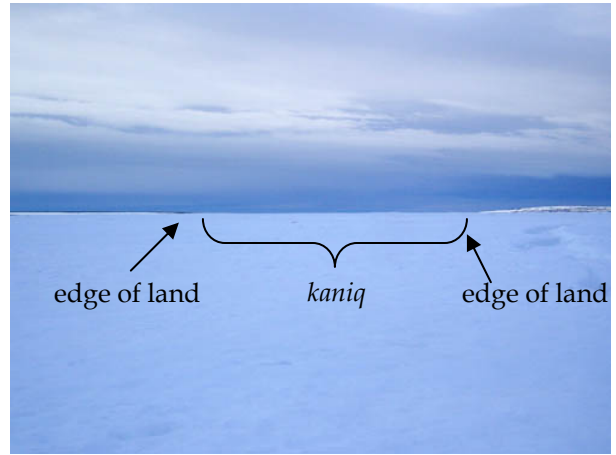
a) view of the south end of *Aukarnarjuq* from a nearby hill, looking east from the west side



b) traveling beside *Aukarnarjuq*



c) *ukpittuq*, the process of the ice being pushed into the edge of the *aukkarniq* by the current, breaking off and sinking underneath



d) *kaniq*, slowly rising ice 'mound' created by the accumulation of ice at the northern end of *Aukarnarjuq*

**Figure 5-16:** Photos showing various aspects of the *aukkarniq* *Aukarnarjuq*, from afar (a), up close (b), the process of *ukpittuq* (c), and the *kaniq* (d). (photos: Gita Laidler)

an accumulation of ice underneath the surface at one end of the polynya (DI1; EI1). This ongoing pressure of ice being pushed into one end of the polynya can also cause ice to break in the direction the current is traveling (*ukpittuq*) (Figure 5-14, 5-16c) (DI1). This can increase the size of a polynya very quickly (ZA1). However, the ice accumulation can also mean that the edges of polynyas become thicker than the surrounding sea ice, as the “current swallows the ice” (*ii jaujuq*) (Figure 5-14) (EI1). In addition, a *kaniq* is a unique formation created by *Aukarnarjuq* at the mouth of Murray Maxwell Bay (Figure 5-14, 5-15, 5-16d) (DAq1; DI1;

EK1; JaP1; MA1). This formation is created when new ice that is forming gets “eaten” by the currents and pocketed on the northern side of the polynya (DAq1; DI1; EK1; JaP1; MA1). It is stopped at the end because of the relatively low current flow in Murray Maxwell Bay, thus causing the ice to accumulate into a mound from underneath (EK1; JaP1; MA1). There, the ice does not freeze solidly, but it remains structured because of the ice that is continually moving in, and worn away (DAq1). Therefore, it can look relatively safe, but people can sink right through if they are traveling on it (DAq1; DI1; JaP1; MA1). Furthermore, cracks in that area can be soft all the way down, even though it can be solid on either side (DAq1; DI1; EK1; JaP1; MA1).

“There is a time when in the winter, when this gets ice-covered, let’s say when the tide is going this way it gets ice covered, and then all of a sudden the tide shifts and the ice is now moving the other way and it gets eaten by the current, under the ice. Therefore, it stops underneath the ice here and creates this mound from underneath [*kaniq*]. As the ice is packing, it’s constantly packing whenever the tide is going in. So therefore, it piles up, becomes a big mound, and then at the rim of this mound there can be cracks, but being snow-covered you wouldn’t be able to know that there’s a crack there. And then at that crack it would be soft all the way to the bottom. It’s not frozen, it’s ice but it’s not frozen at all...It’s ice that’s forming on, and also ice that breaks off here as well, so whatever ice breaks off it just gets under the ice and then it stops here because this is hardly any current at all. This is strong in current, but the current stops here, there’s hardly any in Murray Maxwell Bay.” (Arnatsiaq, 2004)

The monthly new and full moons are a primary cause for the formation, and re-formation, of tidal cracks throughout the winter and spring (Figure 5-14) (DAn1; DQ1; EI1; EK2; JaP1; SA1; TI1; ZA1). The ice will crack open every time the current strengthens, it will re-freeze, and then crack again two weeks later with the next strong tide (DQ1; EI1; TI1). These times of the month there is also an increased probability of *uukkaqtuq* from the *sinaaq* (Figure 5-14) (AI1; DI1; LU1; TI1; ZA1). This is especially of concern during the very cold winter months (i.e. January/February), when the ice tends to crack or break more easily (DAq1; DI1; EK2; ZA1). During the transitions between new and full moons, the currents are not as strong and

thus the ice freezes at a relatively even pace (LU1). When these processes occur in the spring, the ice tends to crack but not re-freeze, resulting in the formation of *ajurait* (Figure 5-14) (TI1).

Currents play an influential role in the melting processes of sea ice, as they wear away the ice surface from underneath (Figure 5-14) (AQ1; DAq1; DQ1; EI1; EK2; JAn1). This is one of the reasons why some early melt stages are difficult to discuss, because they are not visible (AQ1; DAq1; DQ1). The snow may not even be melting on the land or ice, and yet the currents are wearing out the ice from underneath (AT1; DI1; DQ1; EI1; EK2; JaP1; MA1; SA1) and rendering sea ice dangerous for travel (DAq1; DI1; MA1). This process is named *nunguppaliajuq*, “it’s wearing out from underneath”, and could even occur during overcast winter conditions (Figure 5-14) (EI1). Once the snow on the ice has begun to melt, and water is accumulating on the ice, areas with stronger currents may already be opening up (DI1; DQ1). Furthermore, the currents actually seem to be stronger in the spring than in the fall (JaP1), and more influential on the melt processes than the sun (JAn1).

When the tide is coming, it will bring moving ice towards the land or floe edge (Figure 5-14) (AU1; DI1; HP1). Similarly, if the tide is going out, it will take the moving ice with it, away from the land or floe edge (AU1; DI1; HP1). It was noted that rough ice can be particularly influenced by the currents due to their underwater topography. It is recognized that the majority of an iceberg, or piece of MYI, is submerged underwater (EK2). Therefore, the greater the underwater roughness the greater ease with which currents can catch or move rough ice (i.e. there are more protruding features that can be caught within flowing waters) (AQ1; EK1; EK2). This means that larger, rougher moving ice can be more easily affected by currents, and can thus create rougher ice along the *sinaaq* as thicker pieces of ice will collide to form greater piles of ice (EK1; TI1). Consequently, even when large pieces of MYI are lodged within landfast ice – especially around polynyas – they are to be avoided because the currents become funneled around their underwater girth and thus wear away the sea ice that has

encircled the large ice (EK1; EK2). This links to snow accumulation around larger ice formations, which then insulates the ice, and enables the currents to wear away the ice more effectively from underneath (EK1; EK2; TI1; ZA1).

“Ok even before the snow starts melting, wear happens from underneath. The ice gets worn out from underneath from the currents. And the structure of rough ice, where it’s rough on the surface and again, the majority of that ice being submerged...So therefore, if you have rough ice here more than likely it’s rough for quite a ways down. And the ice, having places where it tapers down into the water, those would create a turbulence from the current. Therefore, where there’s snow that’s sheltering the ice, with the turbulence doing the action from underneath as well, the water moving in circles, it wears out the ice underneath, that snowbank. So therefore, the ice can be gone even though the snowbank is looking like it never changed. [There was] an incident once here, where [I] was traveling and [I] was starting to notice that the snowbanks, some places it was dark, it was black, on the rim of the snowbank, in that now this was water. Once [I] started noticing that [I] had to go back even before [I] got to where [I] wanted to hunt for seal...And this is at the time when the ice is not forming anymore. It’s not melting mind you, but it’s not forming anymore.” (Kunuk, 2004b)

### 5.3 Sea ice use

Sea ice travel and hunting are nearly inseparable components of Inuit sea ice use because travel on the sea ice is mainly for the purpose of hunting/accessing hunting grounds. However, travel and hunting will be discussed separately to provide some specific highlights regarding sea ice conditions that relate to travel safety and hunting practices, respectively.

#### 5.3.1 Travel

Sea ice travel is inherently dangerous. The frozen ocean surface is dynamic and unforgiving. Hunters are exposed to various types of conditions as they travel on the ice, many of which have been described in Sections 5.2. In this section, some of these exposures and associated risks (Table 5-2), along with the ways in which community members often minimize these risks, will be discussed.

##### *5.3.1.1 Dangers in sea ice travel*

Wherever there are strong currents, the ice can be worn away from underneath, and even more so where snow has accumulated on the ice (AQ1; EK1; JAn1; JaP1; NQ1; ZA1).

**Table 5-2:** Summary of sea ice-related exposure and associated risks for community members in Igloolik, including some methods of minimizing these risks.

Sources: AI1; AQ1; AT1; AU1; DAn1; DAq1; DI1; DQ1; EK1; EK2; HP1; JAn1; JaP1; LQ1; MA1; NQ1; TI1; ZA1

Type of Exposure	Associated Risks	Actions to minimize risk
Tidal stages, strongest currents associated with new and full moons	<ul style="list-style-type: none"> <li>➤ wears the ice away from underneath</li> <li>➤ cause ice to break off, or pile on, the floe edge</li> </ul>	<ul style="list-style-type: none"> <li>➤ avoid polynyas or areas of thin ice between islands, or at full and new moons</li> <li>➤ avoid areas with strong currents after snowfall</li> <li>➤ note and understand the daily and monthly tidal cycles to minimize risks around the floe edge when attempting to get onto moving ice</li> </ul>
<b>Polynyas</b> ( <i>aukkarniit</i> )	<ul style="list-style-type: none"> <li>➤ travel near of around the <i>kaniq</i> in Murray Maxwell Bay, especially where cracks have formed</li> <li>➤ <i>ukpittuq</i>, at the edge of <i>aukkarniit</i></li> </ul>	<ul style="list-style-type: none"> <li>➤ avoid travel around polynyas after snowfall</li> <li>➤ avoid travel around polynyas when currents are strongest (full and new moon)</li> </ul>
<b>Floe edge</b> ( <i>sinaaq</i> )	<ul style="list-style-type: none"> <li>➤ a smooth, flat, extensive floe edge is more likely to break off</li> <li>➤ during the coldest winter months, ice is more brittle and there is enhanced likelihood of break-off events</li> <li>➤ during full or new moon, more likely to be piling or breaking</li> </ul>	<ul style="list-style-type: none"> <li>➤ note the amount of MYI piling on the three key reefs – rougher conditions decrease the likelihood of a break-off event</li> <li>➤ understand the seasonal dangers of floe edge travel to better evaluate safety</li> </ul>
<b>Moving ice</b> ( <i>aulaniq</i> )	<ul style="list-style-type: none"> <li>➤ always the potential to get stranded on moving ice if it is pushed out due to winds or currents</li> <li>➤ dynamic conditions change very quickly, and can be hard to avoid</li> </ul>	<ul style="list-style-type: none"> <li>➤ dog teams can be more effective, and helpful, during moving ice travel</li> <li>➤ understand the influence of winds and currents on the motion and direction of moving ice</li> <li>➤ know where the key reefs or moving ice grounding points are to ensure safe crossings to the solid ice or land</li> </ul>
<b>Snowfall</b>	<ul style="list-style-type: none"> <li>➤ overcast conditions that typically lead to snow are warmer than clear days, causing ice to thin or melt in any season</li> <li>➤ new snowfall on thin ice insulates the ice and allows it to wear away from underneath (especially with areas of strong currents)</li> </ul>	<ul style="list-style-type: none"> <li>➤ avoid travel after a fresh snowfall, especially during early freezing processes, in areas with thin ice, or around polynyas</li> <li>➤ avoid snow that has accumulated around rough ice</li> </ul>
<b>Freeze-up</b>	<ul style="list-style-type: none"> <li>➤ non-uniform freezing conditions</li> <li>➤ wind direction and strength affects the stability, and roughness, of ice as it freezes</li> </ul>	<ul style="list-style-type: none"> <li>➤ alter routes based on ice conditions and speed of formation</li> <li>➤ detours to cross to Baffin Island or Melville Peninsula</li> <li>➤ avoid areas with strong currents</li> <li>➤ recall wind conditions during freezing process</li> </ul>
<b>Break-up</b>	<ul style="list-style-type: none"> <li>➤ uneven ice deterioration, some areas wear out more quickly than others</li> <li>➤ areas with snow cover can hide the conditions underneath</li> <li>➤ cracks can widen considerably</li> </ul>	<ul style="list-style-type: none"> <li>➤ avoid travel near polynyas, areas of strong currents, or near new ice formations (e.g. <i>uiguaq</i>), even in early melt stages</li> <li>➤ beware of areas where water has drained but snow remains on top of the ice (<i>patikjiuqtuq</i>)</li> <li>➤ note the width of cracks before crossing <i>ajurait</i></li> </ul>



Therefore, there is always danger involved with traveling around polynyas, across narrow channels, or between islands (AI1; AQ1; AT1; AU1; JAn1; ZA1), especially at the *kaniq* or near the process of *ukpittuq* (Section 5.2.3.4) (Table 5-2) (Figure 5-16c) (EK1; JaP1; DI1).

“And again, it’s not just ice that’s breaking off let’s say from the current or the wind. There’s another term that if the current is going that way, and the water is going on the ice, and then with the weight of the water the ice somewhat sinks, and then it breaks in, it’s not broken off from this side it’s broken off where the current is going. And that term is *ukpittuq*. [I] was always instructed when traveling around there to make sure this doesn’t happen to [me]. And then [I] was always told, *ukpiuitsiaqtajiji*, meaning “watch out for that process to happen”. It can happen very quickly, the water gets on there and then with the weight of the water the ice sinks a bit and then crack is created, and therefore the ice goes. And that can be very fast.” (Irngaut, 2004)

Where the *kaniq* begins and ends is very difficult to tell because it rises so gradually, and it is even harder to identify in overcast conditions (Figure 5-16d); therefore, some hunters have found themselves on this formation without even realizing they were traveling on an incline (EK1). Furthermore, around *Agiuppiniq* (Figure 5-9) where the ice is constantly grinding it can actually soften, rendering some areas with a more granulated consistency and making it dangerous to cross (EK2). Currents can also take moving ice away from, or push it into, the floe edge making for precarious sea ice travel (DI1). Therefore, all these dangers are exacerbated during a full or new moon, when the currents are at their strongest peak (*piturniq*) (JaP1; ZA1).

The piling of MYI ice on the three key reefs is a determining factor in the position of the floe edge (Figure 5-8b) (TI1). Therefore, when there is more MYI present the floe edge is less likely to break off, but when there is less MYI and the floe edge forms smoothly there is enhanced likelihood of break-off events (Table 5-2) (TI1). In addition, when the floe edge has frozen out quite far – a large *uiguaq* – it is actually more dangerous because it is more prone to breaking off (DI1; EK2). Break-off events or rapid piling of sea ice at the *sinaaq* are also most likely during *piturniq*, when the currents are strongest. It is also dangerous to be traveling

along the floe edge during overcast conditions (JaP1), where *nunguppaliajuq* is likely to occur (Table 5-2) (EI1). During the coldest winter months visibility is low near the floe edge because of the ice fog created by the temperature difference between the ocean and the atmosphere (JaP1). The vapour released by the ocean can condense on thin ice, or water, making it seem like ice with the crystallization being very white, but in fact it is a very thin film and cannot support the weight of a person much less snowmobile (JaP1). The ice is also more brittle during mid-winter cold, and it thus also more prone to cracking or breaking off (Table 5-2) (JaP1).

Travel and hunting near, or on, the moving ice is perhaps the most dangerous sea ice endeavour (Table 5-2).

“Ok, what [I] have always been told him about the moving ice, it’s *nalianaqtuq*, in that it can be dangerous so caution has to be practiced at all times. And again, that’s the term [I] use for to describe that...elders have always told [me] that it’s *nalianaqtuq*, in that it’s dangerous. And also, when [I’m] traveling on new ice at the moving ice, it’s moving, so therefore you’re traveling on there and you can feel the movement. The movement is called *ningiaqtuq*, the movement of the ice. And again, a lot of times you can determine if it’s safe or not depending on how much it’s moving.” (Kunuk, 2004b)

Hunters must always be aware of the potential for the floe edge to break off (*uukkaqtuq*), or for moving ice to get carried away (*qaattuq*) from land or landfast ice (DAq1; DQ1). This process is more frequent and more unpredictable during the coldest months of the year (DAq1). Where the moving ice has been grinding against other ice, or the floe edge, is also very dangerous (DI1). When it begins to crack and widen the smaller ground pieces begin to spread out as the opening widens, forming a lot of floating ice (DI1). These small chunks are too small to walk on, and so the *kamotik* falls right through (DI1). If traveling by dog team, the dogs can still cross over and drag out the sinking sled, but it is impossible by snowmobile, the action happens too fast (within seconds) to be able to get out of the area (DI1).

The rate of freezing affects travel routes, as people have to take long detours in the early stages of ice formation (in order to cross to Baffin Island) to avoid going through thin ice (Table 5-2) (AU1; DAq1; DQ1; MA1; TI1). The ice does not always form uniformly, so hunters need to watch for areas of open water that are freezing at different rates and are thus dangerous (*nalianaqtuq*) (AU1; DAq1; EK2). In addition, air pockets (*putlaujaraq*) may form underneath the ice; these are hard to distinguish from the surface but are potentially dangerous to fall through, depending on the ice condition underneath (ZA1). Fall freezing conditions can also affect spring melting. For example, the situation described in the fall of 2004 where a lot of newly formed ice had been broken and piled up by SE winds, and then froze into rough ice where snow could accumulate (AQ1; DAq1; HP1; MA1; TI1), rendered travel rough through the winter and created very deep melt sections when spring came (AQ1; TI1). In both cases, it makes sea ice travel difficult (AQ1; DAq1).

Snowfall on newly formed ice is often mentioned as being a safety concern (Table 5-2) (AQ1; AU1; DAn1; DAq1; EK1; HP1; LQ1; MA1; TI1; ZA1). Whenever snow accumulates on thin ice it tends to melt the ice, or insulate the ice so that the currents wear it away from underneath (AQ1; EK1; MA1; TI1; ZA1). Furthermore, in areas with rough ice, the snow tends to form drifts (blown by the wind) around the surface protrusions, also making it dangerous to travel through or near rough ice (Figure 5-17a) (AI1; AQ1; DAq1; HP1; MA1; TI1).

“One way that snow affects ice formation is when it freezes and then a lot of snow falls soon afterwards, in that it gets snow covered and especially where there had been rough ice. Like when the snow covers the ice, it starts melting, the snow starts melting so therefore the ice starts melting as well. And then, at the flat sections it’s not as dangerous because it doesn’t melt right through, but where it’s rough there are places where it can be soft when using the harpoon. So therefore, if you drive through there, more than likely you go through. And a lot, here where it had frozen over, snow had accumulated quite a bit, so therefore it was soft traveling on that. And [I] found it leery to be traveling on that, thinking that somewhere along the way [I] might go through.” (Arnatsiaq, 2004)

Exacerbating the danger of the snow accumulation are the currents that get funneled and strengthened around icebergs or large pieces of MYI lodged into the landfast ice near polynyas (Figure 5-17b) (EK1). These combined traits were especially common in the fall of 2004,



a) when snow accumulates around rough ice it insulates the thin ice and can cause the ice to wear away from underneath due to current movements



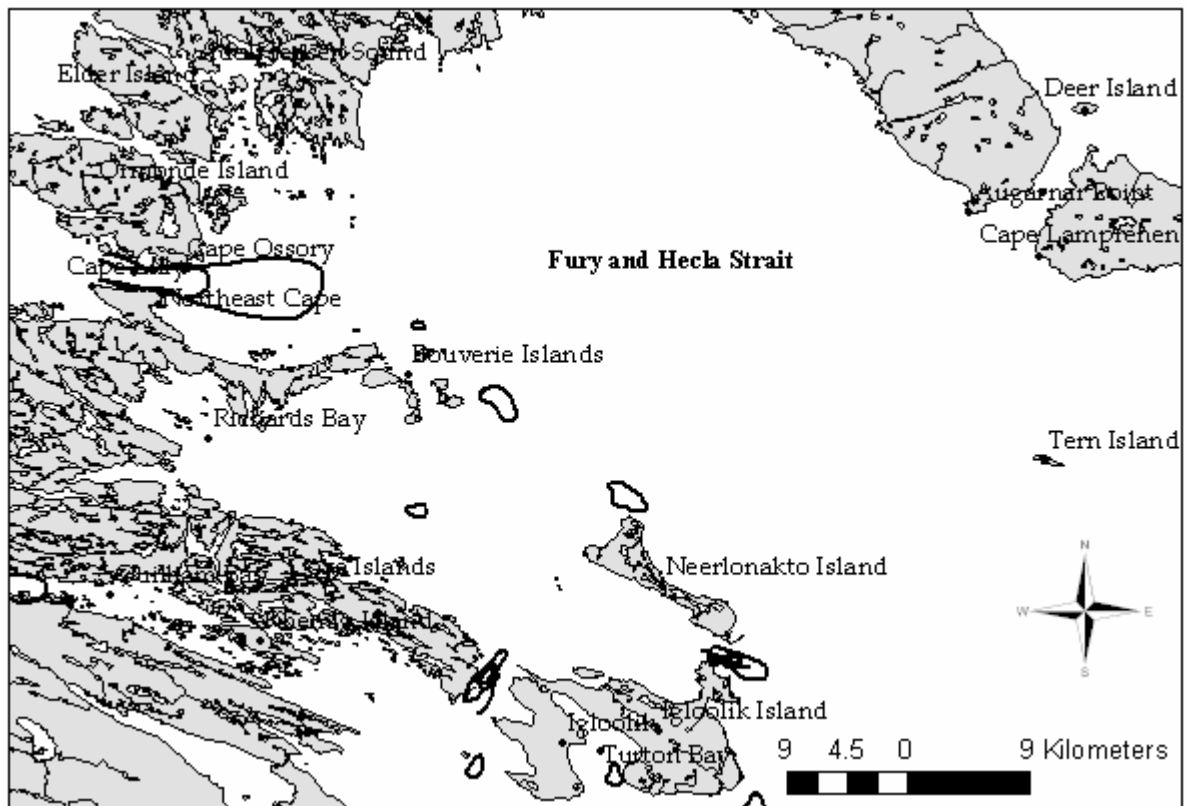
b) where snow accumulates around rough ice near polynyas the currents are funneled and strengthened, which causes exacerbated wear and increased open water

**Figure 5-17:** Photos showing how rough ice can lead dangerous travel when snow accumulates and thins the ice underneath (a), or when currents are funneled under the ice (b).

(photos, Gita Laidler)

rendering it one of the most dangerous conditions for fall sea ice in recent years (AQ1; DAq1; HP1; TI1). However, where ice has actually piled on top of each other (ridges) can render the ice thicker, and thus safer for travel than newly formed smooth ice (DAq1).

The ice can also melt unevenly, wearing out more quickly where there are stronger currents (e.g. polynyas, or narrow areas between land) (Table 5-2) (Figure 5-18) (DI1; JA1; LQ1; NQ1; ZA1), or where the ice had formed later (e.g. *uiguaq*) (AQ1). For example, between islands becomes dangerous earlier than in open expanses of landfast ice, while narrow fiords and bays beginning melting from the end (the head) (LQ1). Interestingly, areas that open early are called *aukkarniit*, the same name given to polynyas (DQ1; MA1; NQ1; ZA1). A particularly dangerous spring conditions is *patikjiuqtuq*, whereby water is seeping through the ice that is under the snow – which cannot be easily detected visually – rendering the surface a safe-looking



**Figure 5-18:** Areas that wear out early in the spring (*aukkarniit*), usually found near polynyas or narrow areas where the currents are strongest.

Sources: AI1; JAn1; JaP1; TI1; ZA1

white when in fact there is no ice underneath (JaP1). In addition, where cracks or small leads have remained open, they can become too wide to cross with a snowmobile (AT1; LQ1). Furthermore, along the coast tends to melt earlier than the larger expanses of landfast ice, due to the heat from the land and stronger currents (Figure 5-19) (DQ1). This can make it challenging to cross from ice to land.



**Figure 5-19:** Areas along the shoreline can wear out earlier due to the heat from the land and potential freshwater influence from runoff or rivers; where they start breaking up can make it challenging to cross from ice to land.

(photo: Gita Laidler)

### 5.3.1.2 Evaluating sea ice safety

When traveling on the sea ice, the most direct route is not always the shortest, or safest (AI1; DAQ1; HP1; TI1). Therefore, by knowing the water depth, current strength, and general ice features of a particular area aids in making navigational decisions that follow lines of least danger (AI1; HP1; TI1). Some people even take trips to evaluate ice conditions before venturing further or planning to reach a distant hunting ground (MA1). The floe edge can be dangerous to travel around, but it is also used as a navigational aid, while simultaneously evaluating ice conditions and safety (LQ1). Noting features like MYI lodged in landfast ice, or pressure ridges, is a navigational tactic as well, but is a matter of safety when traveling in conditions of poor visibility (LQ1). Certain areas are avoided all together (e.g. Labrador Narrows, between islands, the *kaniq*), they are simply too dangerous to travel through, and thus regular travel routes steer clear (AI1; AT1; DI1; EK1; JaP1; TI1). Where polynyas do freeze over, they are still avoided because of their potential thin, unstable conditions (AI1; AQ1; TI1).

In the fall travel is minimized when the ice is newly formed, or after a recent snowfall (DAn1; LQ1; TI1). Whereas after the ice has formed solidly, only specific areas such as *aukkarniit* or *uiguaq* would be avoided after snowfall (DAn1).

“[W]hen the first snowfall occurs after the ice has formed, there’s a layer between the ice and snow where the snow starts melting and then you have that thin layer of liquid, what looks like liquid, that’s the saltwater that’s not frozen. And when you have that then the dangerous areas are present, in that any place with a stronger current is dangerous. But after that initial snowfall and then it snows later, then that water doesn’t form, [so] now [we] would know it is safe, pretty well safe to go anywhere. And [we] use that little bit of water on the ice, under the snow, after the first snowfall, as an indicator of if it can be dangerous in most places.” (Aqiaruq, 2004b)

In the spring travel becomes restricted to larger expanses of landfast ice, as the ice around islands, in narrow bays, and fiords all begin to wear out early (DQ1; LQ1). Specifically, Gifford Fiord is known to melt very quickly from the head of the fiord, as freshwater runoff speeds the melting process (DQ1).

“But [in Gifford Fiord], if let’s say it starts melting from here, and then it works its way down, even though [the ice] is still there it works its way down. [I]f you’re going to make camp, make camp where you cannot see the water. In that it’s so fast in melting that if you’re camping where you can see the water, more than likely it will have passed you while you’re sleeping. That’s how fast this melts. And again as a child, [I] have always known people to be instructed not to camp in Gifford Fiord if it’s melting. If let’s say the melt is down quite a ways, once it gets to about here it’s very quick.” (Qattalik, 2004)

Therefore, some areas can be ice-free while others are still travelable (DQ1; LQ1), so hunters are always on the lookout for characteristic dangers in different seasons or locations (AQ1; DI1; JAn1). It is still possible to cross between solid landfast ice and shoreline ice that is breaking up, by carefully traveling across the large floating pieces that are touching each other (DQ1). This is a common, and even enjoyable, activity for some (DQ1; TI1). However, beyond a certain point it is difficult, or takes a long time, to return to Igloodik; therefore, it is important to return to Igloodik before the melt stages progress too far (DI1).

When planning to hunt on moving ice, hunters always have to be prepared to be stranded on moving ice for a day or two. The moving ice could *qaattuq*, or the *uiguaq* could *uukkaqtuq*, causing people to be carried away (*uukkarutjaujuq*) (DQ1). If this happens it is quite likely that they would spend the night on moving ice waiting for new ice to form, or waiting for the ice to move back towards the land or landfast ice (DI1; DQ1). An important source of water on moving ice is *uukkaruti* (Section 5.2.1.6) (DQ1; EK2), *ijukkaqquti* (AT1; EI1; TI; ZA1), or *apulliq* (DI1), and thus hunters will attempt to reach these formations to access freshwater if they are stranded for a length of time (DI1; DQ1; EK2; TI1; ZA1). This is also a moving ice destination to ensure safety because it is solid ice (DQ1), and there may even be enough snow to build a shelter (TI1).

“One thing, for example this piece of ice that had broken off, once it gets somewhere down here, hunters that go out walrus hunting would eventually run into that. And if they get stranded they can use it for source of water as well. And this one they call *uukkarut*...And because this has snow, the one that was

broken off here, at one time [we] were hunting on the moving ice, and then [we] spent some time overnight on that ice and then [we] went back because [we] couldn't get onto landfast ice. So, [we] went right back to that same place knowing that that's where it won't break up. It has water so it's a place for safety as well." (Qattalik, 2004)

Overnight, new ice can form thick enough for travel (NQ1), but since the ice is also moving it could take a whole day to get back to where they were originally (DQ1). If hunters reach ice that is too thin, they wait – perhaps for another night – but they are also carried out while they wait (DQ1). This process would continue until the hunters are eventually able to get back to solid ice (DQ1). Another suggestion was that hunters should stay relatively near the edge if they become stranded on moving ice, because this ensures that they can hear or see ice piling when it is coming into contact with land or the floe edge (DI1). But, this can also be risky because if you are too near the edge it is easy to get caught in the piling ice, especially in the dark (GQ1; TI1). Therefore, typically the safest option is to go far from the edge of the ice pan (TI1). Furthermore, hunters avoid the middle of *aksajutak* (Section 5.2.3.4) because that section is more prone to *qugluartuq* (cracking and opening up fast) (EK2). Therefore, they stick near the rough edge or they aim for areas that are already overlapping (*qaliriiktinniit*) where *ivujuq* had occurred (Figure 5-20a) (AI1; EK2). Interestingly, it is said to be easier to evaluate ice thickness on moving ice vs. landfast ice, because there is less snow to camouflage ice conditions on moving ice (NQ1). Furthermore, moving ice is simply avoided during snowy conditions because of the danger involved with such travel (LQ1; NQ1). It is also essential to know how to cross between moving and landfast ice. Crossing over from moving ice has to be done with perfect timing, when the ice is touching the floe edge (AI1; AT1), or moving sideways along the floe edge (*sanimuangniq*) (DQ1). This may only occur at certain time of day, or in certain areas (AI1; AT1; DI1; DQ1; EK2; GQ1). For example, it is advised to cross from moving to landfast ice when the currents are at their lowest strength (DI1). So, hunters on the moving ice know





a) *qaliriiktinniit*, where the ice has overlapped other ice, usually from *ivujuq*, making it thicker and safer for travel



b) multiple snowmobile tracks symbolize the description of some participants that they use the ice as much as they can, and they travel all over when the ice is solid enough – travel routes are everywhere

**Figure 5-20:** Photos showing that overlapping sea ice is safer (a), and the extensive use of sea ice around Igloolik makes it hard to delineate particular routes (b). (photos: Gita Laidler)

which direction to travel so that they can always get back onto land or solid ice (AT1; GQ1).

Therefore, patience and strategy could be said to be paramount when navigating moving ice.

It was challenging for respondents to identify specific travel routes. Because there is such extensive ice cover around Igloolik, there are various options to reach certain destinations. Therefore, some respondents had traveled nearly every area on the map, and suggested that they would scribble everywhere if they were to draw their travel (Figure 5-20b) (AQ1; LU1). In the transitional stages of ice formation and decay, it is especially important to be testing the ice thickness and stability – most commonly with a harpoon (Figure 5-21a) (DAq1; EK1). It is possible to walk on much thinner ice than it is to drive a snowmobile (Figure 5-21b) (DAq1). So, as the ice is freezing – or indeed any questionable sea ice condition – it is important to first walk on the ice to evaluate the thickness with a harpoon (AT1; DAN1; DAq1; EI1; NQ1). The harpoon is instrumental in determining the safety of sea ice travel (AQ1; AT1; AU1; DAN1; EK1; EI1; HP1; JAN1; LU1; MA1; NQ1; TI1; ZA1). If striking the ice with a good amount of force and the harpoon goes through easily then it is unsafe (HP; JAN1), but it may be possible to

crawl on the ice (TI1). However, using the same amount of force if the harpoon penetrates somewhat then the ice can be walked on (*atuksaujuk*) (AU1; HP1; EI1; JAn1; TI1). Again with the same amount of force, if the harpoon does not go through the first time, but goes through the second time in the same spot, then it is possible to drive on that ice (HP1; JAn1; TI1). After it has been tested, hunters can then evaluate ice conditions more effectively by sight (AT1; NQ1).



a) Theo Ikummaq tests the ice thickness and stability with his harpoon testing with a harpoon



b) snowmobile and *kamotik* from afar, left behind on thicker ice because we could only progress on foot (looking back from a polynya)

**Figure 5-21:** Photos showing the use of a harpoon to test the ice for safety (a), and that when unsure, the ice should not be driven on (b) and should be tested constantly. (photos: Gita Laidler)

“If at first [I] get to new ice, if [I’m] traveling where people have been traveling on, then [I] know it’s safe. But then if [I] get to newer ice, [I] don’t know off hand just by looking at it if it’s safe or not, so [I] would take a harpoon shaft and check for thickness. If [I] find that it’s safe to be traveling, [I] keep what [I] saw in mind as [I’m] traveling. Anytime [I] can see the same kind of ice it’s safe to travel on. If the ice blackens, then [I] would know that it’s thinner, so therefore [I] would check it again to see if it’s safe, again using the harpoon shaft. And then, and then he would find that even when it’s thinner, you can’t drive on.” (Taqqaugak, 2004)

Even if a hunter is following a previously made trail, the conditions can change and thus may require sporadic testing (DAq1). Where snow has fallen, extra caution and more frequent testing is practiced because it conceals the ice conditions underneath (DAq1; HP1; MA1; NQ1).

Therefore, evaluating the ice by sight is not always feasible, and thus using a harpoon is the only way to be assured of ice safety (AQ1; EI1; HP1; LU1; MA1; NQ1). Often, the darker ice is more dangerous and the lighter ice is safer (AT1; DAq1; EK1). It was also mentioned that if the ice has a reddish hue then it is very thin and dangerous, but if there are spots on the ice that look like crystals or snow then it should be possible to walk on it (DAn1; DAq1). When this crystallization is noted in large patches (*niuma*) it is also an indication of travel safety – so long as the crystals cannot be removed easily (MA1). In addition, travel was cautioned when moving towards the sun – it is very hard to tell ice thickness under such circumstances (LU1). In general, visual evaluations can be deceiving, and the harsh result of misinterpretation is falling through the ice (AQ1; HP1; MA1).

Understanding the processes of freezing and thawing also helps in evaluating ice safety. For example, if the ice freezes on a clear day, and it stays clear for some time, then the hunters know the ice will be safe (LU1). With relatively calm and cold weather, it is known that the ice takes about three days to become travelable (DAq1). Furthermore, if the ice has frozen well in areas with less currents, it is understood that those areas remain safe throughout the winter (DAq1). Continual use and personal experience was stressed as an essential component in sea ice safety evaluation (AI1; DAn1; NQ1).

“And again, like the hunters who are out daily, who are out constantly, they would be the ones to know just by looking if it’s safe. People like [myself] who are employed, and stay in town a lot, and hunt on weekends, it’s quite a bit harder for [us] to tell now if it’s safe or not. Again, it’s constant use of the resource that determines if you can read the signs of it being safe or not.”  
(Angutikjuaq, 2004)

If a hunter has not used the ice for some time, or is venturing into areas where others have not traveled recently, it will be difficult for him to evaluate the ice by sight alone (AI1; DAn1; JAn1; NQ1). The hunter will be generally more leery of sea ice travel if he is inexperienced or the area is unfamiliar, and will thus rely more heavily on testing with the harpoon (NQ1) or on

following other more experienced hunters (JAn1). He will also have to re-initiate the sequence of learning about the safety of ice conditions (DAn1), as it will differ from year to year and place to place with varying weather, current, and wind conditions. But even so, seasoned hunters can have mishaps, and even the most experienced hunters cannot say that they know everything there is to know about sea ice (DI1).

The mode of transportation was also frequently mentioned as a factor in peoples' ability to evaluate ice safety. Some elders feel that traveling on the sea ice is more dangerous now than when they were traveling with dog teams (AQ1; DI1; LU1; NQ1; ZA1). The dogs were able to sense dangerous conditions (e.g. when their feet were going through the snow – and thus through the ice – around MYI, or when they found themselves sinking through *qinu*) (AQ1; EK1). This was a way to tell that the ice was thinner (EK1; LU1; NQ1). The dogs would also tend to veer towards safer ice, or spread out so that they wouldn't fall through thin ice (AT1; AU1; EK1; LU1). Even if parts of the sled (*kamotik*) were going through, the dogs could pull it (and the people) to safety (AQ1; AT1; AU1). However, inexperienced dogs may have moved together if they were scared traveling on thin ice, causing them to go through the ice even if the sled was still on top (AU1). Therefore, the dog team's experience on the ice was nearly as important as the hunters' own experience on the ice. Even in the dark the dogs could evaluate ice safety (AQ1; NQ1), but using the headlight of a snowmobile it is difficult to distinguish thin from thick ice (NQ1). The switch to snowmobile travel has enhanced the necessity for each individual hunter to better understand the sea ice – the dogs knew where to go, but the snowmobile does not so the hunters are on their own (AT1; DI1; EK1; LU1; NQ1). Furthermore, traveling by dog team it was possible to go on thinner (AQ1; AU1; EK1; HP1), or rougher (DI1), ice than with snowmobiles.

“And again, this would have been where it's rough, where some part of it is somewhat piled, especially more where [the solid ice] had been ground...but too small for you to really walk over. And again, this stuff, as the crack widens,

these spread out, it looks like it's ice but as it's opening up it wants to float, so therefore it's spreading itself out...And those are one of the most dangerous areas on moving ice that you have to go through...[I have gone through it] but my dogs had to drag [me] out of there...[With] dog teams [I] could get through it because the dogs had crossed over and then it happened between [myself] and the dogs, that's how fast it is, and [my] sled was already sinking. But you cannot use it by snowmobile. It's too dangerous. It's too fast...[E]ven going by dog team it's high...[The ice can be] more than the height of this room. So it can be quite rough even with a dog team trying to cross over, and the dogs have to crawl up, and then it's moving ice you're doing it, so therefore it can be quite hectic trying to cross onto landfast ice. It's not so much of a problem going the other way because you're falling down, it's more of a problem trying to get back." (Irngaut, 2004)

Today, even if the *kamotik* is not going through the ice, the snowmobile can go through and will pull it down (AU1). So, although a lot more ground can be covered with a snowmobile, increased risks come along with that speed (AT1; DQ1).

### 5.3.2 Hunting

Walrus and ringed seals are the marine staples for the community of Igloodik (AI1; AQ1; AU1; DAn1; DAq1; DI1; DQ1; EI1; EK2; GQ1; HP1; JAn1; JaP1; LQ1; LU1; MA1; NQ1; SA1; TI1; TI2; ZA1), with bearded seals also being hunted when feasible (AU1; DAq1; HP1; LQ1; NQ1; SA1; TI2). Harp seal, harbour seal, narwhal, beluga, and bowhead were also mentioned as being occasionally hunted (JaP1; LQ1; NQ1; TI1; TI2; ZA1). Polar bears are sought after, but because of the imposed quota system they are not hunted often; those engaged in guiding sport hunters are more frequently involved in polar bears hunts (AU1; DAn1; LQ1; TI1; TI2). The sea ice is also used to access Baffin Island or Melville Peninsula hunting grounds to reach caribou (AT1; AU1; DAn1; DI1; DQ1; EI1; HP1; JAn1; JaP1; LQ1; LU1; NQ1; TI1; TI2; ZA1), to fish for Arctic char (AT1; AU1; DAq1; DI1; EI1; EK2; JAn1; LQ1; LU1; NQ1; TI2; ZA1) or lake trout (EK2), to trap foxes (DAn1; EK2; TI2), or to hunt the occasional wolf or wolverine (TI2). Furthermore, char are sometimes caught through *qillait* in the sea ice in the spring, usually near where rivers are draining into the ocean (LQ1).

### 5.3.2.1 Conditions

When the ice is first forming seals can be hunted at *nigajutait* because the small pockets of open water are attractive for wildlife (Figure 5-2c) (AU1; JaP1; TI). Seals are also hunted in bays, where the ice is forming first, but while it is still quite thin (AU1; DAn1; GQ1; JAn1; JaP1; MA1). Numerous seals are also around points of land as the ice begins to form, making them popular hunting grounds (DAn1). As the ice thickens, seals concentrate more at polynyas (Figure 5-15) (AT1; DAq1; EK2), and then at tidal cracks (Figure 5-6) (AT1; DAn1; DAq1; GQ1; JAn1; LQ1; LU1; MA1). At a *nagguti* the seals have an easier time making breathing holes, but is also easier to hunt them because the surrounding ice is too thick for them to get away through other breathing holes (DAq1; GQ1; JAn1; LQ1).

“The reason why it was so enjoyable when it had first, when the cracks had first opened and the ice became ideal for seals to have established their breathing holes, [is that] it’s thick enough that they wouldn’t be able to make other breathing holes easily. And that’s why [I] find it so enjoyable, in that [we] are pretty much guaranteed seal when [we are] hunting through those.” (Aqiaruq, 2004a)

Once the *tuvaq* is well formed and snow has accumulated on the ice, hunters tend to seek seals at the floe edge (AU1; DAn1; MA1). The younger seals usually move towards the floe edge (Figure 5-8a), which is attractive to hunters (TI2). They are smaller and easier to pull into retrieval boats, instead of dragging them behind the boat (TI2). Breathing holes (*aggluit*) will also be made in the snow-free, smooth *uiguaq*, which are easier to identify (Figure 5-22a, b) (DAq1; GQ1). Because the floe edge is relatively smooth and does not have too many cracks it is an ideal area for hunting (AI1). However, if the southeast or easterly winds are blowing, it will push the moving ice towards the floe edge, and if the winds are sustained for a few days then the ice becomes quite thick and rough, with a lot of cracks occurring (AI1I). This not only makes it hard to get around, but also prevents a successful hunt because it is harder to identify where the seals are (AI1).





a) Theo Ikummaq waiting at a seal breathing hole (*agglu*) in November, 2004



b) the size of an *agglu* in comparison to Ikummaq's foot



c) bearded seal *agglu*, considerably larger than that of a ringed because they displace more water when they come up for air



d) where a walrus had broken through fairly thick ice in order to breath, likely on its way to the *sinaaq*

**Figure 5-22:** Photos showing seal breathing hole hunting (a), as well as a ringed seal (b), bearded seal (c) and walrus (d) breathing holes. (photos: Gita Laidler)

Once the darkness of the winter months come (i.e. by November), seals are not hunted as frequently at the floe edge, rather it is preferred to stick to *naggutiit* (DAq1). However, it can be challenging to hunt seals at certain cracks (e.g. *qugluknniit*) because when the ice pushes upwards it creates pockets of open water underneath (Figure 5-5b) (AQ1). That means that seals can come up to breath in the air pockets without making a breathing hole, so it is harder to locate and hunt these seals (AQ1). In the spring, seal pups basking on the ice are the primary target (JAn1). It is challenging to hunt at breathing holes in the spring because all the

holes become interconnected as the ice melts, making it easy for seals to get away (JAn1). Baby seal hunting in the spring (around April) is very popular, and also provides opportunities to hunt foxes, polar bears, wolves, and the occasional wolverine that are also seeking out seal pups in their birth layers (TI2). In addition, there are particular areas (e.g. Murray Maxwell Bay) that are more popular for hunting baby seals (DQ1).

Bearded seals are known to travel towards moving ice as the ice thickens because they prefer open water and do not typically maintain breathing holes in *tuvaq* (Figure 5-22c) (HP1). Then they usually move back in towards the *uiguaq*, and establish breathing holes there, when the sun comes back around mid- to late-January (HP1). Bearded seals are hunted seasonally, mainly in the spring and summer (TI2). Only a handful are secured in the winter through breathing holes (TI2).

Moving ice is the only place to find walrus in the winter, and thus they are predominantly hunted on moving ice (Figure 5-22d) (AU1; DAq1; JaP1; LQ1; LU1). The moving ice is a very dangerous and dynamic environment for hunting; therefore, walrus are hunted after the sun rises again around the third week of January (TI2). It is ideal if the walrus is hauled on the ice (JaP1) or the land (TI2), because it saves a lot of effort and strain trying to pull thousands of pounds up onto the ice or land. Furthermore, the winds and currents factor highly in walrus hunting decisions and location. The ideal circumstance would be when the winds are from the east, southeast, or south (DAq1; LU1), and the tide is coming in (AU1) – meaning that the ice will stay close to land and solid ice.

“And the only time [we] ever hunt for walrus around moving ice is if the wind is favourable. If it’s coming from southeasterly or easterly [directions], so anywhere from this angle, if the wind is blowing and you know for a fact that the ice is going to be touching, then you can go hunting for walrus. You never hunt for walrus on moving ice if the wind is coming from the northwest because again, the ice can move out very quickly, so therefore it’s too dangerous to be hunting at that time.” (Aqiaruq, 2004a)



However, even if the wind is not from an ideal direction, if the currents are right then the ice will stay near enough to the floe edge that it will be possible to get back safely (AU1). In that case, the hunters would get their animal as quickly as possible and get back to solid ice as soon as possible (AU1). Hunters are warned never to hunt walrus on moving ice when there is a northwesterly wind, because the ice can move out very easily, making it too dangerous (DAq1). Interestingly, when hunting walrus hunters actually avoid using the harpoon to test the ice for safety because the sound of the harpoon hitting the ice could scare the walrus away (AU1).

Polar bears are also hunted on moving ice, and are only occasionally found on *tuvaq* (AU1). They tend to be where the ice is thinner so they are moving as the ice thickens (DAn1), although particular bays are popular bear hunting destinations (DAn1). Bears will also be hunted when they are in their dens, on particular islands (DAn1; TI2).

### 5.3.3 Wildlife habitat

Beyond the importance of sea ice for travel and hunting, it is also habitat for many of the wildlife already mentioned. Arctic animals are uniquely adapted to the cold climate as well as to the cold and frozen seas. A full description of sea ice use by different species is beyond the scope of this thesis. However, Inuit and their use of the sea ice is intricately involved with wildlife use and habitat. Therefore, statements of sea ice as habitat frequently entered interview discussions and are thus included here.

Seals can be found nearly anywhere there is sea ice. They create breathing holes through landfast ice or tidal cracks, they congregate around polynyas or at the floe edge, they are in open water, and they are even on top of the ice in the spring (AQ1; AU1; DAn1; DAq1; DQ1; EI1; EK2; GQ1; LQ1; LU1; MA1; NQ1; TI1; ZA1). Ringed seals especially, use the ice more than any other marine mammal (DAn1; DAq1; LU1; NQ1; ZA1). Depending on the type, or age of seals they prefer different ice conditions. Younger seals seem to prefer newer ice to

older ice, and so they follow the ice as it progresses in freezing (AT1; TI2). However, once the floe edge is established, they seem to move back into (under) the landfast ice (AT1; DAq1). The older seals remain more stationary, and thus seek out particular polynyas as the ice extends, instead of following the progression to newer ice (AT1; LQ1; TI2). Because they are older, they know where the good wintering areas are, and prefer certain polynyas (TI2). Some seals will maintain breathing holes throughout the winter, and others will continually seek thin ice to make new breathing holes (e.g. in *naggutiit* or *uiguaq*) (DAq1; DQ1; EI1; GQ1; JAn1; JaP1; LQ1; LU1; SA1; TI2; ZA1). Seals create birth layers under the snow on top of the ice (AU1; DAn1; JaP1; NQ1; TI1), usually where snow has accumulated on or near rough ice (e.g. pressure ridges) (HP1; LQ1; LU1; MA1; NQ1; SA1; TI1). They would tend to establish themselves where there is an adequate food source, such as upwelling nutrients with tom cod and copepods (TI2). They maintain nearby breathing holes, which become interconnected into a large network by the end of the winter (DQ1; HP1; JaP1; LQ1; NQ1; TI1; ZA1). Therefore, pregnant seals will always return to the den they have created, whereas males or other females who are not expecting are continually on the move searching for food (HP1; LQ1). Seal pups are born in these dens in the spring (AU1; DAn1; HP1; JAn1) and they work their way to the shoreline when the birth layers start opening up (JAn1). These dens are also maintained throughout the winter for shelter, not only for the purposes of rearing young (EI1; LQ1; NQ1). Therefore, they can be differentiated on the basis of what seal has created the den (MA1).

“Seals are pretty much all over the place, they can be at the end of bays, even though the bay is huge. Even in the middle of winter they can be in a bay, or they can be where it’s open, or they can be on new ice, or they can be on ice where there’s snow cover, where you have snowdrifts. Where there are snowdrifts that’s where seals have their dens. They dig themselves a hole, [it’s like] they build themselves an igloo. So it’s more or less you know, somewhat dome-shaped, but sort of elongated in the shape of the seal...Anyway, what we have noticed is with the mature male seals, ringed seals, we’re talking about ringed seals, with the mature male ringed seal it makes an opening on the ice, in the snow. Where you have the breathing hole, and then you have this little den in the snow. And it sort of takes the shape of the animals. Whereas, if you have

a den where there's a mother and a pup, then more than likely there's holes everywhere. [I] think it is the young pup [who] practices digging, so it creates all these elaborate holes in the snow." (Arnatsiaq, 2004)

Bearded seals tend to remain near the floe edge, or around moving ice, they do not stick around landfast ice once it has solidified (AT1; DAn1; DAq1; HP1; MA1; TI1; ZA1).

"The bearded seals are all over, let's say in the summer, and in the fall you can find them in polynyas, but in the winter as the ice gets thicker, they move out onto moving ice. And then after that stage they get back at about the third week of January when the sun first comes out, that is when they start making breathing holes at the *uiguaq*, at the newly formed ice close to the floe edge." (Aqiaruq, 2004a)

Bearded seals can be found almost anywhere in the spring and summer (DAq1; TI1; TI2). Then, as the ice starts forming they stay near polynyas, moving out towards moving ice as the *tuvaq* thickens (DAq1; MA1; TI1; TI2; ZA1). However, sometimes young bearded seals are found around tidal cracks (DAn1; TI2) or stranded at their feeding places (TI2). They can survive the winter stranded within *tuvaq* as long as they can access their food on the sea floor (e.g. crawfish, shrimp, starfish, sea cucumber, snails, etc.) as well as maintain a breathing hole (TI2). They could also use ringed seal breathing holes and work themselves down to the floe edge and open water (TI2). Some do make breathing holes along the floe edge in *uiguaq*, but not commonly within landfast ice (AT1; DAq1; HP1; MA1; TI2; ZA1). Bearded seals seem to vanish for some time during the winter, but they return to the floe edge when the sun is returning in mid- to late-January (AT1; DAq1; HP1; MA1; TI2; ZA1). They even have their young on moving ice (DAn1; ZA1) around March or April (TI1). As the ice starts breaking up they move towards the landfast ice, and can use the ringed seal breathing holes as they become enlarged (ZA1).

Walrus habitat is predominantly on moving ice, with plenty of access to open water (AU1; AT1; DAn1; DAq1; DI1; DQ1; EI1; HP1; JaP1; LQ1; MA1; TI1). They haul themselves up on the ice all through the winter (EI1; JaP1; MA1; NQ1), although they will also haul out on

land if there is not enough sea ice (e.g. in the summer) (AT1; JaP1; TI1). The term *ugliit* is used to refer to the places that walrus haul out, but specific areas will have particular names (e.g. *Uglikuluk*, *Uglirlarjuq*, *Ugliarjuq*) (JaP1). As the ice begins to form in the fall, they travel towards the edge and they move farther and farther as it thickens (AQ1; DQ1; LQ1; SA1; TI1; TI2), staying either at the *nuqaq/iq* or beyond (MA1). However, on a few occasions the walrus have not moved out soon enough, and have been stranded on solid ice (LQ1; TI1) or at a polynya (ZA1). In such cases, they actually walk on their flippers back to open water (DQ1; LQ1; TI2; ZA1), or in a very rare case they would remain throughout the winter (TI1). Since walrus are noted to travel upwind, these rare occasions are thought to be caused by a wind shift that moved the ice inwards where it froze and trapped the animals. Either the walrus could not move out quick enough, or they were the younger, less experienced animals that did not know to leave earlier (DQ1). They tend to travel upwind to ensure that they always traveling towards open water (e.g. if the NW wind is blowing the ice moves out and the walrus will move closer to the floe edge) (DQ1; MA1). Vice versa, if the SE wind is blowing the ice will be pushed in and walrus will move away from the floe edge to access open water (DQ1; HP1; TI2). The walrus seem to anticipate the wind direction and duration with their movements (HP1; LU1; TI1).

“One example of animals’ usage of ice is walrus. If you find that there are walrus let’s say along the floe edge, and then the wind starts blowing from the southeast, if the walrus are going down, migrating, or they just go down, as all the walrus do, it goes to show that the wind is going to be blowing from that direction for a long period of time. And if it’s blowing from let’s say down there, from the southeasterly wind as well, and the walrus are not going anywhere then you can be assured that the wind is not going to last...it might change, or it might not be windy at all afterwards.” (Paniaq, 2004)

They also provide an indication of ice movement. If walrus begin to flee sideways then the hunter knows the ice is not going to stay for long (TI1). As the ice begins to break up in the spring, the walrus move out with the ice, so they are further from town in the spring and

summer (AT1; SA1; TI1; TI2). Because walrus migrate with the cycles of freezing and thawing (AQ1; SA1), they are very predictable (TI2). They even have their young on moving ice (TI1). However, in September, when there is the least amount of ice present, they move towards the land (AT1; TI1; TI2). Walrus feed on clams and mussels, so their food source is anywhere on the sea floor (TI1). Despite not being carnivorous, other animals are fearful of walrus because they can protect themselves fiercely (JaP1; TI1).

Narwhal passing by Igloolik belong to one of two populations (TI1). The main migration is a group that comes from the north (from Baffin Bay, and they travel through Prince Regent, Gulf of Boothia) to feed around Igloolik (TI1). However, in the last few years some other narwhal have also been coming up from the south, migrating through Repulse Bay and moving northwards (TI1). Both are believed to be from Baffin Bay, but the northern and southern parts of the bay respectively, whereby the northern population arrives first (TI2). They feed in different areas as well (TI2). Similarly for beluga, there are populations migrating from the north and from the south. However, the main beluga population migrates from the south. Community members always anticipate the arrival of beluga when they hear that some have been sighted around Hall Beach – they will show up in Igloolik a few days after (TI1). They move up to access their feeding grounds (TI1), and they prefer ice-free waters (TI2). They do not come by every year, but when they do they arrive in late summer and leave in the fall heading back south (TI2). However, every now and then a pod of narwhal or beluga will get frozen in (LQ1). As for bowhead whales, they come in the spring and stay near the floe edge, even before the ice starts breaking up (TI2). Following this a second herd of bowheads comes in, from the same population, and they summer in a large group (TI2). Eventually, they move back out in the fall (TI2). When it starts freezing they leave, not wanting to get frozen in (LQ1). They all winter in Baffin Bay, but it is not known exactly where, and they are believed to be a similar group, although they may be two different populations (TI2).

Polar bears tend to be found on moving ice (AU1). They stick closer to where the ice is thinner, so they too migrate with the progression of the sea ice (DAn1). They frequent the ice more during a new moon, where a few males will venture onto solid ice and then travel to moving ice (TI2). The new moon attracts them to hunt at tidal cracks, but interestingly the full moon does not have the same effect (TI2). They were rarely sighted on landfast ice in previous years (AU1; AT1), but more recently they can be spotted anywhere (AT1; LQ1). This is thought to relate to the slow formation (AT1) or the rapid melting (LQ1) of the ice (Section 5.4). Furthermore, they can be sighted on solid ice during mating season, around April, where the males will follow the females wherever they travel (TI2). After this they will travel back to moving ice and remain there until the melt season begins (TI2). Female polar bears den just inland off the coast, often around islands (AU1; DAn1; TI2). They den on land, giving birth where snow has accumulated, around late November or early December (AU1). They will stay in their dens for approximately six months, and emerge with their young around May (AU1).

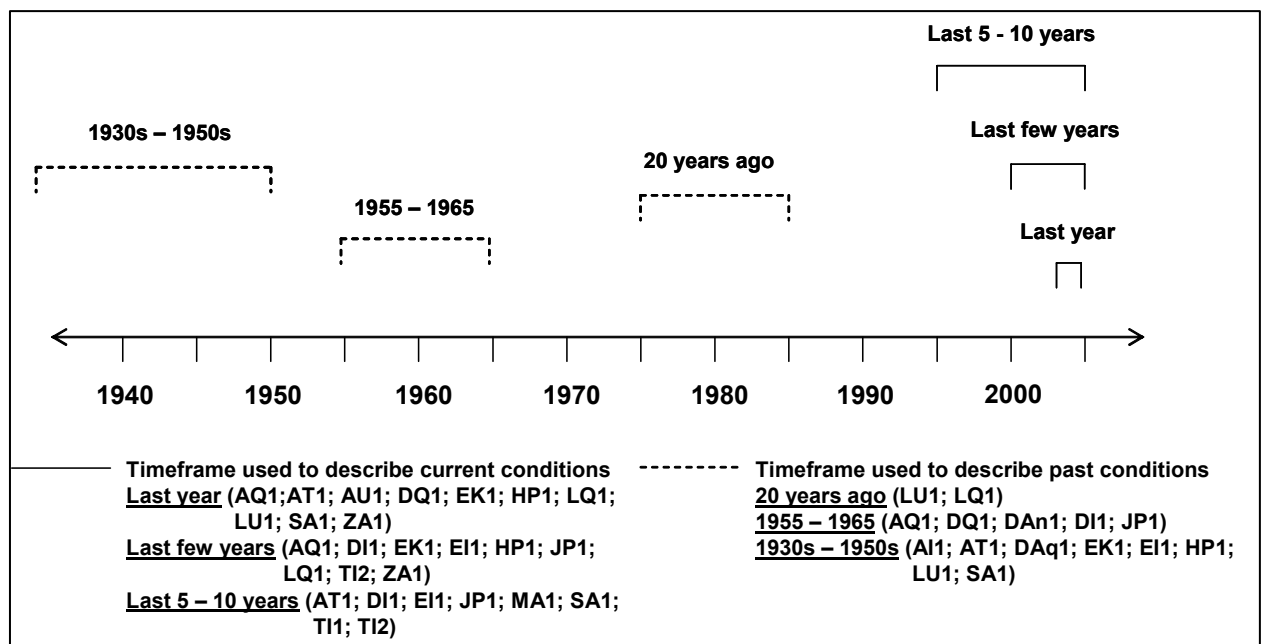
“The polar bears get out of their dens in two stages. The younger females with their, with their young, are out, are out first. And the older females are out a little later. Like in April the younger females are now starting to come out. By May, the older females are coming out of their den. Even though they have been in the den for 6 months, they still have some fat on them...In the span of the 5 - 6 months, the polar bears are born very small, but then by the time they get out they're fairly, about dog size.” (Ulayuruluk, 2004)

Furthermore, because ringed seals are the main prey for polar bears, they can often be found where there is an abundance of seals (DAn1; JaP1) – specifically, where seals tend to make their dens (HP1; TI1; TI2).

Sea ice is used extensively by humans and wildlife alike. People are accustomed to yearly variations in ice conditions and timing, and yet increasingly consistent shifts are being noted that are affecting both sea ice use and safety.

## 5.4 Observations of change

Community members in Igloolik have observed several kinds of change in their local climatic and sea ice conditions. The timeframes used to assess change vary depending on the individual and the phenomena in question, but the broad timeframes used in reference to local changes are summarized in Figure 5-23. Observations of change have been noted mainly in the last few years (indicated as approximately 2000 – present), where very unique ice conditions in the spring and fall of 2004 were frequently highlighted (indicated as last year in Figure 5-23). Melt stages in the spring were unique because of a lack of tidal cracks to ensure water drainage (Section 5.4.2), and overcast, snowy, windy conditions in the fall lead to thinner, rougher ice conditions in the fall (Section 5.4.3). In the last 5 – 10 years a progression towards later freeze-up, earlier break-up, and shifting wind and weather patterns have also been highlighted (Figure 5-23). Typically such changes are compared to sea ice conditions and processes that occurred prior to 1965, although the early 1980s are also used in reference to expected wind and weather conditions. For the most part, elders used their childhood as a reference for



**Figure 5-23:** Summary of the timeframes used in interviews when discussing observations of sea ice change.

expected sea ice conditions and weather patterns (i.e. 1930s – 1950s, estimated based on their birth dates).

There are a variety of indicators that elders and hunters use to gauge change. The most commonly referenced include: i) the position of the floe edge; ii) weather/seasonal temperature or predictability; iii) freeze-up processes and timing; iv) break-up processes and timing; and v) ice thickness. Although not all of these were discussed with similar detail, the same categories are used as in Chapter 4, Section 4.4, to enable comparisons between communities (Chapter 7). The predominant changes observed according to these indicators are summarized in Table 5-3, and additional changes are noted in Section 5.4.6.

**Table 5-3:** Summary of observed indicators and associated changes around Igloolik.

The number of observations refers to the number of interviewees that mentioned this change.

Sources: AI1; AU1; AQ1; AT1; DQ1; DAn1; DAq1; DI1; EK1; EI1; HP1; JAn1; JaP1; LQ1; LU1; MA1; SA1; TI1; ZA1

Indicator	Change	# of Observations
<b>Floe edge</b>	a) Closer to town	a) 2
<b>Weather</b>	a) More unpredictable	a) 3
	b) More overcast in the fall	b) 4
	c) Warmer	c) 6
<b>Freeze-up</b>	a) Takes longer/freezes slower	a) 4 b) 8
	b) Occurring later	c) 6
	c) Rougher	d) 4
	d) Different process	
<b>Break-up</b>	a) Melts/breaks up earlier	a) 2
	b) Melt stages happen faster	b) 3
<b>Ice thickness</b>	a) thinner	a) 2

#### 5.4.1 Floe edge

As mentioned previously in Section 5.2.1.5, the position of the floe edge around Igloolik is highly dependent on the piling of MYI on the three key reefs in *Ikiq*, between Melville Peninsula and Baffin Island (Figure 5-8b). Therefore, while the position of the floe edge was generally estimated to be moving closer to town (Table 5-3), it is frequently mentioned in



relation to the MYI being grounded on the reefs (AI1; DI1; EK1). The floe edge is variable, changing from year to year (Figure 5-8a) (AI1). However, MYI does not seem to be piling up as much on the reefs as in the past (EK1), which leads to a floe edge that is closer to town. Furthermore, even when the *kikiaks* are stopping the ice and creating a floe edge, the ice will still break off (AI1; EK1).

“When [the floe edge] is smooth all the way, that could be one of the factors in that the ice breaks easily, maybe the current is stronger in recent times. But it just breaks off. And then, *Ivunirarjuq*, this reef is *kikiak*, in that it nails the ice, *kikiak* meaning “a nail”. It stops this ice, so therefore once it freezes it stays there, because again this [reef] prevents it from breaking off. It might break off something like this every now and then, but it prevents it from breaking off all together. But in the last few years [I] notice that even though this [reef piling] there, it breaks off here. And [I] don’t really quite understand why it does that. It’s not doing what it used to anymore.” (Kunuk, 2004a)

This renders the floe edge stability more unpredictable, even when it is extending to the reefs.

#### 5.4.2 Weather

Emphasis was commonly placed on the variability of weather, and related sea ice changes, around Igloolik rather than on consistent uni-directional change. No two winters are the same, just as the ice conditions are different from year to year (AQ1; AT1; ZA1). However, within the inter-annual variability is still a sense of expected conditions, processes, and timing. Therefore, some observations of weather changes were noted beyond statements of variability.

In terms of temperature, winters are generally becoming warmer (AT1; EI1; HP1; LU1), although some also mentioned that the cold feels the same (Table 5-3) (DI1; JaP1). The temperature change is gauged on freeze-up processes, as well as the physical signs of very cold weather. One example is that when the ice is freezing, the temperatures used to become consistently colder in the fall, whereby the ice would progress along with the cold (AT1). Now, the ice begins to freeze over, but this is followed by more warm spells, which affects the freeze-up process (AT1). Another common indicator of temperature is the ice fog that used to considerably decrease visibility (e.g. could not see buildings in town or the dog team in front of

the *kamotik*), which is no longer occurring (EI1; HP1; LU1). This type of cold is not happening as often, and certainly not by Christmas as it used to (EI1; LU1). A possible explanation for the warmer than expected temperatures in the fall and early winter may be the increased overcast conditions during freeze-up, which leads to warmer weather, more snowfall, and delayed freeze-up processes (Table 5-3) (AT1; AU1; AQ1; DQ1; EK1; JaP1; MA1; ZA1). With less clear days, it is harder to determine the timing of freeze-up (DAq1). Beyond these general trends of change, discussions of increased unpredictability were prominent in interviews.

Currently, the weather is very hard to predict (Table 5-3). In the past, once the ice had formed people could be confident in the safety of ice travel, but this is no longer the case (DAq1). Now the weather can change very quickly, it may look clear and then it will suddenly change (LU1; TI1). And previously employed indicators of weather pattern shifts are no longer applicable (LU1).

“[I]t’s very hard to predict the weather now. One good example is when [I] was a youth it was clear blue when the clouds were not, when it was not overcast. Even today, if it’s not overcast there’s always that haze that’s present, it’s not blue as it used to be...When [I] was a youth [I] used to notice that the weather change would come from the west, and it would travel from the west. If for example [I] saw clouds in the west, then they would come in. But in today’s time the clouds come from everywhere, which is quite different than when [I] was a youth. Winds, weather, they come from anywhere now, but normally they were coming from the west in the past.” (Uttak, 2004)

Much of the unpredictability of weather is linked to shifts in prevailing winds.

The NW wind is consistently indicated as the prevailing wind of the past (AI1; EI1; HP1; JaP1; LQ1; LU1; SA1; TI1), and with it came more clear days (Section 5.2.3.1) (DAq1). The SE wind would be the main opposing wind, being the only other wind to really blow hard (Section 5.2.3.1) (AT1). Now, they have become relatively even in their prevalence (DAq1; SA1), or SE winds may even be more common (EI1; HP1; JaP1; LQ1). Wind shifts between NW and SE are also now occurring via the West, which was uncommon in the past (AI1). In fact,

winds can now blow hard from any direction, rendering the prevailing wind nearly unidentifiable (AT1; HP1; LU1).

In addition to shifting wind direction, windy conditions are also now more prevalent. In the past winds would not blow for more than three days at a time, but now there can be longer periods of either windy, or calm, conditions (AI1). In the summer, periods of calm conditions were expected, but now it seems constantly windy (LU1).

“In the past, especially in the summer, it used to be so calm that it was mirror, mirror-flat, like a floor, smooth, for let’s say 5 days at a time. But nowadays nothing like that every happens, it’s constantly windy...As of about 20 years ago it started to change to what it has evolved to today. So prior to about 20 years ago it used to be less wind in the summer, but now starting at about 20- years ago it started to get windier over the summer.” (Uttak, 2004)

The wind shifts are also said to have weakened the wind, enabling it to blow for longer periods of time, but not as strong as previously (AI1). These changes in wind direction, strength, and duration contribute to changes in the timing of sea ice freeze-up and break-up.

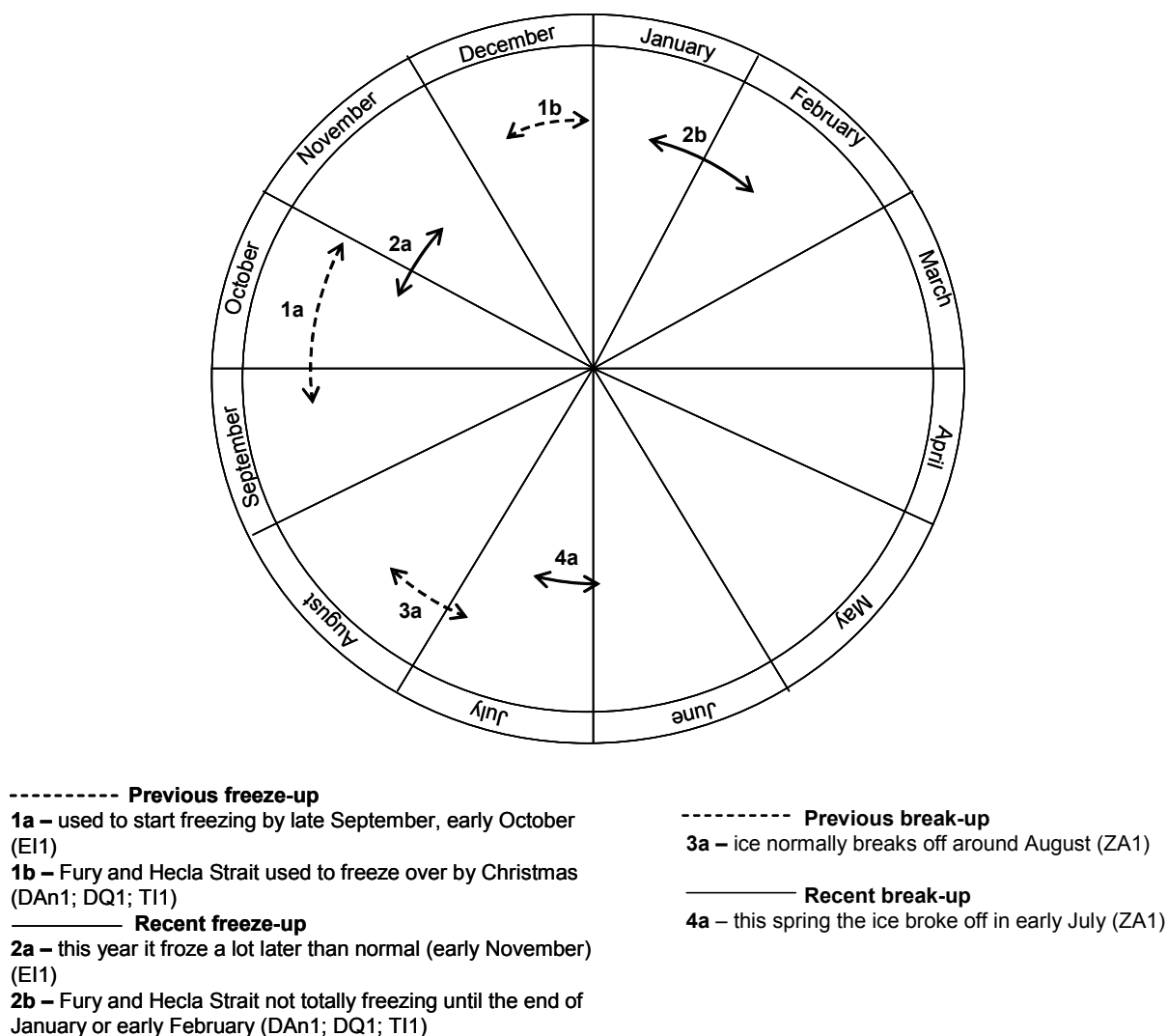
#### 5.4.3 Timing of freeze-up

The actual shifts in freeze-up timing were not emphasized as much in Igloolik as were the alterations in the freezing processes and progression (Table 5-3). Freeze-up is generally occurring later (AQ1; AT1; DQ1; DAn1; EI1; JaP1; TI1; ZA1), but only a few people discussed this timing specifically. Freeze-up around Igloolik used to begin in late September or early October, but especially in recent times has only been forming around November (Figure 5-24) (EI1). Furthermore, an important gauge of freeze-up timing is when it is possible to cross *Ikiq* to reach Baffin Island. This sea ice crossing used to be undertaken before Christmas, but is no longer possibly until late January or early February (Figure 5-24) (DAn1; DQ1; TI1).

In terms of freezing processes, the ice used to form all at the same rate, but it is now freezing section by section (AQ1). This is influenced by changes in weather conditions (Section

5.4.2) where more overcast conditions in the fall render freeze-up slower and later (AT1; JaP1; MA1; ZA1).

“What [I] have noticed is more in the last five to eight years, where when it should be freezing up [I] have noticed that it becomes overcast, snow starts falling for a long period of time. So therefore, that affects freeze-up when it does that. In that, whenever it’s overcast the temperature rises a bit, freeze-up doesn’t occur as quickly, or it doesn’t even occur at all at some times, when you have clouds and the wind working together, and it doesn’t freeze up at all. It might pile up at places and then it disperses. So therefore, what [I] have noticed in the last 5-8 years is what has changed over the years. As opposed to other years where freeze-up was quite constant, it was the same year after year pretty much. But in the last few years is when it has become overcast when freeze-up should have taken place. So therefore, it clears up later, so freeze-up occurs a little later, in the last few years.” (Arnatsiaq, 2004)



**Figure 5-24:** Summary of the changes in freeze-up and break-up timing observed in Igloodik.

Changing wind conditions also make it difficult to predict how the ice will form (AU1). More southeasterly winds in the fall have meant that the ice is blown towards the shore, or floe edge (AT1; LQ1). Therefore, the ice is piling up and freezing much rougher (*maniilaq*) than with the previously common northwesterly winds, and not moving out afterwards (EI1; EK1; HP1; JaP1; LQ1). This means that the ice is more commonly freezing upwind (*aggurtipaliajuq*), creating a different kind of ice, with less sturdy properties than *siku* and more like *qinu* – specifically between the rough ice areas (EK1). In addition, freezing used to begin from the land. Before anything on the ocean would freeze, the land would begin to freeze, and ice would start forming from the tidal zone (DQ1). Once the tidal zone ice had formed, freezing would progress quickly outwards, whereas today it is taking much longer. Even when the ground is frozen, and snow has accumulated, the tidal zone is not always frozen (DQ1; JaP1). This frozen tidal zone, *qaingu*, was used for traveling, but this is no longer possible as it is softer and thus harder to travel on (SA1). Moreover, some areas that used to freeze later in the fall, are now staying open all winter and forming new polynyas (JaP1). Therefore, the general formation of sea ice is happening slower than in the past (DI1; LU1).

#### 5.4.4 Timing of break-up

Similar to the timing of freeze-up, break-up timing was not emphasized as much as the conditions during melt stages (Table 5-3). Break-up was discussed as occurring at a different time every year, although it was considered “normal” to break off around August whereas in the spring of 2004 the ice broke up in early July (Figure 5-24) (ZA1). Thinner ice tends to break up earlier (JaP1), and break-up is occurring quicker despite the weather feeling just as cold as previously (DI1). Conditions during melt stages were described as being different. For example, after meltwater has drained off the ice initially it is wearing out before the water becomes deep again (JaP1). Some of the different melt stages were linked to a unique spring where tidal cracks that normally form in the spring were not present (AI1; DQ1; SA1).

“But this year [2004] for some odd reason, [the cracks never formed to create open leads]. And then you find that all of a sudden the ice wears out faster...[My] theory is that because the cracks are not there, the drainage doesn’t take place, so therefore once the snow melted the water stayed on [the ice]. And again ice just wore out, it just melted, it didn’t break up and go like in normal years. It just melted. And that could be a factor because of that film of water that’s on the ice. Normally the stage would be first there’s water, and then it drains along the tidal cracks or breathing holes, and then it gets deep. We didn’t get to the deep stage this year. And because of the absence of these two cracks, it didn’t get to the stage where it becomes deep and then there’s ice and then there’s deep. In that [I] remember this spring as being able to go back and forth and it was smooth all the way. And again, this was quite different from other years...This has occurred in the past, and the same thing happened when it did occur.” (Qattalik, 2004)

This means the ice just melted away, instead of breaking up (DQ1; JaP1).

#### 5.4.5 Ice thickness

General indications of ice thinning were mentioned in interviews, although most frequently in relation to dangerous ice conditions (AQ1; JaP1). The danger comes from snow accumulation on the ice, causing it to wear away from underneath (AQ1). Seal breathing holes and open cracks are used to gauge ice thickness (JaP1). The ice was estimated at about 3 feet of thickness currently, whereas it used to reach almost 6 feet (JaP1). In those cases, hunters have to look a long way down a tunnel-like breathing hole to be able to identify seals below.

#### 5.4.6 Wildlife

In addition to the sea ice changes mentioned in Sections 5.4.1 – 5.4.5, wildlife are commonly used indicators of change in Inuit culture. Because of the important relationship between humans and animals, there were some changes noted about polar bears, seals, bowhead whales, and walrus that may be linked to changing ice conditions.

Firstly, bears have been sighted more frequently, and seem to be more numerous than in the past (AT1; DQ1; TI1; TI2). Some possible reasons for these more common sightings include the fact that:

- polar bears never used to be found on landfast ice as it was forming, but today they are being seen all over – it is possible that because the ice is not forming as quickly the bears are staying on solid ice longer (AT1);
- because the ice is not forming as well in the south, the bears are moving to places where it is colder and so they are moving northwards (DQ1; TI1; TI2);
- the bears are more frequently going after cached meat (which they never used to do) around the town, or camps, and so they are seen more often (AT1; DQ1; LQ1; TI2); or,
- polar bears can no longer be hunted freely due to the quota system, and thus may be becoming more numerous (DAn1).

An additional indicator linked to potential sea ice change is that polar bears hunted are leaner, they do not have as much body fat (SA1; TI2). Perhaps the ice is not forming early enough, or remaining long enough, for the bears to be effective in their acquisition of food sources (mainly seals) (ZA1) and thus to remain healthy (SA1; TI2).

Secondly, seals used to be more numerous in *Ikiq* and also had more fat on them (EK2; SA1). This change in numbers could be linked to changing ice conditions, but may also be caused by: i) increased numbers of killer whales in *Ikiq*; ii) earlier and more frequent hunting in Hooper Inlet; and, iii) seals moving to different areas to get away from all the snowmobile traffic (EI1; EK2; SA1).

Thirdly, as mentioned briefly, there used to be very few killer whales around Igloolik and their numbers have increased recently (EK2). In addition, bowhead whales are also observed as being more numerous these days (EK2).

Finally, walrus are no longer found to be congregating in certain channels during freeze-up (AQ1). Therefore, they are not migrating to the floe edge through the same areas, and some previously common haul-out areas are also not being used (AQ1; JaP1). Walrus, as with other marine wildlife, may therefore be avoiding high motor traffic areas and not necessarily changing their movements based on sea ice conditions (AI1; JaP1; LU1).

#### 5.4.7 Moving ice

Also unique to Igloolik assessments of sea ice change is the importance of MYI, and moving ice conditions. Most notably, the two commonly expected types of MYI traveling through *Ikiq* ('dirty' and 'clean', Section 5.2.1.6), are both now only concentrated in certain areas (LU1). They are also generally further from town (AI1; TI1) and thus not as influential on summer temperatures (LU1). For example, the yellowish-brownish 'dirty' MYI has been later in moving towards town in the spring (AU1). Furthermore, the 'clean' MYI has been more common in recent years, which is potentially linked to the shifts in wind directions (i.e. not blown in from the NW as much) (LQ1). Furthermore, the moving ice is no longer as solid, there are more cracks present, and the ice pans are smaller/thinner (AI1; LQ1).

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To the elders and hunters interviewed in Igloolik the sea ice is very important, for traveling, hunting, and wildlife. They understand the sea ice processes around their community, and have been keenly observing changes to expected conditions and timing of events.

“And again, the knowledge that’s acquired about moving ice, [I] feel that our youth need to know it. [My] little one, even though they are never going to be hunting there, they will never have the need to go hunting there, probably, seeing as how they don’t use fat anymore, or dogs. They probably won’t have the need to go down, but having the knowledge will help them, if at some point they have to use the moving ice.” (Irnigaut, 2004)

They want their knowledge shared with the younger generation of Inuit, and with scientists, to help educate people from the Inuit perspective. This chapter is a beginning in the sharing process. The means of learning across generations, and cultures, is discussed further in Chapter 8.



## Chapter 6 – Results

### *The importance of sea ice processes, use, and change around Pagnirtung*

“To [me], not only to [me] but to the hunters, you have to have an association with the sea ice. To [me] it’s almost like a gift because you have to depend on the conditions of the ice, and depending on the conditions it will have an effect on how much you’re able to bring in terms of food on the table. So, it has an effect on how you live as a person, as a hunter. Because once we notice that the conditions start to deteriorate at any particular spot, the hunter doesn’t necessarily become totally helpless but he knows that he’s going to have more difficulty in trying to procure the animals that he needs to survive on. So you have to have that association with the ice.” (Maniapik, 2004a)

#### 6.1 Importance of sea ice

Sea ice was described as being a deep-seated part of Inuit culture (Noah, 2004 (MaN1); Kisa, 2004 (MiK1); Maniapik, 2004c (MM1)).

“It’s very very important to Inuit, because it’s our *qaujiti*, which means we were born to it and we’ve always lived in it...If the sea ice doesn’t form anymore, although we still get snow, our life would drastically change.” (Maniapik, 2004c)

Because of Pagnirtung’s location in a fiord, surrounded by high mountains, sea ice has always been an important travel platform in order to leave the community since ice is smoother and faster than traveling on land (Nashalik, 2004 (EN1); Maniapik, 2004a (JoM1); Papatsie, 2005 (JoP1); Evic, 2005 (LE1); Nowyook, 2004 (LN1); Qappik, 2004c (PQ1)). It is also easier to travel on sea ice than on open water, especially in windy conditions (Mike, 2004 (JaM1); JoM1). For these reasons, several interviewees expressed a clear preference for the winter months when the ocean is frozen. When the ocean starts freezing people are joyful to hear that the ice is becoming solid (Alivaktuk, 2004 (JAK1); Ishulutak, 2004b (LI2); LN1; Keyuajuk, 2004 (MoK1)). Meanwhile, when news of ice deterioration is communicated in the spring hunters are unhappy, knowing that their time on the ice is limited (JoM1; LI2). As long as a person knows where the areas of strong currents are, the dangerous zones, it is possible to travel nearly any time, anywhere on the ice (Ishulutak, 2004d (JI2); JoM1; LE1). However, the interest in solid ice for travel is usually directed towards the ability to access key hunting and fishing grounds.

Sea ice is also an essential hunting platform and provides important habitat for a variety of marine and migratory wildlife (JI2; Soudluapik, 2004 (JS1); PQ1). Sea ice travel and hunting used to be one of the most important means of survival (i.e. to access food, clothing, and heat materials), and it remains an essential aspect of subsistence and commercial harvesting today (Anonymous, 2004 (AY1); EN1; JaM1; JI2; JoM1; Qappik, 2004a (JQ1); LE1; LI2; LN1; MaN1; Evic, 2004 (ME1); MiK1; MoK1; PQ1).

“[The ice is] part of the hunter’s life and it can have an effect on his livelihood. {With} the conditions that we have today, [I’m] just using you and [Eric] as an example, [you] have our own place where [you] work where [you] can make [your] money, just by sitting here. But as a hunter, [I] have to hunt out there, and [I] depend on the animals to bring in the food as subsistence and also the skins, depending on what kind of animal it is, to be able to make money off that. So it has already had an impact on how much a hunter, not only [myself] but other hunters, as to how much money [we] can bring into the family.” (Qappik, 2004a).

Therefore, sea ice supports marine mammal hunting whereby ringed seals are a community staple (JS1; ME1; MiK1; PQ1). However, the ice also enables access across the fiord, or across Cumberland Sound, to reach inland Arctic char fishing lakes and caribou hunting grounds (JaM1; JoM1; MiK1). In addition, the ice in Cumberland Sound supports an important economic endeavour in Pangnirtung, the commercial turbot fishery.

“[The ice] is our only road in the winter time that can take us to animals that we can eat. And especially for people like [me], [I] really rely on the ice to form properly so [I] can fish for [my] livelihood.” (Nowyook, 2004)

This fishery began around the early 1980s, where fishermen from Greenland were brought in to teach community members about the long-line fishing technique used to catch turbot (Greenland halibut) (AY1; JS1). Fisherman require solid ice cover in order to employ this technique, as well as to access the desirable (deep) ocean areas that are most productive (Section 6.3.2.1) (AY1; Nowdlak, 2005 (JN1); JS1; LN1).

In using sea ice for travel and hunting purposes, Inuit elders and hunters have developed an understanding of freezing and melting processes. Specific Inuktitut terms are

used to describe ice conditions and transition stages that occur throughout the annual sea ice cycle of formation and decay. These also link to the floe edge, tidal cracks, and polynyas, as influenced by wind and current conditions. Local characterizations of these freeze/thaw and dynamic processes (Section 6.2) will thus be presented prior to discussing sea ice use (Section 6.3). These terms and processes are critical to the presentation of sea ice travel safety (Section 6.3.1) and marine wildlife hunting and habitat descriptions (Sections 6.3.2 and 6.3.3). It is also essential to describe the formation and decay processes as a background to the changes that are currently being experienced by elders and hunters in Pangnirtung (Section 6.4).

## 6.2 Sea ice processes

The general order of freezing and melting processes in Pangnirtung, as well as links to the floe edge and tidal cracks, is shown in Figure 6-1. The processes are described to follow the diagram, so the reader is encouraged to refer to Figure 6-1 and Appendix 16 frequently to better understand the links and terminology presented in the following sections. Furthermore, Appendix 5 acts as a map index for figures that show subset areas around Pangnirtung and in other parts of Cumberland Sound.

### 6.2.1 Freezing processes

#### 6.2.1.1 Near shore freezing

Ice begins forming at the edge of the land in the fall (*qillirusijuq*) (Figure 6-1) (EN1; MaN1). Therefore, small bays and fiords tend to freeze over first (*sikutaq*) (Figure 6-1) (JQ1; LE1; Ishulutak, 2004a (LI1); MaN1; Veevee, 2004 (PV1)), or between islands where the ice can easily become landlocked (ME1). Therefore, *iluvaliajuq* is the first ice forming along the tidal flats (Figure 6-1) (LI1). As this ice extends off the shoreline it becomes *qainngu*, and then *sijja* once it has solidified (often rough from the tidal variations (Figure 6-1, 6-2a, b) (LI1; MaN1).

“Yeah, because what you call a pressure ridge, what we call *sijja*, and then you have the land, well this is the land and then you have the ice that’s sitting between the pressure ridges and the land...that’s what we call *qainngu*.” (Ishulutak, 2004a)





a) spring *qainngu*, an ice ledge along the shore that supports sea ice travel, usually the first part to form and the last part to break off



b) *sijja* rough shoreline ice created by tidal variations, shown here towards spring with flat landfast ice in the background

**Figure 6-2:** Photos of near-shore freezing conditions, including: *qainngu* (a) and *sijja* (b). (photos: Gita Laidler)

When the ice begins forming outwards from the land it is termed *sikuvaliajuq*, “the ice is starting to form well” (Figure 6-1) (JaM1; JQ1; JS1; LI1; LE1).

#### 6.2.1.2 Open water freezing

In open water, it is possible to see the first ice crystals forming in the water when a slight breeze highlights areas that look like oil slicks (*quppirkuaq*) (Figure 6-1) (PQ1). The earliest formation of ice is a slush-like consistency in the water (*qinnuaq*), which can be caused by freezing or by snow falling in the open water (Figure 6-1, 6-3a) (AY1; JS1; LN1 and JoP1; MaN1; MM1; MoK1; PQ1). As this flexible ice stiffens with colder temperatures, the ice will start to form (AY1). Where winds come off the land in bays and fiords, these cause newly formed ice to be blown around, forming *sivaujanguaq* (literally referring to what “looks like a cookie”) (EN1).

“And that first ice that forms at the edge of the land, whenever there’s a wind that comes out of the land and into the middle of the bays and little fiords [I] call it cookie-like pieces of ice that come off the land. And if you get a lot of that then the whole ocean will freeze sooner if you have more of those cookie ice floating all over the place....And [I] call it *sivaujanguaq* [which is a very modern term for looking like a cookie]...Or looking like a biscuit, *sivaujat*.” (Nashalik, 2004)

However, the more traditional term for this kind of ice would be *sikuallaajuq*, referring to multiple pans of *sikuaq* (Section 6.2.1.3) in an area (Figure 6-1) (PQ1). These circular formations can also be created by the influence of currents pushing ice into each other (EN1). If *sikuallaajuq* congregate in certain areas they can actually cause the ice to thicken sooner than if they were not present (EN1).



a) *qiinnuaq*, early slush-like ice formation



b) *sikuaq*, the first continuous sheet of ice that forms in the fall

**Figure 6-3:** Photos of open water freezing conditions, including: *qiinnuaq* (a) and *sikuaq* (b). (photos: Gita Laidler)

### 6.2.1.3 Sea ice thickening

The first sheet of continuous ice is *sikuaq* (Figure 6-1, 6,3b) (AY1; EN1; JaM1; MaN1; MiK1; PQ1). This is a very thin piece of ice that is just on top of the water, whereby *sikuaqtuq* refers to the process of *sikuaq* forming (Figure 6-1) (JaM1). Once the ice is thick enough to walk on (*sikurataaq*) it is *atuqsaruqtuq* (strong enough to hold a person) (Figure 6-1, 6-4a) (JaM1; Ishulutak, 2004c (JI1); JoP1; LN1; MM1; MoK1). Newly formed ice, before snow has fallen on it, is called *nutaaminiq*, and it would be possible to travel on this ice (Figure 6-1) (JoM1; JoP1; MiK1; PV1). When the water becomes covered with ice it is *sikujuq*, which progress to become *nipittuq* (stuck to the land) (Figure 6-1) (JS1; PQ1). Sometimes *qanngut* will form on new ice, appearing to be snow crystals but actually they emerge from the sea ice due to the temperature difference between the ocean and the cold air (Figure 6-1, 6-4b) (Section 6.3.1.1) (AY1; EN1; JaM1; LN1; PV1).



a) *sikurataaq*, ice thick enough to walk on, thus it is *atuqsaruqtuq*



b) *qanngut*, crystallized frost formations that form on thin ice, usually near open water



c) *nigajutaq*, an area where the ice takes longer to freeze



d) looking into Pangnirtung Fiord, standing on *tuvaq*

**Figure 6-4:** Photos of various stages of sea ice thickening, including: *sikurataaq* (a), *qanngut* (b), *nigajutaq* (c), and *tuvaq* (d). (photos: Gita Laidler)

“You know when the ice is first forming it looks like there is little snow crystals on top of it. But they’re actually sea ice crystals...they look like snow but they’re ice, on top of the new ice, whenever there is these little things on top of [the ice] it takes longer to become solid. When it’s clear then it takes less time in order to become solid and then when that *qanngut* is the very top layer.” (Nashalik, 2004)

Where these crystalline formations occur the ice is not as slippery as smooth ice (Figure 6-1) (EN1; MoK1). If snow does fall on the newly forming ice it is referred to as *apputtattuq* (Figure 6-1) (AY1; JoM1). This snowfall on thin ice will melt the sea ice, causing further thinning as well as wet snow on top of the ice (*ittanilapaat*) (Figure 6-1) (AY1; JoM1; JS1; MM1; MoK1). This sets back the freezing progression but the snow can also sink into the ice, becoming part of it (*kiviniq*) and actually strengthening the ice (Figure 6-1) (JoM1). However, usually snowfall will



create areas that are softer than the surrounding sea ice (*sikurinittuq*) (Figure 6-1) (Nuvaqiq, 2004 (MoN1); JS1). Even as the ice thickens, some areas will take longer to freeze than others. Therefore, where winds and currents have delayed freezing they create *nigajutaq* (Figure 6-1, 6-4c) (JaM1; MaN1). The first ice to form, that lasts until the following year, is referred to as *sikuvaalluuti* (Figure 6-1) (EN1). As the ice thickens further it becomes *siku*, a general term for sea ice (Figure 6-1) (AY1; JoP1; LI1; MaN1; MM1; MiK1). The process of *tuvaruqpalliajuq* means that the ice is getting thicker, so *tuvaq* is forming (Figure 6-1) (JI1; JQ1; LE1). Once the *tuvaq* has solidified, it is thick landfast ice (approximately two feet thick) (Figure 6-1, 6-4d) (JoM1; JQ1; LE1; LI1; MaN1; MiK1; MoN1). This means that the ice has formed properly (*sikutiaqtuq*) (MM1), and snow can now accumulate on the ice (*apputaniuliqtuq*) without causing thinning (Figure 6-1) (JQ1). With *tuwallariuliqtuq* it is safe to travel anywhere (Figure 6-1) (JQ1).

#### 6.2.1.4 Tidal cracks

Any crack that forms, but does not widen, is termed *nuttaq* (Figure 6-1, 6-5a) (JoM1; ME1; PQ1). A *nagguti* is a crack that has opened – usually due to tidal variations or lunar cycle – and then refrozen (Figure 6-1, 6-5b) (AY1; EN1; JaM1; JaM2; JI2; JoM1; JoP1; JS1; LI1; LN1; MaN1; ME1; MiK1; MM1; MoK1; PQ1; PV1). They tend to occur in the same places every year, usually between points of land (AY1; EN1; JaM1; JaM2; JoP1; LI1; LN1; MiK1; MoK1) or in shallower areas with more ice movement (Figure 6-6) (JaM2; JoP1; MM1). A crack that does not re-open later in the winter is referred to as a *naggutiminiq* (it used to be a *nagguti*) (Figure 6-1) (JaM1; LI1). Whereas, a smaller crack within a *nagguti* is an *aijuq* (Figure 6-1) (LI1; JN1). In the spring, when there is open water in a *nagguti* it is then called an *aajuraq* (Figure 6-1, 6-5c) (AY1; EN1; JaM1; JaM2; JoP1; JS1; LI1; MaN1; MiK1; PQ1). In some areas a series of *naggutiit* will become a large *aajuraq* in the spring (MaN1), whereby the area of open water in between two large pieces of ice is termed *ikirniq* (ME1; JoP1).



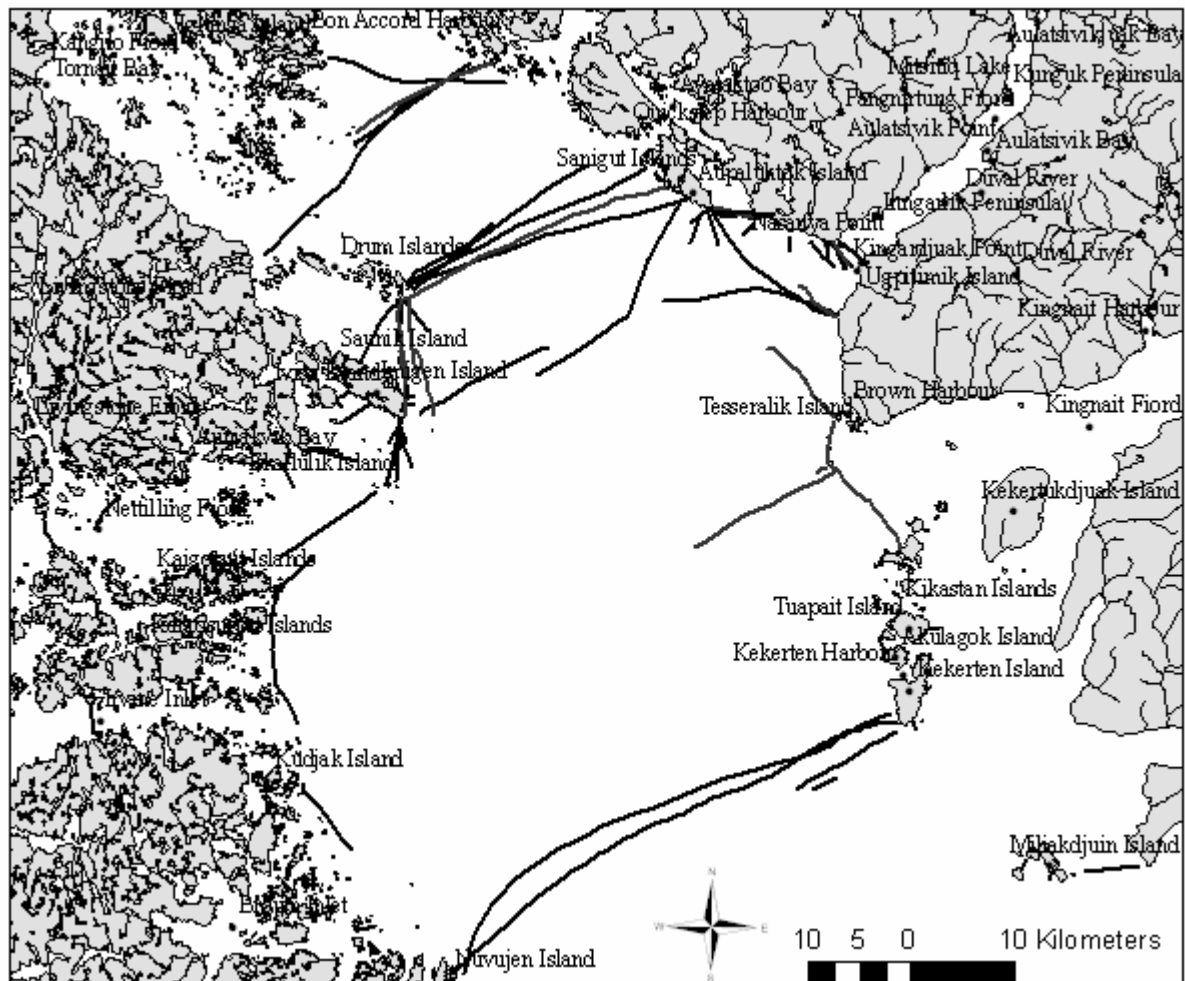


a) *nuttaq*, a small crack in the ice that does not widen

b) *nagguti*, a crack that opens and re-freezes several times during the winter

c) *aajuraq*, a *nagguti* that opens in the spring time and does not re-freeze

**Figure 6-5:** Photos of different types of tidal cracks, including: *nuttaq* (a), *nagguti* (b), and *aajuraq* (c). (photos: Gita Laidler)



**Figure 6-6:** The location of various tidal cracks in Cumberland Sound.

Sources: AY1; EN1; JaM1; JN1; JoP1; JS1; LN1; MaN1; ME1; MM1; PQ1; PV1

#### 6.2.1.5 Floe edge

The edge of the *tuvaq* is called the *sinaaq* (Figure 6-1, 6-7) (JaM2; LE1; LN1; MaN1; MM1), and this can vary in position from year to year (Figure 6-8). Any new ice that forms along this edge is referred to as *uiguaq* (Figure 6-1) (EN1; JaM1; ME1; MM1). This area tends to be thin and smooth due to the fact that it is continually adding on to the *sinaaq* (JaM1; ME1). Therefore, the older *uiguaq* is referred to as *uiguatuqaq*, while the newest ice at the *sinaaq* is always *uiguaq* (Figure 6-1) (ME1).



**Figure 6-7:** Spring *sinaaq* at the mouth of Pangnirtung Fiord in May, 2004.  
(photo: Gita Laidler)

“*Uiguaq*, that’s the term. Like if this is the floe edge, and then this little area will freeze all along the edge, *uiguaq*. And then a couple days later there will be another new *uiguaq* out here, and this keeps getting bigger and bigger like that. So this is solid ice, this is the new ice, so this whole area would be *uiguaq* [drawing]...The first one that forms it’s called an *uiguaq* at first. But then when a new *uiguaq* forms there, this old one is called *uiguatuqaq*, meaning an old *uiguaq*. *Uiguaq* just means an addition, so this would be like the new *uiguaq*, that’s the old *uiguaq*.” (Evic, 2004)

If some of the *tuvaq* breaks off at the *sinaaq* the action is termed *uukkaqtuq* (Figure 6-1) (ME1). Furthermore, *nunniq* is a specialized term used to refer to the extent of freezing in Cumberland Sound – typically when the floe edge is quite far away (Figure 6-1) (AY1; JI1; Maniapik, 2004b (JoM2); LN1; MaN1; ME1; MM1; PQ1). However, this condition does not occur every year (AY1; JI1; JoM2; LN1; MaN1; PQ1), and has been occurring less frequently in recent times (Section 6.4.1) (AY1; JoM2; MaN1; PQ1).





### 6.2.2.2 Water accumulation and drainage

The process of *immatittuq* forms puddles of water on top of the ice (*immatinniit*), due to snowmelt (Figure 6-1) (AY1; EN1; JoM1; JQ1; JS1; MaN1; ME1; MiK1; PQ1; PV1).

“Ok what happens is that when the sea ice becomes *immatinniit*, that’s the result of the snow that’s on top of the [ice] that’s melted, it has become slush. In the early part of spring it gets really slushy out there, and people get stuck in the water, we call it water, *imaq*...but anyways it gets so wet out there that it becomes slush, slushy water, and that’s the result of the snow melting.” (Qappik, 2004a)

This water will accumulate before it starts draining off into *aajurait* and seal breathing holes (*alluit*) (AY1; EN1; JoM1). The very top film of these puddles will sometimes re-freeze at night (*ikiartirtuq*), but water or air will remain underneath (Figure 6-1, 6-10a) (MaN1; ME1; MoN1). The melt water will then collect into little melt rivers (*kujjirtuq*) (MaN1), and where the ice has melted all the way through they will drain into *killait* (melt holes) (Figure 6-1) (EN1; JaM1; ME1; PQ1).



a) *ikiartirtuq*, *immatinniit* where a thin film of ice had formed overnight



b) *puttaijuq*, when the sea ice becomes completely covered with melt water

**Figure 6-10:** Photos of water accumulation on the sea ice, including: *ikiartirtuq* (a) and *puttaijuq* (b). (photos: Gita Laidler)

“And then in May, June, the ice conditions deteriorate to the point where at this time you can see there’s water spots on the ice right now, and you know there’s water. But there’s certain spots that, along these water puddles on the ice, some of them do have small spots of open water that goes right into the sea. And some may be, some are really thin where people should be careful about traveling through those because a snowmobile can literally go through these spots. And that is what we call *killaq*.” (Mike, 2004)



However, sometimes the ice will become completely covered in water (*puttaijuq*) before it starts draining (Figure 6-1, 6-10b) (PQ1).

### 6.2.2.3 Break-up

In some areas, the shoreline ice breaks up first, creating *maujaraq* where people can jump from cake to cake of ice (Figure 6-1) (PV1). After a certain amount of melt water drainage the ice will pop up and float free of the land (EN1; JoM1; MaN1; ME1). There will be short period of smooth, water-free ice (*tikpaqtuq*) that follows as the ice becomes buoyant (MaN1; ME1; PQ1), but once the ice itself begins to melt then puddles indicate the late stages of deterioration (JoM1). In other words, there are really two stages of *immattiniit*, and in the latter one (*immatillarittuq* – really *immatittuq*) it becomes dangerous to be traveling on the ice because it will soon be breaking up (Figure 6-1) (AY1; JoM1; JQ1; MaN1; PQ1).

“The second time [*immatinniq*] happens is when you start having puddles, it’s when the sea ice sort of floats on top of the water and as a result all the water has drained and then you’ll see that it’s completely white, like it is in some parts...it became white. And now the second time the puddles are as a result of water that has come up from the bottom, because the sea ice is full of holes now and the water that’s come up on the ice creates ponds. But they’re puddles, and that’s the second time that they’re called *immatinniq*, but they’re mainly from the bottom of the sea.” (Qappik, 2004a)

As the *tuvaq* thins out (from the sun and winds above, as well as currents below) it becomes “bad” (*tuvarluqtuq*) because it is no longer solid (Figure 6-1) (JI1; LI1; MaN1). Thus, the process of break-up (*surattuq*) is well underway (Figure 6-1) (JS1; MM1; PQ1). Once the *tuvaq* is detached from the land (usually from within fiords) and breaking up (*tuvaigaliqtuq*) it becomes *tuvaminiq* (it used to be *tuvaq*) (Figure 6-1) (EN1; JI1; LE1; LI1; MaN1; MoK1; MoN1; PV1). The *sijja* will then begin to break off in a process called *sijjaigaliqtuq*, leaving *sijjaminiq* floating in the water (Figure 6-1) (LI1; MaN1). The last part to break off the shoreline would be the *qainngu*, with the action of *qainnguigaliqtuq* (Figure 6-1) (LI1; MaN1). After this point, the open water would be conducive to boat travel, and launching boats from the shoreline (LI1).

### 6.2.3 Wind and current influences on sea ice

Mentioned briefly throughout Sections 6.2.1 and 6.2.2, winds and currents greatly influence how and when ice forms, moves, or deteriorates. For both winds and currents, the general conditions around Pangnirtung are described, followed by a characterization of their influence on sea ice.

#### *6.2.3.1 Prevailing winds*

North or northwesterly winds are prevailing around Cumberland Sound (Table 6-1). The predominance of the NW winds is mainly experienced in the fall and winter seasons, while the opposing southeasterly winds are more common during the summer (Table 6-1) (EN1). However, these two winds are known to counteract each other, whereby if one blows for a while the other will almost surely follow – almost like they take revenge (JoP1; JS1; MM1).

“And there are four directions of wind, you have the North and the South and the West and the East winds. And the ones that are more prominent in the community are the East winds when they’re coming in, shooting in from up the fiord, so they get fairly strong. But the major winds that [Cumberland] Sound has are the North and the South. And the North and the South seem to be the strongest in terms of, it’s almost like they compete with each other, they more or less take turns. You may have strong North winds at one point and it gets calm and then the South winds will start. It’s almost like they’re competing against each other, so those are the two major winds within the, within [Cumberland] Sound. (Maniapik, 2004a)

Specifically around the community of Pangnirtung, located in a mountainous fiord of the same name, the topography influences local wind conditions. Because of the orientation of the fiord, it can change the prevailing wind directions more to east/west directions. Therefore, in town the westerly winds are most prominent in the summer, while easterly winds are stronger in the fall (Table 6-1). Those winds coming from the west blow in from the mouth of the fiord and are thus called *isirsangaq* because they are entering the fiord (JoM2), while easterlies come more from inside the fiord, and off nearby Mount Duval (Table 6-1). The influences of all these winds on sea ice conditions or movement are summarized in the conceptual model shown in Figure 6-11.

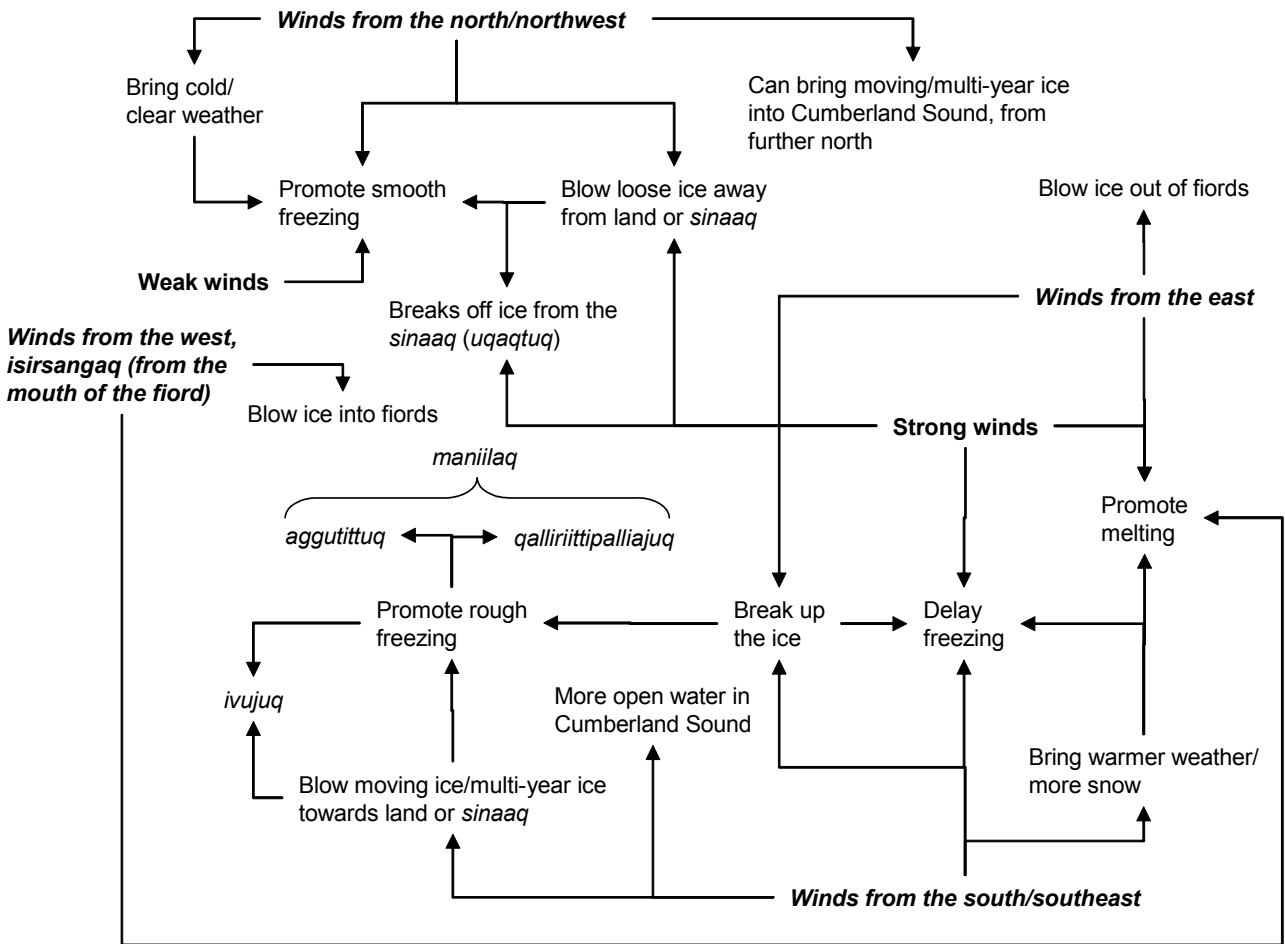
**Table 6-1:** Summary of predominant directional and seasonal winds around Pangnirtung, and their related influences on sea ice.

Direction	Season	Ice influence	Source
<b>West</b>	<ul style="list-style-type: none"> <li>• prominent in Pangnirtung Fiord</li> <li>• afternoon breeze in spring/summer</li> </ul>	<ul style="list-style-type: none"> <li>• not good wind</li> <li>• blows ice into the fiord from Cumberland Sound</li> <li>• melts the ice and snow in the fiords</li> </ul>	EN1; JoM1; JoM2; JQ1; PQ1; PV1
<b>NW</b>	<ul style="list-style-type: none"> <li>• prevailing in fall and winter</li> <li>• colder winds</li> </ul>	<ul style="list-style-type: none"> <li>• can cause the ice to break off at the floe edge</li> <li>• pushes loose ice out</li> <li>• can also bring moving ice into Cumberland Sound from Davis Strait</li> <li>• brings good clear weather</li> <li>• freezes smoothly</li> <li>• freezes quickly</li> </ul>	AY1; EN1; JaM2; JI2; JN1; LE1; LN1; MaN1; MiK1; MM1; MoK1
<b>North</b>	<ul style="list-style-type: none"> <li>• prominent in Cumberland Sound</li> <li>• colder winds</li> </ul>	<ul style="list-style-type: none"> <li>• can cause the ice to break off at the floe edge</li> <li>• pushes loose ice out</li> <li>• can also bring moving ice into Cumberland Sound from Davis Strait</li> <li>• ice thickens faster</li> </ul>	JAK1; JoM1; JoP1; JQ1; JS1
<b>NE</b>		<ul style="list-style-type: none"> <li>• brings good weather</li> </ul>	EN1
<b>East</b>	<ul style="list-style-type: none"> <li>• prominent in Pangnirtung Fiord</li> <li>• strongest winds come off Mount Duval</li> <li>• stronger in the fall</li> </ul>	<ul style="list-style-type: none"> <li>• melts the snow on top of the ice</li> <li>• can break up the ice</li> <li>• floe edge comes closer to town</li> <li>• ‘spits’ the ice out of the fiord</li> </ul>	AY1; JoM1; LI2; MaN1; MoN1; PQ1; PV1
<b>SE</b>	<ul style="list-style-type: none"> <li>• prevailing in summer</li> <li>• warmer winds</li> <li>• more snow</li> </ul>	<ul style="list-style-type: none"> <li>• dangerous when strong</li> <li>• creates cracks in the ice</li> <li>• breaks up the sea ice</li> <li>• pushes moving or multi-year ice in</li> <li>• creates rough ice formations</li> </ul>	EN1; JaM2; JI2; JN1; JoP1; LE1; LN1; ME1; MM1
<b>South</b>	<ul style="list-style-type: none"> <li>• prominent in Cumberland Sound</li> <li>• warmer winds</li> </ul>	<ul style="list-style-type: none"> <li>• breaks up the sea ice</li> <li>• dangerous when strong</li> <li>• floe edge comes closer to town</li> <li>• pushes moving or multi-year ice in</li> <li>• more open water in Cumberland Sound</li> </ul>	JAK1; JoM1; JoM2; JoP1; JQ1; JS1; LI2; MoN1

#### 6.2.3.2 Influence of wind on ice conditions or movement

North and northwesterly winds are described as prevailing, but more so in Cumberland Sound, away from the topographic effects that the fiords have on wind direction and strength (Table 6-1). These winds are also credited with bringing cold, clear weather (Table 6-1, Figure 6-11) (AY1; EN1; JAK1; JI2; JS1).





**Figure 6-11:** Conceptual model of the influences of winds on sea ice formation, movement, or decay based on interviews conducted in Pangnirtung.

“From personal experience, sitting outside when a northwesterly wind is blowing, real cold, [I] know how cold it can be when every time, like you take a fish out of the hole and it freezes right away as soon as you put it down. So it can get very very cold.” (Anonymous, 2004)

With northerly or northwesterly winds, sea ice freezes faster and smoother, if they are not too strong (Figure 6-11) (JAK1; JaM2; JI2; JoP1; LE1; MM1). However, if the winds are strong they can induce *uukkaqtuq* at the *sinaaq*, blowing the ice out towards the mouth of the Sound (Figure 6-11) (EN1; JaM2; JoM1; JoP1; MiK1; MM1). Furthermore, these winds play an important role in bringing moving and multi-year ice down from further north (Lancaster Sound and Greenland) via Davis Strait, and actually blow it into Cumberland Sound (Figure 6-11) (JAK1; JaM2; JoP1; MoK1).

"In the early winter if [we] get a lot of northwesterly winds, that means that northwesterly wind, if you can imagine all of Baffin Island, like right here [going to explain using a map at the back of the room] if you get a lot of northwesterly wind that means all the ice from Lancaster Sound and up here, all the ice would be pushed down here. And then the ice will go into Cumberland Sound sort of on that side [northern side], and then proceed to fill all the fiords with ice. And then later on in August [the moving ice pans], just like animals migrating, they would sort of go along this side of Cumberland Sound, and be spit out on the other side [southern side], almost like a migrating whale or something. So if [we] get a lot of northwesterly winds in the fall that means it's pushing a lot of multi-year ice closer to Cumberland Sound. All the ice would go here by summer, and every summer there's a breeze that goes into Cumberland Sound [from the southeast], and then they would come in here and then they would fill that up, fill that up, fill that up [referring to fiords], and then August they would slowly work their way out on [the other] side." (Mike, 2005)

Southerly or southeasterly winds in the fall delay freezing (JAK1; JoP1; JS1; ME1; MM1) and contribute to rougher ice conditions after freeze-up because they push ice towards the head of Cumberland Sound (Figure 6-11) (JI2; JS1; LI1; ME1). They tend to break up the ice, even in the winter, and are thus highly influential on the position of the floe edge (i.e. stronger southerly winds means the floe edge is closer to land or the community) (JaM2; JI2; JN1; MM1).

"If the ice is kind of thin, then strong winds from here can break it off and get rid of it. However, most of the time it's the southeasterly winds that will jolt it, like sort of move it a little bit, and then the next wind will just pop it right out. *Ujutillaq*, that's another word, it's sort of like *ujutillaq*, if there is an explosion here, it's the effect, the shockwave." (Maniapik, 2004c)

Southerly winds also blow moving or multi-year ice into the Sound, filling it up with icebergs and ice pans (Figure 6-11) (JaM2; JoP1). In the spring, southerly winds play a major part in the deterioration and break-up of sea ice, leading to more open water (Figure 6-11) (AY1; JoM1; LI2; MM1). Therefore, winds from southerly direction are considered more destructive to ice conditions in general, and thus more dangerous for ice travel (AY1; JoM1; LI2; MM1).

"This happens in both fall and spring time. When the ice is trying to form a wind will come up and push everything back here and crunch it all up. And then it'll try and form again and it'll get another wind, it'll just keep on doing that until finally it locks in and freezes. And also in the spring time, it speeds up the break-up of the ice when we get winds that push them together and crunch them together." (Evic, 2004)

The destructive role of southerly winds is linked not only to wind direction, but also the fact that they are generally warmer than winds from other directions (AY1; JAk1; JoP1; JS1; LE1).

As alluded to in Table 6-1 and Section 6.2.3.1, the fiords around Pangnirtung have a strong influence on wind directions. More commonly in the fall, very strong winds blow through Pangnirtung Fiord from the east, off the side of Mount Duval (LI2). These winds can delay the freezing process by blowing – “spitting” – ice out of the fiord (Figure 6-11) (MiK1; PV1). However, this effect is even worse in Kingnait Fiord, which is why the *sinaaq* is usually close to the islands near the mouth that fiord (Figure 6-8) (AY1; JS1). Therefore, the fiords somewhat funnel winds from other directions to create stronger winds along the orientation of the fiord (LI2).

“What happens is that because of our mountains, so the very strong winds are actually coming from the south, the south winds. And what’s happening is that when the south winds are coming in strong, they’re funneling in through the mountains and they’re coming fairly strong because they’re funneling through the fiord. They’re actually south, they may be south or SE winds. And that’s when that the south wind will always have an effect on our sea ice. What happens is that it starts breaking, breaking the sea, sea ice out in the Cumberland Sound. And it also has an effect by way of funneling through our fiord, where it actually starts working on the snow on top of the sea ice.” (Ishulutak, 2004b)

In the spring and summer, *isirsangaq* (Section 6.2.3.1) is most regularly felt in the afternoon and early evening, and it blows floating ice into the fiord (Figure 6-11) (JoM2; PV1).

“And it never fails, you know remember I said there’s a breeze comes in in the afternoon, it never fails. And it never fails, come early evening, it just calms up, there’s no wind to be heard of anywhere. It’s just real flat and you see ice in the water, it’s just marvelous, just beautiful...And it never fails, you would see, or even think that it’s strange that you see people getting ready to go when it’s windy, in Pangnirtung. You know, you’d find it kind of strange, people getting ready to go out boating when it’s really rough in the fiord. But we know that it’s going to be calm, early evening, so you just get ready in the afternoon and then shove off early evening. Because you know it’s going to calm up, calm out in the evening.” (Maniapik, 2004b)

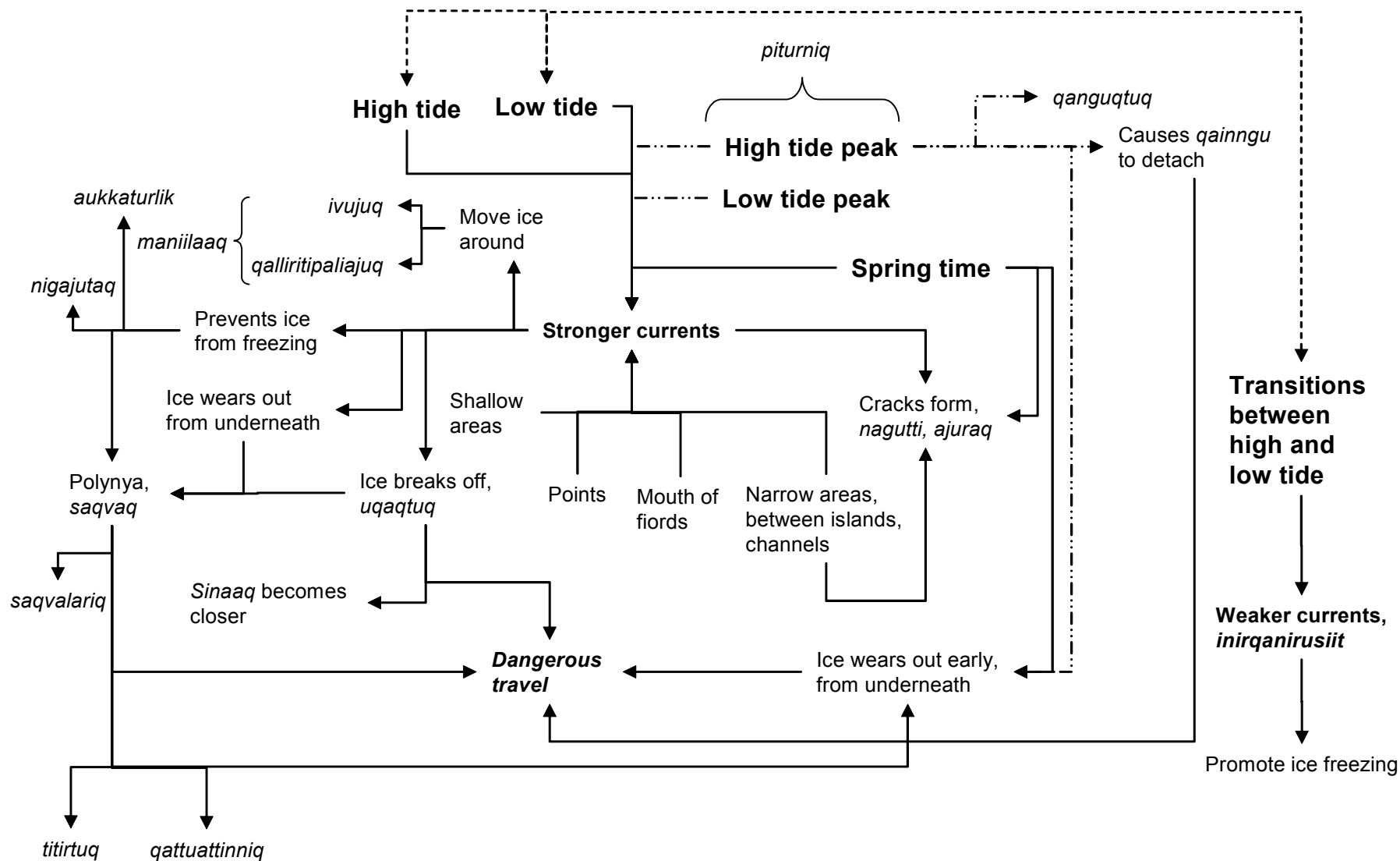
Calm conditions promote freezing in the fall (MiK1), while windy conditions can cause the ice to break and pile into rougher formations (*maniilaq*) (e.g. the process of *aggutittuq*)

(Figure 6-11) (MoK1; PV1). Winds also push new ice on top of other new ice formations (*qalliriittipalliajuq*) (Figure 6-11) (ME1). Therefore, a lot of wind in the fall creates rough, jagged ice (JI2; ME1). As the ice is thickening, winds can also more easily push ice together causing it to pile up, and create ridges (i.e. the process of *ivujuq*) (Figure 6-11) (LE1; LI1; ME1; MM1; MoK1). The ice can even be pushed up right onto land, and *ivujuq* can occur in any season (LI1; ME1; PQ1). Winds control the timing of freeze-up because they can easily break up, and move, thin ice (JaM2; ME1; MM1; MoK1; PQ1; PV1). They also influence the amount of multi-year ice in Cumberland Sound which can affect the speed of the freezing process (i.e. more ice means a cooler water temperature, and thus an earlier freeze-up) (JaM2). Therefore, it is understood that the first ice to form will rarely become solid and stay throughout the winter (JS1; ME1; MM1; PQ1). However, once the ice is solid winds do not have as much effect on ice conditions (JoP1; JQ1). They do play an important role in the melting of snow and ice though, contributing to faster break-up in the spring than the heat of the sun alone (Figure 6-11) (AY1; JQ1; MM1).

#### 6.2.3.3 Tidal cycles and currents

The daily tides operate on a twelve hour cycle between the tide coming in and going out (JaM1). In Cumberland Sound ocean circulation is described as alternating within the tidal cycle in a general east (low tide)/west (high tide) (LI2). However, in the northern end of the Sound it is also noted that currents move more in a north/south direction (LI2).

Beyond the daily high and low tides, once a month *piturniq* occurs – the peak high and low tide associated with the lunar cycle (Figure 6-12) (EN1; JaM1; JaM2; JI1; JoM1; JoP1; JQ1; LE1; LN1; MiK1). It is most commonly described as the “full moon effect” (AY1; JaM1; JI2; JoM1; JS1; LI2), but it can apply to a new moon as well (JAK1; JS1). However, even within *piturniq*, there are varying levels of peak tides.



**Figure 6-12:** Conceptual model depicting the influences of currents and tides on sea ice formation, movement, or decay based on interviews conducted in Pangnirtung.

Where: — = general process direction    - - - - = daily cycle    - · - · = monthly cycle

“On top of the daily tides there are three other different types of tides, levels of tides, *piturniq* occurs once a month where the water level rises a little higher than normal. And then, ok let’s say it’s January we get a *piturniq* which is just a regular very high tide, at one point in the month. You know, if you ever look at a tide table, at certain times of the month the tide gets really really high, and then it’ll taper off, and then it’ll get really really high again, and then it’ll taper off. Let’s say in January there’ll be a big, there’ll be an ordinary *piturniq*, and then in February there would be like a *piturnirusiq*, which is not as high as the *piturniq*. However, a couple of times a year, *piturnivijjuaq*, which is really really high tide and really really low tide at that same day. It’s both ways, it works both ways, if we’re in a *piturniq* period the water will be like up to 20 feet, but the low tide during that day it will be like, I don’t know, -20 feet. But in regular days, it will be like 15 feet, and then 15 feet. It sort of goes like this in the month.” (Nashalik, 2004)

Even between years, the current strength is described as variable; some years can have stronger currents than others (JQ2; LI2). The different temporal scales in which the currents can be stronger or weaker also render them more or less influential on ice conditions, respectively.

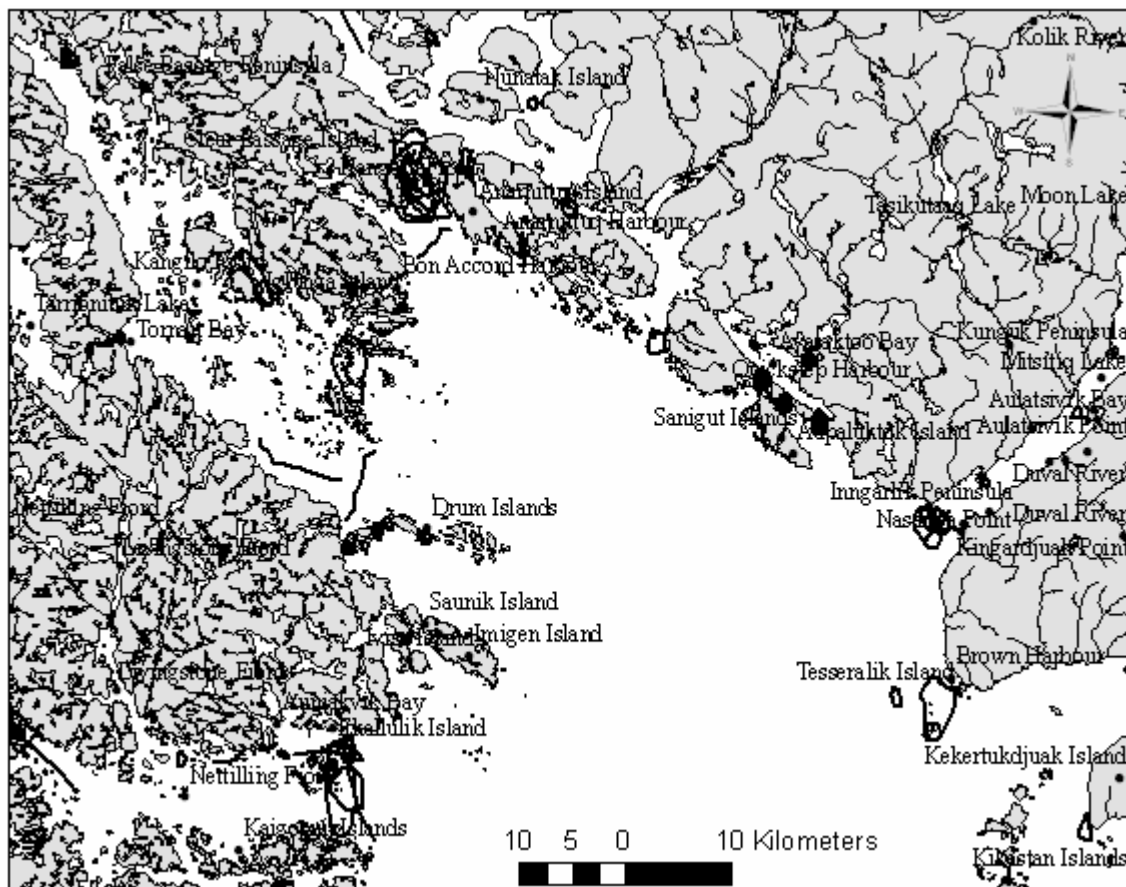
#### 6.2.3.4 *Current and tidal influence on ice conditions or movement*

Underwater topography can strengthen currents as the water travels more quickly through shallow areas, and creates bigger waves (Figure 6-12) (JI1; JoM2; JoP1; JQ2; JS1; MaN1; MoN2). Furthermore, narrow sections between islands, in channels, or at points also strengthen the currents by funneling water to higher speeds (Figure 6-12) (AY1; JN1; JoP1; JQ2; JS1; LE1; LI2; ME1; MoN2; PV1). The mouth of various fiords were often noted as having strong currents, which prevent solid ice formation and lead to earlier melting (AY1; JI2; JoM2; JQ1; JS1; LI2; ME1; MiK1; MoN1; MoN2).

“And also today the terminology used here is *aukkaturlik* meaning if, like in Pangnirtung we have fairly strong currents at the mouth of the fiord and we as hunters know which particular spots will have very weak ice and it will melt, melt fairly quickly and be open water fairly quickly. And we have them right now at the mouth of the fiord.” (Nuvaqiq, 2004)

All these conditions will delay the freezing process, while weaker currents (e.g. *inirqanirusiit*, minor currents) allow the ice to form more solidly (Figure 6-12) (JI1; JoM2; JoP1; LI2; ME1; Keyuajuk, 2005 (MoK2); PV1).

In areas with stronger currents (e.g. shallow or narrow areas), they can delay ice formation (i.e. create *nigajutait* in the fall, Section 6.2.1.3) (MM1), or they can prevent ice formation all together and create a polynya (*saqvaq*) (Figure 6-12) (AY1; JI1; JN1; JoM2; JoP1; JQ2; JS1; LI2; ME1; MoK1; MoN1; PV1). The term *saqvaq* is commonly used to refer to either the continual presence of open water within the *tuvaq*, or the occasional freezing of these areas during weaker current periods (JAK1; JaM2; JI1; JoM2; JoP1; JQ2; LE1; LN1; ME1; MiK1; MM1; MoK1; MoN2; PV1). These are areas “where there are currents”, or “fast flowing waters” (Figure 6-13) (AY1; JAK1; JoM1; MiK1; MM1). However, there can also be a distinction made between the two.



**Figure 6-13:** Key *saqvait* located around Cumberland Sound.

Sources: AY1; JAK1; JaM1; JN1; HoM2; JoP1; JQ1; JS1; LE1; LN1; MaN1; ME1; MM1; MoK1; PV1; JI1; LI2; MiK1

“There are two different kinds of polynyas, *saqvalariq* and *saqvaq*. The *saqvalariq*, the ice will never freeze there and you can hunt at the edges of the *saqvalariq* with no worries of being in danger. However, the smaller *saqvaqs* which are like not as much current, they will freeze in the wintertime, but then they melt a lot faster than the other places in the springtime. They become dangerous sooner than the normal ice, but the ice will freeze for a while there, and those minor *saqvaqs* are dangerous to hunt at the edge of. Because the ice is not as thick.” (Nashalik, 2004)

Even areas that do not freeze over are often associated with dangerous travel conditions (AY1; JaM1; JaM2; JI1; JN1; JoM2; JoP1; JS1; LE1; LI2; LN1; MaN1; MiK1; MoK1; MoK2; MoN1). However, where the edge of the *saqvaq* is well defined (LE1), or where *titirtuq* has occurred (ME1), it can be safe (Figure 6-12).

“*Titirtuq* is another term. Like when the ice on the bottom is worn away by the current, and then the snow on top gets slushy from the water, it absorbs the water, and then it freezes over onto a crust, that’s how *titirtuq*...That becomes safe. It can actually become safe...when it freezes over properly like that.” (Evic, 2004)

Furthermore, where water has continually splashed up over the edge of the *saqvaq* the ice can be considerably thicker (*qattuattinniq*) and thus safer for travel (Figure 6-12) (MoK2). Despite the potential to travel safely around some specific *saqvait*, these areas do tend to wear out earlier than the surrounding sea ice in the spring – and thus become more dangerous (Section 6.3.1.1) (EN1; JaM2; JI1; LE1; LN1; MaN1; MoN2). The size of polynyas varies along with the monthly moon cycles, whereby they are larger at each *piturniq* (JI1; JQ2; MoK2).

The *pirtunig* period, with its extreme high and low tides, is highly influential on ice conditions and stability (AY1; EN1; JAK1; JaM1; JaM2; JI1; JoM1; JoP1; JQ2; LE1; LI2; MiK1; MoK2). The strength of tides around *piturniq* can detach the *qainngu* (Section 6.2.1.1) (EN1; LE1), cause tidal cracks to open or widen (AY1; JAK1; JaM1; JaM2; JI2; JS1; LE1), expand the size of polynyas (JaM2; JI1; JQ2; JS1; LN1), or initiate break-off events at the *sinaaq* (AY1; JaM2; JI1; LE1; LI2; MiK1). During a *pirtunig* period the ice can also deteriorate faster than the diurnal tidal cycle – it will wear away faster from underneath (Figure 6-12) (JAK1; JI2; JoM1; LN1).



“When it’s full moon, at this time of year [May] when it’s starting to melt and deteriorate, when you have that full moon, you can literally see that it actually eats [the ice]. [I] mean it’s almost like you’re seeing somebody eat something right in front of you. It just literally eats that snow away. So the currents are much stronger then, you know it’s just starting to eat the ice...And especially in the strong current areas, even in the dead of winter you can have frostbite on your face and yet if the currents are strong enough they will actually eat away the ice, even when it’s really cold out. Like it’s freezing above the sea ice, but it actually [gets eaten] away in the strong current areas, from the bottom.” (Maniapik, 2004a)

The action of *qanguqtuq* can also occurs during *piturniq*, whereby ice is pried off the land by the strength of the tides underneath and water flowing over top of the ice – a very fast, noisy, and scary experience (Figure 6-12) (EN1).

“This is not a gradual process...This is like a very scary, noisy process that [I’m] talking about. [I] was on the ice and it sounded like it was being destroyed or something, a lot of noise, grinding and sudden rushes of water sounds. So it’s a very, very noisy process...When you don’t expect it it can be very scary because it always occurs very early in the morning. And it’s very noisy, if you’re camping by the shoreline, only if you’re camping by the shoreline will you notice it. But, as soon as you first experience it, then it’s not scary anymore, then you know what to expect. But when you first experience it it’s like the world is falling apart or something.” (Nashalik, 2004)

Tides seem to be strongest in the spring, and this can affect ice deterioration and break-up processes (EN1; JoM2; LI2; MoN1). At any time, the currents can be wearing away (melting) the ice from underneath from the water movement or friction on the ice (Figure 6-12) (EN1; JAk1; JaM1; JI1; JoM1; JoP1; JQ2; LI2; ME1; MoK2; PV1). This process can be exacerbated where the ice is insulated by snow cover (EN1; JaM1; JI1; JoM1; JoP1; JS1; ME1; MoK2; PV1). Therefore, some areas open earlier in the spring time due to the influence of stronger currents, and thus become increasingly dangerous around mid-April or early May (Figure 6-12) (JAk1; JaM1; JN1; JoP1; JQ2; LE1; LI2; LN1; MaN1; ME1; MoK2; MoN1; MoN2).

During the fall, in early stages of ice formation, tidal flats are considered unstable because continual water movement creates considerable variations in water level and thus shoreline ice stability (JaM1). This can also lead to delayed freezing along shore (JaM1; MiK1). Tidal variations can contribute to the formation of cracks in the ice, and when the tide gets

lower it can carry out ice that has become detached from *tuvaq* (EN1; JaM1; JaM2; JI2; JoP1; JoM1; JQ2; MiK1; PQ1), or lead to break-off events at the *sinaaq* (JaM2; LE1; LI2; MiK1). Similarly, as the tide gets higher it can also break the ice, detaching it from solid and ice then moving it with the currents to other areas (Figure 6-12) (JaM2; JoM1; PQ1). Therefore, tidal movements can also create rough ice formations (*maniilaq*) such as *ivuujug* (Section 6.2.3.2) or *qalliriittipalliajuq* (Section 6.2.3.2) as ice is pushed together (Figure 6-12) (LE1; ME1; MoN2; PV1). In the summer, where multi-year ice is still present within Cumberland Sound, currents and circulation patterns can cause the ice pans to group and move together into particular areas (LI2; MiK1). A few key terms associated with moving, or multi-year ice, include:

- *aulajuq* – a general term for moving ice (JoP1; PQ1)
- *kavvaq* – large, thick (high) pans of multi-year ice that come from further north, they are clear blue colour and relatively flat (EN1; JAk1; JaM2; JoM2; MiK1; MoK1; MoN1; PV1)
- *killiminiq* – moving, multi-year ice that “used to be an edge”, they are rougher and not usually as thick as *kavvaq* (JAK1; JaM2; MiK1; MoK1)
- *piqalujat* – icebergs that are floating in the ocean after having calved off a glacier (MiK1)
- *tuvaminiq* – *tuvaq* that has broken off from the *sinaaq* and is moving around freely (MoK1; PV1)

### 6.3 Sea ice use

Sea ice travel and hunting are nearly inseparable components of Inuit sea ice use because travel on the sea ice is mainly for the purpose of hunting or accessing hunting grounds. However, for the purpose of this section travel and hunting will be discussed separately. This will provide some specific highlights regarding sea ice conditions and dynamics that relate to travel safety and hunting practices, respectively.

#### 6.3.1 Travel

Sea ice travel is inherently dangerous. The frozen ocean surface is dynamic and unforgiving. Hunters are exposed to various types of conditions as they travel on the ice, many of which have been described in Sections 6.2. In this section, some of these exposures

and associated risks (Table 6-2), along with the ways in which community members often minimize these risks, will be discussed.

#### 6.3.1.1 Dangers in sea ice travel

Safety depends on where the currents are (EN1; JaM1; JaM2; JI1; JoM2; JoP1; LI2; MiK1; MoK1; PV1). They can delay freeze-up, keep areas open all winter, or cause early melting (Table 6-2) (AY1; JAK1; JaM1; JaM2; JI1; JoP1; LE1; LN1; MaN1; ME1; MiK1; MoK1; MoK2; MoN1; MoN2; PQ1; PV1). The mouth of Pangnirtung fiord can become dangerous very quickly (Table 6-2) (JoM2; LI2; MiK1; MoK2; MoN1; PV1). The community location is actually one of the worst places to be in terms of accessibility to hunting grounds (JaM1). In early winter it is also important to be wary of the tidal flats because they vary greatly in stability within the tidal cycle (Table 6-2) (JaM1; PQ1). At high tide, *naggutiit* tend to open and widen, whereby the ice between the opening thins from the stronger currents (Table 6-2) (JI2). The effects of strong currents are further exacerbated during a *piturniq* period (Section 6.2.3.4), thus enhancing the dangers associated with strong current areas or dynamic features such as the floe edge (Table 6-2) (JI2; JoP1; LI2).

Hunting at *saqvait* is inherently dangerous as they form in areas with stronger currents. However, this danger is heightened when the tide is going up because the ice piles up at one end of the *saqvaq* (Table 6-2) (MoK1). This causes more water to come up onto the ice, making it dangerous while the water is actually spilling over, but sometimes rendering the edges safer after the water re-freezes (because they're thicker) (MoK1; MoK2). Therefore, *saqvait* with well defined edges are safer than those with less defined, thin edges (Table 6-2) (LE1). Moreover, it is important to be wary around *saqvait* because the surrounding sea ice area tends to wear out early in the spring (*aukkaturliit*) (Section 6.2.3.4) (Table 6-2) (JaM2; JoP1; LE1; MaN1).

**Table 6-2:** Summary of sea ice-related exposure and associated risks for community members in Pangnirtung, including some methods of minimizing these risks.  
(AY1; EN1; JAK1; JAM1; JAM2; JI1; JI2; JoM2 JoP1; JQ1; LE1; LI2; LN1; MaN1; ME1; MiK1; MM1; MoK1; MoK2; MoN1; MoN2; PQ1; PV1)

Type of Exposure	Associated Risks	Actions to minimize risk
<b>Tidal stages, strongest currents associated with <i>piturniq</i></b>	<ul style="list-style-type: none"> <li>➤ delay freezing or cause early melting</li> <li>➤ keep areas open all winter (<i>saqvaq</i>)</li> <li>➤ cause ice on tidal flats to vary in stability with the tidal cycle</li> <li>➤ cause <i>naggutiit</i> to open or widen</li> </ul>	<ul style="list-style-type: none"> <li>➤ use extra caution traveling around the mouth of Pangnirtung fiord (and other fiords) in the spring – it becomes dangerous quickly</li> <li>➤ travel on tidal flats at low tide</li> <li>➤ avoid <i>naggutiit</i> with newly formed ice in the middle of the crack, or <i>naggutiit</i> that are close to the <i>sinaaq</i></li> <li>➤ avoid traveling near <i>saqvait</i> or the <i>sinaaq</i> during <i>piturniq</i></li> </ul>
<b>Polynyas (<i>saqvait</i>)</b>	<ul style="list-style-type: none"> <li>➤ created by stronger currents, and thus involved risks associated with tidal stages as indicated above</li> <li>➤ at high tide water comes over the edge, making it unstable and dangerous</li> <li>➤ become <i>aukkaturliit</i> in the spring</li> </ul>	<ul style="list-style-type: none"> <li>➤ use extra caution traveling around <i>saqvait</i>, especially during <i>piturniq</i> or in the spring when melting has begun</li> <li>➤ it is safer to travel around these areas of open water at low tide, or after high tide when water has re-frozen along the edges</li> <li>➤ well defined <i>saqvaq</i> edges are safer than thinner, less defined edges</li> </ul>
<b>Floe edge (<i>sinaaq</i>)</b>	<ul style="list-style-type: none"> <li>➤ always potentially dangerous where the <i>uiguaq</i> has formed</li> <li>➤ where <i>naggutiit</i> form or widen the <i>sinaaq</i> is prone to <i>uukkaqtuq</i></li> <li>➤ straight <i>sinaaq</i> is more prone to <i>uukkaqtuq</i> than a rounded edge</li> </ul>	<ul style="list-style-type: none"> <li>➤ avoid traveling on <i>uiguaq</i>, especially where it is newly formed (e.g. after <i>uukkaqtuq</i>)</li> <li>➤ avoid traveling at the <i>sinaaq</i> during <i>piturniq</i>, near cracks, or when there are high winds</li> <li>➤ avoid traveling where the <i>sinaaq</i> has formed in a fairly straight line</li> </ul>
<b>Snowfall</b>	<ul style="list-style-type: none"> <li>➤ snow on newly formed, or thin, ice makes it dangerous because it insulates the ice and allows it to melt from underneath</li> <li>➤ delays the freezing, thickening process of sea ice</li> <li>➤ snow covers dangerous conditions, making them hard to identify by sight</li> </ul>	<ul style="list-style-type: none"> <li>➤ avoid traveling after a recent snowfall in the fall, when ice is still thin</li> <li>➤ avoid traveling on or near <i>uiguaq</i> after a snowfall</li> <li>➤ avoid traveling near <i>saqvait</i> after a snowfall</li> <li>➤ use extra caution when traveling on sea ice with thick snow, check with a harpoon if unsure about ice conditions under the snow</li> </ul>
<b>Freeze-up</b>	<ul style="list-style-type: none"> <li>➤ ice can freeze unevenly in the fall, due to influence of winds, currents, and snowfall</li> </ul>	<ul style="list-style-type: none"> <li>➤ test the ice for thickness and stability before traveling on it, or traveling in certain areas</li> <li>➤ avoid traveling near <i>nigajutait</i></li> <li>➤ avoid traveling in areas with <i>qanngut</i>, especially if the crystallized flower formations are large and fluffy</li> </ul>
<b>Break-up</b>	<ul style="list-style-type: none"> <li>➤ some areas open earlier than others (<i>aukkaturliit</i>), ice thins unevenly</li> <li>➤ fiords melt very quickly from the head of the fiord due to freshwater snow and river runoff</li> <li>➤ <i>naggutiit</i> widen and become <i>aajurait</i></li> </ul>	<ul style="list-style-type: none"> <li>➤ avoid traveling near the mouths of rivers, especially silty rivers</li> <li>➤ use extra caution traveling in fiords, they wear out very quickly</li> <li>➤ avoid wide <i>aajurait</i>, and <i>aukkaturliit</i></li> <li>➤ use extra caution around <i>immatinniit</i></li> </ul>

The *sinaaq* can be safe for traveling, but it is always potentially dangerous where ice formed most recently (*uiguaq*) (Table 6-2) (JaM1). For example, if *uukkaqtuq* occurred due to winds, then where the ice is re-forming would be very new, thin, and unstable (Table 6-2) (JaM1). Furthermore, cracks are prone to forming and widening at high tide and full moon (JI2), where the *sinaaq* is prone to breaking off during a low tidal stage (Table 6-2) (LE1; LI2).

“When the tide is going up, the current is moving up that way [northwards], so if you’re hunting along the floe edge it’s safer to be hunting at the floe edge when the tide is coming in. So you have to be aware of what time the tides will be coming in and what time the tides will be going out. So like if, when the tide changes and it starts to go out, any chunk can be let go, and the tide will carry it out, and you’ll be on it.” (Evic, 2005)

Even the shape of *sinaaq* formation can impact the probability of break-off events (Table 6-2) (JAK1). It is important to keep in mind that the leading edge of the *sinaaq* is always the weakest (Table 6-2) (MM1).

If snow falls on newly formed, thin ice, it becomes dangerous (EN1; JaM1; JaM2; JI1; JI2; JoM1; JoP1; MoK1; MoN2). If *aputtautigijuminiq* (Section 6.2.1.3) occurs it can delay the freezing process (i.e. delay progression to *tuvaq*), as the snow will melt the newly formed ice (Table 6-2) (AY1; JaM1; JaM2; JI2; JN1; JoM1; JS1; MoK1). This can also occur at the floe edge, where if snow falls on *uiguaq* (JaM1) it is advisable not to travel on it because a person can go right through (Table 6-2) (EN1). However, if a big storm comes and snow falls on *tuvaq*, then it is still quite safe to travel in those areas (EN1). Even in the middle of winter, if snow falls on sea ice that has formed over areas with strong currents, this can insulate the ice and enable the currents to eat away at the ice from the bottom (Table 6-2) (JaM1; JaM2; JoP1; LE1; MiK1; MoK1; MoN2). Snow also hides the ice conditions underneath, making it harder to evaluate ice safety by sight (Table 6-2) (JI1; JS1; MaN1; ME1; MiK1; MoK2).

“And also the most dangerous part of the year is when these certain cracks are covered in snow. And at the full moon, with the full moon effect they may be open to a certain extent, and then if it’s been snowing, if there’s a lot of snow then it’s covered by the snow on top, but it’s actually open water at the bottom. And then

people will not notice these things, but if you know where these particular currents are, and knowing where the high or strong currents are, then you'll know which spots to be on the lookout for." (Mike, 2004)

The ice can freeze unevenly due to the influence of winds or currents, creating *nigajutait* (Table 6-2) (JaM1; MaN1). After the ice is *atuqsaruqtuq* (Section 6.2.1.3) and it becomes travelable, it is *nangiarngnangittuq*, "it is not dangerous anymore" (EN1). Approximately 5 inches of thickness is considered safe enough to travel on (JaM1). However, when the ice becomes *tuwallariuliqtuq* hunters know it is safe to travel almost anywhere (JQ1). If some areas have overlapping ice caused by *ivujuq* or other processes, those can actually freeze thicker and faster than other areas that freeze with progressive cooling alone (ME1). Where *qanngut* occurs on new ice it usually an indication of thin ice (i.e. ice is thin enough to allow heat or moisture exchanges between the ocean and atmosphere to create condensation), and these areas can take longer to thicken and become safe (Table 6-2) (AY1; EN1; LN1; MoK1). This condition is also prevalent at the *sinaaq* throughout the winter (LN1).

"[Where *qanngutiit*] sprout out like a flower, they are the dangerous points. You can tell right away because they're on thin ice. You can tell that it's thin ice. If there's no formation of [those] crystals then you know it's solid ice. The higher the formation of those crystals, the thinner it is. If it's lower then it's thicker. So, you have to know where these spots are, and be aware of those particular spots that may be thin ice. Because the ice anywhere, even in our fiord, the ice conditions in different spots are different." (Mike, 2004)

During the spring, it is dangerous to travel near where the mouths of rivers open into the ocean, these areas open sooner due to the freshwater influence and thus become dangerous quickly (Table 6-2) (JaM2; JI1; MaN1). In addition, when the river runoff is silty, it speeds up the melting process even more (JaM2; MaN1).

"People who are not familiar with this, everybody should be, they have to be aware in the spring time, all fiords start breaking up from [the top] end. The river starts the breaking up process, and then everything gets broken up from the end, [at the head]. So it's not a matter of this piece taking out, that piece taking out, that piece taking out, it's just starting from [the head and the mouth]...And another very important advisory that everybody should know about is if the river is very silty, like muddy, then those are the rivers that you have to be very

careful with. [Like] one day that [fiord] will have ice on it, and then the river will really start flowing, on that same day all this ice will go.” (Mike, 2005)

Therefore, fiords tend to wear out very quickly in the spring, from the head, as soon as the rivers start to run (Table 6-2) (JaM2). Cracks also widen and become *aajurait* in the spring, making them potentially more dangerous to cross (Table 6-2) (ME1). As mentioned previously, *aukkaturliit* begin to form in areas of strong currents as spring melt begins (JaM2; JoP1; LE1; MaN1). Also, as water accumulates on the ice from snow melt (Section 6.2.2.2) it is not always easy to tell which *immatinniit* are a few inches deep in comparison to ones that have melted right through the ice (Table 6-2) (MiK1). As melt stages progress *saallijuq* (the ice is thinning) and *sikuluqtuq* (“bad” ice) are increasingly dangerous ice conditions (Table 6-2) (EN1; JaM1; JN1; MaN1; MiK1).

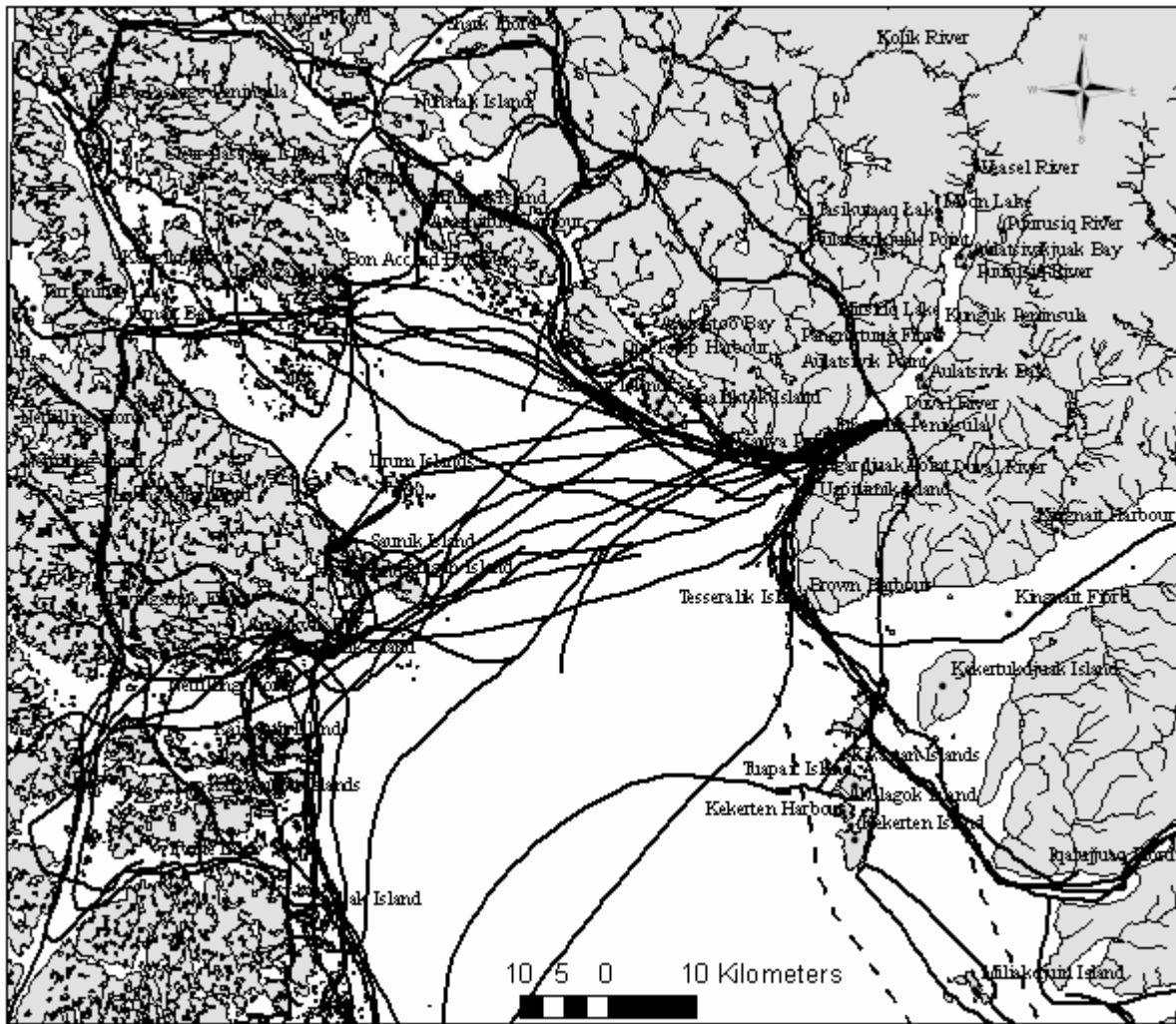
#### 6.3.1.2 Evaluating sea ice safety

In order to minimize the risks involved with sea ice travel it is important to understand and remember the conditions during freeze-up (e.g. the amount of snowfall on thin ice) (AY1; JaM1; MoK2). It is also essential to be able to identify, and avoid, particularly dangerous conditions. For example, it is precautionary to avoid traveling on *uiguaq* (JaM1; MM1), during low tide (LE1; LI2), near cracks (JI2), or during *piturniq* (JI2), at the floe edge. It is imperative to be careful when camping near the floe edge as well, because *ivujuq* can occur and will create rough conditions but also potentially crack the ice causing it to *uukkaqtuq* (LE1). If *uukkaqtuq* occurs with someone on the ice that broke off, then it is termed *uqarujjaq* (ME1). It is possible to tell when the ice has broken off, even at a distance, where you hear a loud sound like a rifle shot (JI2). Furthermore, hunting at the floe edge near the mouth of a fiord can be dangerous if the funneled winds pick up, increasing the likelihood of *uukkaqtuq* (LE1). It is also advised to avoid traveling in areas with strong currents, or known poor ice conditions (JAK1; JI1; JoM2; JoP1; JS1; LE1; MaN1; ME1; MoN1; MoN2) – or know which time of day is the safest to use this ice.

“And just to go back to the time when [the ice] is forming at the earliest part of the winter, when the ice is just starting to form, another area that you have to be wary of is this particular area, I [refer to] it as the tidal flats. The reason why we call it the tidal flats is because this particular area is controlled by the sea, in terms of the tides coming and going. So, it’s very unstable because of the currents, it doesn’t really freeze over, well it does freeze over but in winter, early part of winter, you have to be aware of the tides. As a hunter, you take the time to go out when it’s low tide. When it’s low tide, at it’s lowest, this particular ice goes on the tidal flats, so you can’t go anywhere further [down] than where you are already when it’s low tide. If it’s high tide then you’re likely to fall through, any of the thin ice spots. So, as hunters when you’re going to go out on the main ice you try to go out at low tide, and you spend the day while the tide’s up, that’s normally about 12 hours. So you try and get back at that particular time that you left in the morning, that’s basically 12 hours later. You know, the tide goes in cycles. So you try and ensure that you get back, the safest time that you can get back into the community is at low tide.” (Mike, 2004)

It can be safer to travel close to land around certain areas (Figure 6-14) (JoM2; LE1; MaN1, PQ1), but this does not apply everywhere. Some points have much stronger currents and then travel near land is actually more dangerous (JS1). For example, around the *qillisauti* (barrier rocks) the ice is often thicker than the main ice because of the constant flow of water during different tidal stages (PQ1), but this *sijja* can also be quite rough and make travel difficult (JaM2; LE1). In addition, the *qainngu* is used for travel once Cumberland Sound starts breaking up (Figure 6-15) (JoM2; MaN1; PV1). Therefore, sometimes the longer route is safer (e.g. inland (*itilliq*), near shore, or on *qainngu*) (Figure 6-14), because direct lines are not always feasible or appropriate (JAK1; JaM2; JI1; JN1; JoM2; LE1; MaN1; MiK1; MoK2; MoN1; MoN2; PQ1; PV1). Furthermore, there are some areas that are simply avoided at all times, especially around *saqvait* or points where strong currents cause perpetually thin and unstable ice conditions (AY1; JAK1; JoM2; JoP1; LE1; LI2; MaN1; MiK1; MoK1; MoK2; PQ1; PV1). For example, some polynyas are not even seen in the winter because they are too dangerous to travel nearby and hunters are warned to stay away from them (AY1). However, travel routes often aim for destinations, or run along features, that can be quite dangerous (i.e. *saqvaq*, *sinaaq*, or *uiguaq*), in order to look for wildlife (Figure 6-14) (JoM2; JoP1; LE1; MoK1; MoK2; MoN2; PQ1).





**Figure 6-14:** Common travel routes used around Pangnirtung, and in Cumberland Sound. Sources: AY1; JAk1; JaM1; JI1; JN1; JoM2; JoP1; JS1; LE1; LI2; MaN1; ME1; MoK1; MoN1; PQ1; PV1



**Figure 6-15:** *Qainngu* is often used to access Cumberland Sound in the spring once the ice has broken up, and the mouth of Pangnirtung Fiord is open. Shown here, this 'ice ledge' near the mouth of Pangnirtung Fiord was still travelable on May 24, 2004 when Cumberland Sound was open water. (photo: Gita Laidler)

“The reason [I] took that route is because it was closer to open water, to the floe edge. That’s where most of the polar bears are. So [I] took that route in thinking that [we] would go along this island to go back home. So that’s, the only reason why [I] took that is because it was close to open water...And you know, the reason why it’s good to know that you have those particular bad spots or open spots, even in the dead of winter [is because] normally those are also the spots that you want to go to. Because there’s seals out there, like in open water, so if [we’re] trying to hunt seals and if there’s a spot where there’s currents, you want to go into a bad spot just to hunt the seals...As long as you know when the good time is, like how well it has frozen over, how safe it is to get into those particular bad spots. But you have to be observant of what the conditions are, you have to ensure that you’re safe, your safety first, before you actually do your hunting.” (Maniapik, 2004b)

Essentially, hunters are warned to be most observant and cautious when traveling around the more dynamic or dangerous ice features (JaM2; JI2; LE1; LI2).

Using a harpoon (*unaaq*) or ice chisel (*tuuq*) is the only way to know how thick the ice is (Figure 6-16) (EN1; JaM1; JI1; JI2; JS1; MM1; MoK1), and it is of utmost importance that the ice be tested before using it for travel (JaM1; JI1; MM1; MoK2). Therefore, traveling without a harpoon is considered scary, because then a hunter cannot know for sure what the ice is like (EN1; MM1). If you hit the ice with a harpoon once, hard, and it does not go through then it is possible to walk, dog team, or snowmobile on that ice (EN1; JaM1; JN1; MoK1). If it goes through on the second time, then it is still possible to walk on it (EN1; MoK1). However, that only applies to ice with no snow on it (EN1; JaM1). As a hunter tests the ice with his harpoon, if he finds dangerous or thin sections they are *saallijuk* (MoK1). And, if the harpoon goes through on the first strike it is *sikuluqtuq*, “bad” or “improper” ice, and the hunter should not be traveling there (EN1; JaM1; JN1; MaN1; MiK1). In addition, it is important to use the same amount of force when striking the ice with harpoon, to ensure consistent evaluations of thickness and safety (JaM1; MoK1; MoK2).

“If you sort of go like that [demonstrating] and not give your harpoon [much] force, semi-drop it onto the ice and it goes through, then that’s really dangerous... [W]hen you go as hard as you can and your harpoon doesn’t go through on the first hit, then it’s safe to walk on even though [the ice is] going up and down. If you do it really hard and it occasionally goes through, that’s still safe. If you don’t do it very hard and it goes through then it’s not safe.” (Keyuajuk, 2004)



**Figure 6-16:** Joavee Alivaktuk testing the consistency and thickness of the ice with a harpoon in December, 2004.  
(photo: Gita Laidler)

Once the stability and thickness of the sea ice has been established, then a hunter will stop periodically along a travel route to check the ice for continued safety (JaM1; JI1; JS1). Even following a well used travel route does not preclude the necessity to check the ice thickness, as some people have fallen through on common routes because ice conditions can vary within days, especially in the spring (MiK1; MoK2). It is difficult to evaluate ice safety by sight alone, but some visual indicators of danger include:

- wet spots on the ice or snow (JI2; JS1; MoK2);
- water coming up out of *alluit*, or other holes in the ice (JI2);
- a slight dip (indentation) in the snow (border between older and newer ice) which can indicate a crack underneath where there may just be water, and no ice (MiK1);
- dark/black coloured ice (JN1); and/or,
- movement of the ice (wave-like motion of the ice cover) (JN1; MoK2).

It is important to know and understand localized conditions, and dangerous areas (e.g. where the currents are the strongest) (AY1; JAk1; JaM1; JI1; JoM1; JoM2; JoP1; LE1; LI2; LN1; MoK2; MoN1). It is critical to be experienced in traveling around certain dangerous areas,

especially in the spring when they are wearing out from underneath (JAK1; JaM2; JI1; JoM2; LE1; LN1; MaN1; ME1; MoN1; MoN2).

“Yes, as hunters wherever you’re going out to hunt, the routes or the trails that you’re taking, you have to be very observant of the route that you take and your normal travel trails. You have to know exactly what conditions they are. When you’re traveling out you try and take in the conditions so that you can have a clear view, not a total clear view but have an understanding in the back of your mind what it’s going to be like in the next couple of days, on your travel back. And the question you put in your mind, ‘is that going to be safe within the next couple of days?’ You know, things like trying to understand when the currents are least strongest, those are the times basically you try and travel as well. Where we said, you know the full moon effect it has on the conditions of the land, we call that *piturniq*, and during those times that when it’s full moon effect [I] know [that certain] ice conditions will deteriorate fairly quickly, [more] than it would when you have a regular day.” (Maniapik, 2004a)

This experience is gained by listening to others, learning by watching, and first hand experience (often close calls) (JAK1; JI1; JN1; JoM2; LE1; LI2; LN1; MaN1; ME1; MiK1; MoK2; MoN1; MoN2).

“[One time] I had gone from this camp to go hunting seals in that hole [*saqvaq*] that [I] was talking about, and [I] went past it a little bit, and [I] looked back, [I] realized that the tide was coming in, like really fast. And [I] saw the water coming up from this hole onto the ice. And when that happens during a really strong current then this part breaks up, the water breaks [the ice] up by going on top of it and it just cracks up. And [I] was out here, [I] had to get there, so this is a long distance, a long distance we’re talking about, and [I] had to hurry to get back to safety. And [I] had to do it with [my] harpoon, like every few steps it would go right through, and then [I] had to turn and then [I] would go a few steps that way and then it would go right through again, and [I] couldn’t go back, [I] couldn’t go straight back, [I] had to sort of go like not straight at all. And as [I] was walking these cracks were coming off, the ice was cracking off and being sucked underneath. And [I] could see them go right past [me] and [I] could feel the cakes of ice being scraped along underneath the ice, under [me], and they could pop up at any time if they, like if those big ice chunks hit a really soft spot then they come up. So [I] was shaking and scared out of [my] wits but [I] managed to make it to safe ice eventually...After that it was a while before [I] came back to that hole. [I] didn’t go back there for a while.” (Noah, 2004)

Moreover, hunters are most comfortable traveling along the routes they know best – each person has their preferred routes or hunting grounds (JAK1; JaM2; JI1; JI2; JoM2; JS1; LE1; LI2; MaN1; ME1; MiK1; MoK1; MoN1; MoN2). It is also important to know what to do if you do

fall through the ice, get stranded on ice that broke off from the floe edge, or find yourself on very thin ice. For example, it is easier to get out of the water in the spring, where there are more indentations and bumps on the ice to help pull yourself out (JI1). In the winter, with smoother ice formations it is much harder to find a hand-hold (JI1). After getting out of the water, or even after getting wet feet, it is not advised to pour out the water (LI1). The salt water actually holds in heat because it takes longer to freeze than freshwater and insulates against the air (LI1). However, this does not work as well with today's boots, but works very well with skin *kamiks* that were used in the past (LI1). Therefore, it is prudent to avoid the natural instinct to pour out water from soaking boots. It is also important to be prepared for break-off events at the *sinaaq*. It is highly recommended to always bring extra snow or ice for drinking water when hunting at the *sinaaq* – a precautionary act in case *uqarujjaq* occurs (JI2; ME1). It is also critical to know where the moving ice is most likely to touch the *sinaaq* or land again, based on current and wind conditions, in order to get back to safety (LE1; ME1; MoN2). Interestingly, if someone falls in the water and pulls themselves out, the term *kakki* is used in the same way as when someone steps from moving to solid ice or land (ME1).

*“Kakki, like if I fall in the water and pull myself out it's kakki. But if the ice breaks off and then it goes to solid land, and I just step over there, it's kakki as well...It's practically getting out of the water, so [we] use the same term.” (Evic, 2004)*

Overall, it is best not to travel alone, and to always bring extra emergency gear in order to make a shelter (JI2; JS1; LE1).

Despite warnings of areas with thin ice, or to avoid areas with snow cover, sometimes hunters will accidentally find themselves in a very dangerous area of thin ice. In this situation, even the action of turning the snowmobile may break the ice, so it is advisable to actually get off the machine, unhitch the *kamotik*, manually turn the snowmobile, re-hitch the *kamotik*, and drive back exactly how you came (MiK1). When traveling on new ice, it was noted that the *kamotik* will often go through the ice first, so if you can still drive it is possible to get beyond the

dangerous area (MiK1). And, if the *kamotik* starts falling through it is usually best to keep driving at a steady pace, if you stop you will likely fall through the ice (MiK1). It is not good to drive fast either, because the snowmobile creates a wake on the ice, and if the wake ruptures you go right through the ice (MoK2). A smaller version of this can even be created by walking, so if a person finds themselves on thin ice it is best to spread their legs and walk away, running will cause a larger wake and likely a break in the ice (MoK2). Sometimes hunters will actually attach a small boat on their *kamotik* because it is much safer – it will help the snowmobile stay just enough afloat that it can be retrieved (Figure 6-17) (MiK1).

In the past, dog teams were relied upon as the main means of transportation (Figure 6-18) (ME1; MoK1; PV1). It was also considered safer to travel with dog teams, because they would indicate the kind of ice conditions where a hunter was traveling (EN1; JaM1; MoK2). It was possible to tell that you were on thin ice when the dog team would spread out (JaM1; MoK2) and sometimes refuse to go (JaM1). But now, the hunter has to be careful to have the knowledge of the ice, and the tools to check the ice (JaM1; JI2; MoK2).

“Today, because of the snowmobiles, the hunters do a lot of guessing. They do a lot of just driving around and looking and guessing with the limited senses that they have. In the old days the dogs used to have more senses than we do, because even if you can’t see the seal hole or the seal or the animal, the dogs could smell it. And today we’re basically hunting blind.” (Nashalik, 2004)

The snowmobile cannot sniff out thin ice (JaM1) and does not stop when it senses thin ice.

“It used to be scary in the thin ice areas but not as scary as today because you had two different groups that were looking at the thin ice in the old days, like the dogs would be looking and the person would be looking. But it’s entirely up to the person now, with the snowmobile.” (Keyuajuk, 2005)

People travel much faster by snowmobile, wanting to go at top speeds, especially on smooth new ice (JaM1; JI2; JS1). However, these areas are also more dangerous because they are usually thinner, so if you travel fast in those areas you are very likely to go through (JaM1; JS1).





**Figure 6-17:** Joanasie Maniapik with his snowmobile and hunting gear. The small boat on top of the *kamotik* is useful for seal retrieval but also for safety purposes should his machine go through the ice. It also holds other safety and emergency gear inside. (photo: Gita Laidler)



**Figure 6-18:** Dog teams used to be the main means of winter transportation, now they are not commonly used, and tend to be maintained for tourism or sport hunting purposes. (photo: Gita Laidler)

“Whenever I’m not sure I always check. But I know some people, maybe usually teenagers, they just see a flat ice and they don’t care, just want to go fast and that’s not right I don’t think. If they go to a big area of thin ice, they’re not going to, nobody’s going to be able to get at them, if they go fast and they sink. So that’s why [you] don’t want to go fast if you’re not in a safe area, just go slow, and if you’re not sure just check it with a *tuuq* we call it.” (Soudluapik, 2004)

In general, rushed travel or hunting can lead to more accidents (JI2). Furthermore, dogs were able to go some places that snowmobiles cannot (e.g. dogs can climb up very steep areas) (MaN1), and sometimes they even saved lives (MoK2).

“In the past [I] fell, [my] *kamotik* fell through when [I] was dog-teaming. Dogs never fell through but this *kamotik* fell through, it kept falling through, the dogs would pull it out, it would fall through, the dogs would pull it out, [I] went for a long distance like that. The dogs really saved [me]...Like it was natural for this particular dog, every time they hit a really thick snow, deep snow, the dog would

really yell and encourage his fellow dogs. But at that accident when [I] fell through right off the bat the dog knew that [I] was in trouble so the whole time he was pulling the *kamotik* he was yelling to the other dogs like all the way through he kept yelling and yelling, encouraging the other dogs...That was a good dog.” (Keyuajuk, 2005)

Moreover, snowmobiles frequently break down and leave the hunter stranded.

“[These big journeys that I told you about], today it would be like a fairy tale, like [I]’d never be able to do that in this day and age with [my] condition and no dogs. With snowmobiles, skidoos, if [I] was going to go up on that trip [I] would need two or three snowmobiles to do the trip, just to be safe. But by dog team, [I] can do it with one dog team, no backup, and come back safely. Like even just to make this trip down here you would need two or three snowmobiles just to make it safely, because they can break down any time, dogs don’t break down...if they’re not hungry.” (Veevee, 2004)

Additional safety factors include communicating with other community members. It is always recommended to notify a family member or friend of your travel destination, the supplies and gear you are traveling with, and your anticipated return time (JI1; LI2). Shortwave and local community radio are also used to communicate dangerous ice conditions (JN1; LE1; MiK1; MoN2), or to call for assistance if a machine breaks down or people are stranded somewhere (LI2). In order to use this method effectively, it is essential to know the Inuktitut place names for various water bodies, camps, landmarks, polynyas, fiords, and even ice features (LI2; MoN1; MoN2). Without being able to describe the specific location, it is harder for search and rescue efforts to reach the person in a timely manner (LI2). For these reasons, some of the older or more experienced hunters are doing their best to teach the younger generation of hunters to identify dangerous ice conditions, along with the traditional names used around the area, in order to enhance safety or to effectively ask for help (JI1; JI2; LE1; LI2; MaN1; ME1; MoK2; MoN1; MoN2).

“It’s very, well it’s sort of a requirement, like if [I] travel through this area and [I] finds that it’s not quite safe then [I] make sure that everybody knows so that whoever the next person is going to go there is aware of the unsafe ice conditions. It’s a requirement, you have to tell people...Like for example if [I] was traveling alone by snowmobile and [I] was going along here and [I] find that this area is not safe and it’s really thin, and [I] know that there are people hunting down there, [I]



would make sure that these people get the word that ‘don’t use this area, make sure that you skirt that area.’ It’s very important, because most hunters will follow the skidoo tracks of another hunter. And if a hunter is going into thin ice then the next hunter is going to go along the same ‘railroad track’ into the same problem, so that’s why you have to advise other people...It’s the sort of gung-ho young new polar bear hunters that [we]’re really worried about, that’s why [we]’re going to go on the radio at lunch time to make sure that people are aware of these dangerous areas and to keep reminding them that there are dangerous areas down there. Because with machines nowadays it doesn’t take any time at all for a person to leave Pang and then be down there in just a few hours.” (Nuvaqiq, 2005)

### **6.3.2 Hunting**

Hunting used to be the only means of survival (i.e. to provide heat, light, shelter, clothing, and food for dogs and humans) (AY1; EN1; JI2; JS1; LI2; MaN1; ME1; MoK1; MoN2; PQ1), but it still plays an important role in both subsistence and commercial harvesting today (AY1; JI2; JS1; LI2; MaN1; ME1; MM1; MoK1; MoN2; PQ1). Hunting around Pangnirtung is predominantly conducted along the coasts of Cumberland Sound, and not very much within the fiord itself. Ringed seals (AY1; EN1; JAK1; JaM2; JI2; JN1; JoM2; JoP1; JS1; LI1; MaN1; ME1; MiK1; MM1; MoK1; MoK2; MoN1; MoN2; PQ1) and beluga whales (AY1; JN1; JQ1; LN1; ME1; MiK1; MM1; PQ1) are the staple marine mammals harvested by Pangnirtung community members. Polar bears and walrus are also sought after, but hunters typically have to travel great distances towards the mouth of Cumberland Sound to find these animals (AY1; JI1; JN1; JoM2; JoP1; LI2; MiK1; MM1; MoN1; MoN2; PQ1). However, beluga, polar bear, and walrus are protected under a quota system, so they can no longer be hunted freely (LI2; ME1; MiK1; MM1; MoN2). Narwhal and bowhead whale are hunted occasionally, but they too are under the quota system and thus hunting these animals is restricted (AY1; JS1; LI2; MiK1; MoK2; MM1). Harp, hooded, or bearded seals are also hunted, if they are seen (PQ1). Eider ducks and other migratory marine birds (e.g. Snow Geese, Canada Geese, loons) can also be hunted at the ice edge, or by using ice to access nesting islands (JI1; JI2; PQ1). Complementing duck hunting is eider duck egg collecting, whereby sea ice is used to access the nesting islands

during this important spring activity (although this is changing, see Section 6.4.4 and 6.4.6) (LI2; MaN1; MoK1; MoN2; PQ1). In addition, the commercial turbot (Greenland halibut) fishery in Pangnirtung is included within the hunting section because sea ice is so integral to the success of this commercial venture.

While sea ice is an essential platform for hunting many of the marine birds and mammals important to community members in Pangnirtung, it also enables access to other staple animals (e.g. inland Arctic char fishing lakes, caribou feeding grounds or migration routes, fox trapping trails, Arctic hare, or ptarmigan nesting/feeding areas) (AY1; JAK1; JI2; JN1; JoM2; JS1; LI1; LI2; MaN1; ME1; MiK1; MM1; MoK1; MoK2; MoN1; MoN2; PQ1).

#### 6.3.2.1 Conditions

“You’ll notice that especially Pangnirtung is very much associated with the seal, with the ringed seal. [It]’s one of the major intake of country food in this area. And you can pretty well hunt seal at any time of year, but it’s only when the ice conditions get bad, that it gets difficult to try and hunt them. And then that’s when you have to be more careful in trying to get to some areas where there are seals. Because normally the seal is always in a very thin area of the ice. And in the winter, when it’s just freezing over you can hunt them at their breathing hole. When it snows over you can’t tell if there’s a seal hole unless you’re a first rate hunter, you know you can tell. But in the spring they start coming up, they bear their young, the seal pup, then it gets more exciting for the hunter to be able to hunt the seal pup in the spring. And when they start coming up onto the sea ice and sunbathing, that’s when it gets more exciting, you know even for young hunters, to be traveling on the sea ice, to hunt an *uttuq*. What we call an *uttuq*, it’s called an *uttuq* when they’re sunbathing on the sea ice. So to [me], [I] can associate hunting seals more than the other animals.” (Maniapik, 2004a)

The early winter is preferred for hunting ringed seals at their breathing holes, because with less snow accumulation it is easier to find the seal hole that looks like “a little volcano” on the ice (EN1). Once the snow falls after January it is much harder to identify – although when using dog teams for travel the dogs could sniff out the holes (EN1; LI2). In mid-winter, areas with open water are desirable destinations for seal hunting, as the seals can access air (*pujji*) more easily where the ice is thinner (JoM2; PV1). Therefore, areas with strong currents or *saqvait* are popular seal hunting grounds (JoM2; JQ1; MaN1; MoK2; PQ1). Seal nets will also be

set in *naggutiit* during the darker months (LI2; MM1; MoK1), usually at points of land (JS1; MaN1; MM1; MoK1), or *naggutiit* will be followed (*atuagaq*) looking for *alluit* in the thinner ice (JaM1; LN1). In the spring, seal pup hunting is the preferred activity, as they are basking on the ice (*uttuq*) in the long days of sunshine (JaM2; JI2; JoM2; LI1; LI2; LN1; MaN1; MM1; MoK1; PQ1).

“The ice is very important to [me] because it provides [me] with food, that [we] can go hunting and get seals, beautiful seals, and also baby seals. And then there are seals that are a little bit older than baby seals that are able to be sitting on the ice. Right from when they are babies until they are able to sit on the ice on their own, it’s good for hunting those kind of seals.” (Evic, 2004)

However, they are also taken by breaking seal dens that become more evident as the snow begins to melt – usually found around pressure ridges or where snow has accumulated (LI2; LN1).

“Baby seal hunting, this is a rule straight from the old days, every time a seal den looks obviously like a long seal den, rough ice here and it looks kind of long, narrow, then that usually means that underneath it’s all open water, and if you jump in there and you really jump into the water. But if it’s a short fat one, like short fat den, then that is usually safer. And [we] would jump in no matter how, like [we] didn’t check to see how big the water is before jumping, and it didn’t matter to [us] because [we] wanted the seal so much.” (Keyuajuk, 2004)

Seal hunting is also conducted at the *sinaaq* in the spring, where seals are found in the open water off the ice edge (AY1; JN1; MaN1; MoK2; MoN1; ME1). Once the ice is gone, hunters will go anywhere in Cumberland Sound (by boat) to hunt seals (AY1; MoN1), but small retrieval boats may be used throughout the winter at the *sinaaq* or at *saqvait* (MaN1).

Walrus hunting is more often conducted in the summer by boat, where walrus can be found sunning themselves on moving ice that has collected due to currents (JAK1; LI2). Hunting for walrus typically requires traveling towards the mouth of Cumberland Sound (JAK1; MiK1), to areas that were not even shown on the maps provided (LI2; MM1). Hunting walrus is also safer when they are on top of ice pans, as they can be more dangerous when swimming in the water (LI2).

“Yeah definitely the sea ice is very important also for [me] to be walrus hunting. If there’s not sea ice or floating ice in the water, [I’m] not going to be able to tell if there’s any walrus out there, because they’re basically in the water and there may be some danger to that too because [we] haven’t seen that walrus on a sea pan or on a chunk of ice floating in the water. [I] would be able to know that there’s a walrus sunbathing on an ice pan. And [I] would have a better chance of hunting that walrus with sea ice around.” (Ishulutak, 2004b)

Beluga are spotted by waiting on high hills and lookouts from islands in Cumberland Sound (LN1). Then, they are usually hunted from the *sinaaq* (MiK1). Beluga used to be hunted in the spring near their calving grounds in Clearwater Fiord, but the community of Pangnirtung has stopped this practice in order to protect the beluga populations (JQ1; ME1; MoK2). Therefore, beluga hunting is only done further south now (ME1). However, with the quota system also in effect, once the beluga leave their calving grounds the quota is quickly filled up so many beluga remain and people are not allowed to hunt them (ME1). Beluga are also hunted from open water in the summer time (JN1). The (now historic) Kekerten whaling station was established because of the prevalence of beluga in the area (ME1; MiK1; MM1).

For polar bears, people have to travel far down towards the mouth of Cumberland Sound, as the bears tend to stay closer to where there is open water and moving ice (JI1; JoM2; JoP1; MiK1; MoN1). They are also found in fiords (Figure 6-19) (MiK1) or at the floe edge (JN1).

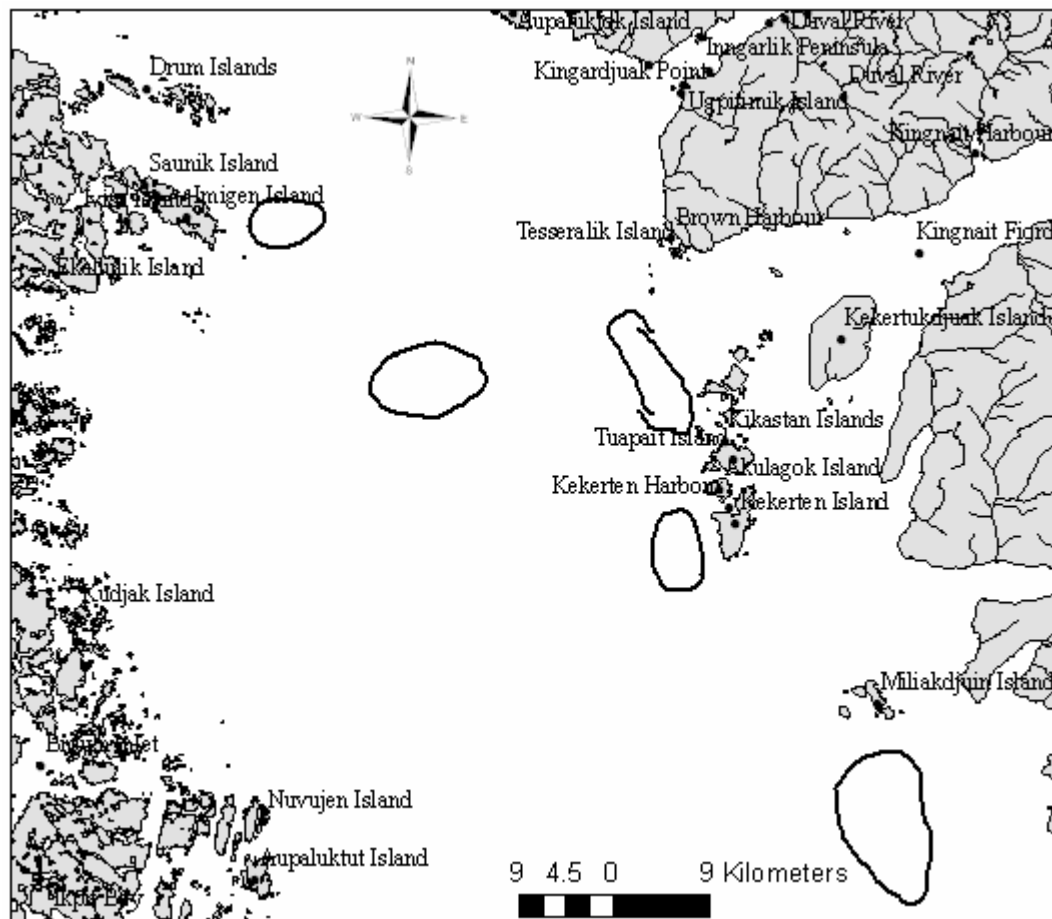


**Figure 6-19:** A glimpse of a polar bear in Pangnirtung Fiord during a sea ice trip on May 24, 2004. (photo: Gita Laidler)



**Figure 6-20:** An example of hauling up the long line used for turbot fishing in Cumberland Sound. (photo: Ed Hudson)

The commercial turbot fishery based in Pangnirtung, but conducted in Cumberland Sound, is highly dependent on the formation of solid sea ice throughout the winter (AY1; JN1; JS1; LE1; LN1; MiK1; MoN2; PQ1). The ice is the platform upon which people set up their fishing camps and cabins, and run their long lines through holes made in the sea ice (Figure 6-20) (AY1; LN1; MiK1; PQ1). The ice needs to form out a certain distance in order for the most desirable (i.e. deep, upwards of 300 fathoms) areas of the Sound to be accessible, because the turbot are deep water fish (Figure 6-21) (AY1; JN1; JS1; LE1; LN1; MiK1; PQ1). Not only do the areas need to be deep, but also preferably with smooth underwater topography (JS1). Therefore, the position of the floe edge is very important to fishermen so they can reach their fishing grounds (AY1; JN1; JS1; LE1; LN1; PQ1). Fishermen also sometimes combine their fishing activities with narwhal or seal hunting at the ice edge (JS1).



**Figure 6-21:** Overview of some key fishing areas in Cumberland Sound. Sources: AY1; JS1; LN1

### 6.3.3 Wildlife habitat

Beyond the importance of sea ice for travel and hunting, it is also habitat for many of the wildlife already mentioned. Arctic animals are uniquely adapted to the cold climate as well as to the cold and frozen seas. A full description of sea ice use by different species is beyond the scope of this thesis. However, Inuit and their use of the sea ice is intricately involved with wildlife use and habitat. Therefore, statements of sea ice as habitat frequently entered interview discussions and are thus included here.

The spring floe edge and polynyas attract a variety of marine and migratory birds (e.g. *mittiq* (King eider)), where they spend their time waiting for the snow to melt on land so they can nest (EN1; JI2). The eiders tend to nest in large numbers on particular islands in Cumberland Sound (JAK1; EN1; JI1; MaN1; MoK1; MoN1; MoN2; PQ1). When the ice is receding in the spring there is a lot of food for them at the *sinaaq*, and thus the reason for their congregation at the ice edge (JI2). Rabbits also use sea ice to travel between islands (EN1; JI2). Furthermore, foxes prowl the ice in the spring as they are avid baby seal hunters (EN1; JI2). Caribou also use the ice to cross fiords, or between islands (AY1; EN1; JS1; MoK1; MoN2). Therefore, most land animals will use the sea ice at one time or another as a way to travel between land areas (JI2).

Ringed seals (*nattiq*) use the ice most extensively, all year round (EN1; JoM1; JQ1; LE1; LI2; MM1; MoK2; MoN2). They maintain *alluit* throughout the winter when the sea ice is at its thickest (EN1; JN1; JoM1; JoP1; JS1; LI1; LI2; MM1; MoK1; MoN2; PQ1). But they prefer where the ice is thinner, and thus will often use *naguttiit* to maintain their *alluit* (JoP1; JS1; MaN1; MM1; MoK1). They may also stick closer to where there is open water, and thus easy access to air (e.g. *saqvait* and the *sinaaq*) (JaM1; JN1; JoM1; JoM2; JoP1; JQ1; LE1; MaN1; MoK2; MoN1; MoN2; PQ1). Moreover, seals depend on the sea ice to bear their young, where they create dens on top of the ice under the snow (AY1; JI2; JN1; JoP1; JQ1; JS1; LI2; MaN1; MM1; MoN2;

PQ1; PV1). In order to create these dens, they usually seek out areas of rough ice where snow accumulates more readily (JI2; JoP1; LN1; MM1; PQ1; PV1). Underneath the snow they maintain an escape hole and a network of *alluit* in the surrounding area (AY1; MM1). However, it is not only the expectant mothers who create these dens, adult males and other young seals make their own dens (LN1; PQ1). The difference between the dens is hard to tell from the outside, but if a hunter breaks into a den it immediately becomes apparent due to the smell of male seal (likened to the smell of diesel fuel) (LN1; PQ1). Usually around the end of April, or early May, all the young seals (about a year old, last year's pups) will come into the fiords from the open water of Cumberland Sound where they had spent the winter (EN1). Those seals are normally very healthy and fat, with good fur (EN1). The time spent basking on the ice (*uttuq*) in the spring time is essential for the seals to molt, to get rid of old fur and allow new fur to grow in (AY1; EN1; JoP1; JQ1; LE1; LI2; LN1; MaN1; ME1; MiK1; MM1; MoK1; MoK2; MoN1; MoN2; PQ1; PV1). Specifically for baby seals, this allows them to rid themselves of their white fur, and for the new black fur to come in (JI2; MoK1). In so doing, they become *nattiaminiq* (MaN1; PV1).

“And a ringed seal turns into a *nattiaminiq*, first it's a *nattiaq*... there's three stages, from a *nattiaq*, and a larger baby seal would be a *nattiarajaaq* with the white fur starting to come off. And after all the white fur is gone it's called *nattiaminiq*, and that's the prime meat that we try to get. That is like the most delicious and the most healthy seal that we can get, that's what we really go after, *nattiaminiq*. And when the ice comes out too soon the baby seals cannot turn into *nattiaminiqs*...It's obvious that seals will no longer be denning anywhere here if the ice no longer forms, so they won't have a place to den, they'll move somewhere, they'll have to move somewhere else.” (Veevee, 2004)

This time on the ice also allows the baby seals to be weaned from their mother (PQ1). Only after they lose their white fur will they begin eating little shrimp, and be capable of finding their own food in the water (PQ1). For older seals, they are on the ice so much in the spring that they are essentially fasting, so they become quite skinny (AY1; EN1). They will stay on the ice the majority of the time until it melts away from under them (AY1; MoN2). They will move

with the receding ice, into the fiords in later spring (*pulattuq*, going into a fiord) (MoN2). They will also congregate in fiords on the *sikutaq* as ice is first forming in the fall (LE1; MoN2; PV1).

The hooded seals are unique in the area, in that they like to be on very high ice floes, like icebergs, that are floating around.

“One of the weirder seals around here is the hooded seal, and they like to be on ice floes which are practically icebergs, like small icebergs, that’s their favorite piece of ice that they want to be on top of. Like they can be really high, and you can look at them, like they don’t have arms but they can climb up these huge huge pieces of ice. On all sides it would be like, no place to climb, but then there they are sitting on top, it’s very strange, and [I’ve] seen it a few times, baby hooded seals on top of small icebergs [broken off from icebergs].” (Nashalik, 2004)

These seals are also well adapted to being underwater for long periods of time. They have an air sack on top of their head that they can inflate like a large bag, allowing them to bring extra air underwater (EN1). In addition, harp seals stay mainly where there is open water, so they are around more in the summer or fall (JoM1; JS1), but they still require sea ice to molt their fur (PV1). Furthermore, bearded seals (*ujjuq*) are larger than ringed seals, and they too use the sea ice (JoM1; MoN2). However, they prefer to be closer to open water, and typically use the moving ice (JN1).

Beluga and narwhal stay closer to the *sinaaq*, where they can easily access air to breathe (JN1; JoM1; JoP1; MiK1; MM1; PQ1). They are constantly moving with changes in sea ice extent throughout the year (JN1; JoP1; MoK2), but beluga will come into certain fiords (e.g. Clearwater Fiord) to have their young (JQ1; ME1; MoK2).

“You know, the animals aren’t in one particular spot all the time, they’re always moving around. Depending on ice conditions, or with ice conditions or without, with only water body areas, the animals are always moving around. And in this, the whales that come into [Cumberland] Sound in the spring will come up into this Clearwater Fiord and this is where they bear their young, calves.” (Qappik, 2004a)

Beluga migrations follow the Cumberland Sound coastlines (ME1; MM1), coming inwards in the spring and moving outwards in the fall (JoP1; MoK2). Therefore, during the winter they are usually around the mouth of Cumberland Sound, in Davis Strait (JoP1). However, there



has been the odd time where several beluga have been frozen in as the ice formed in the fall (LN1; MM1; MoK2). In these cases they keep holes open as much as they can, and are forced to stay in one area (MM1; MoK2). Unfortunately, it is difficult for them to maintain the holes all through the winter (PQ1), and sometimes this leads to large die-off events for beluga (MM1).

Sea ice is also important habitat for walrus. They prefer to be around floating ice pans in open water (LI2; MiK1), but they will sometimes come into Cumberland Sound on multi-year ice from further north (MiK1; PQ1). Even in the winter, where the ice has broken up it is possible to find walrus basking on the ice pans (*uttuq*) (LI2; MiK1; PQ1). Therefore, walrus are often found closer to the mouth of Cumberland Sound (JAK1; MM1; PQ1). However, walrus can also be stranded on the ice that closed in on them, when *nunniq* occurs (MM1). They would maintain a breathing hole, but the floe edge would be too far for them to reach open water again (MM1).

Polar bears can be found almost anywhere on sea ice, although they tend to prefer being near open water or moving ice (AY1; JAK1; JI1; JN1; JoM1; JoM2; JoP1; LE1; LI2; MiK1; MM1; MoN1; MoN2). They seek their food on the sea ice, especially baby seals in their dens or on the ice in the spring (JAK1; JI2; JN1; PQ1). During the winter they are not found much on solid ice, but they harvest seals through their breathing holes (JN1; MoN2; PQ1) or at the *sinaaq* (MoN2). Therefore, polar bears spend a lot of time near points of land where the *sijja* is rough and where seal dens are more commonly found (JI2; JoP1). Bears will actually gnaw away at the *allu* to make the ice very thin, thus it is easier to bite into the ice when the seal comes close to the surface to breathe (MoN2). Polar bears move with changes in sea ice extent, and availability of seals (JAK1; JoP1; MiK1; MoN2). They spend a lot of time actually in the water, but they are also just as comfortable traveling on land (AY1; MM1; MoN2). They den inland to have their young (AY1; JoP1).

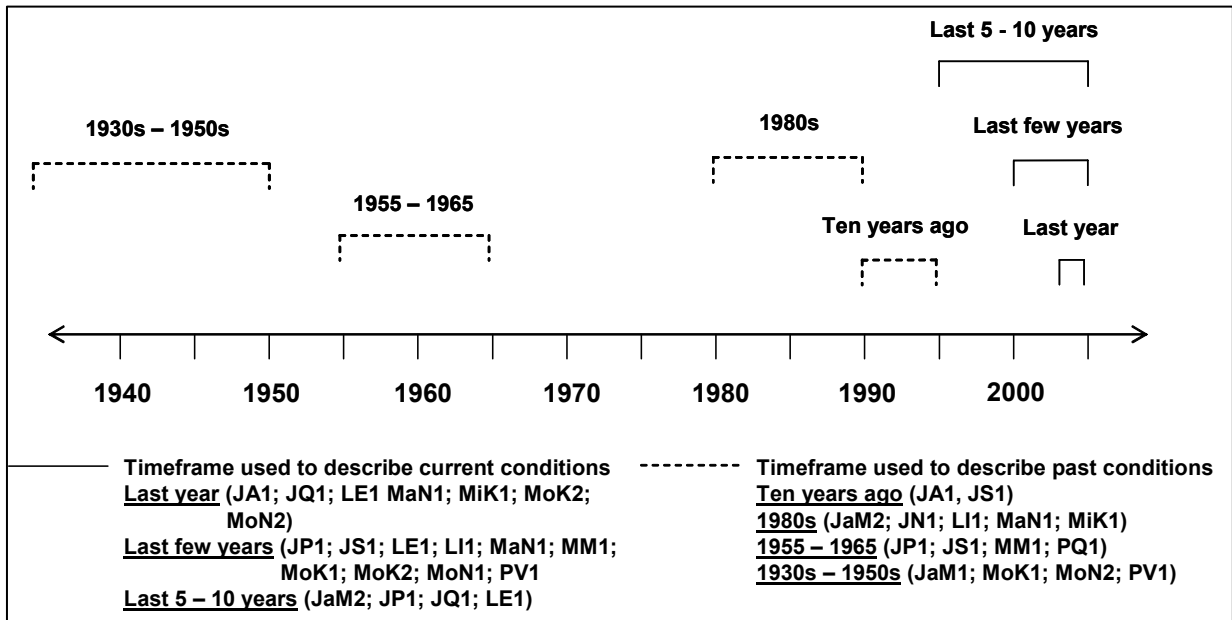
## 6.4 Observations of change

Community members in Pangnirtung have observed, and are experiencing, considerable change in their local climatic and sea ice conditions. When discussing change it is important to be aware of the timeframes used to assess change as they vary depending on the individual and the phenomenon in question. Figure 6-22 summarizes the timeframes referred to within the interviews conducted. Observations of change have been noted mainly in the last few years (indicated as approximately 2000 – present), where unique ice conditions in the spring and fall of 2004 were frequently highlighted (indicated as last year in Figure 6-22). This was indicated as the worst year for ice conditions to date due to different melt processes (Section 6.4.4) along with the latest freeze-up timing (Section 6.4.3). In the last 5 – 10 years shifts in freeze-up and break-up timing, recession of the floe edge position, shortened turbot fishing seasons, and thinner sea ice were also highlighted (Figure 6-22). These changes are evaluated in comparison to conditions in the 1980s (Figure 6-22). However, timeframes from the 1930s to 1960s were also used as a baseline reference for expected freeze-up timing and processes, as well as floe edge location (usually contingent on the age of elders or hunters interviewed) (Figure 6-22).

There are a variety of indicators that elders and hunters use to gauge change. The most commonly referenced include: i) the position of the floe edge; ii) weather/seasonal temperature or predictability; iii) freeze-up processes and timing; iv) break-up processes and timing; and v) ice thickness. The predominant changes observed according to these indicators are summarized in Table 6-3, and additional changes are noted in Sections 6.4.6 and 6.4.7.

### 6.4.1 Floe edge

While the position of the floe edge varies yearly in Cumberland Sound (LI1; JaM2), there were consistent descriptions of the floe edge forming increasingly closer to the mouth of Pangnirtung Fiord in winter (LI2; JI1; JaM2; JoP1; MM1; MoN1) and spring (Table 6-3,

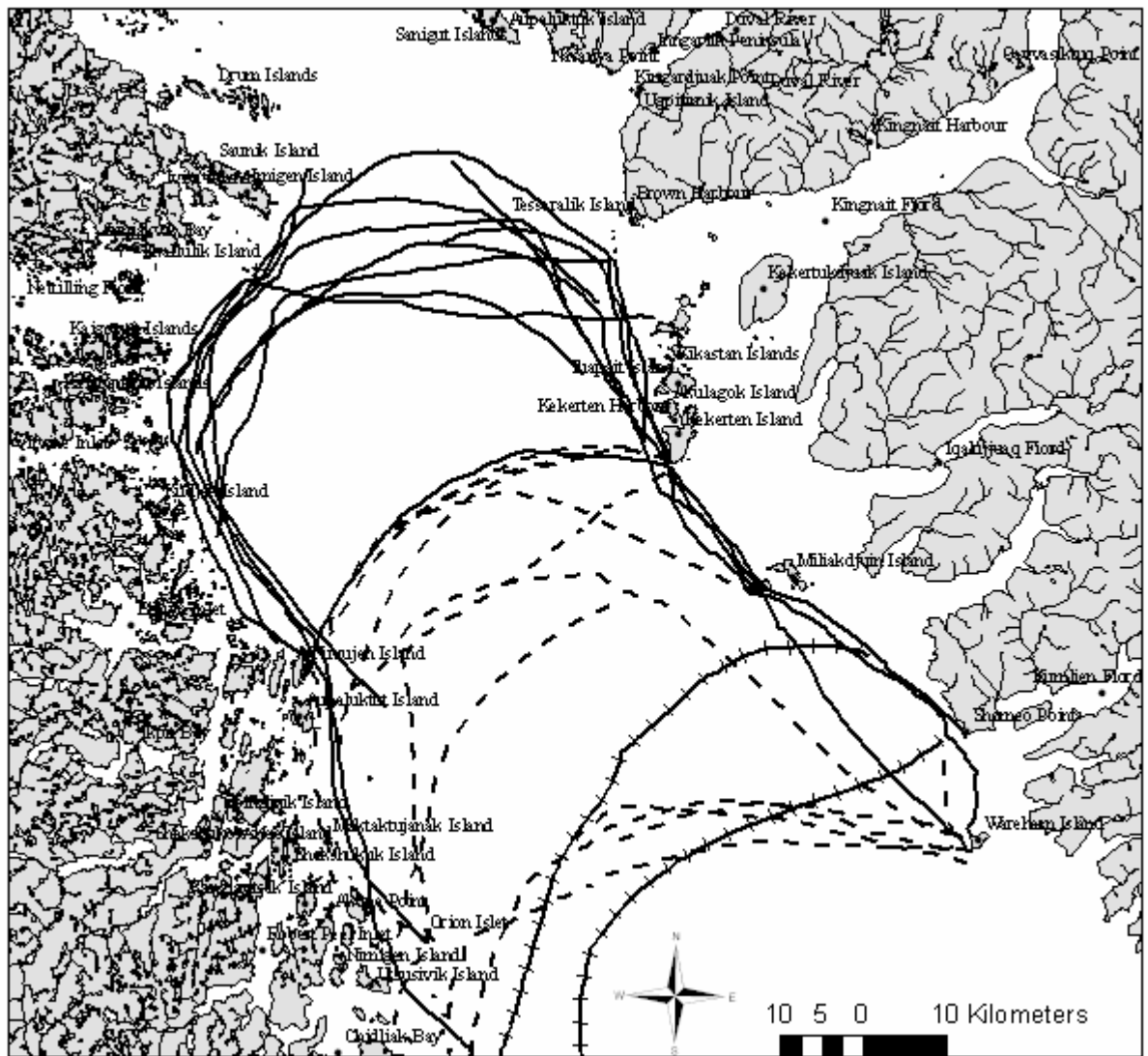


**Figure 6-22:** Summary of the timeframes used in interviews when discussing observations of sea ice change.

**Table 6-3:** Summary of observed indicators and associated changes around Pangnirtung. The number of observations refers to the number of interviewees that mentioned this change. (AY1; EN1; JAk1; JaM1; JaM2; JI1; JI2; JN1; JoM1; JoM2; JoP1; JQ1; JQ2; JS1; LE1; LI1; LI2; MaN1; ME1; MiK1; MM1; MoK1; MoN1; MoN2; PV1; PQ1)

Indicator	Change	# of Observations
Floe edge	a) Closer to town	a) 13
	b) Breaks off more frequently	b) 3
Weather	a) More unpredictable	a) 4
	b) More windy	b) 3
	c) Warmer	c) 8
Freeze-up	a) Takes longer/freezes slower	a) 3
	b) Occurring later	b) 8
	c) Different consistency(softer)	c) 6
Break-up	a) Melts/breaks up earlier	a) 12
	b) Melt stages happen faster	b) 8
Ice thickness	a) thinner	a) 7

Figure 6-23) (AY1; JoP1; MaN1; MM1). One of the furthest floe edges was indicated as being in the mid 1980s, around 1984 (potentially associated with weather currents that year) (Figure 6-23) (LI2; JaM2). However, it is rare these days for Cumberland Sound to become *nunniq* (AY1;



**Figure 6-23:** Delineation of the changes observed in *sinaaq* location over the past twenty years.

Sources: AY1; JaM1; JS1; LI2; LN1; MaN1; MiK1; PQ1

Where: — = recent *sinaaq*      + = 1980s *sinaaq*      - - - = previous *sinaaq*

MiK1; PQ1), and even the ‘definition’ of *nunniq* has been altered due to this infrequent occurrence (MaN1; PQ1).

“When it’s a *nunniq* period it would be normally here and here [demonstrating], like when it becomes called *nunniq*, these would be frozen over, like the floe edge would be here or here, and that would be called *nunniq*. And out here would be like very *nunniq*...Normally [now] it’s even closer, hunters describe it as the floe edge being far away when it’s like this close, because normally it’s even closer now...So if a hunter says the floe edge is far, it’s only over there.” (Qappik, 2004c)

This translates into an increased prevalence of open water in Cumberland Sound, making it harder to access the desirable fishing areas for the commercial fishery (Section 6.4.6) (JS1; LI2).

Because the floe edge is not established properly in recent years, certain areas are more prone to breaking off (MiK1).

#### 6.4.2 Weather

Just as the ice varies from year to year, so too does the weather (MM1). However, various observations were presented that suggest a general warming trend is shortening the winter season and lengthening the summer (Table 6-3) (JAK1; JaM1):

- there is a shorter ice season (JaM1; MaN1; MM1);
- snowmobiling season has shortened (MiK1);
- there is a lack of ice fog during the fall, or at the floe edge (JQ1; JS1; MoN2);
- it is not necessary (i.e. not cold enough) to wear a caribou skin parka anymore (MM1);
- canvas tents are now adequate shelter in January and February, whereas an igloo was a necessity in the past (MM1);
- there is a longer open water season (ME1; JQ1); and,
- the transitional period between ice-covered and ice-free (or vice versa) has lengthened (PQ1).

Furthermore, it seems that there is increased snowfall during the fall, which can also be linked to thinner ice conditions (Section 6.4.5) and a closer *sinaaq* (Section 6.4.1) (EN1; MoK1).

In addition, elders and active hunters find it more difficult to predict weather patterns (Table 6-3) (EN1; JI1; JQ1). Some commonly used indicators of weather condition, or change, are no longer applicable (e.g. the types of weather associated with particular cloud formations or colourations), or have become confusing (JQ1; MoK1).

“And what we have today is that in just observing the clouds, even in dead of winter you can see those black clouds which would normally tell you that it’s going to be a warm spot, you know for the day or two. But it doesn’t come, so these are the type of things that aren’t coming, as normally in the past you’d be able to predict what it’s going to be like. But you can’t today, because [the clouds] are coming, but they’re not saying it’s going to be a warm spot, it’s just an ordinary black cloud. Because it’s not coming out to the type of weather that [we] would normally associate with the clouds’ formations in the past. So it may not be even a warm spell, but you’ll still see those clouds.” (Keyuajuk, 2004)

Beautiful clear, calm weather was also more prevalent, for longer periods of time (i.e. days at a time), in previous years (MoK1; PQ1). These changes in predictability and consistency of weather are often linked to changing wind directions.

In the past, NW winds were prevalent in the winter, and more SE winds in the summer; however, currently the winds seem to blow from any direction regardless of season (EN1; JS1; MoK1; MoN1). Around the community itself, the topographic effects of the fiord and mountain formations meant that westerly winds commonly increased in the afternoon (JQ1). This effect would contribute to the melting stages within the fiord, and was also a cause for most families to camp outside the fiord, or to wait until evening to travel (JQ1; PQ1). With warming weather there is concern that these predominant winds will switch, along with the uncertainty of their effects (JQ1). In general, windy conditions seem more common (Table 6-3) (JS1), also contributing to the challenges of weather prediction (MoN2).

Despite some comments on general warming of the weather, there were also several postulations that it is the ocean – and not the air – that may in fact be warming (EN1; MoN1; PQ1). This increased water temperature may be a key contributor to closer floe edge proximity, thinning sea ice, and alterations in freeze-up and break-up timing (EN1; MoN1; PQ1). Part of this may relate to the cold water layer in the ocean now being much deeper, and thus surface waters being warmer (EN1).

“Where they’ve been able to experience that [dog team] whip that he was talking about this morning, [if you dip it] in water and it cakes with ice right away then it’s real real cold. Another example of that was, you could actually see the difference in the different water temperature, if you look inside a seal hole, inside it looks like it’s got a bottom. But that’s just the beginning of the next layer of water, different temperature water, that used to be a lot closer to the ice back then, and today when you look inside you don’t see that anymore. And in the past, if you shot a seal, and it slipped into the hole, it wouldn’t sink very many feet, it would sort of sink...and then it would be just suspended. And that water was a lot more like slush...It was so cold, it was more like molasses type of substance, consistency, and nothing would sink...Today if a seal falls into the hole it falls, like it sinks and it doesn’t stop. But in the old days it would stop, and you would just get a hook and take your seal out of the ice. So that’s another reason why [I] suspect that the cold layer is lower now, because we get more snow on top of the ice that insulates the water that is directly below the ice, making it warmer, warmer than before.” (Nashalik, 2004)

### 6.4.3 Timing of freeze-up

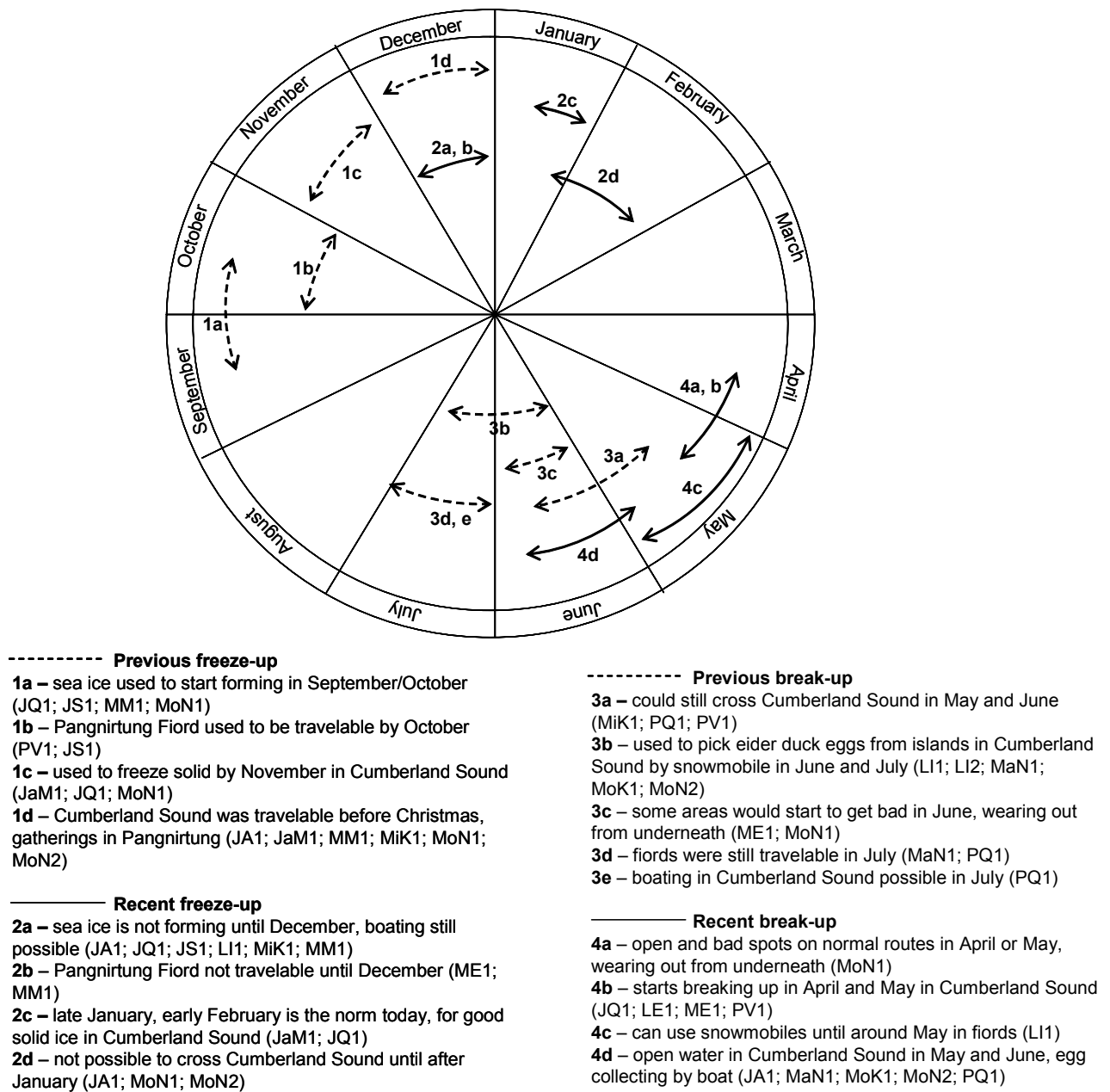
Freeze-up is generally occurring later, taking longer to form travelable sea ice, and some of the expected freezing stages (and associated terms) are no longer happening (Table 6-3). Figure 6-24 provides a visual depiction of the temporal change in freeze-up timing, typically gauged according to when: i) sea ice first begins to form; ii) Pangnirtung Fiord is travelable; iii) Cumberland Sound has solid ice; and, iv) Cumberland Sound is travelable. To summarize the temporal change shown in Figure 6-24, the beginning of the freezing processes are occurring approximately two months later than in the past (i.e. December instead of September/October). Similarly, the ice is not formed solidly enough for travel across Cumberland Sound until January or February, whereas people from the other side of Cumberland Sound used to cross to Pangnirtung to celebrate Christmas. Changing winds are potentially linked to later freeze-up dates, as more windy conditions prevent the ice from freezing due to wave action, or the winds blow the new ice out (Table 6-3) (MiK1; MoN2; PV1). Furthermore, some of the freezing processes seem to be altered, such as:

- *sikuvaalluuti* does not form properly, or stay until the next year (EN1);
- *uiguaq* breaks off much easier, and more frequently (MaN1);
- areas with strong currents are not freezing over where they used to, new polynyas forming (MiK1; PQ1); and,
- some points are thin/dangerous where they used to be solid (JQ1; MoK1; PQ1).

In general, the ice was described as being a different consistency, softer (more *sikurinittuq*) and not as strong as before (JQ1; MiK1; MoK1; MoN1; MoN2; PV1) – it doesn't chip off as easily when it's not hard and brittle (MoK1; MoN2).

### 6.4.4 Timing of break-up

Break-up is generally occurring earlier in the spring than would have been expected in the past (Table 6-3) (EN1; JaM1; JoM2). Break-up timing is often referred to as when the sea ice starts to become dangerous for travel, and when the ice in Cumberland Sound and fiords begins breaking up. Figure 6-24 summarizes the temporal change in break-up timing,



**Figure 6-24:** Summary of the changes in freeze-up and break-up timing observed in Pangnirtung.

alongside the freeze-up timing discussed above. The off-set in dangerous travel, and break-up, timing is approximately two months. For example, crossing Cumberland Sound was still possible in May/June previously, whereas now travel becomes dangerous around April. Furthermore, fiords were still travelable in June, and are now only safe until around May (Figure 6-24). One specific example shared by Noah (2004) was that he made note of some



unusual years, when on June 22, 1984 he did not even have to use the *qainngu* to get out of Pangnirtung Fiord, the *tuvaq* was still solid. Whereas this past spring, on May 8, 2004, he had to use the *qainngu* because the ice was not good enough to travel on anymore. In addition, in Cumberland Sound boating is now possible in May or June, instead of people having to wait until July (Figure 6-24). This means that people are sometimes collecting eider duck eggs by boat, instead of by snowmobile (LI1; LI2; MaN1; MoK1; MoN1). Earlier break-up, and faster deterioration of the sea ice, is linked to thinner and weaker (i.e. softer consistency) ice conditions (JoM2; JQ1; MM1). In addition, it was noted that more storms in the spring time are melting the ice all at once, instead of the gradual melting effects of the sun (AY1). Even certain melt processes are being skipped, also contributing to the increased speed of ice deterioration in the spring (AY1; JQ1; PQ1).

“That’s because...after the snow melts, remember it became *puttaijuq*, [I] called it *puttaijuq* when all you could see was water after the snow melts? This part of the process is being skipped now. That no longer happens...The first process where the snow [melts] still occurs, but this never happens anymore where it all melts at the same time...After all the snow has melted on the ice it’s supposed to be very good to travel on, like it used to be very good to travel on. However, when it becomes *immatinniq*, the *immatinniit* go right down through the ice now, these days, very fast, like they don’t just stay as a puddle for a few days, for a long time. They’re melting right through really fast, so that part of the process is being skipped now too.” (Qappik, 2004c)

#### **6.4.5 Ice thickness**

Sea ice was consistently described as being thinner than in the past (Table 6-3). These observations are based upon a few key indicators:

- seal breathing holes are no longer as deep or tunnel-like, seals do not have to go straight down to get into the hole (MoK1; PQ1)
- melt holes are no longer as deep or tunnel-like (PQ1)
- ice is thinner in comparison to personal height when chipping away a hole (LI1)
- a fishing spear (more than 10 feet long) is no longer necessary to retrieve seals from their breathing holes (now only about 1.5 feet thick (LI1; LI2)
- *tuvaq* is thinner (LI1)

Thinner ice conditions are linked to later freeze-up (Section 6.4.3) due to the diminished amount of time for the ice to thicken (JaM1). Thinner ice also contributes to earlier break-up (Section 6.4.4) because it deteriorates faster in the spring, and is worn away more easily by currents from underneath (JaM1; LE1; MoN1; PQ1).

#### **6.4.6 Wildlife**

In addition to the sea ice changes mentioned in Sections 6.4.1 – 6.4.5, wildlife are commonly used indicators of change in Inuit culture. Because of the important relationship between humans and animals, there were some changes noted about polar bears, seals, beluga whales, and the commercial turbot fishery that may be linked to changing ice conditions.

First, polar bears are affected by shorted ice seasons. They follow the ice, which is one reason why people are noticing more bears close to land (JAK1). Bears were sighted infrequently in the past, but now they are increasingly seen in Cumberland Sound and around the community (JAK1; MM1; MoN2). This seeming increase in numbers may also be linked to the implementation of the quota system, whereby fewer bear kills are permitted and thus the bear population is increasing (MM1; MoN2).

Second, the fur of ringed seals is being affected by the shorter ice seasons (EN1; MoN2). With earlier sea ice break-up the seals are not getting enough time to bask on the ice in the spring and they cannot molt properly (EN1; MoN1; MoN2; PV1). This leads to increased numbers of brown seals (EN1), and also inhibits the amount of time that the young seal pups have to mature before being forced into the water (PV1).

“This was a very important seal denning area, it’s gone. And if that continues those seals, the seal babies or pups are going to be too small when they’re forced into the water. [I] know baby seals don’t have much fat on them, and whenever they don’t have much fat on them they last only a few minutes in the water.”  
(Veevee, 2004)

Some hunters expressed concern for the seals, wondering where they will go if the ice continues to diminish (JAK1; PV1). Some seals have even begun to give birth earlier in the year

(normally this occurs in March) (MM1). Fewer ringed seals were seen in Cumberland Sound in the fall of 2004, but interestingly nearly triple the number of harp seals were observed (JS1).

Third, harp seals may be coming north from Newfoundland to look for good ice to bask on, as they are skinny when they arrive, and still have their baby fur (PV1). It is also increasingly rare for bearded seals to come into Cumberland Sound from the open ocean, but this used to be quite common (EN1). Furthermore, beluga seem to stay closer to Pangnirtung year-round, since there are much longer periods of open water (MM1). They are also more accessible with the closer position of the floe edge (MiK1). In addition, eider duck numbers seem to have declined based on the appearance of islands (i.e. they used to look white when they were covered with male eiders) and the prevalence of eggs on nesting islands (EN1; MaN1).

Finally, the turbot in Cumberland Sound may not be themselves influenced by changing ice conditions, but the ability for fishermen to access desirable fishing spots was mentioned frequently (JoM1; JS1; MiK1; PQ1). This is linked to changes in floe edge position (Section 6.4.1), freeze-up timing (Section 6.4.3), break-up timing (Section 6.4.4), and ice thickness (6.4.5) throughout the year. This has important implications for the local economy, and will be further discussed in Chapter 7.

#### **6.4.7 Multi-year ice**

Because of its mountainous and fiord location, community members in Pangnirtung are used to having icebergs around (that have calved from nearby glaciers), as well as multi-year that is blown into Cumberland Sound from further north, via Davis Strait. Recently, fewer icebergs have been noted in and around the fiord, which leads to warmer summer water temperatures and potentially later freeze-up timing (JaM1). In addition, much less *qapvaq* has been coming into Cumberland Sound (JaM2), and when it does come in the MYI melts a lot faster than previously (MoN2).

“And the *qapvaq*, that [ice that] comes up from up there, when they come into Cumberland Sound they melt a lot faster than they used to...Like for example if the ice came into Pang fiord, and went into the fiord, none of them would come back out, they would all melt up there. It’s a one-way trip when ice comes in, when you see ice coming in and disappearing up there, you won’t see it again, it’s gone, it’s going to melt up there.” (Nuvaqiq, 2005)

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To the elders and hunters interviewed in Pangnirtung the sea ice is very important, for traveling, hunting, and wildlife. They understand the sea ice processes around their community, and have been keenly observing changes to expected conditions and timing of events.

“And because of that the older hunters, older than [myself], you know having that knowledge of the formation of the ice and the conditions within [Cumberland] Sound, or around Pangnirtung, in knowing how the ice formation and also knowing how quickly it’s starting to go, or melt, now the elders are really concerned about that. What they’re doing is informing younger hunters like [myself] or even younger hunters like [Eric] to inform them of the dangers of where the ice conditions are bad or better in some areas, and where not to travel. So [I’m] also involved in trying to inform younger people to be more observant and not to use particular areas, while they’re out hunting.” (Nuvaqiq, 2004)

They want their knowledge shared with the younger generation of Inuit, and with scientists, to help educate people from the Inuit perspective. This chapter is a beginning in the sharing process. The means of learning across generations, and cultures, is discussed further in Chapter 8.

## **Chapter 7 – Analysis**

### *Inter-community comparison of sea ice processes, use, and change*

#### **7.1 Importance of sea ice**

As evidenced in Chapters 4 – 6, sea ice is very important to each of the communities involved in this project. It is a key means of traveling to access wildlife, engaging in subsistence or commercial hunting/harvesting, and enjoying leisure time. With Cape Dorset and Igloolik being on islands, sea ice is one of the most important means of getting out of the community. For Pangnirtung, sea ice is of equal importance for getting out of the community, as it is located in a fiord surrounded by mountainous terrain. Once the sea ice forms solidly there is little distinction between land and ocean. Then people are free to travel wherever they wish, as long as they are aware of the dangerous areas and local ice dynamics. Therefore, sea ice enables community members to access: i) neighbouring islands from all three communities; ii) Baffin Island from Cape Dorset and Igloolik; iii) the mainland (Melville Peninsula) from Igloolik; and, iv) the shorelines of Cumberland Sound from Pangnirtung. For all three communities, sea ice also allows people to reach inland fishing lakes or cabins, and neighbouring communities. Therefore, sea ice provides a smooth “highway” upon which people can travel more directly and quickly than inland routes. However, due to the relatively flat terrain on Melville Peninsula and other islands around Igloolik, there are more over-land travel alternatives than around Cape Dorset or Pangnirtung. In all three communities, people consider themselves stranded in town during transitional stages of freeze-up and break-up, where the ice is too thick to boat and not thick enough to travel on.

Sea ice also provides important habitat for marine wildlife, notably ringed seals, polar bears, and walrus, that have always been staples of northern life. Previously, marine mammals were a means of survival (i.e. clothing, fat/oil for light and heat, food for people and dogs, and equipment). Presently, they provide an important food source and/or income (from skins or

related clothing/craft products). So sea ice travel is rarely undertaken for the sake of traveling, it is usually associated with hunting or harvesting in some manner. In general, sea ice is used to access:

- 1) landfast ice (*tuvaq*), where ringed seals are hunted on the ice or through breathing holes;
- 2) the floe edge (*sinaaq*), where ringed seals, bearded seals, polar bears, beluga whales, narwhals, walrus, and marine birds may be found;
- 3) moving ice (*aulajuq*), where walrus and polar bears may be found, and where beluga whales and narwhals may travel;
- 4) polynyas (*saqvait/aukkarniit*), where ringed seals, marine birds, and less commonly polar bears and bearded seals, may be found; and,
- 5) tidal cracks (*naggutiit*), where ringed seal breathing holes are found in the winter and where ringed or bearded seals may be found in the open leads (*aajurait*) in the spring.

Much of this hunting is conducted to acquire food, although some profits can be made by selling the skins, furs, ivory, or meat of the animals. Sea ice is also essential to support the commercial turbot fishery operating out of Pangnirtung.

While there are many similarities between the importance of sea ice in each community, there are also localized differences in ice conditions and processes (Section 7.2), sea ice uses (Section 7.3), and observed sea ice changes (Section 7.4) that are valuable to explore.

## 7.2 Sea ice processes

In each community there are several commonalities between the descriptions of freezing and melting progressions of the sea ice. Many of the terms used to describe prominent ice conditions or features are shared between the communities, despite some local dialect differences. It is acknowledged that the focus on Inuktitut terminology of sea ice alone does not adequately characterize the complexity and interactions of sea ice conditions in each community. However, it became increasingly clear throughout the research process that to better understand Inuit expertise on sea ice, Inuktitut terminology is an essential starting point. Results from each community (Chapters 4 – 6) have highlighted the manner in which sea ice freezing and melting processes are explained by local experts. This section discusses the

similar, and unique, accounts between communities to determine where: i) unique ice conditions may occur due to local/regional geographic or oceanographic influences; ii) where similar conditions are referred to using different terminology; iii) the sequence of freezing or melting may differ; and, iv) there is overlap between processes/terminology in each community. In order to follow this analysis it would be helpful to refer to Figures 4-1, 5-1, and 6-1, along with the respective glossaries (Appendices 13 - 15), when necessary. Also, please note that the numerical summaries of terminology only provide an indication of relative similarities or differences. The terms identified in this thesis by no means cover all Inuktitut terminology for sea ice, and they reflect only the words that were specifically defined for me over the course of interviews. Therefore, they do not represent the entire scope of sea ice characteristics around each community. They do, however, provide the best basis for comparison at this point.

### 7.2.1 Freezing processes

#### *7.1.1.1 Near shore freezing*

Examining the terminology employed to describe the early stages of freezing along the shoreline, only one term is common to all three communities (Figure 7-1a, Table 7-1a). The process of the ocean freezing over is termed *sikuvaliajuq* (Figure 7-1a, Table 7-1d). However, it is used to describe the earliest freezing in Cape Dorset, early near-shore freezing in Pangnirtung, and sea ice thickening in Igloolik. This may reflect the greater emphasis that is placed on early freezing stages in Cape Dorset and Pangnirtung (Figure 7-1a, Table 7-1a), whereas in Igloolik it is the later stages of sea ice thickening that are described in more detail (Figure 7-1c, Table 7-1c). With Igloolik being further north, freeze-up would generally occur more rapidly, which may explain the lack of unique terms described in Igloolik for varying stages of along-shore freezing (Figure 7-1a). Furthermore, the tides are not as strong in Igloolik, so the common terms between Pangnirtung and Cape Dorset (Figure 7-1a) refer

a) near-shore freezing

1	CD	IG	PG
CD	4	0	2
IG		0	1
PG			2

b) open water freezing

1	CD	IG	PG
CD	3	0	0
IG		0	1
PG			1

c) sea ice thickening

7	CD	IG	PG
CD	6	1	1
IG		6	3
PG			9

**Figure 7-1:** Matrices of Inuktitut terminology showing the number of unique and overlapping sea ice terms for freezing processes, in each community.

**Where:** The number in the top left-hand box indicates the number of terms common to each community; shaded boxes indicate the number of terms unique to a particular community; unshaded boxes indicate the number of terms that overlap between two communities only; and, the empty boxes would mirror the same numbers as the un-shaded boxes.

(CD = Cape Dorset, IG = Igloolik, PG = Pangnirtung)

mainly to tidal zone or shoreline formations (i.e. *ilaupalia*, *sijja*) (Table 7-1a). In Cape Dorset, the focus was on shoreline freezing progression as it varies according to sea ice stability at high or low tide (Table 7-1a). Unique to Pangnirtung was the description of *qillirusijjuq*, the precursor to *qainngu* (Table 7-1a). In both Pangnirtung and Igloolik *qainngu* refers to a type of (relatively narrow) ice ledge that follows the contours of the shoreline. However, in Pangnirtung it functions as an important travel platform throughout the ice season, while in Igloolik it is distinguished as the main near-shore freezing condition (Table 7-1a, 7-1d). In Pangnirtung *sikutaq* (Table 7-1a) was specified due to its importance in traveling out of the community, but this general description of bays, inlets, and fiords freezing before larger water bodies was also discussed in the other two communities.

#### 7.2.1.2 Open water freezing

The strength of currents around Cape Dorset, and the prominence of open water, is likely the main reason for a greater focus on open water freezing than in the other two communities (Figure 7-1b, Table 7-1b). Only the earliest formation of sea ice (i.e. *qinnu*) (Table 7-1b, 7-1d) was described similarly in all three communities (Figure 7-1b). Because it is an important indicator of the beginning of freeze-up, it is a commonly employed term across communities. There is minimal emphasis on early freezing stages in Igloolik (Figure 7-1b). However, the reference to *quvviuat* overlaps with Pangnirtung (Table 7-1b, 7-1d), albeit in a



**Table 7-1:** Comparison of Inuktitut terms related to sea ice freezing stages, in each community.

## a) Near-shore freezing stages

Term (freezing)	CD	IG	PG
<i>sikuvaliajuq</i>	s	sp	s
<i>ilaupalia</i>	s		sp
<i>ilu</i>	x		
<i>qillirusijuq</i>			x
<i>sikutaq</i>			x
<i>kuiviniq</i>	x		
<i>qaikut</i>	x		
<i>qaingu</i>		s	sp
<i>sikurtusijuq</i>	x		
<i>sijja</i>	s		s

## b) Open water freezing stages

Term (freezing)	CD	IG	PG
<i>qinnu</i>	s	sp	sp
<i>qaikuin</i>	x		
<i>qalligirtuq<sup>c</sup></i>	x		
<i>quvviquat<sup>w</sup></i>		s	d
<i>sikualaaajuq<sup>cw</sup></i>			x
<i>sikuliaq</i>	x		

## c) Sea ice thickening stages

Term (freezing)	CD	IG	PG
<i>sikuaqtuq</i>	s		s
<i>sikuaq</i>	s	s	s
<i>millutsiniq</i>	x		
<i>qamittu</i>	x		
<i>nigajutaq<sup>cw</sup></i>	s	s	s
<i>nigajutaviniq</i>		x	
<i>sallivaliajuq</i>	s	d	d
<i>uqurusirtuqsimajuq</i>	x		
<i>sikuriaq</i>		s	d
<i>nutaaminiq</i>			x
<i>sikuqaq</i>	s	s	
<i>qanguti</i>	s	s	sp
<i>qangutaituq</i>	x		
<i>niuma</i>		x	
<i>niumakjuaq</i>		x	
<i>sikujuq</i>	s	d	s
<i>sikurinittuq<sup>w</sup></i>			x
<i>ittanilapaat</i>			x
<i>kiviniq</i>			x
<i>tuvaruajjuqtuq</i>		s	d
<i>kuvviliukajuq</i>	x		
<i>aggurtipaliajuq<sup>w</sup></i>		x	
<i>sikuvaalluuti</i>			x
<i>atuqsaruqtuq</i>			x
<i>nipittuq</i>			x
<i>siku</i>	s	s	s
<i>sikuvik</i>		x	
<i>tuvaq</i>	s	s	s
<i>apulliq</i>		s	d
<i>aputaittuq</i>		x	
<i>tuvallariuliqtuq</i>			x
<i>sikutiaqtuq</i>			x
<i>tuvatuqaq</i>	x		

## d) Similar freezing terminology

Cape Dorset	Igloolik	Pangnirtung
<i>sikuvaliajuq</i>	<i>sikuvalliajuq</i>	<i>sikuvaliajuq</i>
<i>qinnu</i>	<i>qinu</i>	<i>qinnuaq</i>
<i>ilaupalia</i>	n/a	<i>iluvalliajuq</i>
n/a	<i>qaingu</i>	<i>qainngu</i>
n/a	<i>quvviquat</i>	<i>quppirkuaq</i>
<i>sallivaliajuq</i>	<i>puimajuq</i>	<i>apputtatttuq</i>
n/a	<i>sikuriaq</i>	<i>sikurataaq</i>
<i>qanguti</i>	<i>qanguti</i>	<i>qanngut</i>
<i>sikujuq</i>	<i>sikusaaq</i>	<i>sikujuq</i>
n/a	<i>tuvaruajjuqtuq</i>	<i>tuvaruqpalliajuq</i>
n/a	<i>apulliq</i>	<i>apputaniuliqtuq</i>

**Where:**

CD = Cape Dorset, IG = Igloolik, PG = Pangnirtung

s = same term, same meaning

sp = same term, same meaning, different spelling

sd = same term, different meaning

d = dialectical difference in terms, same meaning

x = unique term to that community

<sup>w</sup> = associated with winds (Section 7.2.3.2)<sup>c</sup> = associated with currents (Section 7.2.3.4)**N.B.** the different spellings or terms identified are shown in Table 7-1d.

different order in relation to *qinnu*. In Pangnirtung it is described as a precursor to *qinnu*, and in Igloolik it occurs afterwards. In Pangnirtung they also describe *sikuallaajuq* (Table 7-1b) forming in the open water, which is actually similar to *aqsajutak* in Igloolik (Section 7.2.3.4) and *qaikuin* (Table 7-1b) in Cape Dorset.

### 7.2.1.3 Sea ice thickening

In all communities, the early freezing processes converge with the formation of *sikuaq* (Figure 7-1c, Table 7-1c), the first continuous thin layer of sea ice. In addition, *sikuaqtuq* is commonly described in Pangnirtung and Cape Dorset (Table 7-1a). This process would also be understood in Igloolik (i.e. adding the “*tuq*” ending simply means the action of *sikuaq* forming), but it was not specified in the interviews. Interestingly, the most common, and the most unique, terms between all three communities are highlighted within the sea ice thickening stages (Figure 7-1c). The terms employed consistently in each community reflect prominent transitional stages during freeze-up (Table 7-1c, 7-1d). Therefore, they are commonly employed bench-marks in the progression of sea ice thickening. Within these transitions, the detailed focus in both Pangnirtung and Igloolik is placed on the different thicknesses (i.e. stability) of sea ice (Table 7-1c). While *atuqsaruqtuq* (Table 7-1c) is only mentioned in Pangnirtung during the freezing stages, it is referred to in all three communities regarding the dangers of sea ice travel. Therefore, this term is not actually unique to Pangnirtung. Unique to Cape Dorset are terms that focus more on the ice surface, and the potential deterioration of sea ice during the freeze-up process (Table 7-1c). Here, the sea ice may endure several cycles of freezing over and breaking up before becoming solid enough for travel. At that point the emphasis is on *tuvaq* becoming older (*tuvaqtuqaq*) (Table 7-1c). Between Pangnirtung and Cape Dorset, *nipittuq* and *kuvviliukajuq* (Table 7-1c) refer to similar phenomena of “becoming landfast ice”, but they are subtly different in their descriptions. As the ice is “becoming *tuvaq*”, *tuvaruajjuqtuq* (Table 7-1c, 7-1d) is referenced in both Pangnirtung and Igloolik. However, this

stage is placed between *siku* and *tuvaq* in Pangnirtung, while in Igloolik it is prior to becoming *siku*. This difference seems more perceptual than physical, it is a matter of when people consider the ice to be becoming stable, landfast ice. Finally, once the *tuvaq* is solid, snow accumulation on the ice (*apulliq*) is described in Pangnirtung and Igloolik (Table 7-1c, 7-1d). Snow also accumulates on sea ice around Cape Dorset, so this term would be understood although it was not specified in interviews. This phenomenon may not have been emphasized in Cape Dorset because: i) the lesser sea ice extent and thinner ice conditions do not allow as much snow accumulation; or, ii) snow accumulation is implied with reference to *tuvaq*.

#### 7.2.1.4 Tidal cracks

Common to all three communities are the descriptions of two main types of tidal cracks (i.e. *nagguti*, *aajuraq*) (Figure 7-2, Table 7-2a, 7-2b). These relate to different diurnal, and monthly, tidal stages (Section 7.2.3.4), and serve as important features for hunting and safety assessment in each community. In Cape Dorset and Igloolik they also describe a tidal crack with a peaked formation (i.e. *qullupiarniq*) (Table 7-2a, 7-2b). Unique to Pangnirtung are descriptions of minor cracks, former cracks, and openings (Figure 7-2, Table 7-2a). Unique to Igloolik are descriptions of cracks that continue, stop, and then continue another place (i.e. *pilagiatinniq*), along with cracks that relate to the floe edge or moving ice (Figure 7-2, Table 7-2a). The additional cracks described in Cape Dorset relate to different widths of cracks (or leads) as they form in the spring (Figure 7-2, Table 7-2a). These differences between communities seem to relate to the emphasis on landfast and shoreline ice in Pangnirtung (as

2	CD	IG	PG
CD	3	1	0
IG		3	0
PG			4

**Figure 7-2:** Matrix of Inuktitut terminology showing the number of unique and overlapping sea ice terms for tidal cracks, in each community.

**Where:** The number in the top left-hand box indicates the number of terms common to each community; shaded boxes indicate the number of terms unique to a particular community; unshaded boxes indicate the number of terms that overlap between two communities only; and, the empty boxes would mirror the same numbers as the unshaded boxes.

(CD = Cape Dorset, IG = Igloolik, PG = Pangnirtung)

**Table 7-2:** Comparison of Inuktitut terms related to tidal cracks, in each community.

## a) Tidal crack terminology

Term (tidal cracks)	CD	IG	PG
<i>nagguti</i> <sup>c</sup>	s	s	s
<i>naggutiminiq</i>			x
<i>ajuraq</i> <sup>c</sup>	s	sp	sp
<i>qullupiarniq</i> <sup>c</sup>	s	sp	
<i>napakkuti</i> <sup>c</sup>		x	
<i>pilagiatinniq</i>		x	
<i>quppirniq</i>		x	
<i>nuttaq</i>			x
<i>aijuq</i>			x
<i>ikirniq</i>			x
<i>ikiqtusijuq</i>	x		
<i>nipittupaliajuq</i>	x		
<i>ikiqtuq</i>	x		

## b) Similar terminology for tidal cracks

Cape Dorset	Igloolik	Pangnirtung
<i>ajuraq</i>	<i>aajuraq</i>	<i>aajuraq</i>
<i>qullupiarniq</i>	<i>quglukniq</i>	n/a

**Where:**

CD = Cape Dorset, IG = Igloolik, PG = Pangnirtung

s = same term, same meaning

sp = same term, same meaning, different spelling

sd = same term, different meaning

d = dialectical difference in terms, same meaning

x = unique term to that community

w = associated with winds (Section 7.2.3.2)

c = associated with currents (Section 7.2.3.4)

**N.B.** the different spellings or terms identified are shown in Table 7-2b.

influenced by the ice pack in Cumberland Sound), the presence of nearby open water in Cape Dorset (especially a concern as cracks widen in the spring), and the importance of floe edge dynamics in Igloolik (for hunting and safety).

## 7.2.1.5 Floe edge

In all three communities, common terminology is employed for the floe edge, new ice forming at the floe edge, and ice breaking off from the floe edge (i.e. *sinaaq*, *uiguaq*, *uqaqtuq*) (Figure 7-3, Table 7-3a, 7-3b). Due to the prominent nature and importance of these features it is not surprising that they are referenced frequently, and similarly. In Pangnirtung and Igloolik, overlapping terminology relates to former/older *uiguaq* (Table 7-3a, 7-3b), whereas this likely does not have a chance to form in Cape Dorset. Between Igloolik and Cape Dorset, common terminology relates to sea ice that breaks off due to *uqaqtuq* (*uqakuti*) (Table 7-3a, 7-3b),

3	CD	IG	PG
CD	1	2	1
IG		11	1
PG			0

**Figure 7-3:** Matrix of Inuktitut terminology showing the number of unique and overlapping sea ice terms for floe edge, and related dynamics, in each community.

**Where:** The number in the top left-hand box indicates the number of terms common to each community; shaded boxes indicate the number of terms unique to a particular community; unshaded boxes indicate the number of terms that overlap between two communities only; and, the empty boxes would mirror the same numbers as the unshaded boxes.

(CD = Cape Dorset, IG = Igloolik, PG = Pangnirtung)

**Table 7-3:** Comparison of Inuktitut terms related to the floe edge, in each community.

## a) Floe edge terminology

Term (floe edge)	CD	IG	PG
<i>sinaaq</i>	s	s	s
<i>atirriaruti</i>		x	
<i>uiguag</i>	s	s	s
<i>uiguaviniq</i>		s	d
<i>sinaaviniq</i>		x	
<i>uqaqtuq<sup>cw</sup></i>	s	sp	sp
<i>uqakuti</i>	s	sp	
<i>uukkaqtaqtuq<sup>cw</sup></i>		x	
<i>qanguti</i>	s	s	
<i>qangusirsimajuq</i>		x	
<i>niumakjuag</i>		x	
<i>qullupiaqtuq</i>	x		
<i>qaangajuq<sup>w</sup></i>		x	
<i>qaatuq<sup>cw</sup></i>		x	
<i>sanimuangniq</i>		x	
<i>minuirniq<sup>cw</sup></i>		x	
<i>ukkuartinniq</i>		x	
<i>nipititaaq</i>		x	
<i>nunniq</i>	sd		s

## b) Similar floe edge terminology

Cape Dorset	Igloolik	Pangnirtung
n/a	<i>uiguaviniq</i>	<i>uiguatuqaq</i>
<i>uqaqtuq</i>	<i>uukkaqtuq</i>	<i>uukkaqtuq</i>
<i>uqakuti</i>	<i>uukkaruti</i>	n/a

**Where:**

CD = Cape Dorset, IG = Igloolik, PG = Pangnirtung

s = same term, same meaning

sp = same term, same meaning, different spelling

sd = same term, different meaning

d = dialectical difference in terms, same meaning

x = unique term to that community

<sup>w</sup> = associated with winds (Section 7.2.3.2)<sup>c</sup> = associated with currents (Section 7.2.3.4)**N.B.** the different spellings or terms identified are shown in Table 7-3b.

as well as *qanguti* (Table 7-3a) that forms along the *sinaaq*. This term is also used in Pangnirtung, but it was not specifically described in relation to the *sinaaq* during interviews. In Cape Dorset and Pangnirtung they both talk about *nunniq* (Table 7-3a), but it is used in a different context. In Pangnirtung this is a common reference to the freezing of Cumberland Sound, when the floe edge is far away. Whereas in Cape Dorset, it is used on the rare occasion that areas of Chorkbak Inlet freeze over. Prominent within floe edge descriptions in Igloolik is a unique emphasis on detailed accounts of floe edge dynamics (Figure 7-3, Table 7-3a). This is of most interest to Igloolik hunters since they are the only ones really using the moving ice to hunt walrus. Therefore, it is imperative that they are mindful of the different movements and conditions along the floe edge in order to safely cross onto, or back from, the moving ice.

## 7.2.1.6 Moving/multi-year ice

It was unexpected to have no common Inuktitut terminology for moving or multi-year ice (MYI) between the three communities (Figure 7-4). However, upon examining the

0	CD	IG	PG
CD	7	2	2
IG		2	2
PG			1

**Figure 7-4:** Matrix of Inuktitut terminology showing the number of unique and overlapping sea ice terms for moving or multi-year ice, around each community.

**Where:** The number in the top left-hand box indicates the number of terms common to each community; shaded boxes indicate the number of terms unique to a particular community; unshaded boxes indicate the number of terms that overlap between two communities only; and, the empty boxes would mirror the same numbers as the un-shaded boxes.

(CD = Cape Dorset, IG = Igloolik, PG = Pangnirtung)

differences in moving/multi-year ice descriptions, results seem to reflect regional geography and ocean circulation patterns; both of which are highly influential on the types, and paths, of ice moving in open water. It was anticipated that Igloolik would have the most unique terminology for moving ice due to its implications for travel safety and walrus hunting. However, the most challenging and dynamic aspect of moving ice around Igloolik is at the interface between the floe edge and the moving ice (i.e. *aulaniq*) (Table 7-4a). Hence, the prominence of moving ice terminology around Igloolik has already been outlined in relation to the floe edge (Section 7.2.1.5). Free-moving ice in open water (i.e. *aulajuq*) (Table 7-4a) is further away, so these ice types are less frequently used or seen. Therefore, less terminology is

**Table 7-4:** Comparison of Inuktitut terms related to moving or multi-year ice, in each community.

a) Moving/multi-year ice terminology

Term (moving/multi-year ice)	CD	IG	PG
<i>puktaa</i>	sp	s	
<i>aniqsai<sup>c</sup></i>	x		
<i>asaluaan</i>	x		
<i>aulaniq</i>	s	s	
<i>aulajuq</i>		s	s
<i>tatijaujuq</i>		x	
<i>sikutuqaq</i>		x	
<i>piqalujaa</i>		s	sp
<i>marruluin</i>	x		
<i>qaikuin<sup>c</sup></i>	x		
<i>qapvaq</i>	s		sp
<i>qunni</i>	x		
<i>savittuq</i>	x		
<i>sikurasaan</i>	x		
<i>killiminiq</i>			x
<i>tuvaminig</i>	sp		s

b) Similar moving/multi-year ice terminology

Cape Dorset	Igloolik	Pangnirtung
<i>puktaan</i>	<i>puktaa</i>	n/a
<i>qapvaq</i>	n/a	<i>kavvaq</i>
n/a	<i>piqalujaa</i>	<i>piqalujat</i>
<i>tuvaviniq</i>	n/a	<i>tuvaminig</i>

**Where:**

CD = Cape Dorset, IG = Igloolik, PG = Pangnirtung

s = same term, same meaning

sp = same term, same meaning, different spelling

sd = same term, different meaning

d = dialectical difference in terms, same meaning

x = unique term to that community

w = associated with winds (Section 7.2.3.2)

<sup>c</sup> = associated with currents (Section 7.2.3.4)

**N.B.** the different spellings or terms identified are shown in Table 7-4b.

associated with these conditions. The other communities share moving ice references with Igloolik that relate to their localized ice conditions (i.e. *aulaniq* in Cape Dorset because the interface between the moving ice and floe edge is close by, and *aulajuq* in Pangnirtung because the moving ice pack is far out in Cumberland Sound). In Cape Dorset, a number of unique terms are employed to describe how the ice is moving or the size of the moving ice (Table 7-4a). Terminology for simple floating pieces of ice (i.e. *puktaan*) is shared between Cape Dorset and Igloolik (Table 7-4a, 7-4b), while the MYI reference to *qapvaq* is shared between Cape Dorset and Pangnirtung (Table 7-4a, 7-4b). Unique to Igloolik are the descriptions of ice being dislodged by moving ice at the floe edge (i.e. *tatijaujuq*), along with old ice (i.e. *sikutuqaq*) (Table 7-4a). However, the reference to *sikutuqaq* (or *tuvaluqaq*) would be understood in any community, as the addition of “*tuqaq*” to the word ending simply refers to being “old”. In addition, icebergs (i.e. *piqalujat*) (Table 7-4a, 7-4b) are mentioned in both Pangnirtung and Igloolik. There are many glaciers around Pangnirtung, and around Igloolik the currents sometimes bring glacier-calved ice into Fury and Hecla Strait from further north. Although this word would likely be understood in Cape Dorset, it may not be commonly employed because icebergs do not often circulate through Hudson Strait. In Pangnirtung, moving ice can refer to *tuvaq* that has become detached (i.e. *tuvaluiniq*), while specific MYI formations in Cumberland Sound originate in the High Arctic (i.e. *killiminiq*) (Table 7-4a).

## **7.2.2 Melting processes**

### *7.2.2.1 Snowmelt*

In all three communities, elders and hunters mentioned that melt processes were hard to describe because they do not actually see the ice melting in the early stages. The sea ice begins to wear away from underneath, so the snow melting on top is the early indication of ice melt stages. A similar level of detail was described regarding the melt stages in each community. However, there were more locally distinct conceptions of ice melt than

overlapping ones (Figure 7-5a). The term used to describe areas that open up earlier than others (i.e. *aukaaniq*) (Table 7-5a, 7-5d) is common to all three communities. However, in Igloolik it refers to a polynya (i.e. *saqvaq* in Pangnirtung and Cape Dorset), and not only to areas that open early in the spring due to the influence of currents (Table 7-5a). The term *manguqtuq* (Table 7-5a) is also used in all three communities, but the process itself is described somewhat differently in relation to spring snow conditions and timing of occurrence. In Cape Dorset it describes the snow softening and melting, while the ice is still solid underneath (i.e. comprising *aputlariq* and *qinningijug*) (Table 7-5a). In Pangnirtung it is more of a diurnal cycle (i.e. comprising *manguqtaliqtuq* and *qisusqaqtuq*) that influences sea ice travel (Table 7-5a). In Igloolik *manguqtuq* is a distinct stage in the melt process, leading into *puimajuq* and *qisusqaqtuq* (Table 7-5a, 7-5d). General terminology for early melting (i.e. *aukajuq*) (Table 7-5a, 7-5d) is shared by Pangnirtung and Cape Dorset. Other than these overlaps, the specific conditions relating to snowmelt are unique to each community (Figure 7-5a, Table 7-5a). This is believed to be linked to the seasonal spring temperatures that vary geographically, thus influencing the speed with which melting occurs and the types of snow conditions produced.

#### 7.2.2.2 Water accumulation and drainage

As the snow melts, water begins accumulating on the sea ice, creating melt puddles and melt holes. These are important transition indicators as melting progresses towards break-up, thus they are commonly employed in all three communities (Figure 7-5b, Table 7-5b, 7-5d).

a) snowmelt					b) water accumulation					c) break-up				
2	CD	IG	PG		3	CD	IG	PG		1	CD	IG	PG	
CD	4	0	1		CD	1	0	1		CD	7	0	2	
IG		6	1		IG		4	2		IG		1	2	
PG			5		PG			3		PG			2	

**Figure 7-5:** Matrices of Inuktitut terminology showing the number of unique and overlapping sea ice terms for melting processes, in each community.

**Where:** The number in the top left-hand box indicates the number of terms common to each community; shaded boxes indicate the number of terms unique to a particular community; unshaded boxes indicate the number of terms that overlap between two communities only; and, the empty boxes would mirror the same numbers as the un-shaded boxes.

(CD = Cape Dorset, IG = Igloolik, PG = Pangnirtung)



**Table 7-5:** Comparison of Inuktitut terms related to sea ice melting stages, in each community.**a) Snowmelt**

<b>Term (melting)</b>	<b>CD</b>	<b>IG</b>	<b>PG</b>
<i>aukajuq</i>	s		d
<i>auttuq</i>			x
<i>aukaaniq<sup>c</sup></i>	s	sd	sp
<i>aputlariq</i>	x		
<i>uqurusirtuq</i>	x		
<i>apputailiqaqtuq</i>			x
<i>qinallatut</i>		x	
<i>nanirlijuk</i>		x	
<i>nilaruqtuq</i>		x	
<i>ijaruvauijat</i>		x	
<i>manguqtuq</i>	s	s	s
<i>qinningijuj</i>	x		
<i>manguqtaliqtuq</i>			x
<i>qiqsuqaqtuq</i>		d	s
<i>puimajuq</i>		x	
<i>masaq</i>			x
<i>aktinniq</i>		x	
<i>sallivaliajuq</i>	x		
<i>aumasijuj</i>			x

**c) Break-up**

<b>Term (melting)</b>	<b>CD</b>	<b>IG</b>	<b>PG</b>
<i>matsaaq</i>	x		
<i>qangitarniq</i>	x		
<i>pattituq</i>	x		
<i>sijjaviniq</i>	s		sp
<i>ajuqpaliajuq</i>	x		
<i>aukaaq</i>	x		
<i>tuvarliqtuq</i>		s	sp
<i>siggia<sup>w</sup></i>	s	d	d
<i>qullupiaqtuq<sup>cw</sup></i>	x		
<i>sikuviniq</i>	x		
<i>tuavaviniq</i>	s		sp
<i>tuvaiaqtuq</i>		s	sp
<i>tuvaiajautiit</i>		x	
<i>sijjaijaliqtuq</i>			x
<i>qainnguujaliqtuq</i>			x

**b) Water accumulation**

<b>Term (melting)</b>	<b>CD</b>	<b>IG</b>	<b>PG</b>
<i>immatuqtuq</i>	s	sp	sp
<i>ikiartirtuq</i>			x
<i>immatinniit</i>	s	sp	s
<i>quginiit</i>	s		sp
<i>qalluit</i>	x		
<i>puktailaq</i>		x	
<i>patikjiuqtuq</i>		x	
<i>tikpaqtuq</i>		s	s
<i>puttaijuq</i>			x
<i>maujaraq</i>			x
<i>saluraq</i>		x	
<i>itisiuraq</i>		x	
<i>immaktipaliajuk</i>		s	sp
<i>killait</i>	s	sp	sp

**d) Similar melting terminology**

<b>Cape Dorset</b>	<b>Igloolik</b>	<b>Pangnirtung</b>
<i>aukajuq</i>	n/a	<i>aukkaavaliajut</i>
<i>aukaaniq</i>	<i>aukkarniq</i>	<i>aukkaturliit</i>
n/a	<i>qirsuqqaq</i>	<i>qiqsuqaqtuq</i>
<i>immatuqtuq</i>	<i>immaktittuq</i>	<i>immatittuq</i>
<i>immatinniit</i>	<i>immaktinniit</i>	<i>immatinniit</i>
<i>quginiit</i>	n/a	<i>kujjirtuq</i>
n/a	<i>immaktipaliajuk</i>	<i>immatillarittuq</i>
<i>qillait</i>	<i>killaq</i>	<i>killait</i>
<i>siggia</i>	<i>siruttiq</i>	<i>surattuq</i>
<i>sijjaviniq</i>	n/a	<i>sijjaminiq</i>
<i>tuavaviniq</i>	n/a	<i>tuavaminiq</i>
n/a	<i>tuvarliqtuq</i>	<i>tuvarluqtuq</i>
n/a	<i>tuvaiaqtuq</i>	<i>tuvaiajaliqtuq</i>

**Where:**

CD = Cape Dorset, IG = Igloolik, PG = Pangnirtung

s = same term, same meaning

sp = same term, same meaning, different spelling

sd = same term, different meaning

d = dialectical difference in terms, same meaning

x = unique term to that community

<sup>w</sup> = associated with winds (Section 7.2.3.2)

<sup>c</sup> = associated with currents (Section 7.2.3.4)

**N.B.** the different spellings or terms identified are shown in Table 7-5d.

However, in Cape Dorset and Pangnirtung *killait* are described earlier in the melt process than in Igloolik, where it takes longer for the ice to wear right through. The presence of seaweed or other debris on the ice also contributes to melting, as described in Cape Dorset (*qalluit*) (Table

7-5b) and Igloolik. The reference to melt streams on the sea ice (i.e. *quginiit*) (Table 7-5ab, 7-5d) is common to Pangnirtung and Cape Dorset. This is likely due to more freshwater runoff influence than around Igloolik. Two stages of water accumulation and drainage are identified in Pangnirtung and Igloolik (i.e. one from snowmelt and another from the ice itself melting) (Table 7-5b, 7-5d). Ice thickness and snow accumulation around Cape Dorset likely does not accrue enough for this dual drainage to occur. Unique to Igloolik are terms describing various surface conditions that contribute to the gradual deterioration of the sea ice (Table 7-5b). The distinct terms used in Pangnirtung reflect different types of water accumulation on the sea ice, and localized shoreline ice break-up before the *tuvaq* actually begins breaking up (Table 7-5b).

#### 7.2.2.3 Break-up

Perhaps due to its more southerly location and thus the faster progression of melt stages, elders and hunters in Cape Dorset do not describe as many melt stages as in Pangnirtung and Igloolik (Figure 7-5a, 7-5b). Cape Dorset descriptions focus more on the deterioration of shoreline ice, thus more terminology is incorporated during the final stages of break-up (i.e. *qangitarniq* and onwards) (Figure 7-5c, Table 7-5c). The only commonality between all three communities is a reference to the action of the ice breaking up (i.e. *siggia*) (Figure 7-5c, Table 7-5c, 7-5d). In Pangnirtung and Igloolik they describe the deterioration and break-up of the *tuvaq* (Table 7-5c, 7-5d) similarly. In Pangnirtung specifically, the *qainngu* breaking off (Table 7-5c) is very important because until this final stage occurs it is still possible to travel out of the fiord. Therefore, the focus on melting terminology seems to be mainly determined by the limitations for sea ice travel caused by each spring melt stage.

### 7.2.3 Wind and current influences on sea ice

#### 7.2.3.1 Prevailing winds

Northwesterly winds are described as the prevailing winds in each community. These winds are most common in the fall and winter, and they tend to: i) bring in cold, clear weather;

ii) blow ice away from town; iii) contribute to smoother, faster freezing; and, iv) cause break-off events at the floe edge. For Pangnirtung these winds can also bring moving ice from Davis Strait into Cumberland Sound. The descriptions of winds, and influence of winds on sea ice, were most consistent between interviewees in Igloolik. In contrast, the descriptions of prevailing winds around Cape Dorset actually ranged from NE to NW (i.e. *tunuvia*) (Figure 7-6, Table 7-6a), and in Pangnirtung from NW to north. Nevertheless, the second-most predominant wind in each community was commonly described as being from the SE (although in Cape Dorset varying from SE to SW, and in Pangnirtung from SE to south). These winds are more common in the summer, but they are also an opposing force to NW winds in the fall and winter. SE winds are described as: i) being warmer; ii) causing the ice to break up; iii) preventing freezing because they push ice towards the floe edge or land; and iv) bringing multi-year or moving ice closer to town. In Pangnirtung and Igloolik they describe SE winds as creating rougher ice conditions when they blow in the fall. In Pangnirtung these winds also create more cracks in the *tuvaq* as the ice pack in Cumberland Sound is pushed into the floe edge. In Igloolik the importance of these winds is highlighted because they push moving ice towards land/the *sinaaq*, allowing it to stick temporarily. These conditions facilitate safer crossing from/onto moving ice. In Cape Dorset, when SE winds prevail they often push so much moving ice towards town that boat travel is impossible, and sea ice travel is more difficult and dangerous. In the spring time, these winds also speed up the break-up process in all three communities.

4	CD	IG	PG
CD	4	0	0
IG		6	3
PG			1

**Figure 7-6:** Matrix of Inuktitut terminology showing the number of unique and overlapping terms related to the influence of winds on sea ice, in each community.

**Where:** The number in the top left-hand box indicates the number of terms common to each community; shaded boxes indicate the number of terms unique to a particular community; unshaded boxes indicate the number of terms that overlap between two communities only; and, the empty boxes would mirror the same numbers as the unshaded boxes.

(CD = Cape Dorset, IG = Igloolik, PG = Pangnirtung)

**Table 7-6:** Comparison of Inuktitut terms related to the influences of winds on sea ice, in each community.

a) Terminology related the wind influences

Term (wind influences)	CD	IG	PG
<i>tunuwia</i>	x		
<i>sikuqsasitarivuaq</i>	x		
<i>aguttituaq</i>	s	sp	sp
<i>aukaaq</i>	x		
<i>uqaqtuaq</i>	s	sp	sp
<i>ivuniit</i>	s	sp	s
<i>ivujuq</i>		s	s
<i>sikuijaqtuaq</i>	x		
<i>qimaruutisimajuq</i>		x	
<i>qaattuaq</i>		x	
<i>qaangajuq</i>		x	
<i>sikutuqqijjuq</i>		x	
<i>nipititaaq</i>		x	
<i>quvviquat</i>		s	d
<i>iilikulaak</i>		x	
<i>maniilaq<sup>c</sup></i>		s	s
<i>qaliriiktinniit<sup>c</sup></i>	sp	s	sp
<i>isirsangaq</i>			x

b) Similar wind influence terminology

Cape Dorset	Igloolik	Pangnirtung
<i>aguttituaq</i>	<i>aggurtipaliajuq</i>	<i>aggutittuaq</i>
<i>uqaqtuaq</i>	<i>uukkaqtuaq</i>	<i>uukkaqtuaq</i>
<i>ivuniit</i>	<i>ivuit</i>	<i>ivuniit</i>
n/a	<i>quvviquat</i>	<i>quppirkuaq</i>
n/a	<i>maniilaq</i>	n/a
<i>qullupiaqtuaq</i>	<i>qaliriiktinniit</i>	<i>qalliriittipalliajuq</i>

**Where:**

**CD** = Cape Dorset, **IG** = Igloolik, **PG** = Pangnirtung

**s** = same term, same meaning

**sp** = same term, same meaning, different spelling

**sd** = same term, different meaning

**d** = dialectical difference in terms, same meaning

**x** = unique term to that community

**w** = associated with winds (Section 7.2.3.2)

**c** = associated with currents (Section 7.2.3.4)

**N.B.** the different spellings or terms identified are shown in Table 7-6b.

Unique to Pangnirtung is the influence of the fiords on wind direction and strength. Westerly winds (*isirsangaq*) (Figure 7-6, Table 7-6a) are prominent in Pangnirtung Fiord, and create a daily afternoon breeze in the spring and summer. These winds are considered unfavourable though, as they melt the ice/snow and blow ice into the fiord. Easterly winds are more prominent in Pangnirtung Fiord in the fall, and they can be very strong. This can cause new ice to break up and the floe edge to be closer to town.

### 7.2.3.2 Influences of winds on sea ice

While the main directional influences of winds on sea ice are similar in each community, the way they manifest is sometimes described differently. For example, the process of the ice freezing upwind (*aguttituaq*) (Table 7-6a, 7-6b) is mentioned in each community (Figure 7-6), but in Pangnirtung it is more of a rough ice condition than in Igloolik and Cape Dorset (where it is associated with weak winds). In all three communities winds tend to be responsible for the occurrence of *uqaqtuaq*, as well as the creation of *ivuniit* and *qaliriiktinniit* (Figure 7-6, Table 7-6a, 7-6b). A generalized description of rough ice (i.e.

*maniilaat*) is shared between Pangnirtung and Igloolik, and would likely be understandable in Cape Dorset as well (Figure 7-6, Table 7-6a). Due to the emphasis on *aulaniq* in Igloolik, they have the most descriptive terms for rough ice along the floe edge (i.e. *nipitittaq* and *iilikulaak*) (Table 7-6a). Likely a result of the use of/proximity to the floe edge, Cape Dorset and Igloolik each have unique terms to describe the manner in which ice breaks off from the *sinaaq* (i.e. *aukaag* and *qaatuq*, respectively) (Figure 7-6, Table 7-6a). In addition, weaker winds contribute to the formation of *quvviquat* (Table 7-6a, 7-6b), as described in both Igloolik and Pangnirtung. The greater number of wind influences on the sea ice identified in Igloolik relate to their implications for floe edge and moving ice dynamics (Figure 7-6, Table 7-6a). Unique to Cape Dorset are explanations of the manner in which winds influence sea ice formation or movement in open water (Figure 7-6, Table 7-6a).

#### 7.2.3.3 Tidal cycles

Tidal cycles, and ocean circulation, around each community were not clearly described. I did not ask into these in depth, and where they were discussed conflicting descriptions of ocean circulation arose between interviewees. Therefore, this would require clarification to analyze further. Instead, emphasis is placed on understanding the influences of currents (i.e. strong or weak), or tidal cycles (i.e. high and low tide) on sea ice conditions. These are critical to consider when traveling on the sea ice, and thus were discussed in substantial detail.

#### 7.2.3.4 Current and tidal influences on ice conditions or movement

In all three communities, the importance of understanding the diurnal tidal cycle, as well as the monthly lunar cycle was frequently emphasized. Each community experiences some tidal variations during the day, approximately every 6 hours, which influences local ice conditions. However, the tides are more pronounced, with greater variations, in Pangnirtung and Cape Dorset than in Igloolik (Section 2.2.2). The peak high and low tide each day exhibit the strongest currents in a diurnal cycle, but the monthly lunar cycle is of greater importance

for sea ice travel (Section 7.3.1.1). The full and new moons have a significant influence on tide height and current strength. These monthly increases in tidal variation can be most destructive on ice conditions, and can cause the greatest variation in polynya size or floe edge dynamics. In both Pangnirtung and Igloolik this “full moon effect” is referred to as *piturniq* (Figure 7-7, Table 7-7a). Although Cape Dorset elders and hunters did not specify this term in their interviews, I anticipate the same term would be employed to refer to the influence of moon phases. In Pangnirtung, different types of *piturniq* were also discussed in relation to the yearly cycle (Section 6.2.3.3).

In all three communities, areas with stronger currents are known to move ice around, creating dynamic ice conditions. Terms that are used commonly in each community generally describe the most evident, re-occurring sea ice features created/influenced by ocean currents (Figure 7-7, Table 7-7a, 7-7b). As explained in 7.2.2.1, it is essential to distinguish between the use of *aukkarniq* in Igloolik as compared to Pangnirtung and Cape Dorset. Polynyas (*saqvaq*) (Table 7-7a, 7-7b) are important areas, created and maintained by strong currents, and thus they are frequently discussed in each community. However, the dynamics associated with polynya formations are uniquely described in Igloolik and Pangnirtung (Figure 7-7, Table 7-7a). In Igloolik the focus is on the dynamics at the edge of an *aukkarniq*, whereas in Pangnirtung emphasis is placed on snow/water formations along the edge of a *saqvaq* that can become safe for travel. There is also a distinction in Pangnirtung which identifies a *saqvalariq*

7	CD	IG	PG
CD	3	1	2
IG		5	4
PG			3

**Figure 7-7:** Matrix of Inuktitut terminology showing the number of unique and overlapping terms related to the influence of currents and tides on sea ice, in each community.

**Where:** The number in the top left-hand box indicates the number of terms common to each community; shaded boxes indicate the number of terms unique to a particular community; unshaded boxes indicate the number of terms that overlap between two communities only; and, the empty boxes would mirror the same numbers as the unshaded boxes.

(CD = Cape Dorset, IG = Igloolik, PG = Pangnirtung)

**Table 7-7:** Comparison of Inuktitut terms related to the influences of currents on sea ice, in each community.

a) Terms related to current and tidal influence

Term (current influences)	CD	IG	PG
<i>piturniq</i>		s	s
<i>aquanaq</i>	x		
<i>aukkaturliit</i>	sp	sd	s
<i>nigajutaq</i>	s	s	s
<i>saqvaq</i>	s	d	s
<i>saqvalariq</i>			x
<i>titirtuq</i>			x
<i>qattuattinniq</i>			x
<i>maniilaq<sup>w</sup></i>		s	s
<i>ivujuq<sup>w</sup></i>		s	s
<i>ivuniit</i>	s	sp	
<i>qalliriittipalliajuq<sup>w</sup></i>	sp	sp	s
<i>iilikulaak<sup>w</sup></i>		x	
<i>aksajutak<sup>w</sup></i>		s	d
<i>uukkaqtuq<sup>w</sup></i>	sp	s	sp
<i>ukpittuq</i>		x	
<i>iijaujuq</i>		x	
<i>kaniq</i>		x	
<i>nunguppalliajuq</i>		x	
<i>nagguti</i>	s	s	s
<i>ajuraq</i>	s	sp	sp
<i>qanguqtuq</i>	s		s
<i>nunniq</i>	s		sd
<i>qaarniku</i>	x		
<i>sikuliaqta</i>	x		

b) Similar current influence terminology

Cape Dorset	Igloolik	Pangnirtung
<i>aukaaniq</i>	<i>aukkarniq</i>	<i>aukkaturliit</i>
<i>saqvaq</i>	<i>aukkarniq</i>	<i>saqvaq</i>
<i>qullupiaqtuq</i>	<i>qaliriiktinniit</i>	<i>qalliriittipalliajuq</i>
n/a	<i>aksajutak</i>	<i>sikualaajuq</i>
<i>uqaqtuq</i>	<i>uukkaqtuq</i>	<i>uukkaqtuq</i>
<i>ivuniit</i>	<i>ivuit</i>	n/a

**Where:**

**CD** = Cape Dorset, **IG** = Igloolik, **PG** = Pangnirtung

**s** = same term, same meaning

**sp** = same term, same meaning, different spelling

**sd** = same term, different meaning

**d** = dialectical difference in terms, same meaning

**x** = unique term to that community

<sup>w</sup> = associated with winds (Section 7.2.3.2)

<sup>c</sup> = associated with currents (Section 7.2.3.4)

**N.B.** the different spellings or terms identified are shown in Table 7-7b.

(Table 7-7a) as a polynya that will not freeze in the winter. Otherwise, the polynya references account for occasional freezing in the coldest months, or when the currents are weakest.

Strong currents can also be caused by shallow areas (*aquanaq* in Cape Dorset) (Table 7-7a), as discussed in all three communities. Where the ocean floor is close to the surface, the waters move faster, as well as in narrow areas where the water is funneled into closer confines. Unique to Igloolik are the localized influences of MYI that gets frozen into the newly formed ice. These tend to funnel the water from underneath, strengthening currents and wearing away the surrounding ice. In Pangnirtung, the effects of fiords are highlighted, where points of land and especially the mouths of fiords often have stronger currents than in larger areas of open water. In addition, whenever sea ice is moved around, it tends to create rough ice due to

ice pan collisions. Therefore, currents are linked to the creation of *iilikulaak* and *aksajutak* (Table 7-7a, 7-7b). In all three communities, areas with strong currents or the times of month when the currents are strongest, are frequently related to dangerous travel conditions (Section 7.3.1.1). The ice can be worn away from currents underneath (*nunguppaliajuq* in Igloodik), which is often imperceptible at the surface (Table 7-7a).

The seasonal influences of currents seem more prominent in Pangnirtung and Cape Dorset, likely due to the greater tidal variations creating more pressure on shoreline ice. The *piturniq* high tide in the mid-winter can cause *qanguqtuq* (Figure 7-7, Table 7-7a) in both communities. In Cape Dorset the ice may literally explode upwards due to tidal pressure (i.e. *qaarniku*) (Table 7-7a), while in Pangnirtung the *qainngu* may become detached during *piturniq*. In Igloodik, the influence of the mid-winter cold means that the sea ice is more brittle, so *piturniq* tides can more easily crack the ice or cause break-off events.

The above distinctions and similarities in sea ice conditions/processes are important to keep in mind when evaluating sea ice use around each community. Sea ice travel and hunting are intertwined with the ice types available, associated travel dangers, and wildlife habitat.

### 7.3 Sea ice use

Sea ice travel is predominantly undertaken for the purpose of hunting, or accessing inland fishing lakes, hunting grounds, or cabins. I have continued to discuss sea ice travel and hunting separately for ease of explanation, but the dangers of sea ice travel are directly related to sea ice hunting destinations and/or wildlife habitat. Therefore, several dangers of ice dangers are described first (Section 7.3.1.1) to help understand what is involved in evaluating ice safety (Section 7.3.1.2) and hunting on particular ice conditions (Section 7.3.1.3).

#### 7.3.1 Sea ice travel

The dangers associated with sea ice travel are well understood in each community. Some of the most prominent dangers that hunters are exposed to around each community



include: i) varying tidal stages, whereby the strongest currents are associated with *piturniq*; ii) polynyas; iii) the floe edge; iv) snowfall or snow accumulation; and, v) the transition periods of freeze-up and break-up (Tables 4-2, 5-2, 6-2). In addition, the dangers associated with *aulaniq* and *aulajuq* – the moving ice – are very important in Igloolik. These are also mentioned to some extent in Cape Dorset but more in terms of how they affect boat travel or floe edge stability. While many of the risks associated with sea ice travel are shared between communities, the localized manifestations – and means of dealing with dangerous conditions – vary with geography, hunting techniques, and travel alternatives.

#### *7.3.1.1 Dangers in sea ice travel*

Inuit expertise on local and regional, land and sea ice, geographies is one of the most effective means of minimizing travel risks around all three communities. Knowing where the particularly strong currents are (e.g. narrow or shallow areas), the location of polynyas, areas that melt early in the spring, and the delineation of a stable floe edge, all contribute to safe navigation around danger zones. Sea ice travel routes are well established around Cape Dorset (Figures 4-16a, 4-16b) and Pangnirtung (Figure 6-14), and are used to reach particular destinations, or to avoid dangerous features. In Igloolik, with a greater ice extent, longer ice season, and flatter inland terrain, they have more travel options. While there are also many well-known local and regional travel routes, there are so many more alternatives around this community that interviewees were overwhelmed by the thought of delineating these on a map. Therefore, it would appear that Igloolik has more available choices for travel when attempting to avoid sea ice dangers. In Pangnirtung, routes must be well understood in order to navigate the dangerous fiords, polynyas, mountains, and cracks of the Cumberland Sound shorelines. Cape Dorset hunters are also somewhat constrained in their overland travel, but not nearly as much as around Pangnirtung. However, sea ice routes are fewer since they are forced to travel within the confines of a nearby floe edge. This renders travel around Cape Dorset potentially

more dangerous as alternative travel routes are not as available to avoid polynya, floe edge, or tidal dangers. Perhaps for this reason, hunters in Cape Dorset incorporate the use of boats more than in the other communities, to minimize sea ice risks.

Another important element of safe sea ice travel is the identification of the daily and monthly tidal stage. Avoiding the most dangerous times of the day or month is recommended in all three communities, or at least exercising additional caution and alertness when traveling at critical times. Along with high and low tide, the risks associated with *piturniq* were frequently mentioned. The focus of these descriptions related mostly to shoreline or polynya processes in Cape Dorset and Pangnirtung, while in Igloolik the emphasis was placed on polynyas and the floe edge. In Cape Dorset, flooded shorelines were cautioned as inappropriate for sea ice travel, and the dangers of ice wearing out from underneath (especially around polynyas) were highlighted. Because these areas are especially dynamic, elders and hunters warned that they should be avoided during windy conditions, and should never be traveled over (even if they are temporarily frozen). In Pangnirtung, the timing of travel is important for safely navigating shoreline ice (e.g. at low tide when the ice is close to the ground), due to the large tidal variations affecting the stability and roughness of the *sijja*. Furthermore, polynyas should be avoided when the tide is going in or out. But, these areas can be safer at low tide, or after high tide when the water has re-frozen along the edges. In Igloolik, the timing associated with tidal variations was mostly described in relation to floe edge dynamics and the possibility of safely crossing to or from the *aulanik*. The combination of winds and currents has to be just right to access the *aulajuq*, and thus must be well understood to hunt and return safely. In terms of polynyas, the main risks described were *ugpittuq* and the *kaniq*. Perhaps due to the colder temperatures around Igloolik, polynyas are seen as more predictable and thus somewhat more stable for hunting and travel. Yet, as described in all

three communities, polynyas frequently change their size and extent and should generally be avoided (especially after fresh snowfall, during *piturniq*, or once spring melting has begun).

Understanding the expected seasonal stages and variations in freeze-up and break-up are also essential to minimize the risks of sea ice travel during transition periods. The ice can form in a non-uniform manner depending on fall wind and current conditions. Therefore, all three communities emphasize the importance of knowing where *nigajutait* form, and that the ice should be continually tested during the freezing stages. It is well understood that snowfall insulates the sea ice, creating especially dangerous circumstances on newly formed ice. Where the ice is thinner, snow allows the ice to melt or be worn away from currents underneath. Such conditions are cautioned to lead to dangerous travel on the sea ice, and that travel should be avoided after new snow has fallen. In addition, in Igloolik and Pangnirtung they add that travel after new snowfall should be avoided on the *uiguaq*, and at polynyas, because the snow hides dangerously thin ice conditions. These warnings also apply in Cape Dorset, but such travel would unlikely even be attempted at this stage, and thus were not discussed as frequently. Similarly, the process of melting and break-up also comprise ice conditions that deteriorate unevenly. In all three communities some areas were noted to open up earlier than others (i.e. around polynyas or areas of strong currents). Widening tidal cracks are also of concern as they create vulnerabilities where the ice is most likely to break off. In addition, freshwater runoff can speed up the melting process. This occurs most prominently in Pangnirtung, where meltwater running into the fiords contributes to rapid melting from the head of the fiord. Travel around the river mouths should be also avoided, and caution should be practiced once *immattinniit* have formed. Around Cape Dorset, once water begins accumulating on the ice people are more cautious, sometimes traveling closer to town to avoid being stranded by a sudden break-up of shoreline ice. The freshwater influence is also noted in

Gifford Fiord, north of Igloolik, but more often snow conditions were mentioned as concealing dangerous spring ice conditions (i.e. water may have drained through thin ice underneath).

Finally, the risks involved with travel or hunting on moving ice are uniquely described in Igloolik. Here, the moving ice is the platform upon which walrus are hunted (Section 7.3.1.3). There is always potential to become stranded on moving ice if the winds or currents shift unfavourably. Therefore, it is most important to understand the relationship between winds and currents with moving ice (i.e. know the best times to travel on/avoid moving ice). Dog teams are known to be more effective when crossing onto moving ice, as they can respond quicker than snowmobiles to the dynamic changes along the *aulaniq*. They can also help pull the *kamotik* out of water, or out of trouble, should someone have a close call. In Cape Dorset, there is some mention of moving ice conditions, but more as they pertain to the prevention of boat travel – in any season. In Pangnirtung, the dangers associated with moving ice are mentioned infrequently because the moving ice is typically far from town and not used for hunting. However, in all three communities, the importance of knowing where a person might land – should they be stranded on moving ice – is critical to arriving safely back on land/solid ice. It is essential to be able to assess wind and current directions, in order to: i) know which way to travel on moving ice to stay out of danger; and/or, ii) be in a position to cross to safety when the opportunity arises.

Overall, the sea ice travel risks described in Pangnirtung focus mainly on understanding the timing of tidal cycles, along with knowing the local geographies of polynyas, fiords, and floe edge variations. In Igloolik, the emphasis is more on the local geographies of dangerous areas, as well as the combined influence of winds and currents affecting the floe edge and moving ice. In Cape Dorset, hunters aim to manage the dynamic nature of local/regional sea ice conditions, mainly through an understanding of tidal variations. They are used to the open water close by, and thus will more often practice

avoidance of certain ice conditions or routes, depending on the season. Here, they have a lesser sea ice extent than the other two communities, so they do not have as many travel alternatives. Therefore, while the descriptions of several sea ice dangers overlap between the communities, they each emphasize the areas/conditions that are most important for local hunting or travel. Since many dangerous ice conditions are also important hunting destinations (i.e. polynyas, floe edge, moving ice, tidal cracks) (Section 7.3.1.3), they will never be completely avoided. The focus is then placed on effective evaluation of ice safety in order to travel or hunt to/in areas that are intrinsically more dangerous than common travel routes.

#### *7.3.1.2 Evaluating ice safety*

An essential element of sea ice safety evaluation is knowing what to look for, and where (Section 7.3.1.1). Many dangerous sea ice features, and indicators of danger, are shared among the three communities – to a degree. However, the local and regional sea ice extent/conditions factor greatly into hunters' choices for navigation or destination. Understanding local ice dynamics, along with a detailed and extensive network of Inuktitut placenames, helps to guide sea ice travel in a relatively consistent manner. Such placenames and a myriad of ice “highways” may be likened to the street signs guiding motorists in the south. A driver very familiar with one city cannot easily maneuver a new city street network without first knowing intricacies of that area (e.g. street names, grid orientation, one-way streets, dead ends, highway exits, etc.). Similarly, while indicators of ice stability or danger may be similar between communities, without knowing the local “street names” and “highways” it is more difficult for a hunter to transfer their knowledge to a different area. Like a motorist who is familiar with the general rules of the road, and how to interpret maps, a hunter is familiar with general sea ice travel/hunting techniques and prominent ice features. Therefore, the motorist can use that underlying knowledge to get to know a new city quicker, with the help of a map. Similarly, a hunter can use previous sea ice experiences to inform themselves of travel in a new area, but it

is faster – and safer – with the help of a hunter who knows the local geography. However, there are no formal maps available to help the hunter identify dangerous sea ice areas, and only recently have Inuktitut placename maps begun to be developed. While motorists can purchase a map to facilitate the learning curve, hunters need to accumulate substantial localized experience before confidently navigating new surroundings alone. This local geographic knowledge, along with an understanding of seasonal cycles, wind and current influences on sea ice, and extensive practical experience, is what renders some hunters and elders as experts on sea ice travel, hunting, and safe navigation.

No matter where sea ice travel takes place, the use of a harpoon to test ice thickness and stability was continually emphasized as the most definitive means of gauging ice safety. However, this tool must be well understood to use it effectively. When striking the ice with a harpoon, hunters take into account: i) the strength with which they are hitting the ice; ii) the weight of the harpoon; iii) their own weight; and, iv) their method of transportation (e.g. snowmobile and *kamotik*, dog team and *kamotik*, just snowmobile). All these factors influence the number of strikes it takes to be sure the ice is safe for travel (Sections 4.3.1.2, 5.3.1.2, 6.3.1.2). Therefore, while the harpoon is important to determine ice safety, it cannot be used in the exact same way by each person because: i) their purpose for testing may differ; ii) their own weight may differ; and, iii) the weight of their harpoon may differ.

A person's familiarity with sea ice travel, and the surrounding geographic area, relates to their degree of comfort traveling around their community. Those who use the ice the most, who are most experienced, and who know the area well, are more confident than those who are less experienced. However, no matter how experienced a person, accidents can happen. Hunters and elders in each community stressed the importance of being prepared if they become stranded on the ice, or if they must find alternative travel routes. Bringing along extra food, water, and shelter supplies is imperative if a trip lasts longer than anticipated, for

whatever reason. Also, knowing where to reach solid ice or land is critical to survival when stranded on moving ice. Traveling with other people is also a valuable safety precaution. This way, help is available when needed instead of having to wait for help, or a search and rescue party. Furthermore, continuous use of the sea ice was highlighted in all three communities as the main way to ensure that a hunter's knowledge of the ice is current and reliable. Each year ice conditions are different. So each year observations made from the earliest signs of freeze-up are useful for sea ice safety evaluations throughout sea ice thickening, winter travel, and melting. If there is a break in sea ice usage, it is almost as if the hunter has to re-learn the ice conditions before being able to use it freely and safely again as a travel and hunting platform.

#### *7.3.1.3 Hunting in each community*

In all three communities, sea ice is used as a hunting platform for marine mammals, as well as a travel platform to access inland hunting and fishing grounds. Sea ice is integral in efforts to hunt seals, walrus, and (to a lesser degree) beluga. The particular ice conditions and hunting techniques utilized vary in their importance depending on the community.

Seal hunting is important in all three communities, with ringed seal being the primary target. Bearded seals are less commonly hunted. However, due to their large size they will be hunted if the opportunity arises. Sea ice was frequently highlighted as essential habitat for ringed seals in order for them to mate, den, raise their young, and moult their fur. In each community, seals were described as using the ice more than any other animal, and that they tend to follow the sea ice through its cycles of formation and decay. They are always seeking areas of thin ice to make breathing holes, or areas of open water to access air. Despite the similarities in which seals use the sea ice, there are numerous ways that hunters go after seals, and they vary in importance between communities (Table 7-8). Breathing hole hunting through *tuvaq* is not as important in Cape Dorset since seals are more easily accessible when they are breathing in open water, or through *naggutiit* (Table 7-8). On the other hand, with

**Table 7-8:** Summary of ice conditions used for different types of marine mammal hunting, in each community.

<b>Ice condition</b>	<b>Method</b>	<b>Community</b>
<b>Seal hunting</b>		
<i>sikuaq</i>	Through breathing holes in the new ice	<b>Cape Dorset, Igloolik, Pangnirtung</b>
<i>naggutiit</i>	Seal net running under the ice	<b>Cape Dorset, Pangnirtung</b>
<i>naggutiit</i>	Through breathing holes	<b>Igloolik,</b> somewhat Cape Dorset and Pangnirtung
<i>sinaaq</i>	Retrieval from the ice edge, or by boat	<b>Cape Dorset</b>
<i>uiguaq</i>	Through breathing holes	<b>Igloolik</b>
<i>saqvaq/aukkarniq</i>	Retrieval from the ice edge, or by boat	<b>Cape Dorset,</b> somewhat Pangnirtung and Igloolik
<i>tuvaq</i>	Through breathing holes	<b>Igloolik,</b> somewhat Pangnirtung and Cape Dorset
<i>tuvaq</i>	Seals (often pups) basking on the ice in the spring	<b>Cape Dorset, Igloolik, Pangnirtung</b>
<b>Walrus hunting</b>		
<i>aulajuq</i>	Moving ice hunting	<b>Igloolik</b> (January – March)
open water	Hunting by boat	<b>Cape Dorset</b> (fall and summer), somewhat Pangnirtung (summer)
<i>sinaaq</i>	Hunting by boat	<b>Cape Dorset</b> (winter)
<b>Beluga hunting</b>		
<i>sinaaq</i>	Retrieval from the ice edge, or by boat	<b>Cape Dorset,</b> somewhat Pangnirtung and Igloolik

more extensive ice formations, and more solid floe edge positions, Igloolik hunters use the *uiguaq*, *nagutiit*, and *tuvaq* for breathing hole hunting whenever possible (Table 7-8). Pangnirtung seal hunting practices are quite similar to those described in Cape Dorset, although with a lesser emphasis on hunting at the *sinaaq* (Table 7-8). In all cases newer, thinner ice is preferred for breathing hole hunting because it is easier to locate the holes. In addition, spring seal hunting as the animals bask on the ice is one of the most popular forms of seal hunting in all three communities (Table 7-8).

Walrus are known to stay within moving ice pans in open water. They generally avoid solid ice formations, and are thus most often found beyond the floe edge, moving further as the ice extends further. Walrus hunting is highly emphasized in Igloolik and Cape Dorset, although it is conducted in very different ways (Table 7-8). These variations revolve around proximity to walrus, and localized ice conditions. The dynamic and dangerous *aulajuq*



environment is uniquely used by people from Igloodik (Table 7-8). This is the main reason why their terminology for moving ice (Sections 7.2.1.5, 7.2.1.6), and their consideration of many interrelated factors affecting moving ice travel safety (Section 7.3.1.1) are only described in Igloodik. The winter months, after the sun has risen again (i.e. after January), are the times to use moving ice for walrus hunting. However, in order to do so the moving ice has to have formed solidly enough for travel, combined with adequate wind and current conditions. In contrast, walrus hunting in Cape Dorset is done mainly by boat, and in a different season (mainly fall and summer, although open water hunting in the winter is occasionally conducted) (Table 7-8).

Beluga are also important marine mammals for community harvests. However, less detail was provided on these hunting methods (Table 7-8). Hunters did not associate beluga as much with the ice because these mammals do not 'travel' on the ice. Therefore, more specific beluga-related questions would be required to understand the dynamics of using sea ice to hunt beluga.

In Pangnirtung there was more frequent mention of polar bear hunting than the other communities. However, hunters have to travel quite far out Cumberland Sound to access either walrus or polar bear, so it is not commonly practiced. Furthermore, in Pangnirtung the sea ice supports the commercial turbot fishery. Fishermen depend on sea ice to access the best fishing spots and to support their long-line fishing method (i.e. from the ice platform through to the bottom). Although this is not hunting per se, this important economic venture is of great interest to the community. Therefore, ice conditions are of particular concern to fishermen when things are not forming properly (Section 7.4.2.7).

In looking at some of the means of using sea ice for hunting purposes, and the sea ice conditions in each community, there many similarities but also differences in technique and timing. In Cape Dorset, they have open water close by year-round so their use of the sea ice

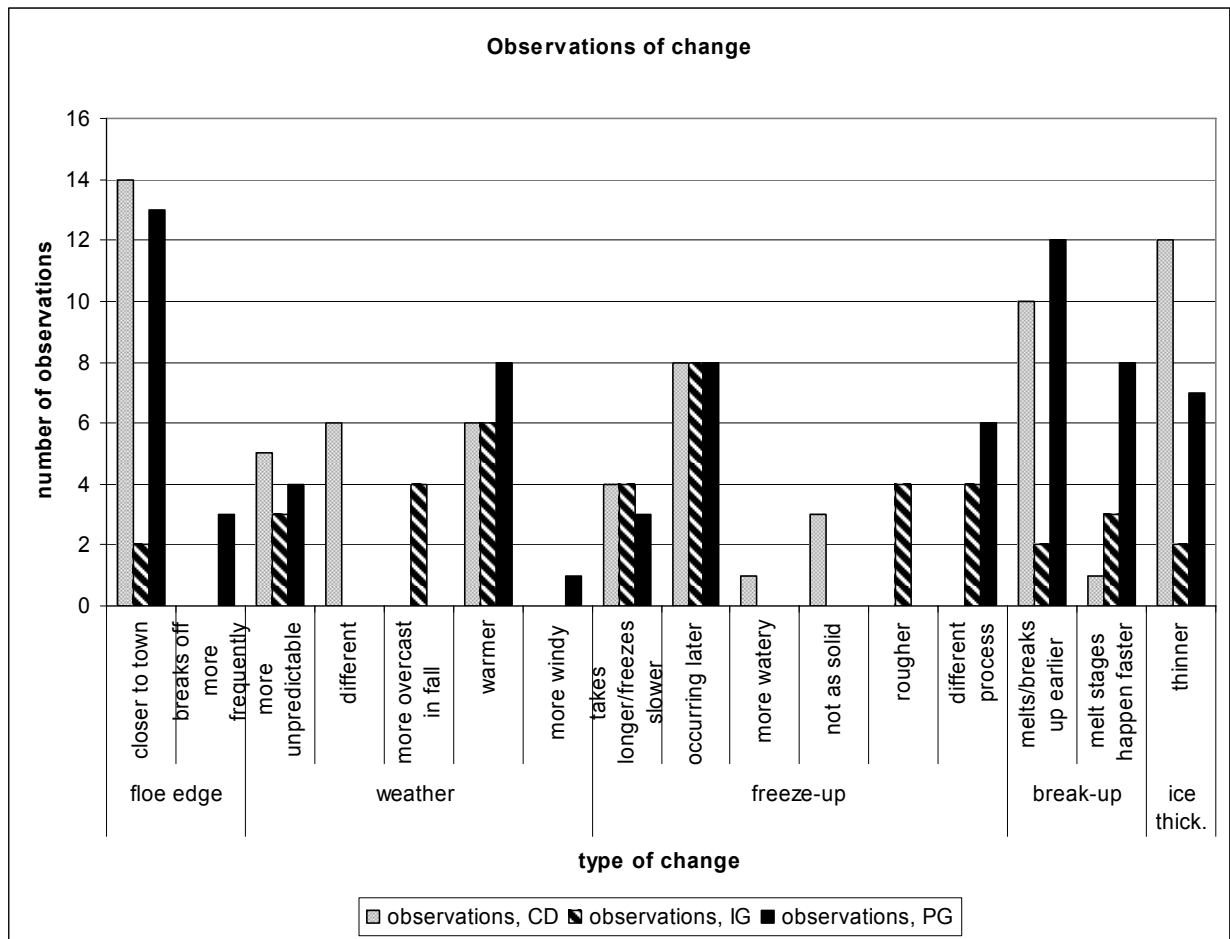
focuses mainly on the floe edge (*sinaaq*) and polynyas (*saqvait*). The use of boats is possible throughout the winter due to the proximity to open water, and is also a safety precaution around dynamic polynyas and floe edge delineations. In Pangnirtung, they use the landfast ice and polynyas more often, although floe edge hunting is conducted when the floe edge is stable enough. Around Igloolik there is more extensive ice formation, so although landfast ice is abundant it is harder to hunt seals. Therefore, polynyas and the *aulaniq* (both floe edge and moving ice) are used most often. These variations in hunting practices between communities would suggest that similar changes in sea ice conditions may affect communities differently. Furthermore, they may experience different changes all together, due to their unique geographic locations and local variations of sea ice use.

#### **7.4 Observations of change**

Sea ice change is being observed and experienced in all three communities. The changes noted as unique, or unexpected conditions are mainly mentioned since 2000. In Cape Dorset and Igloolik these changes are compared to conditions in the 1960s or earlier, but the spring and fall of 2004 were highlighted as very unique in Igloolik. In Pangnirtung, changes are typically compared to the 1980s. In addition, spring and fall conditions of 2004 were also highlighted as unique. In all three communities, evaluations of change frequently centered around the position of the floe edge, weather predictability, ice thickness, freeze-up timing, and break-up timing (Figure 7-8). Other key indicators of change include wildlife and moving/multi-year ice.

##### **7.4.1 Indicators of change**

Change in the floe edge position is typically gauged by its proximity to the community. This is the most frequently referenced indicator of change in Cape Dorset and Pangnirtung (Figure 7-8). The alterations in floe edge delineation are most dramatic in Cumberland Sound, as they are forming considerably closer to the mouth of Pangnirtung Fiord (Figure 6-23). In



**Figure 7-8:** Summary of sea ice and related changes observed in each community.

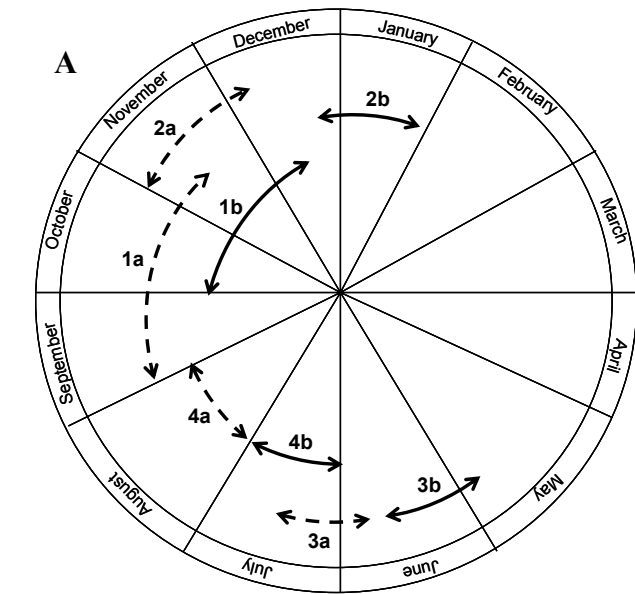
**Where:** CD = Cape Dorset, IG = Igloolik, and PG = Pangnirtung. The number of observations refers to the number of interviewees that mentioned this change.

In addition, more frequent occurrences of break-off events have been noted (Figure 7-8). In Cape Dorset a nearby floe edge is common due to the strong Hudson Strait currents, but recently the shifting floe edge position has been restricting travel access to some areas of the Baffin Island coastline (Figure 4-23). In Igloolik, the floe edge is described most often in the context of yearly variations, which are highly dependent on the piling of MYI on three nearby reefs.

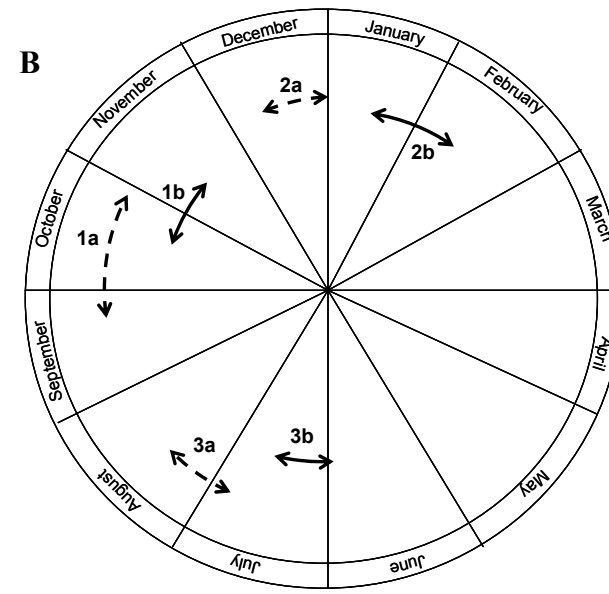
Between the three communities, the most common observation of weather change was a warming of temperatures (Figure 7-8). Another commonly shared observation was the increased unpredictability of weather, and shifts in the weather (Figure 7-8). This was also linked to changing prevailing winds in each community, whereby the NW winds were

commonly prevailing, but more SE winds have been experienced. Also, there have been more wind shifts noted, with no real prevailing direction. Unique to Cape Dorset was a general description of the weather being “different” than expected, while in Igloolik more overcast conditions have been noted in the fall. In Pangnirtung more windy conditions have been experienced in recent years. These shifting weather conditions were also linked to longer transitional periods in freeze-up and break-up, in each community, and are influential on the ice conditions year-round.

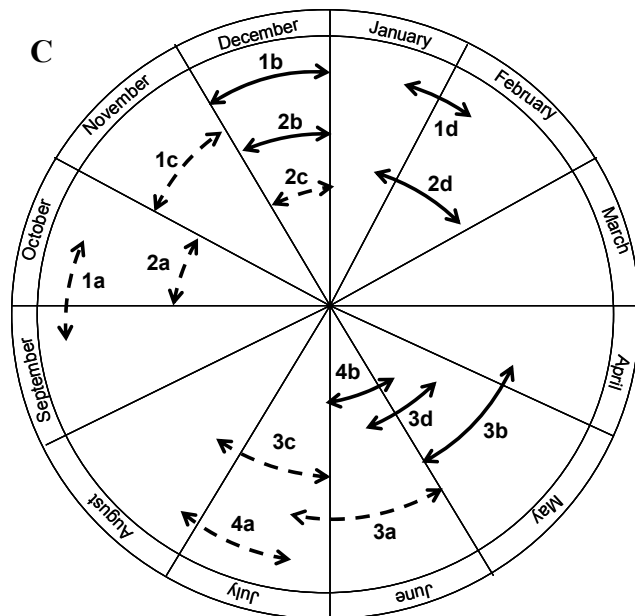
All three communities equally noted that freeze-up is occurring later each year, and to a slightly lesser degree that the freezing process is taking longer (Figure 7-8). Interestingly, the timing described for past, and more recent, freeze-up was not as different between communities as initially anticipated (Figure 7-9). However, it must be noted that not as many people in Igloolik specified the timing of freeze-up, in comparison to Cape Dorset and Pangnirtung. In all communities the freeze-up process was identified in two stages: the very early signs of freezing, and once the ice was travelable. The shifts identified in Cape Dorset (Figure 7-9a) and Igloolik (Figure 7-9b) were quite similar, although the travel references in Igloolik are referring to a much larger ice extent (i.e. to cross Fury and Hecla Strait vs. crossing Tellic Inlet to reach Baffin Island). In Pangnirtung, freezing was described distinctly for the timing within the fiord, and then within Cumberland Sound (Figure 7-9c). The most drastic shifts in freeze-up have been noted in this area, with almost a two-month shift in ice formation timing in both areas (Figure 7-9c). In addition to changes in timing, around Cape Dorset the ice has been more watery in the fall, and less solid as it is freezing (Figure 7-8). Around Igloolik the ice has been freezing more roughly than usual (Figure 7-8) (due to increased southeasterly winds in the fall). Furthermore, around Igloolik and Pangnirtung the ice was even noted to be freezing with a different consistency than previous years (Figure 7-8). All three communities have also noted a shift towards earlier spring ice break-up, and an increased



- 1a = Previous freeze-up
- 1b = Recent freeze-up
- 2a = Previous travelable
- 2b = Recent travelable
- 3a = Previous break-up
- 3b = Recent break-up
- 4a = Previous ice-free
- 4b = Recent ice-free



- 1a = Previous freeze-up
- 1b = Recent freeze-up
- 2a = Previous travelable
- 2b = Recent travelable
- 3a = Previous break-up
- 3b = Recent break-up



- 1a = Previous freeze-up (PG)
- 1b = Recent freeze-up (PG)
- 1c = Previous freeze-up (CS)
- 1d = Recent freeze-up (CS)
- 2a = Previous travelable (PG)
- 2b = Recent travelable (PG)
- 2c = Previous travelable (CS)
- 2d = Recent travelable (CS)
- 3a = Previous deterioration (CS)
- 3b = Recent deterioration (CS)
- 3c = Previous deterioration (PG)
- 3d = Recent deterioration (PG)
- 4a = Previous open water (CS)
- 4b = Recent open water (CS)

**Figure 7-9:** Summary of observed freeze-up and break-up timing changes, in each community.

**Where:** A) Cape Dorset;

B) Igloolik;

C) Pangnirtung (PG = Pangnirtung Fiord and CS = Cumberland Sound)

———— = recent timing

- - - - - = previous timing

speed with which ice conditions deteriorate. However, these changes are most prominent in Cape Dorset and Pangnirtung for early break-up timing (Figure 7-8, 7-2a, 7-2c), and in Pangnirtung and Igloolik for faster melt stages (with some stages being skipped) (Figure 7-8).

Thinning ice conditions were most prominently noted in Cape Dorset, with Pangnirtung and Igloolik also mentioning this trend (Figure 7-8). It is challenging to evaluate the degree of change from interview descriptions, since changes in sea ice thickness vary according to a person's height and visual perception of depth, as well as the initial ice conditions to which they are comparing. For example, areas with strong currents would be thinner to begin with, but may be experiencing a greater amount of thickness change. Unfortunately, further clarification of specific areas used to evaluate change, complemented with sea ice thickness measurements, would be required to estimate the amount of thinning occurring around each community.

In addition to the physical indicators of sea ice change, some observed differences in wildlife presence or behaviour were also described as potentially related to changing ice conditions (Sections 4.4.6, 5.4.6, 6.4.6). First, in all three communities increased polar bear sightings were noted with concern, and were described as a combination of both sea ice and human-induced changes. Second, also in all three communities, the health and behaviour of ringed seals was described as changing along with ice conditions, as well as other environmental and human influences. However, the changes themselves were different in each community. In Cape Dorset seals have been popping up in polynyas more frequently, and have been basking on the ice in the winter (i.e. linked to warmer temperatures). In Igloolik, fewer seals were observed in *Ikiq*, along with a general decline in health (i.e. less fat). Also concerned with the health of seals, hunters in Pangnirtung noted the difference in fur conditions, and a lower survival rate for seal pups, due to earlier break-up (Figure 7-9c). Ringed seal numbers also seem to be decreasing in Cumberland Sound, but the number of harp

seals is said to be increasing rapidly. In both Cape Dorset and Pangnirtung, the number of bearded seals seems to be decreasing. Third, some notable differences in whale numbers were also mentioned. In Cape Dorset beluga whales were not sighted as often, but in Pangnirtung they seemed to be staying closer to the community year-round. In Igloolik, the number of killer whales seems to have increased, along with the number of bowhead whales sighted. Finally, unique to Igloolik were observations of changes in walrus congregation areas. They are no longer found in certain channels during freeze-up, and are taking different routes in their migration to the floe edge during freeze-up.

Moving and multi-year ice were also observed as different from the past, with a very different focus in each community. In Cape Dorset, less MYI has been noticed drifting by the community, and that the pieces seem smaller. In Igloolik, the two different types of MYI are concentrated in fewer areas, and are generally further from town. Also, the 'dirty' ice that normally comes up from the south has arrived later in the spring, while the 'clean' ice that normally comes from the north has been more common in recent years. In Pangnirtung, there have been fewer glacier-calved icebergs noted in the fiord. Furthermore, less MYI coming from the north has been collecting in Cumberland Sound, and it melts much faster than previously when it does enter the Sound.

#### 7.4.2 Implications of change

After comparing the results between communities, the question remains: what do these changing ice conditions mean for each community in the context of their local ice processes and uses? Many of the changes described in Section 7.4.1 exacerbate the risks identified in Section 7.3.1.1, and make indicators of safety less reliable than they were in previous years. Therefore, the documentation of specific types of change, and their local implications, is an important first step towards a comprehensive assessment of community vulnerability to sea ice change. Based on the main indicators of change used in each community (i.e. floe edge, weather, freeze-up

and break-up timing, ice thickness, and moving/ multi-year ice) the following sections present some of the implications of changing ice conditions for each community. These changes also have influence marine wildlife health and the success of subsistence and commercial harvests.

#### 7.4.2.1 *Floe edge*

In all three communities, the increased proximity of the floe edge to the community leads to an increased potential of break-off events and people getting stranded on moving ice. Usually, smoother ice extending to the floe edge would indicate a higher likelihood of the ice breaking off. However, in all three communities the floe edge seems to break off more frequently, and more unpredictably, regardless of ice surface topography. Furthermore, key travel routes are being compromised, especially in Cape Dorset and Pangnirtung, where a floe edge that is too close forces people onto land. In Cape Dorset specifically, a closer floe edge means increased access to marine wildlife (associated with open water). However, this is also accompanied by enhanced danger of sea ice travel and reduced access to Baffin Island. In Igloolik the floe edge position is more variable, and is linked to other ice stability indicators (i.e. a closer floe edge would not be uncommon if ice was not piled on nearby reefs). Although there is less emphasis on change around Igloolik, when there is less MYI ice the floe edge is closer meaning increased access to the moving ice and wildlife. In addition, travel routes to the mainland or Baffin Island may have to be altered, depending on the extent of variation in the floe edge position. In Pangnirtung, the floe edge is now considerably closer to the mouth of Pangnirtung Fiord, meaning increased open water in Cumberland Sound. Sea ice travel is rendered more dangerous and travel routes must be altered. Moreover, commercial turbot fishing locations have limited access since the ice needs to extend a certain distance to reach the desirable, deep fishing areas. Indeed, the actual definition of *nunniq* has been altered. People now use this term when the northern end of Cumberland Sound freezes over, whereas it used to be used when the ice had formed solidly over more than half of the Sound. Therefore, even



sea ice references are being changed along with changing ice conditions. This is an important implication for language tied to environmental conditions, and it must be acknowledged in order to improve communications and minimize misinterpretations (Section 8.3.3).

#### *7.4.2.2 Weather*

Generally warmer winters are shortening the ice season, which means that hunters do not have as much time to use the ice. One benefit of this warming is that hunters do not have to wear the same heavy clothing during the winter, and tents suffice as shelter (i.e. building igloos is no longer a necessity). However, this concerns some people as they fear that the ice may no longer form at some point in the future. In contrast, others feel that the temperatures are not changing, which makes it even more difficult for community members to understand the cause of the altered ice conditions. Some postulations are that a warming water temperature is responsible, while others mention that increased windy/wavy conditions are preventing adequate ice formation. In all three communities, the increased unpredictability of weather shifts and traditional weather prediction techniques are rendering sea ice travel more dangerous. The diminished prevalence of NW winds have not only affected these shifting weather patterns, but also the ability to navigate accurately using snowdrifts. If snowdrifts form based on a shifted prevailing wind, then it is essential that hunters note the directional shift in order to continue using the drifts effectively. Moreover, increased prevalence of SE winds means more open water, or moving ice being blown towards the communities, making sea ice travel more difficult. It also makes wildlife more accessible where open water is maintained, but more frequent wind shifts increase the likelihood of ice breaking off from the floe edge. This (lack of) pattern has restricted walrus hunting opportunities in Igloodik, and influenced the amount of moving ice that concentrates around the community. In Pangnirtung, people have noticed more frequent windy conditions in the fiord as well as in the Sound, rendering ice conditions less stable and more prone to breaking up. These conditions

also speed up spring melt as the winds melt the snow on the ice surface faster than the sun alone. The changes in previously used indicators of weather and wind direction have meant that more people are: i) being stranded on the ice or land away from the community; ii) getting lost; and/or, iii) having more accidents. People are thus increasingly turning to weather forecasts, satellite imagery, and GPS technology to help evaluate ice conditions prior to travel, or to maneuver ice conditions in poor visibility (Section 8.2.3). Furthermore, since good weather systems are not remaining for as long as previously, hunters find that they have to be prepared for anything when they embark on longer sea ice trips.

#### 7.4.2.3 *Freeze-up timing*

All three communities have noted later, slower freeze-up timing. In Cape Dorset and Igloolik sea ice travel has been delayed nearly a month, and in Pangnirtung nearly two months. This contributes to thinner and non-uniform ice conditions, which hamper ice travel and can lead to an early break-up. All three communities described a consistent freezing progression that occurred in previous years, whereas now it tends to form, break up/get blown out, then start forming again. This cycle goes on several times before the ice actually solidifies, which can lead to rougher ice conditions when it does form. This makes it more dangerous to begin traveling on the ice in the fall, and less predictable as changed weather conditions could drastically affect freeze-up progression. Shifting prevailing winds also lead to rougher ice conditions as the ocean freezes, making travel more difficult once the ice has solidified. In Cape Dorset, some freeze-up stages are being skipped completely, which makes it more difficult to evaluate the freezing conditions. This may also affect the usage of particular sea ice terminology (Section 8.3.3). In Igloolik, elders and hunters have noted that the ice is taking longer to form solidly. This is likely linked to more overcast conditions and higher amounts of snowfall in the fall months. These factors combine to delay freezing while contributing to thinner, more dangerous ice conditions. Furthermore, with the *qaingu* not forming along the

tidal zone earlier than when the ocean begins freezing, it can no longer be used for travel in the fall. Therefore, sea ice travel is less predictable and travel routes must be altered. In Pangnirtung, softer sea ice formations are also thinner, which creates new polynyas or other dangerous areas. Furthermore, the slower freeze-up progression has extended the boating season, while substantially delaying the start of the turbot fishing season. In all three communities, hunters and other community members are essentially stuck in town as they wait for ice to form solidly. People express their unhappiness and impatience with this delay, as they are eager to be on the ice hunting when it is newly formed. In addition, altered travel routes tend to be longer and rougher as zig zag trails follow thicker ice areas or shoreline contours. This not only affects sea ice hunting, but also inland hunting in areas that are only accessible by sea ice.

#### *7.4.2.4 Break-up timing*

All three communities have also noted a shift towards earlier spring ice break-up. Once water begins accumulating on the sea ice, deteriorating ice conditions become increasingly risky for travel. Specific areas open up two to three weeks earlier than others, so these non-uniform melt conditions translate into dangerous travel, and often altered routes. For people in Cape Dorset there is an increased potential to be stranded away from town if snow/ice melt is sudden. In addition, spring leads are opening up earlier than normal, forcing people to follow the shorelines for travel (which is longer and rougher than the regular routes). It also translates into a longer boating season, which increases access to soap stone mines, walrus hunting areas, and even other communities. In contrast, around Igloodik deeper water accumulation was noted in the spring of 2004 due to decreased numbers of tidal cracks. This meant that some areas were wearing out before the ice even started breaking up (due to inadequate meltwater drainage through the cracks). In Pangnirtung, the sea ice has been deteriorating more from underneath, which leads to faster more sudden melting and an

increased potential for break-off events. This augments travel danger and forces people to alter travel routes (e.g. traveling along the *qaingu* instead of the *tuvaq*, or having to travel inland due to open water areas). Earlier break-up has enabled earlier boat travel, but it has also markedly shortened the turbot fishing season (not to mention the ice season overall). Specific melt stages were noted as being skipped around Pangnirtung. Consequently, melt stages are occurring more rapidly as the ice begins breaking up after the snow meltwater has drained away – there is no second water accumulation stage from ice meltwater anymore. This has implications for travel danger, prediction of ice break-up, and use of sea ice terminology (Section 8.3.3). Moreover, with the mouth of Pangnirtung Fiord opening earlier in the year, access to Cumberland Sound is progressively restricted. In each community, longer transitional stages (both freeze-up and break-up) mean that people are ‘stuck’ in the community for longer periods of time.

#### 7.4.2.5 *Ice thickness*

Observations of thinning ice were mentioned in all three communities. This greatly enhances the risks associated with sea ice travel. Thinner ice is less resistant to the influences of currents, lunar cycles, winds, and snowfall. In other words, thinner ice deteriorates more easily from currents underneath, or can be broken up more easily from waves or winds. Thinner ice can also initiate the occurrence of larger or new polynyas. Around Cape Dorset, thinner sea ice leads to less predictable ice safety along with enhanced danger associated with hunting around polynyas or at the floe edge. For example, one route that was used to access soap stone mines in the winter has not been used for 20 years due to increased amounts of open water – and thus dangers in that area. In Igloolik, thinning ice conditions were discussed mainly in the context of the unique fall of 2004, whereby more snowfall – and snow accumulation between MYI – caused the ice to melt from underneath. These conditions exacerbated the dangers associated with sea ice travel off the island of Igloolik, making it one

of the most dangerous years that some hunters had experienced. As for Pangnirtung, thinner sea ice makes it more difficult to access the southern coast of Cumberland Sound, which is a popular hunting and fishing destination. The ice has been wearing away from underneath even before all the snow has melted from the surface, rendering it deceptively solid when there is little ice under the snow. If the ice is not solid enough at the mouth of the fiord, and along the northwestern shoreline of the Sound, then it is very dangerous to travel around the shores to reach the opposite part of the Sound. In all three communities, thinning sea ice was also linked to later freeze-up (i.e. not as much time for the ice to thicken), and earlier break-up (i.e. contributes to earlier break-up because the ice wears away faster).

#### 7.4.2.6 *Moving/multi-year ice*

Less moving or multi-year ice around each community was linked to potentially warmer water or air temperatures, especially in the summer. This may, in turn, contribute to the delayed freezing of the sea ice in the fall and thinner ice conditions overall. Therefore, the presence or absence of MYI has implications for other ice conditions or indicators of change. In addition, more MYI frozen into the *tuvaq* around Igloolik contributed to enhanced travel danger as they strengthened currents under the ice. Snow then accumulated between the large protrusions above the ice, causing thinning to occur around these large ice formations due to the insulation from above and forces acting below the ice cover. In addition, moving ice hunting has been more dangerous around Igloolik because the ice itself has been smaller, had more cracks, and been less solid. It has also been further from town, and thus harder to access walrus. In both Igloolik and Pangnirtung, less MYI present in the summer renders boating conditions more difficult. Waves propagate higher and further when there are no large ice pans to shelter boats from the wind or to dampen the effects of waves. Also noted around Pangnirtung was that when *qapvaq* do enter Cumberland Sound, or are blown into Pangnirtung Fiord, they are melting much faster – they no longer last through the summer. This is another

potential indicator of warming water temperatures, as well as being a contributor to warmer water temperatures. Around Cape Dorset, less MYI was explained as potentially being part of an ice movement cycle. It was likened to the migration of animals, whereby the ice might congregate in an area one year, and another area another year, depending on wind and current circulation (e.g. accounts of MYI piling up recently around Coral Harbour and Nunavik).

#### *7.4.2.7 Subsistence and commercial harvesting*

All the implications for sea ice change affect sea ice travel, but they also influence subsistence and commercial harvesting success. Therefore, hunters are dealing with enhanced travel danger to access marine wildlife, reduced time within which to use the sea ice, as well as a changing habitat that may affect the health and well-being of the animals themselves.

Polar bear populations around each community have been observed to be increasing (to varying degrees). Some local postulations for this trend include: i) slower freeze-up meaning that bears may be staying on landfast ice longer (Igloolik, Pangnirtung); ii) sea ice conditions further south (i.e. Hudson Bay) are deteriorating and thus bears are moving northwards (Cape Dorset, Igloolik); iii) polar bears are not hunted as much these days due to the quota system, thus bear numbers are increasing (Cape Dorset, Igloolik, Pangnirtung); and, iv) bears are going after cached meat more frequently, thus they are seen more often (Igloolik). These noted changes in polar bear sighting or behaviour are a combination of both environmental and human-induced change, thus it is difficult to tease out which is more influential. Regardless of the cause (or combination of causes) polar bear populations seem to be increasing around each of the communities, which has several implications for community life. With their habitat diminishing, bears may become over-populated in more northern latitudes, which may in turn affect the number of ringed seals around the communities (the main prey for the polar bears). Furthermore, earlier break-up forces bears onto land earlier in the spring, not allowing them to catch their fill of baby seals during a critical time of the year (i.e. before summer 'walking

hibernation'). In addition, later freeze-up means the bears have to go longer without sea ice to hunt seals. Consequently, it has been noted around Igloolik that bears are becoming increasingly lean. They do not have the same amount of healthy fat that they need to survive the winter and to support their young. Furthermore, with shifting trends in timing, as well as thinning ice cover, it is believed that the polar bears may be less effective in their hunting. Therefore, some hunters expressed concern about the health of polar bears if the ice continues to retreat. There is also danger involved with increased numbers of bears, especially hungry bears. As more bears venture into communities seeking food, the number of defense kills have increased. The bears are raiding meat caches more often around Igloolik, and due to strict quotas people are not able to hunt those bears. It is believed that bears are becoming less afraid of humans, since they can raid caches and not be shot at (unless the person has a polar bear tag). For this reason, bears may become braver and venture into communities more often, creating enhanced risks of bear encounters or attacks. Setting quotas is thus becoming increasingly controversial. Community members believe that there are too many bears around, while conservation agencies and some scientists are concerned for the long-term vitality of the polar bear species and may seek more restrictions on polar bear hunting. Polar bear sport hunts are also an important source of income for some hunters, so there are economic implications of shifting polar bear populations and health beyond the environmental aspects.

Ringed seals were described as using the sea ice more than any other animals, thus they are likely the animal that would be most affected by sea ice change. All three communities noted a decreasing number of ringed seals around their towns. Hunters themselves may be influencing seal congregation areas since increased hunting and associated motor traffic around the communities tends to drive seals away. In Igloolik, increased numbers of killer whales in Fury and Hecla Strait were also mentioned as a potential reason for fewer seals in the area (nearly all marine mammals are scared of killer whales, and will flee the areas where they

are present). However, changing ice conditions are also influencing the health of seals. Thus, both the subsistence and commercial value of seal hunting may be affected. A healthy seal is a fat seal, and hunters in Igloolik have noted less fat on the seals they are catching in the fall. This has also been noted around Pangnirtung, where substantial changes in ice conditions are already translating into negative effects for the local seal population. One that has been mentioned previously is that with earlier break-up the seals do not get enough time to bask on the ice in the spring, meaning that they cannot moult adequately. For young seals this makes it more difficult for them to rid themselves of their white fur (to allow their dark, spotted fur to come in). Because this moulting cannot occur on land more brown seals are being caught in the spring. These are considered bad skins, meaning that hunters are affected economically because they cannot sell the furs. Even the practice of hunting seals as they bask on the ice is highly curtailed because of poor ice conditions. Furthermore, important denning areas are breaking up early. This forces the pups into the water when they are too young (i.e. they have not accumulated enough fat), meaning they die soon after being in the cold water. This may increase the mortality rate of young seals, in turn affecting both the seal population and hunting success. Increased snowfall on the sea ice would actually be a positive implication for seals, as they would be more effective in building and maintaining safe dens. However, a decrease in snowfall could be detrimental for seals as they would not be able to create adequate shelter for themselves or their pups in the winter months. Some hunters wonder where all the seals will go if the ice should cease to form, or become too thin for use.

Walrus around Igloolik are now much further from the community. This may be linked to the decreased prevalence of moving ice near the community, and/or to increased motor vehicle traffic on the sea ice or in the water. Eco-tourism and guided sport hunting were actually thought to be driving walrus away, since they track walrus and try to get as close as possible. In addition, sport hunters may approach walrus groups several different times sizing



up their choice animal, which means that walrus will continue traveling further from the disturbance. As a mainstay for the community, this makes it difficult for local hunters to continue practicing their moving ice hunting techniques to reach and catch walrus.

Perhaps most influential in an economic sense is the effect of shorter ice seasons, and thinner ice cover, on the commercial turbot fishery in Cumberland Sound. Several Pangnirtung fishermen make a living off seasonal long-line fishing, and solid ice cover is essential to reach the most desirable and productive fishing spots in the Sound (Figure 6-21). There is greater danger involved in this profession now, with increasingly unpredictable weather and ice conditions. In addition, the fishing season has been drastically shortened, and in the past few years it has barely occurred due to the frequency of storms and high winds. Fishermen are also more cautious now because of the enhanced likelihood of the ice breaking up, meaning they can lose all their equipment at once. This had happened to several people interviewed, and to several more that I met in Pangnirtung. Some people were able to claim this through worker's compensation, but in many cases the equipment is simply irretrievable and irreplaceable. This has caused many people to abandon fishing completely due to the financial burden of trying to start anew.

#### 7.4.3 Considerations for assessments of change

An assessment of the influence of sea ice change on northern communities must consider the nature and degree of the environmental changes, and the implications for community members, simultaneously with social and lifestyles changes that northern communities are undergoing. Individuals may perceive, or react to, changes differently depending on their economic status, hunting methods, interest in new media, family history, to name a few. For example, increased open water could be considered a positive influence of sea ice change. It allows more access to air and food for marine wildlife and decreases travel time for hunters to reach marine wildlife. But, it also makes for potentially dangerous travel,

restricted hunting options, and less habitat for some key marine species (e.g. ringed seals and the polar bears who prey on them). Community members would also enjoy longer summer boating seasons. However, boat travel is more sensitive to wind, current, and weather conditions than sea ice travel due to the dangers of rough open seas or navigating through moving ice. In addition, the financial implications of boat ownership and maintenance are higher than for snowmobiles, so less people may be able to engage in boat hunting activities.

Additional considerations for the perception/influence of sea ice change relate to the degree to which community members participate in hunting or other traditional/cultural activities. Compared to the more traditional and mobile lifestyles prior to permanent community settlement, people are no longer traveling on the sea ice as much. Country foods are an important part of the local diet, but are no longer essential for survival. Furthermore, because dog teams are rarely used for travel the requirements for hunting have greatly diminished along with the necessity of feeding dog teams. Therefore, people are not hunting (or not hunting certain animals) as frequently as they would have in the past. Some people are too busy with employment to be able to use the ice on a regular basis, while others are aging and not as able to travel (and the younger generations in their family are not as interested). Therefore, ice conditions may seem different, or the weather may feel warmer, simply because community members are not spending as much time outside. Without using the ice regularly, some community members may be less aware of the environment, and less adept at sea ice travel. As such, accidents may happen more frequently not only because of sea ice change, but perhaps because: i) less people are checking the ice properly; ii) travel is faster by snowmobile and lacks the helpful canine instincts of dog teams; iii) people are not waiting long enough before traveling on the sea ice in the fall; and, iv) younger people are not as familiar with sea ice routes. Nevertheless, during the spring season sea ice travel remains popular. It is an

important time when extended families travel together to go hunting or fishing. In contrast, winter sea ice travel is mainly undertaken by hunters for subsistence or commercial harvesting.

A further consideration is that northern, and indeed global, news media are bombarding people with articles and reports of climate and environmental change of all sorts. This does not necessarily influence how community members report changes in their region, but in some cases it has rendered people more observant because of concerns for the local effects of climate change. It also meant that the issue of change was forefront on people's minds when discussing the topic of sea ice, although I never introduced change into interviews until after it was initiated by the participant. Community members are experiencing changes in sea ice, and they hear about it all the time, so it is not surprising that they want to talk about these issues. This is especially the case when they do not agree with scientific reports and findings. Their own observations and theories have not always been incorporated into studies of change or results analyses.

Interestingly, a few elders in each community explained that they were warned by their parents and grandparents that the weather and sea ice would be very different when they became adults and had their own grandchildren. In Pangnirtung, Anglican ministers were also said to have foretold that Cumberland Sound would not freeze over at some point in the future. Having now reached that age, the seemingly unbelievable predictions of warmer winters, thinner ice, and shorter ice seasons are actually coming true. Because they expected this type of change, some elders are not surprised or concerned. They were also told not to blame anyone for the changes because nothing can be done about it. There is no way to control the changes, so it was advised that whatever is destined to happen will happen. Moreover, some people feel that the current changes in ice conditions are part of a long-term (approximately 50-year) cycle, and that a cooler phase will return in the future. Therefore, long-term change has perhaps become a part of the ever-variable arctic sea ice system, whereby

the Inuit continue to adapt as best they can.

These are only a few of the potential influences of social or lifestyle changes on Inuit expertise, or local perception of change. These were not investigated in depth, but it would be important to attempt to tease out such effects when assessing change, and peoples' ability to adapt to changes. Ice conditions and processes are changing physically, but the degree to which they are noticed, and are affecting people, is also a function of: i) who is using the sea ice; ii) how the ice is being used; and, iii) what time of year the ice is being used. Many of the observations of change described in interviews depend on the initial sea ice conditions, and the areas used, around each community. This makes it challenging to compare the extent or implications of change for each community. For example, a similar reduction in floe edge extent could minimally influence sea ice travel around Igloolik, but could prevent community members in Cape Dorset from getting off the island. Another example would be that new polynyas around the shores of Cumberland Sound could prevent access to key hunting grounds outside Pangnirtung, while new polynyas near Cape Dorset could make it easier to access wildlife despite declining ice extents. Furthermore, changes occurring in areas that are not frequently used may be dramatic (i.e. some polynyas are too dangerous to venture near, so people are unable to monitor conditions), but these do not affect people as much as areas that are frequently used and are experiencing moderate change. Such considerations for the assessment of sea ice change, and related implications for northern community life, present an important argument for community-based studies that evaluate local implications. It should be clear by this point that it is essential to incorporate community knowledge and context in identifying indicators of change, assessing change, and evaluating the effects on community members. Otherwise, it is impossible to know how physical changes will affect community lifestyles and well-being. However, due to the relative nature of changes (as linked to local and regional geographies, local and regional sea ice use, and qualitative assessments of change), the

utility of some standardized measures to quantitatively assess physical change is also recognized. Therefore, linking local and scientific expertise on sea ice, while accounting for changing conditions and local uses, will lead to more comprehensive and representative assessments of community vulnerability to sea ice change. The next challenge is how to effectively link different conceptions of sea ice processes, and how to work collaboratively to adequately represent different perspectives and standards of knowledge valuation.

## Chapter 8 – Analysis

### *Linking Inuit and scientific expertise*

#### 8.1 Evaluation of the collaborative research approach

In working closely with community members I was continually reflecting upon the methods I employed, attempting to refine things as the project progressed. Presenting research results and analysis can contribute to the understanding of localized sea ice conditions, uses, and change, as well as variations between the three communities. However, reporting on the effectiveness of research methods can contribute to an increased understanding of researcher-community relationships. Therefore, discussions in this chapter can relate outside the realm of sea ice. These sections are more broadly applicable, and aim to inform efforts to work collaboratively with Inuit communities.

##### 8.1.1 Preliminary community visits

Among researchers working in the North American Arctic, the approach of visiting communities prior to conducting research is increasingly common (Johnson and Ruttan, 1992; Ford, 2000; Jolly *et al.*, 2002; Kofinas *et al.*, 2002; Krupnik, 2002; Norton, 2002; Thorpe *et al.*, 2002). This is also more typical of projects that invite, or require, substantial community involvement. I wish to highlight the importance of these visits because often they receive only a brief mention in methodological descriptions. This lack of emphasis may be due to page limitations in publications, or the difficulty of reporting “results” from such early research interactions. Yet, they are fundamental in facilitating subsequent research relationships and progress. Therefore, preliminary community visits (Section 3.3.1) are deserving of specific attention because they are critical to overall project success. These visits are: i) an important first step in relationship-building; ii) a good orientation to community dynamics and services; iii) helpful in developing future field research plans; and, iv) important to gain insight into community perspectives on the research.

First, visiting each of Cape Dorset, Igloolik, and Pangnirtung prior to finalizing research plans, or commencing interviews, provided the initial personal contact that was critical to overall project success. In northern communities, more emphasis is placed on the value of inter-personal relations than on written correspondence (Ford, 2000; Thorpe *et al.*, 2002; Furgal *et al.*, 2005). Therefore, this first trip was an important step in relationship-building. It allowed me time to get to know the community members and organizations a little before initiating the formal research process. It also helped to build trust through face-to-face interactions and answering questions at local meetings with targeted small groups (i.e. key local organizations). Since I had no previous community contacts or working relationships with local officials, coordinators, or interpreters it would have been difficult to convene a large group or public workshop. It was also more practical to be a delegate in regularly scheduled meetings, than to request a special meeting (i.e. requiring more time and financial compensation to individuals in attendance). The personal interactions in a small group setting made it easier to solicit feedback and gain the much needed local support. People also asked a lot of (sometimes challenging) questions that helped me gain perspective on local views of research, and the role that community members should have in research. Some examples of these questions include:

- Who is paying for this project?
- What is the pay for being interviewed?
- Where do you come from?
- Who do you work for? (i.e. some concerns for links to government or environmental activists)
- How long will this study take?
- Will you be getting out on the sea ice to learn?
- Where else do you work? (i.e. what other communities)
- Why are you doing this work?
- Are you part of a research group, or working alone?
- When will the information from this study be available?
- You get a degree out of this research, what do we get?

I addressed the questions or concerns as best I could, which was helpful in gaining the support of local organizations and establishing positive working relationships. I was also able to use

feedback from these meetings to refine and revise the project. However, if initial meetings had gone poorly, or there was a lack of interest in the proposed project, this type of preliminary visit would have enabled a re-evaluation of community selection and inter-personal relations.

Second, the preliminary visits also aided with orientation to the community in terms of: i) community dynamics; ii) locally available services; and, iii) an understanding of limitations to my proposed research. One example of this is that in both Pangnirtung and Cape Dorset there is a local visitor's centre. However, in Pangnirtung the Angmarlik Visitor Centre is like a central organization where the coordinator was extremely helpful. She was able to connect me with several people around town, including the arrangement of an elder's group meeting. This centre also acts as a cultural hub with a local library, small museum, and repository for research results. In contrast, the Malikjuaq Visitor Centre in Cape Dorset is locked most of the year unless there is a cruise ship or a large tour group in town. Although it does house cultural exhibits and local tourist information, it is generally unused. So, there was no equivalent networking organization in Cape Dorset as there was in Pangnirtung. This is just one example of the many ways in which these initial trips introduced me to adjusting plans "on the fly".

Third, the preliminary visits helped build a solid foundation for all future fieldwork. They aided in the planning of subsequent research trips (including timing and duration), along with refining project objectives. It was through these initial interactions that repeat visits at different stages of the seasonal cycle of ice formation and decay became prioritized. This eased research planning because I could follow local recommendations rather than having to estimate the best timing to undertake field work.

Finally, preliminary community visits were valuable in learning more about community perspectives on research. It seemed that they found it odd for me to be in town just to meet with organizations, and to talk with people, without actually moving on to interviewing and asking questions. The main interest in the project was sparked by local



concerns for sea ice conditions and change, along with the desire to pass on Inuit expertise to youth and scientists. However, it was sometimes difficult for people to respond without a concrete proposal and plan laid out for them – as though they were not used to being asked for input in directing a project. Sometimes this led to comments like “if you’re not going to be interviewing, we don’t have much more to say.” People are busy with many meetings, committees, and life commitments. Therefore, after expressing interest in the project it was sometimes preferred to move on to other subjects. There was also some (understandable) skepticism about research based on previous experiences with poor results reporting and/or treatment of community members (Section 8.3.1). Despite these few challenges, my approach was well received in the communities overall. They seemed to appreciate that the trip was just to propose an idea, get their feedback, and develop the project further.

### 8.1.2 Semi-directed interviews

As one of the cornerstone methods of qualitative research, semi-directed interviews have been previously evaluated as a valuable means of eliciting information, and gaining insights into Inuit expertise (e.g. Huntington, 1998; Fox, 2002). However, since it is not customary to ask questions in Inuit culture – learning would be undertaken through listening, watching, and practicing (Section 8.2.2) – there are some limitations to the value of interviews to adequately represent the depth and complexity of Inuit knowledge.

Strict question and answer sessions are suggested to be avoided within Inuit communities, which is why structured interviews or questionnaires are generally inappropriate for northern community-based research (Ferguson and Messier, 1997; Huntington, 1998; Ford, 2000). Sea ice processes are hard to describe in isolation; therefore, they would not be well represented within a constrained questioning structure. I also tried to minimize the drawbacks of the unnatural context of interviews to transmit information by allowing the interview to flow as much like a discussion as possible. To do this, I had to learn how to ask questions

appropriately. My original interview guide asked how each person would describe certain ice conditions in Inuktitut, based on the scientific terms I had learned in the literature. These did not lead to very rich responses, and sometimes even created confusion. As we worked through the questions further, Ikummaq suggested that we ask people to describe the freezing or melting processes. We found that it was more effective to begin the interview by asking for a description about how the ice begins to form in the fall, which eventually led to explanations of floe edge dynamics, tidal cracks, and polynyas. Wind and current influences were often incorporated into these descriptions, but when this did not occur it was easier to ask for clarification in the context of the overall process description. This sequence of explanation then naturally led to the processes of melting. Starting with one timeframe and continuing in sequence, following the seasonal ice cycle, also facilitated my comprehension of explanations. Therefore, this revised interview guide transformed the interview process. After one question it became common for hunters or elders to offer long explanations, or stories, that incorporated nearly every question that I had intended to ask. Their exceptional ability to tie together the components of a complex process into a comprehensive explanation highlighted: i) the holistic aspects of Inuit understandings of environmental processes; and, ii) personal connections to sea ice cycles or changes.

Leading questions or statements should also be carefully avoided within interviews so as to minimize the researcher's influence on knowledge/experiences shared (Fox, 2002). Such questions are especially inappropriate for Inuit participants since they may not openly disagree if they feel there might be a sound basis for the question (Ferguson and Messier, 1997). This could result in participants responding positively even without any personal knowledge of the issue (Ferguson and Messier, 1997). Worse would be that the interviewer could lose credibility, as it is considered impolite to ask such questions and may be construed as intent to mislead (Ferguson and Messier, 1997). In transcribing interviews I found that some of my clarifying

questions were unintentionally leading at times, although these were infrequent and interviewees seemed to understand where I was coming from. In addition, it is important in Inuit culture to wait until the person is done speaking before asking another question. This was sometimes challenging when I was trying to keep up with an explanation while making mental notes to ask for clarification. Occasionally I could not stop myself from interrupting when things became confusing. Nevertheless, semi-directed interviews are beneficial in aiding to conceptualize individual experiences (Bennett, 2002b). They provide an important interpersonal context and allow participants the opportunity to ask questions, tell stories, make comments/suggestions, and share experiences. Such settings may not be conducive to the traditional means of Inuit teaching (Section 8.2.3), but they were invaluable to introduce me to the detailed terminology, environmental relationships, uses, changes, and socio-economic implications of sea ice in each community.

The importance of a reliable, supportive, dedicated interpreter to the success of the project, and the collaborative research process itself, cannot be overemphasized. Often referred to as a translator, I employed the title interpreter because they do much more than strict translation. They often act as a:

- a) **research assistant** → helping to set up and take down maps and equipment for interviews; helping to organize, schedule, and follow up on interviews; helping to plan equipment, food, and gas requirements for sea ice trips;
- b) **local liaison** → helping to establish and maintain contacts with local organizations and key interview participants (during field work and when I was not in the community); helping to communicate or distribute information around town;
- c) **guide** → guiding me on sea ice trips; arranging for a guide, and accompanying us to help with interpretation on sea ice trips; taking responsibility for my safety and well-being while traveling on the ice; teaching me about ice conditions, hunting, and safety while traveling on the ice;
- d) **project ambassador** → supporting the project to other community members, friends, family, organizations, etc.; they worked with me most closely, and most consistently, so they knew the most about the project and could describe our objectives, answer questions, or clarify misunderstandings when I was not around;
- e) **translator** → in the literal sense, by translating written documents from English to Inuktitut; and,

- f) **collaborator** → helping to analyze or revise results; clarifying misunderstandings or misinterpretations on my part; providing feedback on interview methods, field work plans, project results; co-authoring papers/posters.

Furthermore, in order to effectively “translate” a concept from Inuktitut to English, or vice versa, they have to interpret the meaning and explain it as closely as possible in the other language. This takes a skilled person, fluent in both languages. For this project they also needed to be knowledgeable of the highly specialized sea ice terminology (especially the older, more sophisticated terms that the elders use). Therefore, interpreters themselves essentially had to be hunters, or have experience on the sea ice, to accurately interpret interviews. They are a bridge between the researcher and the community, thus they can enhance the project or be a detriment to progress. The success of the project is inherently tied to the interpreter-researcher relationship, as well as the community-researcher relationship.

I am fortunate to have worked with four talented, interested, and committed individuals. Their involvement in the project was invaluable, as they:

- helped in identifying and contacting people to interview;
- facilitated the interview process, enabling communication between myself and the unilingual Inuit;
- improved the types and formats of questions that I asked, making the interviews both easier to translate and easier for the participant to respond;
- interpreted cultural differences along with languages (e.g. the way people acted, expressed things, or asked questions – or not); and,
- continued to help me learn about Inuit culture, perspectives, and practices outside of the interview setting.

However, working with people always poses some element of challenge:

- there can still be misunderstandings, even with the use of a skilled interpreter, because different mindsets can result in different interpretations (especially if this is not noticed, expressed, or clarified early on);
- it is sometimes difficult to adequately explain specific concepts between English and Inuktitut, so points may be missed or misinterpreted;
- the relationship of the interpreter to other community members can affect the people who are interviewed, or the depth of the interview (i.e. there are tight family, lifestyle, and religious groups in each community, and thus some may be better represented than others); and,
- interpreters have their own lives, which must understandably take priority over research and work; because of the daily challenges experienced by many in northern

communities (e.g. family problems, lack of employment, suicide, substance abuse, health problems, childcare responsibilities, etc.) there were times when interpreters were unable to make a scheduled interview, were hard to get a hold of, or were not available on certain field research trips.

These are all important considerations for research in a northern community context, both for the selection of an interpreter and in finding a similarly skilled, reliable “back-up”. Some of these challenges can never be fully addressed or alleviated, but I feel that we made the most of our opportunities. By working closely with interpreters to develop and conduct the research we covered as many people and as many topics as was feasible. By maintaining frequent contact, and organizing for direct involvement in terminology/results revisions, we also minimized the chances of misunderstandings. I attribute much of the success of this project to the skills, patience, and ongoing contributions of Andrew Diallya, Pootoogoo Elee, Eric Joamie, and Theo Ikummaq. They acted as teachers throughout the research process, and many of my reflections on methodology were instigated by our shared conversations and experiences.

### 8.1.3 Participatory mapping

In addition to the types of questions asked in the interviews, the visual element provided by incorporating maps proved to be valuable in triggering: i) memories of sea ice conditions or travels; ii) stories of sea ice travel or hunting; and, iii) descriptions of ice conditions or terminology. At first the maps were not an interactive part of the interview process, they were saved until the end and were then the specific focus of questions and descriptions. However, early in the second field research trip Ikummaq suggested that we alter the process to include maps as part of the interviews from the outset. This meant that the map was in front of the individual throughout the interview, and they were free to refer to it, draw on it, or write on it any time. Questions were no longer directed specifically at the map, rather the interviewee would frequently incorporate the map to: i) focus on a specific geographic area; ii) explain a particular ice condition or localized process; and/or, iii)

demonstrate stories or travel routes. This use of maps was effective as it led to richer interview responses, as well as more features/terms/indicators actually being drawn on the maps. Inuit are visually orientated people, as well as very spatially oriented and adept (Morantz, 2002). This came across clearly with the use of maps, and became an important complement to both my questions, and interviewee responses. This has also been the case with other environmental topics (Turner and Hiernaux, 2002; Smith, 2003; Cronin *et al.*, 2004; Natcher, 2004) that are geographically influenced and may be difficult to describe with words alone. Furthermore, the maps as a visual aid helped to improve communication between myself and the interviewee (Section 8.3.3.4). It provided a medium through which people were able to bridge simple descriptions with their experiences of sea ice.

Despite the advantages of using maps as part of the interview process, there were also some short-comings of this representation of the local and regional landscape/ocean expanse around each community. First, by using a 1:250 000 map scale, three or more map sheets had to be combined to show ocean areas around the general vicinity of each community. I was frequently reminded that even this coverage was inadequate in showing the areas that people have actually traveled, or that they wished to describe, in terms of ice conditions or hunting grounds. So, there is an inevitable tradeoff between map detail, coverage, availability, and size. Employing 1:500 000 maps sheets would not provide enough shoreline detail to indicate fine scale features (e.g. tidal cracks, travel routes, or even polynyas) but it would adequately show the extent of sea ice use. On the other hand, 1:50 000 maps would greatly enhance the detailed map representation, but these are not readily available for many areas of the Arctic (and their format and dates vary greatly). It would have been impractical to add more 1:250 000 maps sheets since the map extent already exceeded most regular table sizes (i.e. would have been unwieldy in small interview spaces). Therefore, map scale and size is an important

consideration depending on the features of interest and the requirements for large or small scale coverage.

Another challenge with using multiple 1:250 000 maps sheets was that the area around each community actually crossed two Universal Transverse Mercator (UTM) zones. Therefore, the digitization and post-processing involved was tedious and time-consuming (Section 3.3.3.2). Due to the different zones each map sheet had to be digitized separately, followed by data re-projection into a common coordinate system. This was relatively straightforward, although necessitated individual feature editing to match some of the areas that touched UTM boundaries. Due to slight differences in the map sheet registration on the digitizer, as well as minor manual error, they did not always provide a continuous line to link the same features drawn over two map sheets. These necessary steps did not alter the data itself, but it can be a challenge to ensure map accuracy and precision after several rounds of data processing.

Further to some of the short-comings of the maps themselves, some people interviewed were not used to interpreting maps. Therefore, it was difficult for them to identify with the two-dimensional surface and to draw sea ice features. Although maps are a western/southern/scientific way of representing the physical world, it was deemed the best option in terms of standardization and availability. However, even people who felt they were not familiar enough with maps to employ them in delineating sea ice conditions were able to recognize important terrestrial features and associated placenames. By visualizing the areas as if they were traveling there, interviewees could use the map with incredible precision to indicate important features, dangerous areas, or aspects of change. Interestingly, this process of orienting themselves to familiar travel routes or landmarks highlighted my own assumptions on directional preference for map placement. I had fastened the map to the table facing the interviewee, with north pointing upwards away from them. This seemed like a natural map position, but depending on the community (and where people normally traveled)

some interviewees had difficulty associating with the map until they could position themselves as they normally traveled. For example, in Pangnirtung this meant that people preferred to be looking out of the fiord, as if they were beginning their journey to Cumberland Sound (i.e. facing west). In other cases, where interviewees were more familiar with map use, they were comfortable with any way the map was situated. They could interpret areas around the community regardless of their viewing angle.

Sea ice itself is a challenging feature to represent on a map because it is dynamic, cyclical, and variable. Therefore, different people would draw a feature with a different conceptualization in mind. This meant that points and lines could be used for the same kind of feature, depending on how the individual thought of that feature. Furthermore, frequent caveats were made by interviewees when drawing features such as the floe edge or tidal cracks, cautioning that the interpretation of the line should be either approximate, or as representative of only one year. It was continually mentioned that these features were variable with each year, and even within a year, and thus map representations were not to be taken as fixed positions. Once all the features were compiled this aspect of variability became clear. Yearly variations were often represented through different peoples' representation of like features, yet the geographic consistency of delineations still provided a good indication of actual positioning. The consistent overlap of feature placement between interviewees (albeit with slightly varying local extents), as well as hunters' agreements with the map compilations provided in reporting trips, support confidence in the approximate map locations delineated.

While acknowledging the short-comings of incorporating maps into interview and sea ice analysis, this component was one of the most fascinating parts of the project. Interviewees seemed to prefer discussing the map rather than being asked a string of questions. When it was in front of them almost every response incorporated a map reference. The maps also sparked comments and explanations that enhanced interview responses. Finally, the maps



were an effective means of shifting the focus away from the individual, so people seemed more comfortable discussing the map than speaking directly to me or the interpreter.

#### 8.1.4 Experiential sea ice trips

Traveling on the sea ice was highlighted by many interviewees as being critical for learning about ice conditions, Inuktitut terminology, and travel safety. Sea ice cannot be adequately described indoors, in an interview setting (Section 8.2.3). Therefore, elders and hunters insisted that I should have some of this experience. As a result, it became a priority for me to get out on the ice whenever possible. This type of experiential learning and research was a personal challenge for me in many ways, such as: i) giving up control; ii) facing the elements; and, iii) conquering fears. It was much more than participant observation. My experiences were most critical, and my observations were as much of the people as the surroundings. The cold was somewhat arduous, but it also provided perspective on what it is like for hunters who are traveling whenever the ice is safe enough. It was also sometimes difficult to rent equipment, plan trips (i.e. according to weather and peoples' schedules), and find reliable guides while balancing costs and interview/focus group plans. Despite my multiple research trips at different ice formation and decay stages, it was impossible to capture and experience all potential ice conditions and stages myself. It was even more challenging to try to represent my experiences of these trips in this thesis. Most of the accounts are based on recollection, and it was very much a personal experience. Furthermore, with no consent forms required for the actual trips, it is difficult to assess: i) where to draw the line between stories employed for sea ice instruction and personal stories; ii) what types of pictures are appropriate (i.e. sensitive about the act of hunting or preparing meat); iii) how to incorporate video into interpretations; iv) how to separate my impressions from the actual experience the hunters/guides were trying to provide; and, v) how to separate my interests of providing educational materials and conducting research.

On each trip I was well taken care of. The hunters were patient, careful, and even protective. I felt fortunate to be taken on the ice, as gender roles in Inuit society would mean that it is uncommon for women to be on the ice hunting with other men, particularly men who are not their husbands or direct family members (Section 3.3.2.1.1). I believe this gendered relationship also influenced:

- the manner in which things were demonstrated to me (i.e. directly and patiently explained);
- the types of experiences we had (i.e. mostly sea ice travel and observation, hunting only when there was a particularly good opportunity, and careful explanations around dangerous features); and,
- the amount of responsibility given to me (i.e. almost always a passenger on the snowmobile or in the *kamotik*, and no offers of firearms use or hunting attempts).

For my personality, and my objectives for the sea ice trips, this treatment was ideal and considerate. However, it may have been a very different experience if I were a male researcher doing the same kinds of trips on the ice, for the same purposes.

Most of the challenges of experiential sea ice trips were internally driven by my own personality, expectations, and experiences. However, there were also great benefits of this practical learning. The sea ice trips provided valuable photo and video opportunities. These means of recording ice conditions and expert explanations aided to provide visual sea ice representations in order to link sea ice terminology or descriptions. Consequently, after these trips I learned the sea ice terms much faster, and was able to visualize the specific conditions as elders described them. I gained tremendous respect for the danger and dynamism involved in sea ice travel and hunting. These trips helped me realize the practicality of sea ice knowledge and terminology, as related to weather, current, wind, ice, and snow indicators, as well as placenames or landscape/icescape features. This type of geographic knowledge cannot be adequately understood without experiencing it.

### 8.1.5 Focus groups

The focus groups conducted in Cape Dorset and Pangnirtung proved to be valuable interactive sessions. Each group session was small, with a specific objective (i.e. linking sea ice terminology to photographs, or verifying the seasonal chronology of freeze-up and break-up). These were an important complement to semi-directed interviews, and experiential sea ice trips. Employing all three methods in concert allowed for broader triangulation (Baxter and Eyles, 1997; Yeung, 1997). Specifically, focus groups were beneficial to the research process for several reasons:

1. **The group setting helped ensure broader accuracy of research results.** → It was fascinating to watch how people were accounting for local dialect variations and individual expertise. Depending on where the elders had grown up, each was an expert on the particular area where they had lived prior to community settlement. I was surprised at the dialect variations that stemmed from that, despite having lived in the same community for many years. Typically, a consensus on each topic, photo, and term was reached through discussion, but it also became clear that there were elements of deference for: i) the most experienced, respected elder; and/or, ii) the person most familiar with a particular hunting ground or travel route.
2. **Focus group interactions helped limit the potential for misunderstanding on my part.** → My analysis of interviews and/or experiences on the sea ice were useful in linking photos to terminology. Yet the focus group highlighted some of the areas where I was unclear, or I had misunderstood an explanation. My use of pictures and Inuktitut terms was rendered more accurate after having discussed them with community experts.
3. **Targeted group sessions mean that community experts are involved in some aspects of interpretation/analysis research stages.** → This is important in the collaborative research approach, and the beginning of moving towards a research partnership.
4. **Focus groups provided valuable insights into varying individual perspectives.** → Based on the interviews I expected that each of the elders would be in quick agreement with most photos or terms. However, bringing people together and having visual representations of sea ice brings up many more topics that were not introduced in the interviews. Therefore, discussions were dynamic and revealing in terms of what each elder was trying to get across. As mentioned earlier though, consensus was nearly always reached, and in the process the older Inuktitut terminology (or locally varying dialects) were highlighted. None of these aspects would have come out of interviews alone, so they were important additions to my results interpretation.

As in most aspects of research, there are also challenges in working with interactive qualitative methods such as focus groups. First, conducting a focus group through an interpreter is demanding for both the facilitator and the interpreter. For me, it was difficult to

follow the discussions since there was frequent back and forth between elders. It was impossible for the interpreter to translate everything without losing the thread of the discussion. Therefore, it is hard to interject to ask for clarification. It is also difficult to evaluate how things are going or when it is necessary to re-focus the group. There are many things that I missed, but the elders and the interpreter were patient as they would stop to explain particular terms or ice conditions when the discussions had resulted in a consensus. For the interpreter, it is equally hard to keep up with simultaneous translation as to remember all the details to translate when there is a pause in conversation. Inevitably some aspects were missed, and although the session was taped with a digital audio recorder, it is confusing to transcribe overlapping speech and with minimal translation.

Second, whenever involving more than one person it can be more difficult to organize and coordinate sessions. Both the preparation and the execution of the focus group were more time-consuming than interviews. However, the unique results and insights into inter-personal dynamics are worth it.

Third, because inter-community dialects (and even pronunciations) were elucidated through focus groups it became more challenging to represent Inuktitut terminology to the satisfaction of each elder. These variations related back to particular camp leaders or families having their own way of speaking (although it is still understandable to other families). Therefore, compromises were necessary where one term could not be agreed upon. In those cases two to three dialect variations would be represented (or a more traditional Inuktitut term would accompany the recently used term for the same ice condition) to ensure that the language components were as representative of the community as possible.

Fourth, inviting people to group sessions highlighted the blurry boundaries between relationship-building, knowledge-sharing, and research. It raised the issue of how to distinguish between talking to people, and conducting research. Focus groups conducted in

the third research trip were formally scheduled, with invitations extended to specific individuals (Section 3.3.2.3). Therefore, honorarium amounts were mutually agreed upon prior to the group session. In contrast, the group sessions in the fourth research trip (Section 3.3.2.3) were promoted as informal drop-in sessions. These aimed to provide participants an opportunity to see interim results, and to provide feedback where they felt revisions were necessary. However, those who showed up stayed for hours, carefully reviewing results. This was much appreciated on my part, but it was not anticipated. I had not planned to provide honoraria for dropping by, but individuals expected to be compensated for their time after staying for several hours. So the informal sessions turned into focus groups, and participants were given honoraria accordingly. People are accustomed to being paid for attending meetings, as well as for participating in interviews or other aspects of research. Therefore, it is important to clarify expectations and to establish honorarium amounts prior to meeting in groups, in order to avoid potentially awkward situations. There is also potential for concern where expectations may become unreasonable (e.g. chatting over lunch could be construed as requiring payment).

Finally, focus groups can sometimes lead to more confusion or work to sort through the different responses. Nevertheless, I feel they were an important complement to other research methods. They helped with aspects of results triangulation and terminology accuracy to ensure that my interpretations were as close as possible to the intended meanings of a particular term or explanation. These group sessions were thus part of the reporting and verification process, as well as the beginning of efforts to improve communications between community members and scientists.

#### **8.1.6 Communication strategy**

Developing an effective and appropriate communication strategy (Section 3.4) was crucial in gaining, and maintaining, community support for/involvement in my sea ice project.

This began in the initial contact phase, and continued throughout the entire research process, whereby reporting and knowledge-sharing were essential to each research phase (Section 3.1.1.7). I found that developing the communication strategy from the outset, and maintaining ongoing communication with community members and organizations throughout the project, was advantageous for several reasons:

- initial and ongoing contact improves community awareness of research objectives, methods, and findings;
- early and continuous communication builds community familiarity with the researcher, and increases the researcher's visibility and recognition;
- providing interim results and requesting feedback throughout promotes two-way dialogue;
- providing interim results and requesting feedback throughout improves the accuracy of representing the community perspective;
- ongoing communication enables progress towards true collaboration;
- continued dialogue helps researchers and communities to understand each other's experiences, interests, and concerns; and,
- a sound communication strategy establishes a foundation for research partnerships.

The communication methods employed throughout this research process are important to examine for their relative strengths and weaknesses in a northern, community-based research context. Through a refinement of my communication strategy I attempted to incorporate the elements that community members themselves suggested would be the most appropriate ways to report on project progress/results, including:

- written materials (bilingual in English and Inuktitut, although not everyone can read, or pays attention to written materials (AE1; IN1; JoM1; LU1)
- the Internet (but Internet access and speed can be a problem) (AN1; LU1)
- video (AN1, LU1; JoM1)
- audio (AN1; JoM1)
- in person (AN1)
- over the radio (IN1; KS1)
- presented in a (community) meeting (SS1; EN1)
- making results available to the public (in any way) (AE1; KS1)
- incorporating results into school programs (AE1; KS1)

Interim reports (Section 3.4.1) along with informal meetings/presentations (Section 3.4.2) alleviated some of the local concerns of the lack of reporting from previous projects (Table 8-1). Although they did not provide results per say, their recurring nature helped to

**Table 8-1:** Summary of the strengths and weaknesses of various communication methods used in the overall communication strategy.

Communication method	Strengths	Weaknesses
<b>Interim reports</b>	<ul style="list-style-type: none"> <li>- provides updates throughout the research process</li> <li>- opportunity for community review of preliminary results</li> <li>- shows who had been involved and the topics covered</li> <li>- direct form of communication</li> <li>- brief overview of project progress</li> </ul>	<ul style="list-style-type: none"> <li>- time-consuming to write and mail reports to each person/organization involved in/supportive of the project</li> <li>- translation time required can cause delays in sending reports</li> <li>- some people do not pay attention to mail, or written materials</li> </ul>
<b>Informal meetings/presentations</b>	<ul style="list-style-type: none"> <li>- useful to propose the project, gain valuable feedback, and gain support from local organizations/coordinators – continued communication</li> <li>- small group numbers, and joining previously scheduled board or council meetings, assures attendance of key people</li> <li>- raises awareness about the project in the community</li> </ul>	<ul style="list-style-type: none"> <li>- people attending are not always interested</li> <li>- the informal aspects make them difficult to formally incorporate in results or analyses</li> <li>- time-consuming to prepare for</li> <li>- difficult to appropriately target the age or audience composition</li> </ul>
<b>Radio shows</b>	<ul style="list-style-type: none"> <li>- reaches a broad community audience in a short time</li> <li>- useful to propose a project, present updates, or present results</li> <li>- informs community members who were not involved</li> <li>- easy for people to provide feedback or ask questions</li> </ul>	<ul style="list-style-type: none"> <li>- hard to gauge community response to information presented</li> <li>- cannot incorporate visual aids or explanations</li> <li>- limited radio hours due to funding, permits, or lack of volunteers</li> <li>- lack of air time when important community events are underway</li> </ul>
<b>Posters</b>	<ul style="list-style-type: none"> <li>- visual summary of interim or final results – greater interest than reports</li> <li>- accessible in public places – more likely to be read or referred to</li> <li>- raises awareness of the project beyond those who were involved</li> </ul>	<ul style="list-style-type: none"> <li>- time-consuming to create and print</li> <li>- large format can take up too much space on office walls (either no room, or other information/posters have to be taken down)</li> </ul>
<b>Information pamphlets</b>	<ul style="list-style-type: none"> <li>- brief, easy to read, and more appealing than reports</li> <li>- easy to distribute, whether in person or not - can reach a broad audience</li> </ul>	<ul style="list-style-type: none"> <li>- pamphlet size does not allow for much detail on the project</li> <li>- a one-way form of communication, does not elicit much feedback</li> </ul>
<b>Results summary reports</b>	<ul style="list-style-type: none"> <li>- condensed point-form results with visual aids highlights key results</li> <li>- results can be directly mailed to individuals/organizations that were involved in/supportive of the project</li> </ul>	<ul style="list-style-type: none"> <li>- challenging to adequately summarize results and still provide an informative and useful overview of research findings</li> <li>- lengthy documents are of little interest, and are costly to translate</li> </ul>
<b>Public meetings</b>	<ul style="list-style-type: none"> <li>- personal contact was emphasized throughout the project</li> <li>- valuable discussion forum, encourages involvement of people who had not participated in the project directly</li> </ul>	<ul style="list-style-type: none"> <li>- difficult to organize (requires local help and several days in the community to arrange for food, drinks, and adequate advertising)</li> <li>- poorly attended, does not reach a large audience</li> </ul>
<b>Maps</b>	<ul style="list-style-type: none"> <li>- maps are of most interest, they have the most potential for practical use</li> <li>- community members can relate to, and interpret, results more easily</li> <li>- valuable learning and communication tool, always sparked discussion</li> </ul>	<ul style="list-style-type: none"> <li>- static, two-dimensional representation does not adequately reflect the dynamics, dangers, and yearly variations of sea ice conditions</li> <li>- some people are not familiar with reading or using maps</li> </ul>
<b>Copies of audio/video tapes, transcripts</b>	<ul style="list-style-type: none"> <li>- most detailed accounts of interviews, un-edited full length interviews</li> <li>- provides access to original statements made by each individual involved</li> </ul>	<ul style="list-style-type: none"> <li>- can be an overwhelming amount of information</li> <li>- not everyone knows where to find this information</li> <li>- storage space may limit the amount of time materials are kept</li> </ul>
<b>Website</b>	<ul style="list-style-type: none"> <li>- project information, timeline, summaries, and other documentation is widely accessible</li> </ul>	<ul style="list-style-type: none"> <li>- Internet access can be slow</li> <li>- not everyone has access to the Internet or can use computers</li> <li>- does not provide directly practical information</li> </ul>
<b>Informal communication</b>	<ul style="list-style-type: none"> <li>- most personal, and so the most relaxed</li> <li>- covers diverse topics, important for gaining community context</li> </ul>	<ul style="list-style-type: none"> <li>- ethical considerations for directly incorporating these communications into research results</li> </ul>

maintain ongoing contact with individuals and organizations. Interim reports sent to each individual involved in the project helped to reassure people that they were not forgotten, and that their contributions were valued. Similarly, informal meetings and presentations allowed for ongoing updates which provided additional opportunities for local support and feedback (Table 8-1). These types of meetings proved to be the most productive, and the most feasible, over the course of the project (Table 8-1). Preparing for the meetings, and especially writing/sending the interim reports, was time consuming to maintain a timely reporting schedule (Table 8-1). However, these efforts were worthwhile since they were among the most direct (i.e. personal) means of keeping people informed. From a few comments I received in each community, people were happy to receive interim materials and updates. They appreciated even brief reports, so they were aware of project progress. However, mailing written reports may not be effective for everyone. Some elders do not pay much attention to written materials (Table 8-1). Furthermore, the high school class presentations I conducted in each community (grades 9 – 12) were an important step towards informing and involving the youth. These presentations were perhaps not critical to the research itself, but they were a way to: i) give back to the community; ii) provide students with ideas for project or career options; iii) learn more about sea ice around their community; and, iv) encourage involvement in educational programs. However, not everyone in a group will be interested, and it can be challenging to appropriately target the age and/or composition of the audience (Table 8-1).

Going over the local radio (Section 3.4.3) is one of the most effective ways to reach a broad community audience (Table 8-1). I found that this method of communication was most valuable in the initial stages of the project due to the higher numbers of comments and suggestions that I received. During the reporting stages it was challenging for me to effectively summarize the results in a 10-minute radio slot and still provide a meaningful, representative indication of what the project achieved. It is also hard to gauge community views over the



radio (Table 8-1), but at least it is assured that many people hear it. Some challenges with radio station staffing and air time also hindered the number or duration of radio opportunities in each community (Table 8-1). As a complement to on-air communication are visual or written project summaries such as posters (Section 3.4.4) and information pamphlets (Section 3.4.5), respectively. These are effective because they are accessible in public places such as the Hamlet Office, school, or HTA. For posters this means they are referred to more often, and for information pamphlets it facilitates distribution (Table 8-1). Furthermore, both provide short project summaries. Posters would be more appealing to those who are visually oriented, and pamphlets to those who prefer to read (Table 8-1). The drawbacks to posters include the fact that they can be time-consuming to create, and sometimes they take up too much space to be feasibly showcased in local offices (Table 8-1). As for the information pamphlets, they do not incite much feedback (Table 8-1).

In terms of communicating research results, I incorporated written results summaries, public meetings, maps, and copies of original audio/video/transcript data. It was challenging to effectively collate and summarize results chapters (Section 3.4.6) without refining things so much that the points were too general and vague (Table 8-1). These documents also had to be translated, whereby the per page translation cost is another impetus for having short summaries (Table 8-1). Along with the results summary reports I arranged for an open public meeting (Section 3.4.7) in each community to provide a summary of the results in person. Presenting the results in person was deemed important, but such meetings were considerably harder to organize, and less well attended, than initially anticipated (Table 8-1). Interestingly, the meetings drew people who had not participated in the project, whereas I had anticipated the opposite. In addition, from discussing these experiences with others in each community it seems that open meetings were not of much interest for several possible reasons:

- a) it was spring time, and although the kids were still in school many families were out traveling or hunting in the evenings nearing 24-hour daylight;
- b) it was playoff hockey time, so people may prefer to watch the game than attend a meeting;
- c) some people are overloaded with meetings to attend, so meetings that are not mandatory are not appealing;
- d) some people have no interest in the project;
- e) when there are family issues that need to be taken care of, they are understandably prioritized over meetings; and,
- f) some people do not have transportation and thus may not have been able to get to the meeting location (e.g. some elders cannot walk across town).

Based on these experiences, it might be advisable to only attempt such public meetings: i) in the late fall or winter when most people are in town; ii) when there is another large meeting going on to which it could be added to the agenda; iii) when direct invitations are sent out to people, instead of an open invitation; and/or, iv) at the end of a longer research trip, so that more time is afforded to informing organizations and the researcher has had more presence in the community prior to the meeting. These meetings were still beneficial in that the people who did attend seemed interested and appreciative of learning more about the project results. However, it may be more valuable to present the research results in smaller, more informal meetings such as in the preliminary community visits (Section 3.3.1).

Additional results reporting was provided through compilation maps (Section 3.4.8) and copies of original audio/video/transcript data (Section 3.4.9). The maps drew the most attention, and seem the most likely materials to be of practical use to community members (Table 8-1). Many of the experienced hunters were interested to see how conditions were represented, or what areas were missed. However, for the younger hunters it was somewhat of a learning tool to locate ice conditions where they may not be familiar with the area (Table 8-1). The maps were also important discussion pieces. They got people talking to each other about particular places, routes, hunting grounds, and even stories (Table 8-1). Hunters are well aware of the short-comings of maps (Section 8.1.3, Table 8-1), but they still found that they were a valuable representation of sea ice conditions, dangers, and change. In contrast, while

the audio/video tapes and interview transcripts provide the most detailed accounts of research outcomes, the volume of information can be overwhelming and thus referred to infrequently (Table 8-1). Furthermore, it is important to consider where the results will be stored because sometimes space limitations in a local office are such that older reports get thrown away (Table 8-1). Therefore, it can be difficult to maintain continuity of the research results, or even to access previous research done in the community. In addition, when results or reports are deposited in a central location, often people are not aware that they are there – despite a researcher's best efforts to inform people (Table 8-1). So, people may think that reports were never made, when in fact they are sitting in the community. This is why it was important to have radio shows, community meetings, results summaries, and information pamphlets to highlight where results were made available.

The website (Section 3.4.10) was perhaps of most use to other project partners in southern or academic institutions (Table 8-1). I did not monitor traffic to the site, but only in the fall of 2005 did the communities gain access to high-speed broadband Internet. It is not yet a popular option for locating information for the middle-aged hunters and the elders who were most directly contributing to the project (Table 8-1). However, youth in the schools are avidly using the Internet on a consistent basis, so this tool could become increasingly valuable for future communications with younger generations. Another consideration for the lack of utility for a project website is that it is not of direct practical importance to community members (i.e. in comparison to weather forecasts or satellite image access) (Table 8-1).

Informal communication (Section 3.4.11) is the most personal interaction, and thus is possibly the most valuable and informative (Table 8-1). A lot of valuable cultural and community context was provided in informal settings. These informed my own self-reflection and research process, but they could not be formally incorporated into the results (Table 8-1). This was one of the most challenging aspects I found with the collaborative research approach.

It was sometimes difficult to separate the research process from my own personal learning and experience.

Developing and implementing a communication strategy requires a lot of time and effort. Within this project, maintaining and improving communication throughout the course of the research took up nearly half of all the time dedicated to the project. These efforts can easily go unnoticed in communities, as well as in academic institutions, and yet they are imperative time investments to ensure successful and representative research. Communications, and ongoing alterations according to what is most locally effective or appropriate, are essential if we are to improve our collective capacity to link Inuit and scientific expertise in a practical, useful manner.

## **8.2 Community perspectives on working with researchers**

Underlying the entire research process is the issue of research relationships between Inuit and scientists. Challenges or opportunities would arise in field research depending on a person's past experiences with scientists or their perspectives on what researchers do and why. In order for scientists to learn from Inuit about sea ice, or to link Inuit and scientific knowledge on sea ice, Inuit have to be willing and interested in working with researchers (Laidler, 2006b). To find out what community members think of working with scientists I asked into: i) previous experiences with researchers; ii) methods of research reporting; and, iii) views on working with scientists (i.e. analysis codes: experience with scientists, learning from each other, reporting of research results, scientific methods, working with scientists (Section 3.3.3.1)). The comments provided in the interviews are important to share so that researchers – myself included – can better understand, and thus respond to, community perspectives on northern research and those who undertake it.

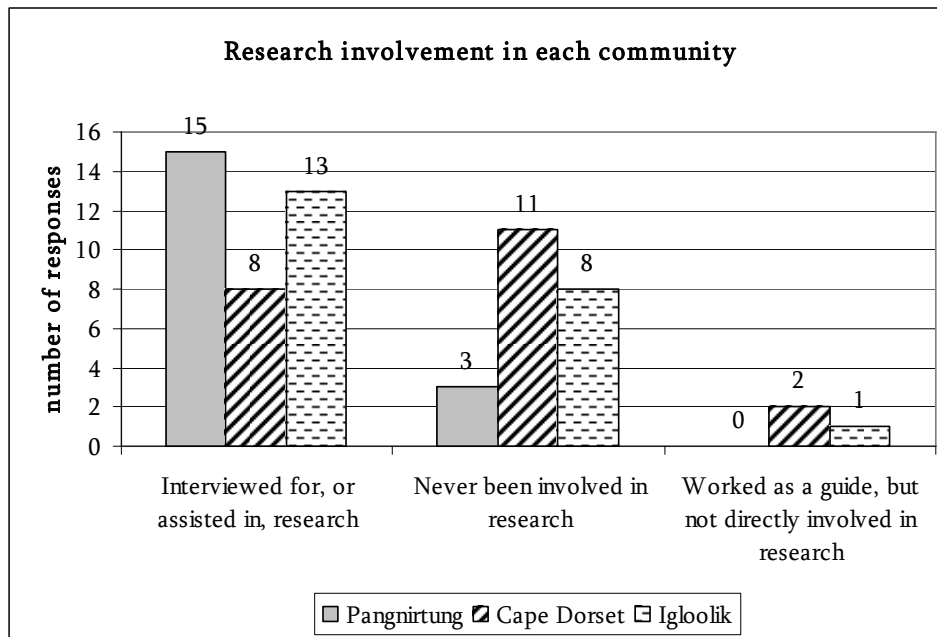
Efforts to link Inuit and scientific sea ice expertise, in a manner that broadens both knowledge bases, requires consideration for the underlying differences in: i) life experiences; ii)

methods of learning or investigation; and, iii) goals for understanding sea ice (Laidler, 2006a). Cultural and epistemological differences influence these distinguishing characteristics of Inuit and scientific knowledge (Section 2.1.1). As researchers we are mainly familiar with western-influenced ways of thinking, according to the particular discipline in which we have been trained. Even in speaking the English language, our thought processes are very different from Inuktitut speakers. Therefore, this section aims to familiarize the reader with some of the Inuit perspectives on scientific means of monitoring or characterizing ice conditions and change. It is hoped that an enhanced comprehension of local viewpoints can contribute to more practical ways of intersecting different knowledge systems.

### **8.2.1 Previous community experience with researchers**

Of the three communities, elders and hunters in Cape Dorset seem to have the least experience working with researchers (Figure 8-1). Common research topics in Cape Dorset focused on: artifacts, carvings, art work, placename mapping, climate or weather change, caribou and seal skin clothing, and wildlife. Two of the elders interviewed had also acted as teachers in school programs where children were taken out on the ice and taught about how to use a harpoon, and how to test ice safety. In contrast, people in Pangnirtung have worked with researchers the most (Figure 8-1). They have been asked, or assisted in, research about a range of topics, including: life in the past, wildlife (seals, beluga, caribou, falcons, arctic char), sea ice conditions and change, weather prediction and change, climate change, clouds, minerals, lakes, glacier changes, carving, hunting, and travel safety. Six people had assisted scientists with data collection such as beluga or arctic char tagging, lake coring, and mineral sampling. Three had acted as guides, taking researchers to and from field sites safely, and one had been a teacher in an ongoing university summer field school (run through the University of Winnipeg). Igloolik was similar to Pangnirtung in terms of the number of people having worked with researchers before, but there was also a higher number who had never been involved in research (Figure 8-

1). Those who had research experience were interviewed on, or assisted with, projects that focused on: sea bottom animals, lake or ocean fish, marine mammals, plants and Inuit traditional knowledge. Furthermore, several people had also been: i) involved in the Igloolik Oral History Project of the Inullariit (elders') Society, run through the NRI (Igloolik branch); ii) working with Isuma Productions in terms of Inuit heritage; iii) employed by the NRI; or, iv)



**Figure 8-1:** The number of people previously involved, or not, in research in their communities.

involved in making their own videos. Elders and hunters in Igloolik seem more actively involved in research, as seven had acted as research assistants in collecting samples for biologists, geologists, or photographers, four had worked as guides, and two had worked as interpreters. Furthermore, one person had previously worked as a wildlife officer, so he had experience working with numerous scientists and biologists, as well as developing survival courses and materials.

### 8.2.2 Life experiences

One of the most prominent differences between Inuit and scientists are the life experiences that influence the way they learn, and come to understand, sea ice characteristics

(Laidler, 2006a). Inuit live in the Arctic, so they experience sea ice dynamics, variability, and change in ways that affect their daily lives (Laidler, 2006a). In contrast, scientists study the sea ice environment, which may or may not occur daily and is typically removed from experiences that would physically affect life outside the workplace (Laidler, 2006a). Therefore, the implications for Inuit understandings of sea ice can literally be a matter of survival, while for scientists the implications are more theoretical by nature (Laidler, 2006a). Granted, scientists refine their understandings through years of practical experience and learning from others in an academic setting, but the intimate relationship between hunters and the sea ice necessitates a different form of learning than from books, journal articles, and scientific field work and/or experiments (Kawagley, 1998; McGrath, 2003; Bennett and Rowley, 2004). Rather, experiential and practical learning through sea ice travel and use are critical in the development of Inuit sea ice expertise (Nelson 1969, Freeman 1984, Riewe 1991, Immaruittuq *et al.*, 2000; Aporta 2002). Gaining first hand knowledge on sea ice is vital for safe ice travel and navigation, making each experience a lesson and the observation of others an essential component of learning (Laidler and Elee, in press). People are learning about the ice through hunting or traveling on the sea ice. It is not a formalized teaching, and often the hunters interviewed explained that as youth they did not even realize they were being taught; traveling with their fathers or other family members was mainly how they learned (JI1; MJ1; MM1). When people were mobile (i.e. not yet settled in the communities), observing the ice, the weather, the environment was a way of life. It was intertwined with daily and seasonal routines, it was not a conscious decision (ME1; MM1; TI2). Young boys were taught through demonstration, as they would observe older hunters going about their hunting techniques, preparation routines, or sea ice navigation (EM1; KS1; MJ1; MoK2; NQ1; TI2). Their experiences would thus follow a natural progression of watching others, trying it for themselves in a supervised or controlled setting, and then with their confidence building they would venture off on their own (MoK2; EK1; NQ1).

Furthermore, individualized experiences accumulate as part of a self-teaching process, through trial and error, and most importantly through constant sea ice use (AQ1; EK1; DaN1; NQ1).

“A lot of information [I’m] giving out is self-taught, a lot of it came from different sources of people. When [I] was a youth, [I] would travel with different companions, and from those different people [they] had different knowledge bases. So therefore, [I] was learning different things from different hunters, when [I] was first getting out and about, and [I] was traveling, just accompanying other hunters. And then afterwards [I] learned a lot of it by [myself], through trial and error.” (Qamaniq, 2004)

Therefore, a person’s experiential education was dependent on the types of hunting and travel that their family undertook, who they hunted with, and their relation to the individual (MJ1; SA1).

“So the difference he finds, for example himself (Ammaq) and myself (Ikummaq). He grew up around his father, and his father was the only one that he was accompanying when he was young, on hunting trips. Whereas myself, I went with cousins, uncles, brothers, whoever was going out pretty much. And he stuck to his father. In our culture we find that when you have a situation like this, they’re more hesitant to ask their father about certain items, there’s less communication than, for example, between me and my cousin. So we confer more than they would. So therefore, what language that might have been taught on those trips wasn’t done when he was out hunting with his father. Whereas if you take a person like myself, going out with brothers, uncles, aunts, not aunts, cousins, we talked more I think. And I wasn’t hesitant to ask questions either. And he was hesitant to ask questions. So therefore the language probably didn’t come out exactly as it did to some of us, the language that had been taught. The knowledge was there, the language isn’t.” (Ikummaq explaining based on Ammaq, 2004)

Inuit have lived on, and used, the land and sea ice for generations. Therefore, community members feel that if scientists want to learn about these environments they should be asking Inuit – learning from Inuit (AN1; KS1; DAq1; MA1; AI1; JoP1; EP1; DI1; JoM1; MM1; PQ1; JI2; ME1; LI1).

“[I] can understand the fact that in the 1970s the Inuit literally battled and fought with scientists, wildlife officials, because of the fact that Inuit were using what they already knew, what they had already experienced...In utilizing that information, every time they tried to explain to the kallunaat<sup>1</sup> what it was, the kallunaat would say ‘no, this is not true, we have our own theory, this is how we see it’. And that was literally in Inuktitut what you call ‘backward people’, because of the fact that

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<sup>1</sup> *Kallunaat* refers to white people, or southerners, in Inuktitut.



they think they do have an understanding but that literally they don't. And this is the time when the elders and the scientists are to meet half way and then start utilizing their knowledge to work together towards bridging that gap in order for them to have a clear understanding where things are coming from....And [I'm] always hopeful that the scientists can get off their high chair and come down to being a human, human enough to understand that Inuit way of life. This is the life that [we've] lived and [we] know what [we're] talking about. You know you don't have to be a rocket scientist to understand some of the issues up north. So [I'm] just hopeful that [we] can work together, you know for a better future." (Ishulutak, 2004a)

If scientists are not consulting local Inuit experts then some interviewees felt that they are taking the long way around, they will be less efficient (MJ1; AE1; QT2).

Because scientific means of studying the sea ice are typically conducted outside the community, and even beyond the physical sea ice context (i.e. remotely through satellite imagery or sporadic field work), some community members see no value in scientific information. Nevertheless, the majority of respondents felt that because of the different ways of relating to sea ice, that Inuit and scientists have a lot to learn from each other. Therefore, working together was seen as being potentially beneficial to both (AN1; OO1; EP1; LU1, DAn1). If scientists and Inuit each do their own studies, more mistakes can occur, so by working together they can keep an eye on each other (MM1). Hunters saw themselves as having the knowledge about ice conditions and the environment, and scientists as having the technology (DQ1; AT1, NQ1, ZA1) and the ability to put it all together (AU1). Therefore, in the community context Inuit knowledge is considered more concrete and practical (MJ1), while scientific knowledge is more abstract, or uncertain (TI2).

"[T]hey should work together, but there's a lot of things that they wouldn't be in agreement much, I think. It's only what I think ok? It's not what is. Ok if you look at scientific journals, there's all these 'ifs', and 'when', and 'maybe', and you know, if you ever read scientific journals, 'it could have been', 'should have been', there's nothing definite about let's say the findings in a scientific journal, it's all guesswork. Whereas with hunters there's no guesswork. As a matter of fact, if there's guesswork involved in your hunting, you're not successful. Everything that you use for your hunting, it has to be concrete, it has to be something that you can rely on that's definite. So therefore if you're hunting you have to be definite, there's no maybes, there's no ifs, there's nothing like that, it is as it is. And guesswork is out of

the question, if you're guessing as you're going you're not going to be successful. And I find these two ways of doing things, where the hypothesis is thus, so therefore they try and figure out what the hypothesis is going to prove, and in doing that you forget everything else. Whereas, a hunter looks at everything and then comes up with the hypothesis at the end. So there's these two ways that I think could conflict along the way, but if they were to work together it would be beneficial for both. The Inuit might learn how to guess, the researcher might learn how to be more concrete." (Ikummaq, 2004b)

"...let's say we would go back in the 1960s, we are nothing to scientists. We are just poor smiling Eskimos to them, to the scientists, they know everything....Those days they know everything. I got those information from my uncles, they used to get frustrated trying to explain to the guy and that guy didn't believe. Nowadays like I told you I travel some places, we are trying to work the traditional knowledge, compare it to western science. Somewhere it never fits together, you have to go around that and try to explain both of them, try to explain, and sometimes they don't understand what is going on. The people who are living in that area and the scientists come in, they know everything, they come from university, and they think they know lot of things. Here to there is totally different. You go to Broughten [Island] from Pangnirtung, it's different. So scientists intend to have the whole Baffin Island same thing, but every place is different so sometimes we seem to be lying when we try to explain something to the scientist. Because he has a written text that was done in Pond Inlet, somewhere, he tries to use that in Pangnirtung area. Pangnirtung is totally different from Pond Inlet so that's difficult. And they wanted to try and put things together, it's a lot more understandable when they work together...But nowadays a lot easier, it's 2000 now, it's not '60s now, it's a lot easier to explain. But the most frustrating is, us we don't have even grade 12, but scientists have university degree, that's a difficult situation we have, that we don't have grade 12, he doesn't believe what we are saying. But we live here....[it's] like being a father, the kid trying to be the boss when he wants something, at first it's very hard to stop him doing that eh? It's like scientific and traditional knowledge colliding together." (Papatsie, 2005)

Despite the emphasis on enhanced consideration of Inuit expertise in research, there is also a recognition that as lifestyles change in northern communities (Duerden, 2004; Armitage, 2005) there will be a need for more formalized teachings. Using the ice is no longer a way of life for today's youth (Ford, 2005; Ford *et al.*, 2006a; Ford *et al.*, 2006b), so they have a lesser understanding of ice conditions, dangers, changes, variability, uses, terminology, etc. (ME1; MM1; TI2). Without using the ice every day sea ice expertise is quickly lost (TI1). Therefore, in the long run working together with scientists was seen

as providing more information on ice conditions and change (SK1; JoP1; MoN1), as well as improving the quality of the findings (DAn1).

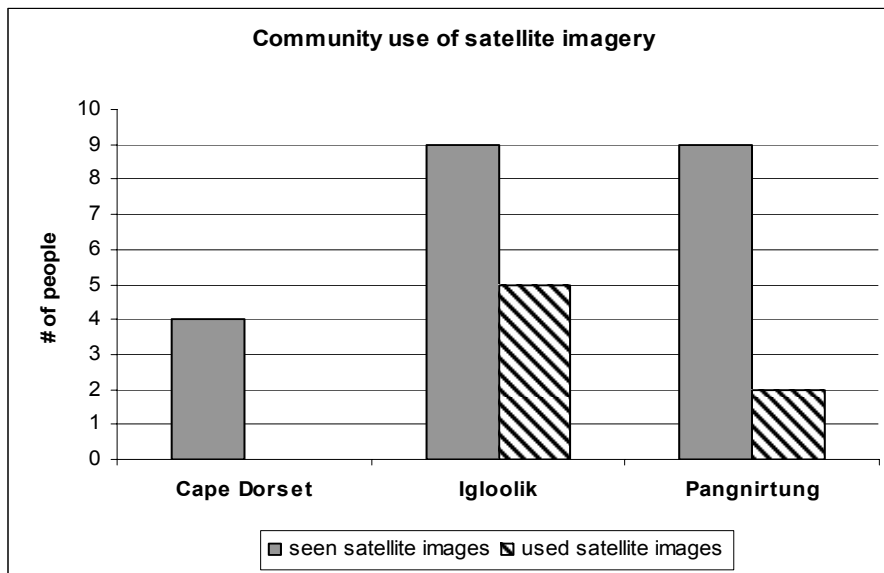
### **8.2.3 Methods of sea ice investigation and knowledge acquisition**

Because of the vast expanse of sea ice cover around the poles, satellite imagery is currently one of the most commonly employed methods of monitoring and assessing sea ice conditions and change in the polar regions (Mysak and Manak, 1989; Johannessen *et al.*, 1999; Parkinson *et al.*, 1999; Huntington, 2002). Therefore, this scientific means of remotely monitoring sea ice will be employed as an example to explore Inuit perspectives on scientific methods. Having gained some insight into the life experiences that contribute to learning about sea ice (Section 8.2.2), we can focus specifically on satellite image interpretation/use in the three communities. This will aid to find some common ground or mutual benefits in linking sea ice expertise based on different modes of knowledge acquisition.

Through years of personal interaction with, and inherent observation of, the marine environment Inuit hunters have gained individualized knowledge that cannot be learned through hearsay or observation alone (LI1, EN1; MM1; AT1). Within the community context, learning about sea ice inside, or away from the ice, was considered inappropriate since it will be impossible to use that information if a person has never seen the condition described (JAK1; MoK2; AQ1; EK1). Furthermore, it is harder to teach indoors because it is more difficult for the elders or hunters to think of all the important features, terms, or conditions when it is not in front of them (AA1; AP1). Therefore, traditional teaching methods would be to undertake practical tasks that require the use of sea ice knowledge (MoK2; AT1; AQ1; EK1; AA1; AP1; QT1) and the interpretation of environmental indicators (MJ1; TI1). Knowledge is passed on orally, and through repetitive experience (LI1, EN1; MM1; JN1; TI1; ZA1; MJ1). This transmission process provides 'information packages' that enable hunters to undertake real-time evaluations of ice stability and safety (Laidler, 2006a). While the more elderly and active

hunters prefer to rely on this method of learning and using the sea ice (AA1; AI1; AQ1; HP1; NP1; PP1; QT1; ZA1), other community members are interested in the potential utility of satellite imagery to assist their travel navigation or assessment of ice conditions (AT1; DQ1; JaM2; JoM1; JS1; LU1; MJ1; MoK1; TI2).

When asked for opinions on the use of satellite imagery to study the sea ice (based on images in Appendix 13), people in all three communities responded positively that they felt the technology can be useful (AN1; AT1; JaM2; JM2; JoM1; LE1; LN1; ME1; MoK1; MoN2; SK1). Despite the interest in using satellite imagery, very few of the interviewees are actively using images on a regular basis (Figure 8-2). This is most prevalent in Igloolik, and then Pangnirtung, while in Cape Dorset no one responded as having used satellite images before (Figure 8-2). The imbalance between having seen, and having used, satellite imagery for sea ice



**Figure 8-2:** The number of people who have seen, or used, satellite imagery of ice conditions.

navigation may be due to the fact that: i) Internet access is slow in northern communities (AN1; AE1) (although by the fall of 2005 high speed broadband access was available and may affect responses if this question was asked now); ii) Internet access is not available to everyone (e.g. hunters often rely on employees of the government building, hamlet office, or HTA office to

download the images) (AN1; AE1; DAq1; HP1; LU1); iii) not everyone knows how to use a computer (AN1; AE1; DAq1; HP1; LU1); iv) the imagery can be difficult to interpret (DAq1; DI1; DQ1; EI1; HP1; MaN1; NP1); and, v) there is limited imagery available for free (AE1; SK1). Nevertheless, some community members are already putting satellite imagery to use in several ways, by:

- consulting images to evaluate the ice conditions before leaving town (AN1; JaM2; JoM1; LE1; LN1; ME1; MoK1; MoN2)
- planning travel routes, especially for boat travel (AT1; DQ1; JM2; JS1; LE1; LU1; K1; TI2)
- assessing ice conditions in places that people would not normally see (either they are too far away or the ice conditions are too poor to access them) (AT1; JaP1; LN1)
- identifying areas of open water (AY1)
- understanding the progression of break-up (LN1)
- incorporating them in search and rescue operations (ME1)

Community members also recognize some of the short-comings of using satellite images to evaluate conditions used for sea ice travel. One is that the images only provide a ‘bird’s eye view’ of the ice, and most hunters prefer to be evaluating the ice ‘on the ground’ as they travel (NP1). Therefore, there is a disjuncture with the *in situ* experiential methodology employed by community members and the remote, coarse resolution investigations undertaken by scientists. It was frequently reiterated that just looking at images cannot do justice to the ice conditions, you have to be there to really know what the ice is like (DAN1; DI1; DQ1; LQ1; MA1; MaN1; TI1). Another factor is that there is no indication of snow in the images, so it is difficult to tell how thick the ice is (LQ1). This also links to the fact that hunters feel that the images cannot tell them enough about related factors such as the currents, wildlife, weather, etc. (EK1; MA1). These would need to be accounted for in order to properly study or evaluate ice conditions in a manner that would be beneficial at the community level.

Interestingly, the real value associated with the satellite imagery – also the main application of satellite imagery within a community context – was the ability of radar images to provide clear delineations of ice versus open water. Therefore, the most frequent use of the

images was in the summer to indicate areas without too much moving ice, thus rendering them accessible by boat (AT1; DQ1; JM2; JS1; LE1; LU1; K1; TI2). In Igloolik especially, satellite imagery was deemed useless during the winter, where the only way to really know the ice conditions is to use it (DAn1; DI1; DQ1; EI1; LQ1; MA1; TI2). Referring to satellite imagery in the winter was more prevalent in Pangnirtung, but the focus was on the identification of open water conditions, and thus the position of the floe edge (AY1; JI2). Therefore, satellite imagery is already being used as a complement to Inuit expertise. It is valuable to see ice conditions or features in areas hunters cannot normally access, or that are far from the community. Also, hunters are increasingly asking about scientific results when they find things that they cannot explain (e.g. why certain changes are happening).

Some hunters are combining the best of both satellite imagery and local expertise, in order to provide a more comprehensive view of ice conditions. Furthermore, younger or more inexperienced hunters are beginning to incorporate satellite and GPS technologies into their methods of learning about the sea ice (Aporta, 2004; Aporta and Higgs, 2005). They do not have the local expertise to fall back on, so they may ask for older hunters' advice, along with referring to GPS locations or recent imagery to plan or navigate ice routes. Therefore, life experiences, along with methods of learning about, and understanding, the sea ice are intimately related to the goals which inspire interest in sea ice.

#### **8.2.4 Goals in investigating or using sea ice**

Broadly speaking, Inuit communities value, and seek, sea ice knowledge that promotes reliable personal safety assessments, harvesting success, and weather prediction (Laidler, 2006a). In contrast, scientists seek an understanding of the physical and internal processes of ice formation, decay, and motion, while also aiming to identify long term trends in sea ice extent, thickness, and distribution (Laidler, 2006a). While both Inuit and scientists value reliability of observations and expertise, an underlying variation between goals leads to a

different focus on ice conditions or change. Scientific studies are predominantly time-focused, aiming to create reliable time-series and uniform, chronological data sets (Krupnik, 2002). On the other hand, Inuit knowledge focuses mainly on developing detailed, localized accounts of sea ice characteristics and environmental influences (Kofinas *et al.*, 2002; Krupnik, 2002; Norton, 2002; Oozeva *et al.*, 2004). Therefore, the assessments of reliability within Inuit expertise are derived from the age or experience of the person making observations/warnings/predictions (MoN1; ME1; JN1; AT1; ZA1; AN1; EP1; MJ1; EE1) rather than on statistical significance. Since the information is stored in peoples' minds (JQ2), and passed on orally (LI1), Inuit sea ice expertise is passed on through demonstration and explanation. This contributes to the goal for Inuit understandings of sea ice – to enhance the safety of travel and the success of hunting – with such information being accepted as true based on the person who is sharing it (MK1; TI1). Therefore, local expertise, especially the older ways of teaching and learning, are likened to the quality of education received at university (MK1). There is great pride taken in providing accurate information, thus there is hesitancy for Inuit elders and hunters to speak of things that they have not been directly experienced and/or verified (LI1; EN1). Only after a certain number of experiences, accumulated over years of hunting and traveling on the sea ice, does an individual obtain responsibility for their knowledge (i.e. becoming an adult) (JI1). In contrast, it is recognized that for scientific expertise to be considered accurate and reliable, it must be in writing (i.e. published) (LI1). This too takes many years of learning, experience, and trial and error, but in a very different context (i.e. formalized education). This links to the scientific goals of refining the accuracy and understanding of sea ice processes, ocean-atmosphere influences, and physical characteristics through empirical evidence and experimental modeling.

Along with the differences between the temporal and spatial focus of scientists, and the relationship focus of Inuit, the variations between Inuit and scientific goals for

using/investigating the sea ice are reflected in the terminology they use (Laidler, 2006a). Scientific terminology and jargon are notoriously hard for the layperson to comprehend (Norton, 2002), and yet Inuit ice vocabulary is perhaps even more challenging (e.g. Nelson, 1969; McDonald *et al.*, 1997; Oozeva *et al.*, 2004). Inuktitut terminology refers to ice states and processes, along with human interactions with the sea ice (Nelson, 1969; Aporta, 2002). Scientific sea ice classification focuses on physical characteristics (e.g. size of ice pans, thickness of sea ice), while the verb-based nature of Inuktitut recognizes interactions between humans and the environment through the process of naming sea ice (Aporta, 2002). Therefore, scientific terms may have universal meaning to those who are familiar with the literature, but local languages such as Inuktitut are not easily understood when separated from the experiential processes in which they were derived (Laidler, 2006a).

Within Cape Dorset, Igloolik, and Pangnirtung it was highlighted that in order to learn sea ice terminology you have to use it. Otherwise, a person cannot understand what people are talking about when they mention a certain ice type, they would not know what to look for (MA1; AA1; JaM1; LI1; MoN1; TI1; MJ1; QT2). For this reason there are more sea ice terms for conditions that are used more (NQ1; TI1; LQ1), and it is easy to forget the terms when not using the ice regularly (PP1; MJ1). Along with sea ice and local lifestyle changes being experienced in each community, sea ice terminology is also changing. Older Inuktitut terminology is not as commonly used, so distinctions were made between traditional and modern terms (JaM1; JQ1; PV1; AT1; DI1; SA1; LQ1; AA1; OO1; PP1; EP1; OM2; MJ1; QT1; QT2). Community members are using the traditional terms less because they are using the ice less, and so more modern terms are being incorporated into the sea ice lexicon (JAK1; AT1; DI1; AA1; OO1; PP1; EP1; OM2; QT1; QT1). When people move into a community, or have not used the ice in a while, they have to learn everything all over again (JAN1; SK1). Residential schooling for middle-aged Inuit meant a loss of Inuktitut language and terminology (OO1; SK1;



JAn1; EN1; Elee, personal communication). Even for the younger hunters, they are not as familiar with sea ice terminology because their schooling has been more formalized (LQ1; JAn1; SK1). This may be a combined result of more English instruction and less time on the ice. While Inuktitut is increasingly being emphasized in the school system, English is still predominantly used in classrooms and is becoming more common in homes and schoolyard interactions (AN1). Therefore, elders and active hunters feel strongly that Inuit youth should know more about the older ways, they want to pass on this knowledge in an effort to carry on Inuit culture (LI1; LI2; MoN1; MoK2; MoN2; DI1; TI1; TI2; AA1; OO1; QT1). Terminology and local expertise are essential components of this educational process, and contribute greatly to enhancing the safety of sea ice travel for people who are less familiar with particular sea ice dangers (AA1; AE1; LE1; LI1; MoK2; MoN1; OO1; OM1). While the goals of Inuit knowledge accuracy and transmission remain consistent with previous times, community members are recognizing the necessity of incorporating the school system (and some elements of formalized education) to facilitate the learning process (MoK1; EP1; AE1). Some hunters and elders feel that their knowledge would be more believable if they worked with scientists (LE1; JS1).

“Again, with the knowledge of the hunter, knowing again his surroundings in good detail, it would be beneficial to the person who’s doing the study. What [I notice] about today, for example the youth wouldn’t believe [my] knowledge if it’s not written down. They’re more into written material, something that they can see, and if a scientist has done a study on ice and that is presented to the youth, more than likely the youth will believe him because he has something written. Even though [I’ve] got all that information in [me], because [I don’t] have anything written they wouldn’t believe [me] as much as they do the researcher. So therefore, [I find working together] beneficial in that what reports are coming out of it would include the knowledge of the guy using it, for example the hunter. The hunter’s knowledge would now become documented, and them working together would be beneficial in that sense.” (Irngaut, 2004)

The emphasis on documenting local knowledge in order to provide written versions was highlighted as essential to rendering it more accessible to youth, and the school curriculum (DI1).

“...[I’ve] begun to understand more of how scientists work in trying to gather information. And the reason why [I’m] accepting it now, [I’m] thinking for the future of our children and our grandchildren in order for them to be able to have something on paper to understand what, how the changes have evolved over a period of time. And especially for the rest of the world to understand the environment that we live in.” (Nuvaqiq, 2004)

Beyond the inter-generational gaps in sea ice and terminology use, observations of changing ice conditions have also been linked to changing sea ice terminology. A part of the Inuit culture may be lost with the changes in sea ice conditions, since there would be no time to learn about the conditions with an abbreviated or altered ice season (PQ1). The ice terms themselves would not necessarily change, but if a particular condition no longer occurs then the term might no longer be used, or it would be employed at a different time of year (JQ1). Overall, elders and hunters want to teach others (including scientists) (Qappik, 2004b; Ishulutak, 2004b; MK2), but especially the younger generations (MoN1; MoN2; AT1; PP1; MK2; OO1; JAk1). They do not want the language and terminology to be lost (OM2), so there is increased interest in collaboration as traditional methods alone are not as effective in communicating with youth. Scientists too are interested in learning more about localized conditions, and the influences of these conditions on community life, in order to better tailor their studies to northern needs (e.g. Nichols *et al.*, 2004; Ford, 2005; Furgal *et al.*, 2005). Furthermore, there is great potential for the enhancement of scientific research quality and accuracy where Inuit expertise could provide a type of “ground truthing” that is impossible to gain through field work alone. Therefore, the integration of new, and different types of knowledge, could improve the ability of both scientists and Inuit to reach their goals related to sea ice use or investigation.

### 8.3 Linking Inuit and scientific expertise

#### 8.3.1 Overcoming skepticism and misunderstandings

Some Inuit remain skeptical of the value of research to northern communities (e.g. Nuttall, 1998; Wenzel, 1999; Furgal *et al.*, 2005), a sentiment echoed by other Indigenous groups (e.g. Deloria, 1995). This stems from concerns about: i) the intrusive nature of research methodologies; ii) a lack of local involvement in research; iii) poor communication with affected populations; iv) short field seasons; v) inadequate acknowledgement of credit; and, vi) conflicts over data ownership (Bielawski, 1984; Nuttall, 1998; Wenzel, 1999; Duerden, 2004; ITK and NRI, in press). Some manifestations of this general skepticism were encountered in the context of my thesis research, mostly revolving around researchers' motives and the use of research results. These perspectives seem to derive from misunderstandings about the purpose of research, as well as previously unpleasant research experiences. Some examples include beliefs that:

- scientists provide misleading information, mainly with regards to wildlife (scientific results vs. local observations/experiences, conflicts over establishing quotas)
- information given by community members has to be bought back
- researchers are profiting financially from the information they are given
- researchers are just out for personal acclaim (AI1; EE2; OM2; JaP1; JQ1)

These ideas about research may be due to limited interaction with researchers, or may be based on experiences with a few projects conducted in a different era, with a different mentality.

“[The researcher’s] frame of mind would be they come in, they get the information, and they use it out there on their behalf. Forget what this guy said. That was their mentality then and that’s one of the reasons why [I] never really got to working with them, even though [I] would have been able to work with them.” (Ivalu, 2005)

Unilingual hunters, and especially elders, have had less direct interaction with scientists, and generally do not understand the processes or purpose of research – ‘if you’re not going to be using the ice, why would you study it?’ For these reasons, some hunters are more confident in the utility and reliability of Inuit knowledge (AQ1). On the other hand, bilingual hunters,

especially those who have participated in the formal education system (i.e. middle-aged Inuit who have experienced both traditional Inuit, and southern, schooling) have a better grasp of both the advantages, and challenges, of working with scientists. Because of this, the middle generation of Inuit may be either the greatest proponents, or opponents, of northern research.

In addition, misunderstandings can be amplified through misinterpretation between languages. As such, the importance of a skilled and committed interpreter is emphasized (Section 8.1.2). If translations are unclear, if the interpreter is not supportive of the research, or if the interpreter is not allowed to make suggestions for improving questions or clarifying responses, it can compound communication problems. Without effective language skills in both English and Inuktitut, the subtleties of interview responses can be lost.

### 8.3.2 Local concerns with collaboration

The majority of Inuit elders and hunters interviewed believe that it is a good idea for Inuit and scientists working together (i.e. 48 out of the 52 people who were asked “Do you think that Inuit should, or could, work together in studying the sea ice?”). But despite this positive response there was no shortage of community concerns expressed with regards to the practicality of collaborating with scientists. Some of the challenges identified include:

- a) conflicting personalities
  - b) conflicting knowledge bases and tools used to study the ice
  - c) language barriers
  - d) decision-making (who is in charge, and how receptive they are to suggestions – specifically with regards to sea ice travel – either Inuit or scientists)
  - e) superiority (scientists deemed dominant)
  - f) what factors to consider in sea ice or wildlife studies
  - g) appropriate level of compensation (payment for time, services, or interviews)
- (MJ1; EE2; QT1; TI2; DQ1, AI1; LQ1; JoP1; JAn1; MoK2; MM2; AQ1; EN1)

Some of these challenges are described by Qattalik (2004) and Maniapik (2004c), respectively.

“...it’s beneficial for them to work together, that it can be a learning experience if the [researchers] are willing to learn. A lot of times you can have a scientist who comes here, knows everything, doesn’t want to listen to the hunter, no matter what he says. A lot of times that has happened in the past, and [I keep] that in mind. And also, if those two are working together the Inuk would have the knowledge

about the ice, wherever it may be. And then, if the researcher says they want to study ice and the Inuk says it's too dangerous to go there, then they conflict. More than likely the person in charge would be dominant in that they would have to go there, and face danger wherever they go. But the Inuk would know that it would be dangerous to be traveling through there. And if that happens they cannot work together. If any bit of conflict occurs. And if vice versa, let's say the researcher knows, by looking at previous photographs, that it would be safe to go traveling somewhere for some length of time that the hunter hasn't been using, then it can be beneficial for the hunter as well, using the knowledge of the researcher about that area that hasn't been utilized in recent times. So it can work either way. But then...if there's any conflict of any sort in how the study is going to be, where they're going to go, then more than likely it won't work at all. But if they're in agreement on what's to be done, when it's to be done, and both of them are quite in agreement on what the final outcome is going to be, then it would be very beneficial to both." (Qattalik, 2004)

"Like every human being hunters talk among themselves on their observations and what they've gone through. A lot of times [I've] heard after these hunters have been interviewed by anybody, they usually complain that they don't pay much. And then [I think] that [the researchers] forget to consider the fact that these hunters have their own lives. Like they had things to do today and they're taking time out of their lives and their livelihood to assist a researcher or scientist. And some scientists take them for granted and don't pay very much or don't give much back. And that's why [I] put forward those ideas to employ someone for a while. That would be looked on more favourably...[Like myself for example, I'm] a carver, that's what [I do] for a living. And [I'm] taking time out of [my] carving schedule because [I know] what this project is and [I know] how important it is." (Maniapik, 2004c)

Perhaps the most prominent concern expressed in interviews was the lack of research reporting from studies where people have participated, assisted, or contributed.

"[I don't] remember getting any results directly sent to [me], but [I know] for a fact they were writing down a lot of information when they were measuring, taking weight, and collecting samples, they were constantly writing in their journals. So therefore [I know] for a fact that they were collecting information. And then later on somebody told [me] that these are the writings that were done when they were collecting samples then. So that information [I] found out was existing, it's in existence, in that it was shown to [me] at a later [date], way later..." (Kunuk, 2004)

In Pangnirtung, ten people had never heard back from researchers they had worked with, or been interviewed by, while there were three in Cape Dorset and four in Igloolik (Section 8.2.1). Individuals who had not heard back from researchers to whom they had shared information –

especially when they were promised correspondence – felt as though the information may have been sold (EI1) or simply thrown away (ME1).

“[A]round town, or anywhere in other communities, [I don’t] see or hear it brought out in public...[I haven’t] seen that come back. It seems like all the people that have interviewed [me] over the last few years, it’s like they forgot about [me]. They say they’ll bring information back to the community, but they don’t.” (Kellypalik, 2004a)

“[I’m] not trying to pick bones with anybody, [I] just [want] to know exactly where this is coming from. You know personally there’s been a lot of research done for personal benefits. There’s been so-called journalists that comes up and says that they’re doing a project so-and-so, and then they just leave and they get paid for it and we get no feedback, no results.” (Maniapik, 2004a)

Without hearing back about the results, people do not know what happened to the interviews they provided and thus do not see if, or how, it has helped (AU1; EE1; EI1; JoM1; LU1; ME1; MK1; ZA1). Ulayuruluk (2004) explained that he understood that results are often published in scientific journals, but he would have to look hard to find them (i.e. they are not very accessible). However, some results of wildlife filming were seen on television (LQ1; TI1), which seemed to be appreciated.

Further to concerns with the lack of results reporting, there was some ambivalence about whether or not research is beneficial to the communities themselves. The main benefit of participating in, or contributing to, research was the financial gain (AU1; EK1; EN1; LI1; ZA1). For the most part interviews were seen as being too rushed (EN1; MoN2) and not covering enough detail (AQ1; DI1). However, some people were also quite happy to be interviewed, just knowing that it will help other people in some way. Ulayuruluk (2004) found working with biologists enjoyable because they were entertaining, and Qamaniq (2004) considered it useful. Frustrations would arise though, when people described their own project ideas – they found it very hard to find, or secure, funding to conduct their own research/education program (OO1; AE1).

Despite dissatisfaction with the lack of results reporting and local research benefits, elders and hunters remain interested in working with researchers on topics that are important to them. By working together Inuit would have more access to research results and to other information of interest (AN1; JM2), along with more say in defining research topics (PP1; OM2; AN1). Preliminary visits, ongoing reporting, and effective communication are essential to begin overcoming skepticism, minimizing misunderstandings, and addressing local concerns.

### 8.3.3 Effective communication

To enhance collaborative research relationships, communication needs to begin early and be nurtured throughout the research process. This will be influenced by the personality of the researcher(s), interpreter(s), and contributing team member(s). There is no easy formula for ensuring effective communication, but the more issues, concerns, questions, ideas, and interpretations can be discussed, the more clearly understood they will become for all project partners and participants. This element of transparency in community-based research is receiving increased attention in academic and community circles, as communication is the primary means of conducting, analyzing, and presenting research (Ford, 2000; Furgal *et al.*, 2005; ITK and NRI, in press).

#### *8.3.3.1 The role of the interpreter*

As discussed in Section 8.1.2, the role of the interpreter is central to facilitating communication. These highly skilled individuals would ideally be full project partners as they are the most familiar with both community and researcher perspectives. With both local expertise and formalized education, they have the best tools to understand where different worldviews overlap, and how they may potentially be linked. For example, interpreters that I worked with would comment that they could understand a particular written translation into Inuktitut because they are bilingual, but for a unilingual Inuk they would not understand some English-to-Inuktitut translations. There were other times where interpreters were capable of

explaining a sea ice concept to me, as described by elders using more traditional Inuktitut, only because they had experienced these conditions and were familiar with the more nuanced terminology themselves. Both these scenarios would not be possible if they were unable to combine their school and traditional teachings to interpret between different ways of knowing. Despite the skills of the interpreter to facilitate interview conversations, several elders still wished they could communicate with me directly (EN1; LI2). They wanted to share their experiences fully, and no matter what the competency of an interpreter it cannot replace direct communication between individuals fluent in the same language. The role of the interpreter in research has not been adequately investigated in the literature, and much more would be required to comprehend their influences on the accuracy and quality of research.

#### *8.3.3.2 Concepts in Inuktitut*

Understanding Inuktitut to the point of becoming fluent would take years, and perhaps never manifest, especially when living outside of northern communities. However, even when employing an interpreter it is valuable to know some characteristics of Inuktitut to help understand interview statements and create communication materials. One important distinction for environmental research is the different directional concepts between English and Inuktitut. While north, south, east, and west are understood by Inuit with even minimal grasp of English, the most traditional directional references are between the cardinal points (i.e. northwest, northeast, southwest, southeast), along the lines of the prevailing winds (TI1). Directional concepts in Inuktitut are also more complex (MacDonald, 1998). This increases the chance of misunderstanding or confusion when interpreting directions because the Inuktitut term for NW will often be used in translations from the English reference to North (TI1). A second distinction to note is that there are short (i.e. simple), or long (i.e. more sophisticated and descriptive) ways of saying the same thing in Inuktitut (PV1). This means that although some people employ the same root word, they can be providing greater or lesser depth to their



explanations depending on their capability in Inuktitut. This has implications for interpretation (i.e. if the interpreter is familiar with the more complex terminology), as well as for results analysis (i.e. may not be two different words, but one provides more context than the other). A third element is that there are no idioms or metaphors existent in Inuktitut (SA1; Ikummaq, personal communication). Therefore, such references completely lose meaning when they are translated, and may cause confusion with the reader or the interview participant. For example, I found out on my second to last research trip that the title of my project “Ice, through Inuit eyes” would be translated literally as “ice in the eyeball of Inuit.” This would not make sense to those unilingual in Inuktitut. These are just a few examples to highlight that individuals who are functional in both English (i.e. educational setting) and Inuktitut (i.e. the traditional setting) would be the key means of providing opportunities for intersections of terminology and expertise on sea ice.

#### *8.3.3.3 Sea ice terminology*

Based on interview results, and the subsequent conceptual models that were created for each community, we now have a very basic platform from which to build our shared understanding of sea ice terminology and conditions. It can be difficult to link English and Inuktitut sea ice terminology due to the nuances of localized terminology referring to practical uses, or specific ice conditions only observed up close (TI1; MJ1). There is also the added complexity of contextual references whereby different variations of a term will be used depending on whether a person is describing a condition to you from a distance, while on the ice, or while the process is actually occurring (AA1). It is important to note that Inuktitut terminology is very descriptive, so the names are not necessarily always ice-specific. They can be simple descriptors (e.g. thick and thin, the same words in Inuktitut could be used for ice or a piece of wood), similar to English (PV1; SA1; TI1). This means that terminology analysis alone cannot be used to represent Inuit expertise on sea ice, but it is a critical foundation to being able

to interpret localized descriptions and assessments of change. On top of this are the dialect differences that surface both within communities, and between communities (NP1; PP1; PV1; QT1). Nevertheless, just as between communities (Section 7.2), there is overlap between Inuktitut and scientific ice descriptions based on major features or seasonal processes (Table 8-2). This helps to identify common sea ice processes/conditions that are being referred to. An emphasis on terminology may also improve working relationships by developing a shared lexicon, and expanding our awareness of unique sea ice terms or conditions only described in one language or another.

**Table 8-2:** Overlapping Inuktitut and scientific terminology for sea ice (based on the closest approximations of meaning).

Cape Dorset terminology	Igloolik terminology	Pangnirtung terminology	Scientific terminology
<i>sikuvaliajuq</i>	<i>sikuvaliajuq</i>	<i>sikuvaliajuq</i>	freeze-up (early stages)
<i>qinnu</i>	<i>qinu</i>	<i>qinnuaq</i>	frazil/grease ice
<i>sikuliaq</i>			ice rind
<i>sikuaq</i>	<i>sikuaq</i>	<i>sikuaq</i>	nilas
<i>qaikuin</i>	<i>aqsaikutak</i>	<i>sikuallaajuq</i>	pancake ice
<i>qinnu</i>	<i>qinu</i>	<i>qinnuaq</i>	slush
<i>sikuaq</i>	<i>sikuaq</i>	<i>sikuaq</i>	young ice
<i>qanguti</i>	<i>qanguti</i>	<i>qanngut</i>	frost flowers
<i>siku</i>	<i>siku</i>	<i>siku</i>	first-year ice
<i>tuvaq</i>	<i>tuvaq</i>	<i>tuvaq</i>	fast ice
<i>sinaaq</i>	<i>sinaaq</i>	<i>sinaaq</i>	floe edge
<i>nagguti</i>	<i>nagguti</i>	<i>nagguti</i>	crack
<i>ikiqtusijuq</i>		<i>ikirniq</i>	flaw
<i>ajuraq</i>	<i>aajuraq</i>	<i>aajuraq</i>	lead
<i>saqvaq</i>	<i>aukkarniq</i>	<i>saqvaq</i>	polynya
		<i>nuttaq</i>	fracture
<i>ivuniit</i>	<i>ivuit</i>	<i>ivuniit</i>	ridge
<i>qullupiaqtuq</i>	<i>qaliriiktinniit</i>	<i>qallirittipalliajuq</i>	raft
<i>qillait</i>	<i>killaq</i>	<i>killait</i>	thaw hole
	<i>tikpaqtuq</i>	<i>tikpaqtuq</i>	dried ice
	<i>tuvarliqtuq</i>	<i>tuvarluqtuq</i>	rotten ice
		<i>maujaraq</i>	shore melt
<i>qapvaq</i>	<i>sikutuqaq</i>	<i>qavvaq</i>	multi-year ice

#### 8.3.3.4 Visual aids in communication

Visual tools are also effective means of overcoming some aspects of language barriers. These could play an important role in enhancing communication (between community members, or between community members and researchers), as well as linking different types

of sea ice knowledge. Using maps as part of the interview process proved to be valuable in sparking conversations, explanations, and spatial delineations of sea ice features (Section 8.1.3). This form of depicting sea ice greatly enhanced my comprehension of the verbal descriptions provided in interviews. It can also be an effective way of presenting – and in some cases legitimizing – Inuit sea ice expertise to scientists. The compilation maps that were produced based on individual drawings were also seen by community members as: i) valuable research outputs; ii) an informative way to present research results; and, iii) an educational tool to convey local sea ice expertise to Inuit youth, or other researchers (based on feedback from public reporting meetings (Section 3.4.7)). Therefore, mapping efforts can facilitate the transition from research result to educational resource (Section 8.1.3). Furthermore, this type of illustrative conveyance enabled more direct communication between myself and the interviewee. My interpretation of their intended meaning became less dependent on the English translations provided by the interpreter. For these reasons, maps and other visual forms of portrayal (e.g. video, pictures, gestures, illustrations) augment both researcher-interviewee interactions and the quality of research results. When incorporated into interactive sessions, graphic aids can also contribute to enhanced knowledge-sharing when participants discuss what types of maps, visual materials, or other formats would most appropriately represent their knowledge. This may additionally provide opportunities to learn which scientific products (e.g. satellite imagery, ice charts, Internet forecasts, weather warnings, etc.) are commonly consulted, or considered valuable, in daily activities.

#### *8.3.3.5 Multiple components to a communication strategy*

The effectiveness of communicating within a collaborative research context, especially across cultures, is contingent on the communication strategy employed and the amount of effort expended by all involved. The advantage of developing a communication strategy lies in the combination of various communication methods. The strengths of one method can account

for the weaknesses of another. Therefore, multiple means of communicating with community members and organizations ensures that at least some of them are effective. The appropriateness of methods will vary with each: i) individual involved; ii) supporting organization; and, iii) type of project. Therefore, the more variety or modes of communication, the more likely that a few will appeal to each interested person. In developing a communication strategy it is helpful to know what has worked previously, and in what context (Section 8.1.6) (Huntington *et al.*, 2002; Furgal *et al.*, 2005; ITK and NRI, in press). Many responses to the different forms of communication were shared across the three communities, and to some degree I believe they would be shared across other Nunavut communities. However, individual community characteristics must be incorporated when establishing and maintaining contacts (i.e. to account for the fluctuating nature of community dynamics or current events).

#### 8.3.3.6 *Communicating to a broader audience*

Researchers (myself included) have a lot to learn about communicating to a public audience, much less another culture. In response to Laidler (2006b), Dr. Roy (Fritz) Koerner, emeritus scientist at the National Glaciology Program of the Geological Survey of Canada, rightly pointed out that no one teaches scientists how to make their results interesting to northern students or the general public (Koerner, personal communication). It is difficult to effectively summarize scientific results in an accessible, yet informative presentation. And despite concerted efforts to involve community members or report results, some people are simply not interested or they forget about the efforts made by previous scientists (Koerner, personal communication). Therefore, complaints about a lack of results reporting may indeed be warranted (Section 8.3.2), but in some circumstances previous reports may have been lost, people were not aware of them, or they were forgotten as more pressing daily issues took precedence. By continuing to explore the effectiveness of communication and a collaborative

approach to research we can improve our understanding (linguistically and conceptually) of what people mean when describing a particular phenomenon, environmental or otherwise. The advancement of such inter-personal and language dynamics may even necessitate targeted, systematic studies with this specific focus. This would enable other projects to employ the most appropriate communication methods and tools to: i) interact with community members; ii) move towards equal contributions in a collaborative research project; iii) generate more accurate and locally representative research results; and, iv) facilitate practical linkages between Inuit and scientific expertise.

#### 8.3.4 *Appropriate topics*

Moving towards the practical intersection of Inuit and scientific expertise requires a topic of mutual interest or concern to both northern and academic communities. Without a common goal it will be difficult to reach, or maintain, equality in collaborative contributions and benefits. Not all northern research topics require full collaboration, nor is it desirable (ITK and NRI, in press). For example, characterizing tundra vegetation with empirical indices derived from remotely sensed imagery will draw less local interest for collaboration than beluga tagging to determine whale population and health estimates. The sea ice focus of this thesis was of great interest to community members because they are experiencing so much change in local ice conditions. Therefore, they wanted to document and communicate their expertise on the subject. This was a strong foundation upon which to collaborate. Moreover, the expertise elicited through the research process provides ample opportunities to link with scientific expertise on the same subject. Beyond common interest, the distinguishing characteristics of Inuit and scientific sea ice knowledge are what also render them complementary (Laidler, 2006a). When both groups are willing to learn from each other, and when their joint contributions can expand the understanding of environmental or socio-economic processes, is when the greatest opportunities arise for collaboration.

One example of complementary knowledge contribution incorporates the differing life experiences, methods, and goals in evaluating sea ice extent and stability. Satellite imagery can be acquired for large or small spatial scales, but its temporal resolution is limited to the past thirty years or so (Riedlinger and Berkes, 2001). In complement, Inuit expertise covers a range of spatial scales (local to regional). It also incorporates a temporal scale spanning present and living memory to historical recall through oral traditions and localized knowledge-sharing (Riedlinger and Berkes, 2001). Because Inuit tend to acquire their knowledge in an experiential manner (Sections 8.2.2, 8.2.3) they can relate the potential effects of local weather events to altered ice conditions, as well as how such circumstances may affect the distribution, behaviour, or well-being of a variety of marine bird, fish, and mammal species (Laidler, 2006a). Their perspectives can also provide broader conceptions of sea ice in community and wildlife contexts. In complement, scientists can offer more technical and detailed accounts of ice thermodynamics, dynamics, and physical interactions, as well as their interactions with global climate and ocean circulation (Laidler, 2006a). Monitoring and modeling efforts are often undertaken at scales that are too coarse to account for regional, much less local, variations in ice conditions (Copley, 2000; Demeritt, 2001a; Duerden, 2004; Nichols *et al.*, 2004). To date, they also tend to be conducted outside the context of the human dimensions of climate change. However, because of the ways in which Inuit and scientists interact with sea ice, as well as the methods they use to evaluate ice conditions, they can provide some of the missing components that aid the other in their goals for sea ice use or analysis (e.g. cross-scale linkages). Scientists could benefit from localized Inuit expertise to improve interpretation of satellite imagery. This would help address frequent laments of the lack of ground truthing data available for remote regional scale observations. It could also improve efforts to create climate change assessment models, especially where socio-economic implications are considered. Without direct involvement of Inuit, the appropriate parameters and outcomes are more likely to be ill-

defined and representative of artificial circumstances. In turn, Inuit can benefit from the regional perspectives and systematic assessments provided through satellite imagery and change detection. This may improve local hunters' ability to evaluate distant ice conditions prior to travel, and thus complement their local expertise to minimize accidents. Furthermore, scientific investigations could target local concerns or project ideas sparked by the inability of local experts to explain some environmental phenomena or trends.

Further to appropriate research topics, collaborative research needs to provide opportunities for two-way dialogue, contributions, and benefits. More often it seems that researchers learn from community members, and gain from publishing study results, but that few practical benefits accrue to the communities who provided the original materials. While community members are interested in contributing to scientific research, they also want to learn about – and utilize – scientific studies or technologies for their own purposes. For example, frequent access to recently taken imagery was of great interest to many of the interviewees (AE1; AI1; AN1; AT1; AY1; EE2; JI2; JM2; LQ1; LU1; MK2; SK1). They recognize the value of this coarser scale monitoring to evaluate changes in ice conditions and extent, and want to use it for their own purposes (AI1; DAn1; JAn1; MM1). At the same time they would require additional training in image interpretation, and would welcome more results from related scientific studies (AT1; EN1; JaM2; PP2). This way, there would be a balanced sharing of information – and ideally benefits – from both sides, inherently expanding the nature of collaborative research. Therefore, in order to overcome some of the skepticism of the value of science (natural or social) to northern communities (Section 8.3.1) some of the responsibility falls on researchers to convince community members that their study is meaningful, and will have implications or benefits at the local level (Laidler, 2006a).

### 8.3.5 Rigorous research

There remains some inertia and inflexibility in gaining acceptance of the reliability of Inuit knowledge in the broader science community (Huntington, 2000). This may be due in part to the conventional requirements for evaluating scientific validity (i.e. numerical evidence, journal publications, generalization, replicability) (Schenider, 2001) that are hard to provide within a social science, qualitative, community-based research setting. Subjectivity has been used to contest the credibility of findings that are outside the realm of objectivity, hypotheses, and statistical evaluation (Collings, 1997). While it is recognized that subjectivity can also affect the development of climate models or sea ice parameterizations (Demeritt, 2001a), natural sciences are more advanced in their development of rigorous evaluations of data/model accuracy and reliability (Laidler, 2006a). However, when I say accuracy and reliability of knowledge, I do not mean Inuit knowledge itself – for only Inuit can evaluate the accuracy of their knowledge within their specific cultural context – but rather the presentation of Inuit knowledge within social science research results. A systematic process for assessing the accuracy of Inuit knowledge presented in research (i.e. the degree to which it reflects what Inuit shared with the researcher) has not been developed. However, it is suggested that this is a desirable endeavour (Wenzel, 1999; Duerden, 2004) because:

1. individual statements can be too quickly (and inaccurately) generalized to represent all Inuit;
2. knowledge varies in quantity and quality between members of any given community, it is constructed, created, and modified in specific social and environmental contexts; and,
3. local knowledge can be influenced by the researchers themselves through research methods or analysis. (Nuttall, 1998; Wenzel, 1999; Ellerby, 2001; Searles, 2001).

Therefore, working in a collaborative context requires that researchers move beyond the minimum methodological descriptions described by Davis and Wagner (2003) to:

- specify the methods and reasoning for local expert selection;
- outline the purpose and details of data collection methods;
- explain what information was considered “data”;



- detail the criteria employed for evaluating information credibility, transferability, dependability, and confirmability (within the local context); and,
- disclose the methods of documentation (and communication), acknowledging their relative strengths and weaknesses. (Lincoln and Guba, 1985; Baxter and Eyles, 1997; Huntington, 2000; Searles, 2001; Davis and Wagner, 2003)

Granted, such evaluations are not straightforward, especially where the results can have local implications through inter-personal dynamics or community-researcher relationships. Research (especially conducted by non-Inuit), can never capture the intricacies of the relationship between Inuit and sea ice, but through diverse methods such as participant observation, social science evaluations, or evaluations from other community members (i.e. triangulation) (Baxter and Eyles, 1997; Yeung, 1997; Baxter and Eyles, 1999; Wenzel, 1999; Huntington, 2000) it can provide a picture that is as representative of Inuit knowledge as possible. Improving the transparency of the research process, along with an evaluation of methods, would simultaneously improve the quality of data interpretation. This then enables other researchers to learn from previous experiences or mistakes (Davis and Wagner, 2003). Such disclosure of research methods (and the subsequent reliability of results) also provides enhanced opportunities to practically link different forms of expertise. It would facilitate: i) a greater degree of confidence in information; ii) assessments of potential uncertainty; and, iii) an improved understanding of different research approaches.

In the process of ensuring rigorous social science research, there are added challenges of avoiding decontextualization (Nuttall, 1998) and responding to community interests and feedback (Laidler, 2006a). This is especially difficult to overcome when attempting to link Inuit and scientific knowledge. It is perhaps more feasible to acknowledge the limitations in this realm than to think they can be fully accounted for. From my own experiences, the act of interviewing, discussing sea ice indoors, communicating in English, and interpreting interview statements all decontextualize the Inuit expertise that was shared with me – before even reaching the knowledge representation stage. The practical nature of Inuit knowledge

acquisition, and the experiential elements of knowledge transmission, along with the nuanced complexities of sea ice terminology and environmental influences, can never be fully conveyed. Although I did my utmost to ensure rigour in the research process (Section 3.3), to verify information with community members (Section 3.4), and to accurately represent community expertise (Section 3.5), it is impossible to avoid decontextualization. Transcribing interviews, creating conceptual models, and providing written or map documentation all occur outside the context in which knowledge was originally gained, produced, and shared. Nevertheless, this does not detract from the value of the research. Community members felt strongly that their knowledge should be documented and made available in written format (AE1; DI1; EP1; JS1; LE1; MoK1; MoN1). They felt this was a way to provide educational materials to younger Inuit, as well as to be taken more seriously by scientists. Rigorous research ensures that these efforts are undertaken with paramount consideration for community perspectives and reliability of information. However, the limitations are well understood by community members. Research results would never replace the contextual knowledge which they continue to rely upon, and convey, through the use of the sea ice environment.

#### 8.3.6 A long-term process

Working together collaboratively, and finding ways to practically link Inuit and scientific expertise, is undeniably a long-term process. It takes time to establish research relationships, and to negotiate mutually acceptable roles for community members and researchers throughout the research stages (ITK and NRI, in press). This is an ongoing process of compromise, revision, and refinement in order to: i) minimize skepticism and misunderstanding; ii) address local concerns for collaboration; iii) establish, maintain, and improve communication; iv) choose an appropriate research topic; and, v) undertake rigorous methodological evaluations. However, where both Inuit and scientists are motivated by the

results stemming from joint efforts there is incredible potential for advances in collaborative research methods and outcomes.

Community members are interested in collaboration, but they want to ensure that their wishes are taken seriously, that research reporting is timely and informative, and that Inuit knowledge is represented accurately and appropriately. Even though not everyone in Cape Dorset, Igloolik, and Pangnirtung is using the sea ice, it is still deemed important to understand what is going on with ice conditions, and to be able to travel on the ice (MK2; PP1). Despite the potential challenges, Inuit elders and hunters generally felt it would be good to work together. There is no way to control the environment, but at least by working together we can know more about what is going on (AP1; JS1). Elders want to share what they know (EN1) and are concerned about losing the knowledge base as elders pass on (KS1).

“...most definitely...like we don’t have a choice anymore because of the factors we’re, we have to deal with those and get the information from our elders, the knowledge that they have of the land the sea ice. And with the cooperation of scientists and the elders we may be able to have more information for not only for the hunters today to have that knowledge but for the benefit of our children and their children to be able to have that information available and to have an understanding of how it has evolved over time.” (Nuvaqiq, 2004)

To facilitate more collaborative research, Inuit elders and hunters in all three communities provided some suggestions for how scientists could improve working relationships that are perceived to have been science-biased for too long. These include:

- Inuit prefer to work with scientists face-to-face
- researchers should work in communities more frequently
- researchers should work in communities for longer periods of time
- researchers should inform communities of their research results more often, and not only when something drastic happens
- researchers should be more visible in communities
- reports should be translated into Inuktitut
- researchers should help hunters access satellite imagery or other information of interest
- researchers should be willing to learn from Inuit
- researchers should get more hands-on experience with sea ice
- there should be a fair sharing of knowledge (i.e. elder or hunter learning as much from the scientist as the scientist does from the Inuk)

- community members should be invited on ice breakers when they are anchored near town
  - Inuit knowledge should be considered in addressing complex northern topics
  - Researchers should inform community members where field camps will be set up
  - Inuit and researchers should come to an understanding of how to work together
  - Researchers should work with the most knowledgeable Inuit with regards to traveling or hunting on the sea ice (usually referring to elders), not everyone uses the ice frequently and thus not everyone is equal in their knowledge of the sea ice
  - Considering hiring fewer people, for a longer period of time, to go into more detail on a particular topic
- (NP1; QT1; MK2; AN1; EE2; AT1; DQ1; AI1; EI1; LQ1; SA1; JaM2; JoP1; MaN1; JoM1; JAk1; MM1; LI1, MoN2; EP1; EN1)

The last two points are further elaborated by SA1 and MoN2, respectively.

“...But what [I have] noticed over the years, for example if [I find] there’s activity happening out there, for example somebody is out there doing some studies on the ice, and then it’s mainly let’s say the researcher, plus a guy he just picked up from the street, one who had a snowmobile, some gas to blow, and time on his hands, young guy...[I feel] that people like [myself], or the older folks who use the land, who use the ice, should be on those, in that they would be able to see what those people are doing, and again share it among people who are using the ice, as opposed to the street person that’s now going out with that researcher. [I feel] that the hunters should be more involved in cases like this.” (Ammaq, 2004)

“[I] always [wonder] why people do these half-way interviews where they sort of touch on important topics such as the ice but they never really go all out, like spend a lot of time with [me] and then [I] can teach you a lot. That’s [my] problem. [I’m] wondering maybe it’s got something to do with funding or something. If you spend a lot of time with one person then that one person can teach you a lot instead of like spending a couple of hours and try to get his entire life experience in that couple of hours.” (Nuvaqiq, 2005)

I would add to that in order to link disparate forms of expertise it is important to:

- consider different epistemological claims
- recognize that both Inuit and scientific expertise are socially and culturally influenced
- be willing to learn from each other
- ensure mutual interest
- foster mutual respect
- incorporate visual communications
- establish long-term relationships with community members and organizations
- understand the local and scientific relevance of research
- manage the challenges involved
- tailor the research approach to community needs

I think the more researchers can communicate the purpose of their studies, report back on their results, and involve community members in any feasible manner, we can improve the mutual understanding and benefits of research in the Canadian Arctic. These efforts will, in turn, contribute to the advancement of linking Inuit and scientific knowledge on topics of common interest. This is an especially important undertaking when dealing with complex issues (e.g. sea ice in the context of local conditions, community use, and climate change) that cross human and environmental systems as well as temporal and spatial scales. Ultimately, I believe that Inuit are requesting mutual respect from researchers. The more we can work towards reciprocal research relationships, the more we will be able to learn from each other.

“All researchers and university students that come up here to do research, they all have to be aware of the knowledge that they are being given. They have to respect the knowledge that they are being given. And they have to make sure that the knowledge that they receive is used for the proper purposes.” (Evic, 2005)

## **Chapter 9 – Conclusions**

### ***Moving forward***

This thesis was undertaken to address research needs and gaps relating to Inuit sea ice expertise. It also aims to contribute to improving research relationships between Inuit communities and northern researchers. We have much to learn from the long-term experiences and accumulated knowledge that elders and hunters have gained regarding sea ice (and the complex links with wind, weather, and tidal conditions). Different underlying epistemologies, methods of knowledge acquisition, and goals for use/investigation render Inuit and scientific knowledge as potentially an ideal complement (Laidler, 2006a). Therefore, gaining insight into local characterizations of the importance of sea ice processes, use, and change are an important beginning. Without this initial foundation it is difficult to move forward to facilitating research relationships. And yet, it is not the only component of enhancing collaborative research. Much work still needs to be done (from both sides) to refine appropriate research methods, modes of communication, and means of knowledge representation to more effectively link the two forms of expertise. Therefore, based on experiences in this research, the identification of future research directions aims to move towards more comprehensive inclusion of Inuit expertise in assessments and decisions that directly affect their lives.

#### **9.1 The importance of sea ice processes, use, and change**

In addressing the first thesis objective, sea ice has been shown to be equally important in Cape Dorset, Igloolik, and Pangnirtung, Nunavut, as a means of traveling and hunting, and sustaining marine wildlife. As an inherent part of Inuit culture, local ice conditions are intertwined with daily activities. The importance reflects localized differences in ice conditions, terminology, and use, while similarities in these characteristics serve to tie communities together from across Baffin Island.

In order for people to effectively travel and hunt on the sea ice, they have to become knowledgeable about the complexity and dynamism of the oceanic environment. This was elucidated through detailed explanations of local ice conditions, seasonal processes, and Inuktitut terminology. In each community they account for near-shore and open water freezing, as well as several stages of sea ice thickening. Variations in these descriptions highlight some of the unique geographical influences related to temperature and speed of freezing, as well as localized wind and current direction. In addition, local dialects or specific local sea ice uses also influence the degree to which processes are described. For example, Cape Dorset and Pangnirtung focus more on shoreline processes due to the prominent tidal variations in these areas, while in Igloolik they focus more on sea ice thickening and the establishment of the floe edge. Inuit elders and hunters skillfully incorporate the multiple influences of weather, winds, currents, and season in their explanations of sea ice formation or decay processes, which also includes the formation of tidal cracks, floe edges, and polynyas. These are all important hunting destinations, although methods for hunting and target animals may vary somewhat according to local practices. For example, Igloolik's focus on moving ice, and extensive terminology for the interface between the floe edge and moving ice, is directly linked to their walrus hunting techniques that necessitate venturing onto moving ice pans. Melt processes around each community were described as beginning with various stages of snowmelt. However, these stages also varied according to regional texture differences and patterns of spring sea ice use. As water accumulates, and the ice deteriorates towards break-up, many of the major transition stages are commonly emphasized between communities. But again, varying emphases reflect the processes that most affect sea ice travel and access to hunting grounds. Temperature alone is not a key focus for Inuit descriptions of ice processes, but rather the combined effects of winds, weather, and currents (or lack thereof) are considered the most influential forces on ice conditions.

Consistent with many of the changes being experienced across Nunavut (NTI, 2001; Nickels *et al.*, 2005), elders and hunters in Cape Dorset, Igloolik, and Pangnirtung are noticing, and feeling the effects of, sea ice change. They relate these occurrences to the pattern of long-term climate change at broader scales. Key indicators (i.e. the floe edge, weather predictability, ice thickness, the timing of freeze-up and break-up, wildlife, and moving/multi-year ice) are employed within a local context to evaluate change over the past four decades. The shifts occurring in Pangnirtung seem most drastic (i.e shifts in the timing of freeze-up and break-up, thinning sea ice, reduction of moving/multi-year ice, and reduced sea ice extent), while in Igloolik inter-annual variability is the focus more than long-term change. In contrast, with the least ice extent, Cape Dorset's changes may be the smallest but may have the largest impacts if cumulative change reduces access beyond the island.

## **9.2 The relevance of sea ice to human and animal activity**

In addressing the second thesis objective, it may be concluded that the preeminent dangers associated with sea ice travel relate to: i) variable conditions along the floe edge or polynyas (influenced by winds and currents); ii) navigating sea ice during transition periods; iii) traveling on sea ice after fresh snowfall; and/or, iv) the tidal cycle at a particular time of day or month. All these factors are taken into account during sea ice travel or hunting, and yet no one person can ever know everything about the sea ice. Even the most experienced hunters have accidents. Therefore, methods for evaluating ice safety are continuously stressed, along with a healthy dose of caution. Because the most dangerous areas of sea ice are often the main destinations for hunting purposes, the management of risk is paramount in peoples' evaluation of danger. Preparedness, combined with years of experience, can minimize mishaps and enhance the chances of hunting success.

Beyond caribou and arctic char, the key staples of northern diets rely on the sea ice as their habitat (i.e. ringed seal, walrus, polar bear, narwhal, etc.). Because of the importance of



marine wildlife to sustain community members (historically for heat, light and equipment, and continuing to the present for food and financial gain), learning about sea ice is implicit in hunters' efforts to characterize the behaviour and habitat of wildlife. Sea ice expertise is also essential to be able to access this wildlife. For these reasons hunters have specific hunting areas where they are most familiar with ice conditions, dangers, and travel routes.

### **9.3 Collaborative research**

Learning about sea ice "through Inuit eyes" required close collaboration with local interpreters and community members. This afforded many opportunities to reflect upon the benefits and challenges of working across cultures. A collaborative research approach proved effective overall, but in addressing the third thesis objective important considerations were highlighted to facilitate future research relationships.

#### **9.3.1 Working together**

Evaluating the effectiveness of working together collaboratively in a northern context, and employing multiple research methods, serves to inform other research efforts in Inuit communities – even in different disciplines. Undertaking preliminary research visits were critical to overall research success, as they laid the initial interpersonal and logistical groundwork necessary to refine subsequent research phases. When conducting field research, semi-directed interviews were valuable in gaining detailed insights into local sea ice expertise. However, conducted indoors, outside of the practical context of sea ice use, there were constraints to the types of descriptions provided. The inclusion of participatory mapping in interviews helped to bridge the worlds of experience and description, as the interview focus was shifted onto spatial representations of sea ice. This elicited richer interview responses while also alleviating some of the potential tension in a direct question-answer session. Experiential sea ice trips filled in gaps by providing invaluable practical context, as well as opportunities to capture visual representations of sea ice with video and photography. Both

the interviews and sea ice trips were complemented by focus groups. These helped refine my own interpretations, as well as link terminology and sea ice descriptions to the visual references. These methods had to be somewhat tailored to the individual community and current events, yet it is hoped that reflections in Section 8.1 contribute to ongoing (re)evaluations of the utility of conventional social scientific methods to learn across cultures.

Also critical to the collaborative research approach was the maintenance of ongoing, effective communication. This required considerable effort, along with the need for continued assessment of what types of communication were most appropriate. Different mediums for providing information, updates, or encouraging feedback/involvement vary by person, community, culture, and discipline. Each method has their own strengths and weaknesses depending on the research stage, purpose, and community context. Therefore, it is recommended that a combination of methods is the most effective way to ensure that information is passed along to those who are interested. This must be conducted alongside concerted efforts to incorporate feedback into ongoing assessments and alterations of the research methods and communication strategy. By learning from previous experiences, and building towards long-term research relationships, researchers can enhance practical efforts to link Inuit and scientific knowledge.

As summarized in Laidler (2006a), collaborative research that aims to represent both Inuit and scientific perspectives can be facilitated by:

1. starting early to establish the feasibility of community-researcher collaboration;
2. investigating topics of interest to both Inuit and scientific communities;
3. involving community members in all research stages (from proposal to analysis) at a mutually desirable level;
4. engaging in a variety of participatory research methods; and,
5. maintaining ongoing communication.

Admittedly, considerable practical and methodological challenges remain in attempting to intersect different knowledge systems. Nevertheless, possibilities for a positive enhancement

of both Inuit and scientific expertise on sea ice are proposed to outweigh the perceived barriers to such collaborative efforts (Laidler, 2006a).

### 9.3.2 Linking Inuit and scientific expertise

Sea ice use will not halt in a changing climate, but as conditions become more unpredictable community members and scientists alike are concerned about the potential physical and cultural impacts of such change. As seen in examples from Cape Dorset, Igloolik, and Pangnirtung, similar types of sea ice change can have different local implications. Inuit elders and hunters are the experts on local ice conditions, and are most knowledgeable of how such changes might affect community lifestyles or livelihoods. In addition, there are climate and cryosphere scientists investigating trends in sea ice freeze-up and break-up timing, ice thickness and extent, and long-term temperature changes (and related atmospheric influences) on regional and global levels (e.g. Wang *et al.*, 1994a; Wang *et al.*, 1994b; Mysak *et al.*, 1996; Gough and Allakhverdova, 1999; Parkinson *et al.*, 1999; Gough and Houser, 2005). Thus, documenting and understanding Inuit expertise on sea ice processes and change can enhance community and researcher capacity to converge their methods and goals for climate change research by:

1. gaining local scale expertise;
2. expanding climate history and baseline data;
3. formulating research hypotheses;
4. providing insights into community adaptation; and,
5. reflecting cumulative, local monitoring systems (Riedlinger and Berkes, 2001).

Establishing joint interests, and developing an appreciation for the complementary nature of Inuit and scientific knowledge of sea ice is one thing, but efforts must still be expended to overcome skepticism and misunderstandings that linger between Inuit and scientists. Furthermore, local concerns for collaboration with researchers must be addressed in order to work towards practical intersections of the two forms of expertise. In so doing, effective communication is essential, along with the selection of an appropriate research topic and an

effort to maintain rigorous research processes. Neither Inuit nor scientific knowledge can be accepted uncritically, but at the same time it is imperative to better understand what types of knowledge are valued in each epistemology, and why.

Through this thesis, substantial groundwork has been laid to facilitate intersections between Inuit and scientific expertise. Without gaining detailed insights into how Inuit characterize, use, and value ice conditions, practical linkages would not be possible. There are emerging studies that focus on the complementary nature of these different types of information in an applied manner (Norton and Gaylord, 2004; Meier *et al.*, in press; Tremblay *et al.*, in press), but continued and concerted efforts to develop reciprocal research partnerships are necessitated to begin working collaboratively from the outset of a project. Therefore, it is essential to characterize efforts to link disparate knowledge systems as a long-term process. Moving in this direction may encourage the evolution of a new generation of interdisciplinary researchers that specialize in interpreting/linking different ways of knowing (Laidler, 2006a). An equal evolution of Inuit involvement in/control over research that affects their lives would be required to parallel developments in academic arenas, if the capacity and interest in collaborative research is to be fostered.

#### **9.4 Future research directions**

As discussed above, scientists are actively exploring topics that are of interest to Inuit. Therefore, in addressing the fourth thesis objective, new research directions are identified according to their importance for Nunavut communities. They focus on intersecting the research/monitoring needs of both Inuit and scientists, and provide the impetus for future research to jointly investigate:

- ocean temperature characteristics and change, to identify potential correlations with ice conditions and change;
- current and ocean circulation at a regional and local scale, to identify potential correlations with ice conditions and change;

- wind directions and strength, to determine the consistency or direction of wind shifts along with links to weather patterns and ice conditions
- the social and cultural implications of a changing sea ice environment, especially combined with social and cultural changes in Inuit lifestyles
- how community members are currently adapting to variable or changed ice conditions, or how they anticipate community responses under a given future circumstance
- the influence of shipping and submarine activity on marine wildlife movements and health
- pollution of oceanic and hydrologic systems, specific local concerns with visible contamination of ice, snow, and water
- effective ways of communicating with northern communities
- effective ways of representing Inuit knowledge so as to minimally detract from the original meaning or context
- spatial delineations of Inuit sea ice expertise to contribute to real-time monitoring, change assessments, or interpretation of remote observations at coarser resolutions
- the evolving nature and context of community-researcher relationships
- ice thickness monitoring
- the size and position of polynyas, and how they are represented at various scales
- the position, shape, and variability of local and regional floe edge delineations
- wildlife health indicators
- the number and causes of sea ice accidents
- how to increasingly involve youth in research, and improve connections between youth and elders
- local economic implications of a changing sea ice environment
- methods of communicating both scientific and Inuit expertise to policy- and decision-makers at various levels of government

Therefore, my longer term research goals include contributions to:

- a) comparing – and linking – results of Inuit and community-based monitoring to the current state of scientific knowledge on ice trends and cycles in the vicinity of local observations;
- b) refining the representation of sea ice dynamics and Inuit expertise through spatial delineations or multi-media; and,
- c) expanding collaborative research partnerships with northern community members to direct, and apply, sea ice/climate change research.

These are already underway in a preliminary manner through my involvement in International Polar Year (IPY, 2007-2008) project proposals such as: i) SIKU (Sea Ice Knowledge and Use); ii) ISIUOP (Inuit Sea Ice Use and Occupancy Project); and, iii) Variability and Change in the Canadian Cryosphere. However, these efforts will be continued throughout an academic career that seeks to build on the foundations created in this research.

Inuit can provide local scale expertise, and ongoing sea ice use, that contributes to change assessments in a way that complements scientific observations and modeling exercises (Laidler and Elee, in press). Through the identification of commonly employed environmental, social, or cultural indicators Inuit and scientists have a shared starting point from which to develop research of mutual interest. Along with ongoing communication, collaborative research is most likely to succeed when both groups are directly involved from the outset. In so doing, research relationships, and the degree of local or scientific involvement, can be negotiated throughout various research stages (ITK and NRL, in press). In building these connections more effective assessments of community vulnerability or resilience to climate, and resulting sea ice, change may be undertaken. This would contribute to the development of appropriate adaptive strategies for the populations most affected by climatic change.

### **9.5 Community vulnerability or resilience?**

Sea ice travel is hazardous in any season, yet experienced hunters are skilled in managing the associated risks. However, sea ice changes may exacerbate risks associated with sea ice travel, which could increase community sensitivity to the long-term implications of change. Sea ice change can affect local health, lifestyle, well-being, and culture, and is thus necessarily implicated in the broader context of assessing community vulnerability or resilience to change.

Adapting to yearly variations in sea ice cycles and conditions is incorporated in Inuit sea ice knowledge, and their respective use of the sea ice environment (Nelson, 1969; Freeman, 1984; Riewe, 1991; Aporta, 2002). Plans to hunt, travel, or camp at particular times/locations are continually altered according to conditions at the time, but these are not consciously delineated adaptations to change. They are a reflection of Inuit flexibility and skill in dealing with the variable and extreme nature of the arctic ecological system (Jolly *et al.*, 2002; Nichols *et al.*, 2004; Ford, 2005; Ford *et al.*, 2006b). Local coping mechanisms are effective within a certain

range of expected climatic or sea ice variability, but when the conditions exceed expectations (i.e. going beyond coping ability) is when people may become vulnerable (Ford, 2005). It is also under this pretense that people can become resilient.

Characterizing a population's vulnerability to climatic, or related, change has become an important element of the UNFCCC, IPCC, ACIA, IPY, and other large international efforts to understand or characterize the influence of climate change on human systems (Smit *et al.*, 2000; Ford and Smit, 2004; McCarthy *et al.*, 2005). Therefore, assessing community vulnerability to sea ice change becomes implicated in politics, research, economics, and environmental change at every level from global to local. In order to address vulnerability within a local context, Ford and Smit (2004) outline a useful framework for vulnerability assessment. It begins locally to identify the environmental or socio-economic conditions to which a community is most vulnerable – or adaptive. Therefore, the vulnerability of a community is a cumulative function of both local exposure (i.e. environmental factors) and adaptive capacity (i.e. human factors) under current, and future, circumstances (Ford and Smit, 2004). In employing this concept, vulnerability assessments begin at the community level to identify the factors of most pertinence. It can then be expanded to incorporate the larger biophysical and socio-economic elements that influence these local scale factors (Ford and Smit, 2004). Therefore, the concept of resilience can be used to characterize areas in which a community has a high adaptive capacity. As such, the importance of incorporating social and lifestyle elements into vulnerability assessments cannot be over-emphasized. This thesis can contribute to evaluations of local sea ice exposure, and to some degree adaptive capacity, but much additional work would be required to elucidate determinants of community response to changes (i.e. population characteristics, community economics, and local adaptive capacity (Duerden, 2004)). These play heavily into a community's ability to work with changes (i.e. resilient), or to be negatively impacted by changes (i.e. vulnerable). In addition to

individualized adaptation, there is also adaptation as a policy option or response strategy (Smit *et al.*, 2000). Therefore, the complexity of assessing community vulnerability is compounded by the types of change, local responses, and national and international policies to mitigate change/foster adaptation.

Ultimately, vulnerability assessments that incorporate community perspectives need to first understand the importance of a particular environmental phenomenon, as well as how community members understand and use that phenomenon. This thesis has focused on sea ice as a means to better understand the feasibility of collaborative research, and to contribute an essential element to climate change vulnerability assessment in northern latitudes. Detailed local expertise is not easily accessible to a scientific audience, and it must be incorporated into evaluations of current and future exposure. This work can complement other studies being conducted on the physical, cultural, and socio-economic aspects of vulnerability assessment. Granted, there are many more pressing issues facing northern communities than climate change (Duerden, 2004). However, because sea ice has direct implications for multiple aspects of Inuit community health, safety, and well-being there is strong local interest in communicating their expertise on this subject. Through my own experiences I also hope to have contributed to efforts in refining collaborative ways of working with Inuit communities. I am still a long way from where I aimed to be at the conclusion of my thesis, but the importance of understanding Inuit sea ice expertise and working collaboratively remained my priority throughout. Perhaps if I had worked with only one community for the duration of the research I would be farther along with the practical linkages. Yet the insights gained through regional comparisons would have been lost. Furthermore, individual community dynamics would not have informed my evaluations of the participatory methods and communication strategy. There is still much to learn, but least we are one step closer.



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## Appendix 1

### *Common, scientific, and Inuktitut names for wildlife species*

Table arranged in alphabetical order according to common species name.

<b>Common name</b>	<b>Scientific name</b>	<b>Inuktitut name</b>
Arctic char	<i>Salvelinus alpinus</i>	<i>Iqaluk</i>
Arctic fox	<i>Alopex lagopus</i>	<i>Tiriganiaq</i>
Arctic hare	<i>Lepus arcticus</i>	<i>Ukalik</i>
Bearded seal	<i>Erignathus barbatus</i>	<i>Ujjuk</i>
Beluga whale	<i>Delphinapterus leucas</i>	<i>Qilalugaq</i>
Black guillemot	<i>Cephus grylle</i>	<i>Pitsiulaaq</i>
Bowhead whale	<i>Baleana mysticetus</i>	<i>Aroiq</i>
Canada goose	<i>Branta canadensis</i>	<i>Nirliq</i>
Caribou	<i>Rangifer tarandus</i>	<i>Tuktu</i>
Eider duck	<i>Somateria mollissima</i>	<i>Mitiq</i>
Greenland halibut	<i>Reinhardtius hippoglossoides</i>	<i>Nataarnaq</i>
Harbour seal	<i>Phoca vitulina</i>	<i>Qasigiaq</i>
Hooded seal	<i>Cystophora cristata (christata)</i>	<i>Natsivak</i>
Murre	<i>Uria lomvia</i>	<i>Appak/Akpa</i>
Narwhal	<i>Monodon monoceros</i>	<i>Allanguak/tuugalik</i>
Polar bear	<i>Ursus maritimus</i>	<i>Nanuq</i>
Ringed seal	<i>Pusa hispida (Phoca hispida)</i>	<i>Natsiq</i>
Snow goose	<i>Chen caerulescens</i>	<i>Kanguq</i>
Walrus	<i>Odobenus rosmarus</i>	<i>Aiviq</i>

## Appendix 2

### *Glossary of scientific sea ice terminology*

**Based on:** WMO (1970); Lock (1990), Wadhams (2000), Eicken (2003), Thomas and Dieckmann (2003), and presented in alphabetical order.

*compact ice* – floating ice with high concentration and no visible water

*consolidated pancake ice* – pancake ice frozen together

*crack* – any fracture of fast ice, consolidated ice, or a single floe (separation of centimeters to meters)

*dried ice* – the surface of the sea ice after melt-water has drained through cracks and thaw holes

*fast ice* – commonly known as landfast ice, but specifically referred to as ‘fast ice’, this ice is literally stuck ‘fast’ to the continent (or other fixed objects such as islands, grounded icebergs, and peninsulas); it may be formed by the freezing of sea water, or by the freezing of floating ice of any age which attaches to the shore; it may be more than one year old, and would then be prefixed with the appropriate age category (e.g. second-year, multi-year, etc.)

*first-year ice (white)* – sea ice of not more than one winter’s growth (categorized as thin, medium, or thick)

*flaw* – narrow separation zone between drift ice and fast ice

*floe edge* – commonly known as the floe edge, the more specific term would be ‘ice edge’; this term refers to the demarcation (or boundary) at any time between the ice-free ocean (or sea) and ice-covered ocean (or sea), whether fast or drifting ice; this delineation is highly dependent on the scale of investigation

*fracture* – any break or rupture –usually refreezing quickly – through compact, consolidated, or fast ice, or a single ice floe, resulting from deformation

*frazil ice* – fine spicules or plates of ice suspended in water during ice formation, these randomly shaped crystals increase the density of the surface water whereby freezing occurs around -1.8°C

*grease ice* – an accumulation of frazil ice, when ice crystals coagulate forming a soupy layer on the surface

*ice floe* – any relatively flat, discrete, piece of sea ice that varies in area from a few square metres to the area of a small town

*ice rind* – a brittle shiny crust of ice formed on a quiet surface by direct freezing or from grease ice, usually where there is lower salinity

*lead* – a linear open water feature occurring in the ice pack between ice floes caused by ice break-up, and may be covered with new ice

*nilas* – a thin elastic crust of ice (dark and light nilas according to thickness)

*pancake ice* – predominantly circular pieces of ice (around 3cm to 3m in diameter, less than 10cm thickness) with raised edges

*polynya* – a polynya is considered to be any non-linear shaped opening that is enclosed by ice; they may form from latent heat (i.e. near coastal areas of islands and created by wind or current displacement) or sensible heat (i.e. from upwelling warm water), both of which prevent solid ice formation

*raft* – ice deformation where one piece of ice overrides another

*ridge* – a line or wall of broken ice forced up by pressure, where the submerged portion is the keel and the exposed portion is the sail

*rotten ice* – sea ice which is in an advanced state of disintegration, appearing like a honeycomb

*shore melt* – open water between the shore and the fast ice, formed by melting or due to river discharge

*shuga* – accumulation of small spongy white ice lumps, formed from wind-driven accumulation of grease ice or slush

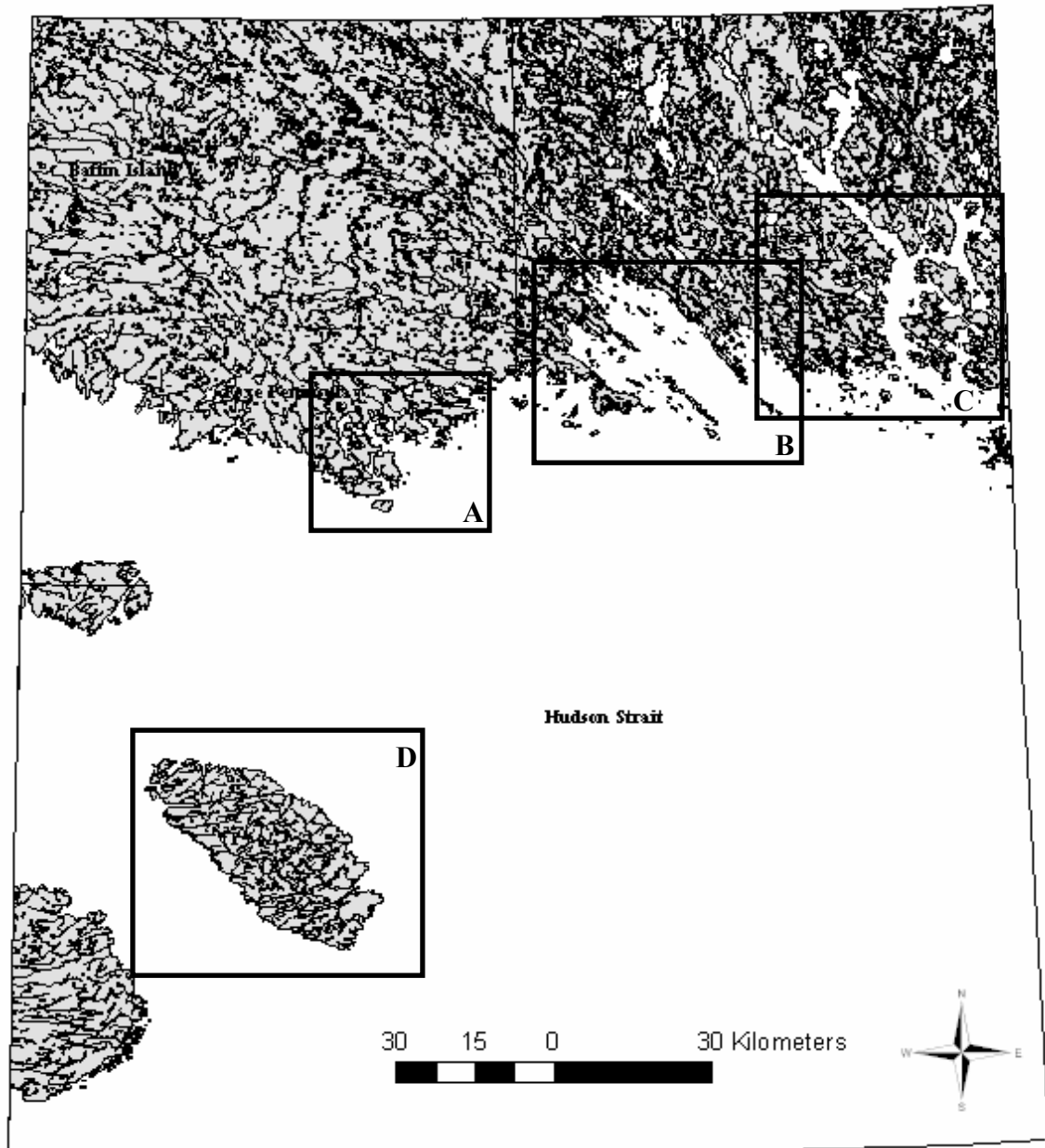
*slush* – a viscous mixture of snow and water

*thaw holes* – vertical holes in the sea ice formed when surface muddles melt through to underlying water

*young ice (grey)* – transition stage between nilas and first-year ice (grey and grey-white according to thickness)

### Appendix 3

#### *Map sheets covering the Cape Dorset area*



#### **Index of Figures showing map subsets around Cape Dorset:**

**A** = Cape Dorset Island and surroundings

(Figures 4-8, 4-10b, 4-11, 4-15b, 4-16a, 4-20a, 4-21b, 4-23)

**B** = Andrew Gordon Bay (Figures 4-10a, 4-16b, 4-20b)

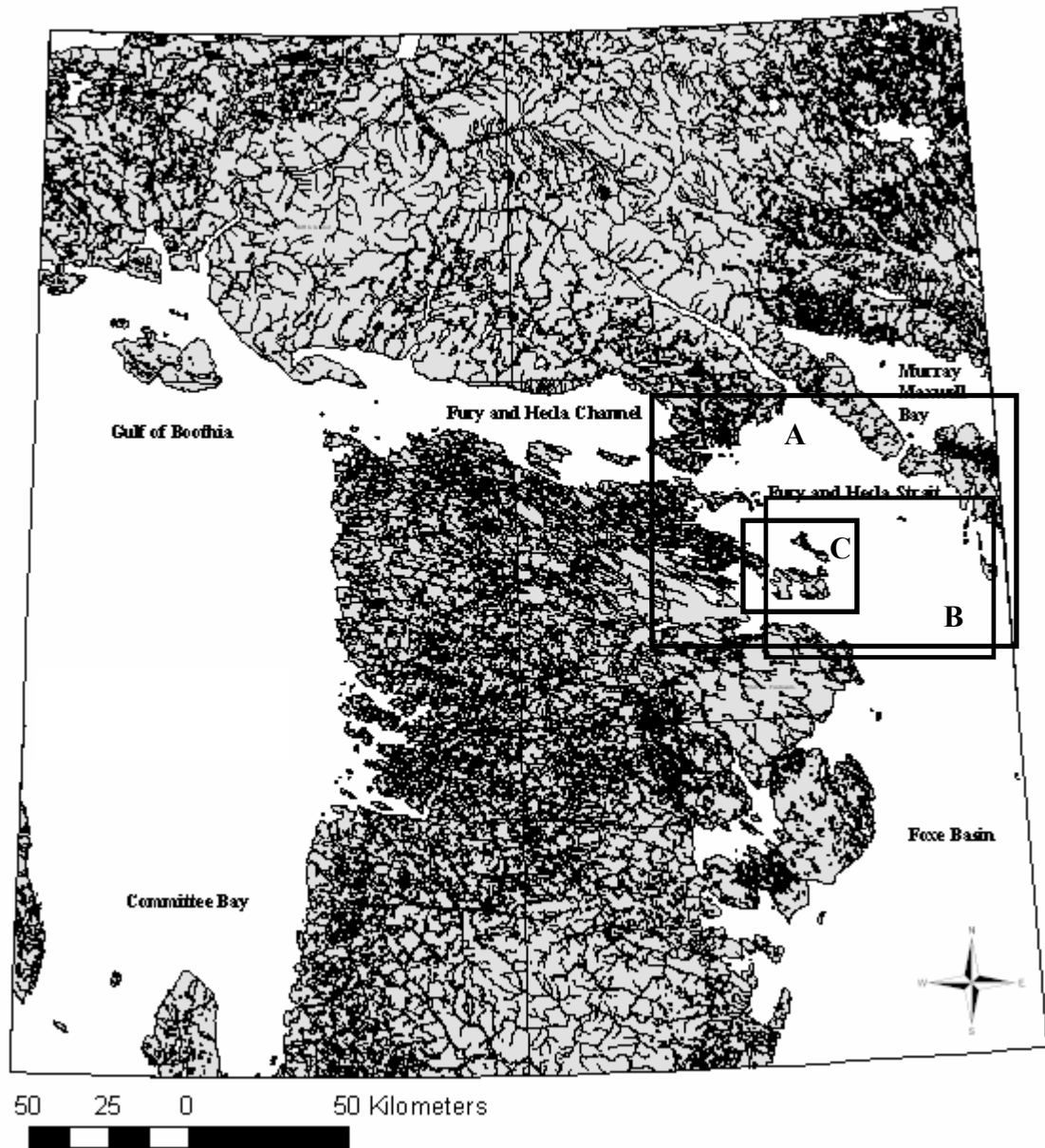
**C** = Chorkbak Inlet (Figure 4-15a)

**D** = Salisbury Island (Figure 4-21a)



## Appendix 4

### *Map sheets covering the Igloolik area*



**Index of Figures showing map subsets around Igloolik:**

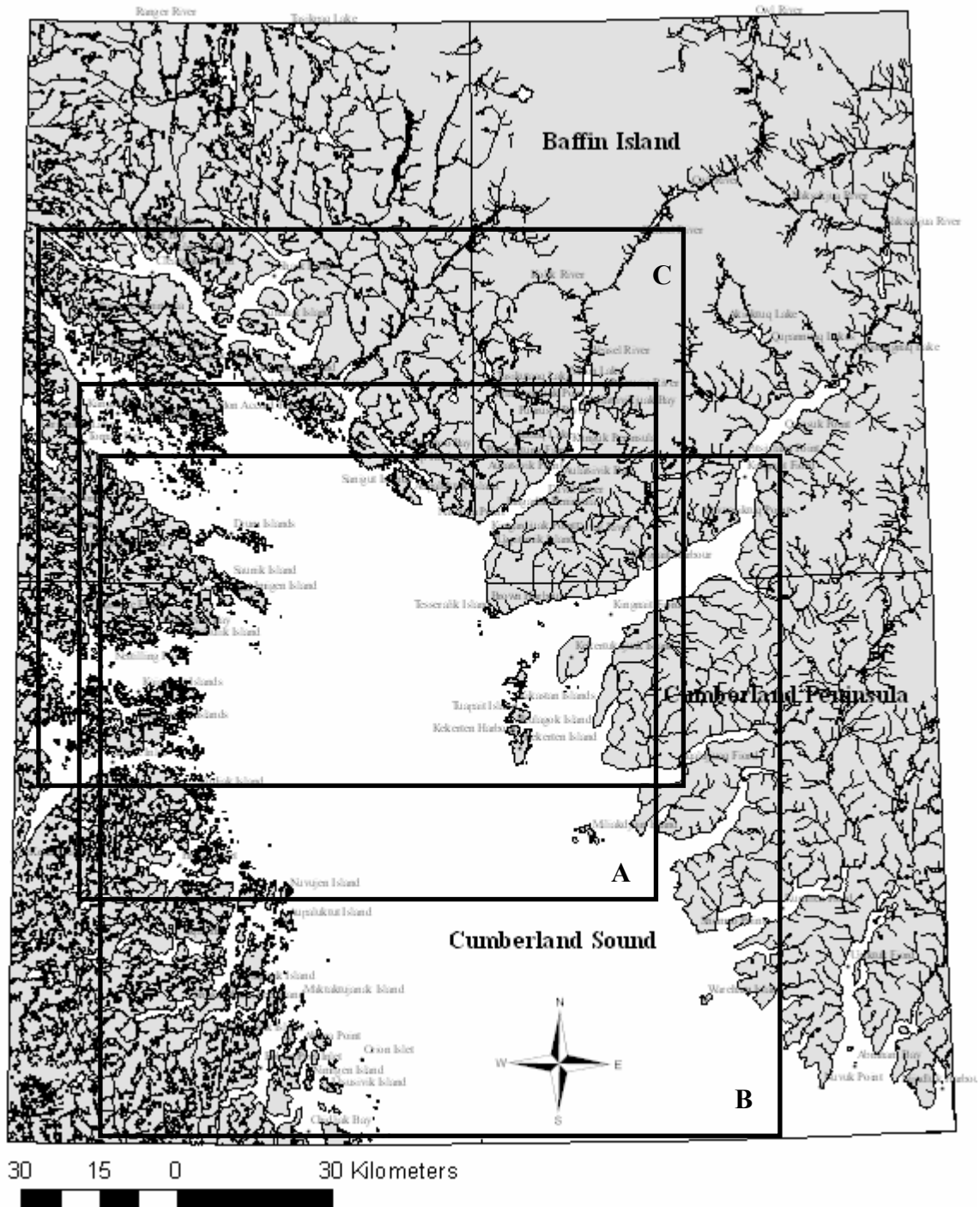
A = Fury and Hecla Strait (Figures 5-6, 5-8a, 5-15, 5-18)

B = Igloolik area (Figure 5-8b)

C = Igloolik close up (Figure 5-9a)

## Appendix 5

### *Map sheets covering the Pangnirtung area*



**Index of figures showing map subsets around Pangnirtung:**

A = North Cumberland Sound (Figures 6-6, 6-9, 6-13, 6-21)

B = South Cumberland Sound (Figures 6-8, 6-23)

C = North Cumberland Sound and inland (Figure 6-14)

## Appendix 6

### *Preliminary community visit summary – Cape Dorset*

#### Kinngait Trip Report (October 6 – 15, 2003) *Summary of Gita Laidler's Preliminary Research Visit for "Ice, Through Inuit Eyes"*

Purpose of the trip: to meet community members and organizations to discuss a project on sea ice and see if there is any interest in collaborating on future research trips.

Purpose of this report: to update the community members of Kinngait on: i) what I did during my trip; ii) concerns that were raised; iii) observations that were shared; iv) recommendations that were made; and, v) my future research plans.

#### **What I did during my visit to Kinngait →**

- |  |   |
|--|---|
| <ul style="list-style-type: none"> <li>○ Met with the SAO and the Hamlet Council</li> <li>○ Met with the Qikiqtani Inuit Association Representative</li> <li>○ Met with the Lands Committee (through QIA)</li> <li>○ Met with the HTA board members</li> </ul> | <ul style="list-style-type: none"> <li>○ Held a call-in radio-show</li> <li>○ Met with the Peter Pitseolak Secondary School principle, and some teachers</li> <li>○ Met Nunavut Arctic College representatives</li> <li>○ Met many community members along the way</li> </ul> |
|--|---|

#### **Concerns raised →**

- Scientists have been coming to Kinngait since the 1960s, but many researchers have not reported back to the community about their study results.
- Sea ice conditions are a definite concern since there is always a floe edge near town, and it is always changing with different winds, currents, and seasons.
- Pollution from the town, and from burning, is found on snow and ice far away. Some concern was expressed for the wildlife that might be ingesting this pollution.

#### **Observations shared →**

- No research like this, that people know of, has been conducted in Kinngait before.
- Kinngait is one of the few communities in Nunavut where you can boat year-round.
- The ice is forming later each year, and it is not as easy to read the clouds or weather to determine what short-term forecasts might be.
- The ice used to be twice as thick as it is today.
- In the spring time, the ice is not as safe compared to the same times in the past, when people used to be able to walk/drive on it.
  - It was possible, in the 1960s, to travel on the sea ice until the end of June, and now it cannot be used at the end of June.
  - These changes are especially noticeable in the inlets, where July used to be the latest time to travel and now it is more like the end of April.
- People used to be able to walk on the ice in October, now not usually until December.
  - When some elders were growing up, the ice would be forming in the inlet around early-mid October, and now it is not.
  - When travelling by dog team people used to be able to travel in November, but now in the same areas they cannot travel until around January.
  - The floe edge is closer in January/February/March, compared to 40 years ago.
  - In the middle of winter, when the ice breaks up (due to the difference in high and low tides), it used to crack in the same areas throughout the winter – now it cracks in more, and different, areas.

- Every year in the last few years, the ice has been leaving sooner than it used to.
- The ice is a lot rougher than it was during the 1960s.
- The currents are getting stronger.
- This type of research can be really useful, it can help the younger people.
  - It would be good to involve the younger people so they can learn from elders, but younger people should also be consulted about their own observations/concerns.

#### **Recommendations made →**

- People to talk to:
  - Active hunters – because they travel on the sea ice a lot and know which areas, and which types of ice, are suitable/desirable for particular kinds of marine wildlife.
  - Elders – because they have detailed and historical knowledge of the different local ice conditions around Kinngait and the Hudson Strait area.
  - Names of several individuals were put forward as excellent people to talk to/interview on return research visits.
- Consult the weather station at the airport regarding ice thickness records and other weather gauge records.
- Report back to community contacts throughout the project, and with final results.
- During the radio show community members, of all ages, were encouraged to speak their mind, share their concerns, and voice suggestions i.e. (to get involved in the project).
- This project has to be right out in the community, people have to know about it because they are not talking about these issues.
  - The weather and climate are changing, and it is good to tell community members in Kinngait, but also to tell other communities about what is going on here.
- Return for freeze-up (November/December) and break-up (May/June) times
  - Coming back in early November would be a good time to see early stages of ice formation, especially in inlets.
  - Come back in spring because the ice is getting thinner/more dangerous in June, so it would be good to learn about thawing processes and how people manoeuvre it.

#### **Future research plans**

- November, 2003 onwards → I, along with my professors and your recommendations, will develop a variety of funding proposals to send to different agencies to acquire sufficient funds to conduct this project.
- November, 2003 – April, 2004 → I will conduct a lot of background research on ice conditions, climate, and previous research in the Kinngait/Hudson Strait area.
- June, 2004 → return to Kinngait for a 1-month field research trip.

*Thank you for hosting me in your community, and for all your support. I very much enjoyed my time in Kinngait, and I look forward to returning and working with you in June. Feel free to contact me any time with comments, questions, or suggestions.*

Sincerely,

Gita J. Laidler

## Appendix 7

### *Preliminary community visit summary – Igloolik*

#### Igloolik Trip Report (February 13 – 21, 2004) *Summary of Gita Laidler's Preliminary Research Visit for "Ice, Through Inuit Eyes"*

Purpose of the trip: to meet community members and organizations to discuss a project on sea ice, and see if there is any interest in collaborating on future research trips.

Purpose of this report: to update the community members of Igloolik on: i) what I did during my trip; ii) concerns that were raised; iii) observations that were shared; iv) recommendations that were made; and, v) my future research plans.

#### **What I did during my visit to Igloolik →**

- Met with the Mayor and SAO
- Met with Nunavut Research Institute representatives
- Met with Nunavut Arctic College representative
- Held a call-in radio show
- Met with the Wildlife Officer
- Met with Department of Sustainable Development representatives
- Met with the HTA board members
- Met with the Ataguttaaluk High School principle, vice principle, and some teachers
- Met with Igloolik Isuma Productions representatives
- Met with the Qikiqtani Inuit Association representative
- Met many community members along the way
- Looked through the Oral History Database

#### **Concerns raised →**

- Many researchers have not reported back to the community about their study results.
- People are worried that the information and results will only go back to the university, and not the community – *this will not be the case.*

#### **Observations shared →**

- Many people who work mainly in offices are not as aware of sea ice conditions.
  - People do not go on the radio as much to tell the community what the ice conditions are like.
  - Knowing what the ice conditions are during the winter helps people know what they will be like in the spring.
- There is a lot of snow around the bay, but if you go down to the floe edge there is less snow.
- There have not been many differences observed in sea ice conditions.
  - Things always change from year to year.
- A few differences identified:
  - Ice at the floe edge, that is not connected to landfast ice, used to go back and forth at the edge – now more is leaving and not coming back.
  - The ice seems thinner than years ago.
  - Some people have noticed changes in the freezing rates of sea ice, and the sizes of polynyas.
- Sometimes satellite images of ice distribution are downloaded off the internet, but people find it hard to interpret them.
  - The images do not help that much in determining the colour, or other safety-related, ice conditions.

- People can start travelling on the ice in October and November.
  - There is still ice around in June, but it is starting to get rotten. It is a great time for seal hunting though.
  - It is too dangerous to travel on the sea ice in July.

#### **Recommendations made →**

- People to talk to:
  - Active hunters – people most involved in marine mammal harvesting would know the most about sea ice travel, conditions, changes, and important wildlife habitat.
  - Elders – because they have a lot of experience, and are very knowledgeable. But they have different areas of expertise, so again it would best to talk to those who were mainly involved in marine mammal harvesting.
  - Names of several individuals were put forward as excellent people to talk to/interview on return research visits.
- Researchers should come to the community with an open mind and be willing to learn, not just telling people what to do or how things *should* be done.
  - Report back to community contacts throughout the project, and with final results (from all three communities – Pangnirtung, Kinngait, and Igloolik).
- It would be helpful to learn more about interpreting satellite imagery that is available on the internet, so that images can be better understood (and possibly used).
- It might be valuable to have students involved as assistants, or even observers, in future research trips.
- Since Inuit ancestors did not have anything in writing, it was suggested that it would be useful to have some of this knowledge/information in writing.
- Talk to the HTA board members when I come back, and they will help me identify people to interview, or travel on the ice with.

#### **Future research plans →**

- March, 2004 onwards → I, along with my professors and your recommendations, will finalize funding details to ensure sufficient funds to conduct this project.
- April – September, 2004 → I will visit Pangnirtung and Kinngait to begin research (April/May), and will conduct more background research on ice conditions, climate, and previous research in the Igloolik area.
- October/November, 2004 → return to Igloolik for a 3-week field research trip.

*Thank you for hosting me in your community, and for all your support. I very much enjoyed my time in Igloolik, and I look forward to returning and working with you in October. Feel free to contact me any time with comments, questions, or suggestions.*

Sincerely,

Gita J. Laidler

## Appendix 8

### *Preliminary community visit summary – Pangnirtung*

#### **Pangnirtung Trip Report (September 24 – October 5, 2003)** *Summary of Gita Laidler's Preliminary Research Visit for "Ice, Through Inuit Eyes"*

Purpose of the trip: to meet community members and organizations to discuss a project on sea ice, and see if there is any interest in collaborating on future research trips.

Purpose of this report: to update the community members of Pangnirtung on: i) what I did during my trip; ii) concerns that were raised; iii) observations that were shared; iv) recommendations that were made; and, v) my future research plans.

#### **What I did during my visit to Pangnirtung →**

- |   |   |
|---|---|
| ○ Met with the Mayor and SAO                              | ○ Met with the HTA board members  |
| ○ Met with the Wildlife Officer                           | ○ Met with the Elder's Group  |
| ○ Met with the Angmarlik Visitor's Centre manager         | ○ Held a call-in radio-show (having become a member of the Allaniq Radio Society) |
| ○ Met with Nunavut Arctic College representatives         | ○ Met with the Fisheries plant manager  |
| ○ Met with the Qikiqtani Inuit Association Representative | ○ Met with the Attagoyuk High School principle, vice principle, and some teachers |
|   | ○ Met many community members along the way  |

#### **Concerns raised →**

- Many researchers have not reported back to the community about their study results.
- The effects of global warming (i.e. how livelihoods, access to country foods, and Inuit culture would be affected if the ice were to ever disappear).
- Uncertainty about the total, and final, project budget.

#### **Observations shared →**

- No research like this, that people know of, has been conducted in Pangnirtung before.
- An "Area Economic Survey" of the East Coast of Baffin Island was conducted in 1966 (it has informative historical sea ice, wildlife harvesting, and climate data).
- The ice is forming very late and is not very safe. People cannot get out hunting until later and caribou hunting grounds are harder to access.
  - In the past 2 winters there has been thicker ice that lasted longer than previously.
  - Freeze-up often does not occur until mid- or even late-December (some people have still been boating until the end of December), and it used to be frozen in November or even late-October.
  - When the ice first forms, it used to only take 2-3 days for someone to be able to walk on it. Now, even after a week, it may be unsafe.
  - The summers are longer now.
  - Nearby glaciers are melting or have disappeared.
- Polar bears never used to be spotted around town, only within the last 10 years or so.
- Sea ice seems to have a different consistency, or different formation process than before, and there has not been as much extreme cold.
  - Traditional rules used to determine whether the ice is safe, just by looking at it, no longer apply (the ice always has to be tested to see if it is safe).

- The ice these days is of a different consistency, it looks different.
- When the ice is melting, there seems to be more pollution on the ice, stuff that looks like soot, and that may be causing the ice to melt faster.
- Documenting community members' knowledge and observations of sea ice characteristics and/or changes not only helps future generations, but it also enables scientists to access this information and, therefore, take it more seriously.
- People of Pangnirtung are/will be very affected by global warming trends.

### **Recommendations made →**

- People to talk to:
  - Fishermen – because they work on the ice all the time in the winter months.
  - Active hunters – because they travel on the sea ice a lot and know which areas, and which types of ice, are suitable/desirable for particular kinds of marine wildlife.
  - Elders – because many of them come from different outpost camps around Cumberland Sound, so they have detailed knowledge of the different local ice conditions around the Sound.
  - Names of several individuals were put forward as excellent people to talk to/interview on return research visits.
- Researchers should come to the community with an open mind and be willing to learn, because it is a continual, lifelong process.
  - Report back to community contacts throughout the project, and with final results.
- One research priority should be safety. Snowmobiles are now used instead of dog teams; therefore, many people have lost the help of canine instincts to guide them around unsafe ice.
  - People have to be able to gauge ice safety from a machine, and at faster speeds.
- Return for freeze-up (December/January) and break-up (May/June) times.
  - To see the ice in its most frozen state, it is best to return in February, but to see it before the snow comes it would be good to return in January.
  - The project should last more than one year to see the whole ice cycle.

### **Future research plans**

- November, 2003 onwards → I, along with my professors and your recommendations, will develop a variety of funding proposals to send to different agencies to acquire sufficient funds to conduct this project.
- November, 2003 – April, 2004 → I will conduct a lot of background research on ice conditions, climate, and previous research in the Pangnirtung/Cumberland Sound area.
- May, 2004 → return to Pangnirtung for a 1-month field research trip.

*Thank you for hosting me in your community, and for all your support. I very much enjoyed my time in Pangnirtung, and I look forward to returning and working with you in May. Feel free to contact me any time with comments, questions, or suggestions.*

Sincerely,

Gita J. Laidler



## Appendix 9

### *Interview participants in each community*

#### Interview participants in Cape Dorset

(sorted alphabetically by code to facilitate interview identification)

Name	Interview Date	Code
Atsiaq Alasuaq	Apr 27/04 (x2)	AA1
Ashevak Ezekiel	Jan 18/05	AE1
Adamie Nuna	Apr 15/04	AN1
Aleka Parr	Nov 30/04	AP1
Etulu Etidlouie	Nov 14/04	EE1
Etulu Etidlouie	Nov 15/04	EE2
Elijah Mangitak	Apr 16/04	EM1
Etidlouie Petaulassie	Nov 25/04	EP1
Iqadluq Nunguisuituq	Apr 19/04 (x2)	IN1
Jimmy Manning	Jan 19/05	JM1
Jimmy Manning	Jan 28/05	JM2
Kanayuk Solomonie	Apr 28/04	KS1
Mathewsie Joanasie	Nov 20/04	MJ1
Mangitak Kellypalik	Apr 15/04	MK1
Mangitak Kellypalik	Apr 16/04	MK2
Mikisiti Saila	Nov 26/04	MS1
Ningeoseak Peter	Nov 22/04	NP1
Oqutaq Mikigak	Nov 26/04	OM1
Oqutaq Mikigak	Nov 27/04	OM2
Oqsuralik Ottokie	Apr 27/04	OO1
Paulassie Pootoogook	Apr 23/04 (x2)	PP1
Paulassie Pootoogook	Jan 13/05	PP2
Qatsiya Petaulassie	Nov 29/04	QP1
Quvianaqtuliaq Tapaungai	Nov 29/04	QT1
Quvianaqtuliaq Tapaungai	Jan 21/05	QT2
Sandy Kelly	Jan 29/05	SK1
Simigak Suvega	Apr 28/04	SS1

**Interview participants in Igloolik**

(sorted alphabetically by code to facilitate interview identification)

<b>Name</b>	<b>Interview Date</b>	<b>Code</b>
Arsene Ivalu	Jun 10/05 (x2)	AI1
Anthony Qrunnut	Nov 1//04	AQ1
Augustine Taqqaugak	Nov 5/04	AT1
Abraham Ulayuruluk	Nov 2/04	AU1
David Angutikjuag	Nov 2/04	DAn1
David Aqiaruq	Nov 4/04	DAq1
David Irngaut	Nov 12/04	DI1
Daniel Qattalik	Nov 11/04	DQ1
Eugene Ipanak	Nov 9/04	EI1
Enuki Kunuk	Nov 10/04	EK1
Enuki Kunuk	Nov 12/04	EK2
George Quviq Qulaut	Jun 9/05	GQ1
Herve Paniaq	Nov 2/04	HP1
John Arnatsiaq	Jun 13/05	JAn1
Jaipiti Palluq	Jun 13/05	JaP1
Levi Qaunaq	Jun 9/05	LQ1
Louis Uttak	Nov 1/04	LU1
Maurice Arnatsiaq	Nov 4/04	MA1
Nathan Qamanig	Nov 4/04	NQ1
Samuelie Ammaq	Nov 9/04	SA1
Theo Ikummaq	Nov 1/04	TI1
Theo Ikummaq	Nov 8/04	TI2
Zacharias Aqiaruq	Nov 5/04	ZA1

**Interview participants in Pangnirtung**

(sorted alphabetically by code to facilitate interview identification)

<b>Name</b>	<b>Interview Date</b>	<b>Code</b>
Anonymous	Dec 7/04	AY1
Enoosie Nashalik	May 5/04 (x2)	EN1
Joavee Alivaktuk	Dec 9/04	JAk1
Jamesie Mike	May 11/04 (x2)	JaM1
Jamesie Mike	Feb 7/05	JaM2
Jaco Ishulutak	Dec 8/04	JI1
Jaco Ishulutak	Dec 9/04	JI2
Jackie Nowdlak	Feb 17/05	JN1
Joanasie Maniapik	May 12/04	JoM1
Joanasie Maniapik	May 13/04	JoM2
Joeelee Papatsie	Feb 9/05	JoP1
Joanasie Qappik	May 17/04	JQ1
Joanasie Qappik	May 18/04	JQ2
Joopa Soudluapik	Dec 10/04	JS1
Levi Evic	Feb 10/05	LE1
Lazarusie Ishulutak	May 6/04	LI1
Lazarusie Ishulutak	May 7/04	LI2
Lootie Nowyook	Dec 13/04	LN1
Manasie Noah	Dec 15/04	MaN1
Manasa Evic	Dec 7/04	ME1
Michael Kisa	Dec 6/04	MiK1
Manasie Maniapik	Dec 14/04	MM1
Mosessee Nuvaqiq	May 6/04	MN1
Mosessee Keyuajuk	Dec 16/04	MoK1
Mosessee Keyuajuk	Feb 14/05	MoK2
Mosessee Nuvaqiq	Feb 2/05	MoN2
Peterosie Qappik	Dec 18/04	PQ1
Paulosie Vevee	Dec 13/04	PV1

## Appendix 10

### *Semi-directed interview guide*

PLEASE NOTE → Questions will be used only as a guide during semi-directed interviews, along with 1:250 000 scale maps. Not every question will be asked, it will depend on participant responses and the direction of discussions. Therefore, while this list is quite long, be assured that they are only examples of possible questions to ask – they do not represent an exhaustive list to be covered in interviews.

#### **Interviewee Biography**

1. Where were you born?
2. What year were you born?
3. Who are your parents, spouse, and children?
4. Where have you and your family traveled in your lifetime?
5. How long have you been living in this community?
6. Have you ever worked with scientists before?
7. How did you feel about these experiences?
8. Where were the reports published? Are the results stored within your community?
9. Did you feel that they were beneficial to you or your community?

#### **Background**

10. Do you, or have you, spent much time observing, traveling, or hunting on the sea ice?
11. What words do you use to describe such sea ice characteristics as:
  - a) first-year ice
  - b) multi-year ice
  - c) landfast ice
  - d) icebergs
  - e) pancake ice
  - f) frazil or grease ice
  - g) leads
  - h) pressure ridges
  - i) ice formation processes
  - j) ice decay processes?
12. Do these words mean the same thing as the English descriptions? Or do they refer to different concepts or ice conditions?
13. Can you tell me about other Inuktitut concepts related to sea ice? I am trying to learn the words you use to describe different ice conditions, formations, and processes.
14. Do you have place names that refer to sea ice features?
15. Are there particularly important coastal locations that are linked to sea ice travel, hunting, or observation of the marine environment?

#### **Winds and Ocean Circulation**

16. Is there a predominant wind direction around your community?
17. How do winds affect sea ice formation and distribution?
18. Are winds different today than they were long ago?
19. Do you notice any links between wind (direction or strength) and ocean circulation?
20. Can you describe the ocean circulation and currents around your community?
21. Can you describe the ocean circulation and currents in areas you travel to or hunt in throughout the year?

22. Do notice any links between wind (direction or strength) and sea ice formation or distribution? Can you describe these processes to me?
23. Do notice any links between ocean circulation (direction or strength) and sea ice formation or distribution? Can you describe these processes to me?
24. How important you feel that winds and ocean circulation patterns are to sea ice formation or decay processes?

### **Rare Events**

25. Can you tell me about any rare or notable sea ice features or events that you have experienced over your lifetime?
26. What do you think caused this rare event to occur?
27. Do you remember what year it was or what was going on in the community at the time?
28. How did this rare occurrence affect community lives and/or hunting practices?
29. How did this rare occurrence affect the wildlife?
30. How often did such rare events occur? Were they similar, or different each time?

### **Climate**

31. How is the weather today compared to long time ago?
32. Can you tell me about years when the weather was really cold?
33. Can you tell me about years when the weather was really warm?
34. How does a change in the weather affect ice conditions?
35. How does a change in the weather affect wildlife that live on the ice, under the ice, or along the coastline?
36. Have you noticed changes in the coastal zone, sea ice, ocean water, or snow because of changes in the weather?
37. Do animals or people like certain types of ice conditions for traveling? Can you describe these conditions for people and each animal?
38. How do the animals know when the ice is going to melt?

### **Community Use**

39. Why is sea ice important to the Inuit?
40. Do people use sea ice today in the same ways that they did long ago?
41. What are the most common uses of sea ice in your community today?
42. How is sea ice important to you?
43. How is the ocean used in different seasons?
44. What does the sea ice tell you about changing seasons?
45. Do you use particular observation techniques that tell you about ice conditions? Can you describe them to me?
46. Are you, or people you know, able to predict how ice conditions may change over a day or two? If so, what clues do they (you) use to help you make these predictions?

### **Wildlife Use**

47. Why is the sea ice important to wildlife?
48. Can you tell me what different animals use the sea ice around your community?
49. Can you tell me what different animals use the sea ice in other areas that you travel to throughout the year?
50. What are the Inuktitut names for these animals?
51. Are there different names for different ages or sexes of these animals?

52. How do the animals use the ice when it forms a solid cover over the ocean?
53. How do the animals use the ocean when there is no ice cover?
54. How do animals adjust to ice in its transition stages?

### **Hunting Activities**

55. Do you, or have you, taken part in hunting animals that live in the ocean, on the sea ice, or along the coast?
56. Which animals did you hunt as a child?
57. Where did you hunt as a child?
58. Which animals did you hunt as a young adult?
59. Where did you hunt as a young adult?
60. Which animals do you hunt now?
61. Which animals do you hunt most often? How often would that be?
62. Who do you normally hunt with?
63. Where would you tend to set up hunting camps?
64. Which routes would you take when hunting different animals?
65. Where are the places you are most likely to find these animals? Why?
66. At what times of the year would you hunt each different animal?
67. Would you hunt only a particular age, sex, or species, depending on the animal you are looking for?
68. Can you tell me about the different ways to hunt each animal?
69. What does each type of animal eat?
70. Where are important feeding grounds? What makes them good feeding grounds?
71. What are the uses for these animals after a successful hunt? How are they prepared for such uses? What is done with unused animal parts (now and long ago)?
72. Are there certain things that an Inuk is not allowed to do when hunting these animals?
73. What will happen if a hunter does not follow these rules?
74. How many of each type of animal do you hunt in a year?
75. How many of each type of animal does your community hunt in a year?
76. Do you remember years when there was a shortage of a particular type of animal? What did you do?

### **Migration and Denning**

77. What time of year and how do male and female animals start looking for each other to reproduce?
78. How many days do they spend together during their mating period?
79. What time of year do they come together again? Or do they stay together at all?
80. When do you see the first female animals in the spring? What about male animals?
81. Can you use the maps to show me where you see them and in which direction they are moving?
82. Have their movement patterns changed since long ago?
83. Where do you see the animals in the summer?
84. What are some of their most important seasonal stages? Why?
85. Where have you seen denning grounds for polar bears, seals, or walrus?
86. Where do whales or narwhals have their young?
87. Why do they choose these areas?
88. Where do the mothers go after having their young?

89. Do the animals congregate to have their young? When would the first and last mothers arrive?
90. What happens if the young are born before the mothers reach their denning grounds?
91. When people are hunting, how can they tell when each type of animal is pregnant?
92. Will people hunt pregnant animals?
93. Are unborn babies important to the Inuit for eating?
94. How can people tell when a mother is about to give birth?
95. How often does each animal have a baby? Every year or few years? Do they even have more than one baby at a time?
96. How long do the young stay with their mothers?

### **Wildlife Health**

97. Where have you seen any of these animals dead or sick?
98. What are the natural predators of these animals?
99. How can you tell when an animal is sick, from a distance?
100. How can you tell when an animal is sick, after it has been killed?
101. Are there more sick animals today than long ago? How does it vary among animals in the marine environment?
102. How many sick animals, of each species, do you see in a year?
103. What do you think causes an animal to get sick?
104. Do you think there are any links between sea ice conditions and sick animals?
105. What are the Inuktitut names for sick animals?
106. Does their meat taste the same all year round?
107. Does the meat taste different depending on the age or sex of the animal? Which do you like best?

### **Recommendations/Questions for Sea Ice and Scientists**

108. Is there anything about the sea ice or marine environments that concern you?
109. How do you think changes in sea ice formation or distribution would affect community life?
110. What do you think of scientists' methods of study sea ice (i.e. satellite images and computer modeling)?
111. Are there types of scientific studies that you would like to know more about?
112. Are there particular sea ice or marine issues that you think scientists should be studying more?
113. How do you think your experiences could help scientists learn about the sea ice and marine environments?
114. If you could meet with sea ice researchers, what would you like to tell them? What would you like to ask them? What would you like to learn from them? What would you like to teach them?
115. Do you think that Inuit and southern scientists should work together in studying certain aspects of sea ice or ocean characteristics? Which areas do you think they should study together?
116. What do you think the best way would be to establish long-term collaborative studies with Inuit and southern scientists?
117. What would you recommend as priority research areas?

**Closing**

118. What does *Inuit Qaujimajatuqangit* mean to you?
119. What is the most interesting thing you have learned about sea ice?
120. Do you know of any old stories about sea ice or marine animals?
121. How have you learned all the knowledge you have just shared with me about sea ice, wildlife, hunting techniques, winds, circulation, weather, etc.?
122. How do you feel about this interview experience? How does it compare with past experiences?
123. How would you describe Inuit science? How does it differ from southern science?
124. Do you think that it is possible to join IQ with southern scientific studies? Do you think this would be worthwhile? How do you think this can be best achieved?
125. Is there anything else that you would like to share with me at this time?
126. Is there anything we can do to make this interview better?



(size has been reduced from the original)

- **Scientists** have been investigating Arctic sea ice patterns and processes for the past 50 years, but they have rarely consulted Inuit community members to learn the ***Inuit Qaujimajatuqangit (IQ)*** of sea ice and marine environments.
- This project recognizes that **IQ** (Inuit knowledge) is valuable expertise and a perspective that **has much to contribute to sea ice and climate science.**

- ❖ Igloolik
- ❖ Pangnirtung
- ❖ Cape Dorset

- i) better understand the **meaning of sea ice** to Inuit culture and identity;
- ii) better comprehend the traditional and contemporary ways that Inuit characterize **sea ice variability**;
- iii) evaluate **methods** of collecting, analyzing, and using IQ and scientific knowledge within a common framework; and,
- iv) establish **future collaborative research/monitoring needs** based upon the issues of greatest concern or priority to Nunavut communities.

- Develop a **partnership** with interested community members.
- Determine the best ways for Inuit voices to be heard, and included, in assessments of community vulnerability and/or adaptation to potential changes in marine and sea ice environments.

- I invite **elders, hunters, trappers**, and other **local experts** to contribute in ways they feel comfortable with.
- It is hoped that these efforts will evolve into **ongoing collaboration** between Inuit communities and scientists.
- This could improve our collective knowledge of the links between sea ice, climate, wildlife, and human well-being.

<http://eratos.erin.utoronto.ca/grad/laidler>

A person is shown from the waist up, wearing a dark blue hooded jacket with a white stripe across the chest and a black beanie with a red tassel. They are sitting outdoors, with a body of water and a rocky shore in the background.

***THANK YOU... for your interest and for  
hosting me in your community.***

[illegible]

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# Ice, through Inuit Eyes

ኖልግ፣ ልዑል  
ክፍሉን፣ ክፍሉን  
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Part of a University of Toronto research project to  
improve communication between Nunavut  
communities and sea ice/climate scientists

## Appendix 12

### Consent form

Dear Participant,

This consent form is a simple formality to make sure that both you, the participant, and myself, the researcher, have followed all appropriate research guidelines as outlined by the Nunavut Research Institute and the University of Toronto.

All background information on this project called Ice, Through Inuit Eyes: Contributions of Inuit Qaujimajatuqangit to sea ice and climate science in the Canadian Arctic is provided in the information pamphlet that comes along with this consent form.

Gita Laidler is the researcher requesting your participation in this research project, as part of her PhD research in the Department of Geography at the University of Toronto. Should you have any questions or concerns, feel free to contact her, or her supervisor, at the numbers indicated below.

**Gita Laidler** (Researcher)  
Department of Geography  
University of Toronto at Mississauga  
3359 Mississauga Road North  
Mississauga, Ontario L5L 1C6  
Phone: 416-934-0062  
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**Vincent Robinson**  
(Co-supervisor with **Deborah McGregor**)  
Department of Geography  
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#### Project Consent:

I have read the information pamphlet provided, have understood the project objectives, and voluntarily consent to participating in the interactive session indicated below. I understand that this session will remain confidential, including the secure storage of all data during and after project completion. Some of my responses will be used anonymously in publications or presentations related to Gita Laidler's PhD thesis, unless I consent to being identified. I also understand that I may withdraw from the study at any time, without any repercussions. I am aware that this session will be recorded (by audio tape, video tape, or photograph), with my permission. With my consent to be taped and/or photographed, I may additionally choose how/if this information is released, and I may withdraw any data that I have provided. I am aware that I will have full access to all research documents including proposals, interim results, and final reports/publications. I realize that there are no foreseeable risks, harms, or inconveniences caused by my participation, and that the most direct benefits will be financial compensation and cross-cultural learning opportunities. I understand that compensation is dependent upon project funding, but that amounts will be agreed upon prior to providing my consent. I am aware that I may contact the researcher and/or the Nunavut Research Institute at any time throughout the project, with any questions, concerns, or complaints that I might have.

- By signing below I CONSENT to the following (check appropriate box(es)):
- I prefer to provide verbal consent, so by checking here \_\_\_ I CONSENT to the following (check appropriate box(es)):

❖ Being identified in information release: ☐ Yes ☐ No

❖ Being: audio taped ☐ Yes ☐ No

video taped ☐ Yes ☐ No

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AND

Allowing the release of :

audio/video tapes ☐ Yes ☐ No

photos ☐ Yes ☐ No

Print name: \_\_\_\_\_

Sign name: \_\_\_\_\_

Date: \_\_\_\_\_

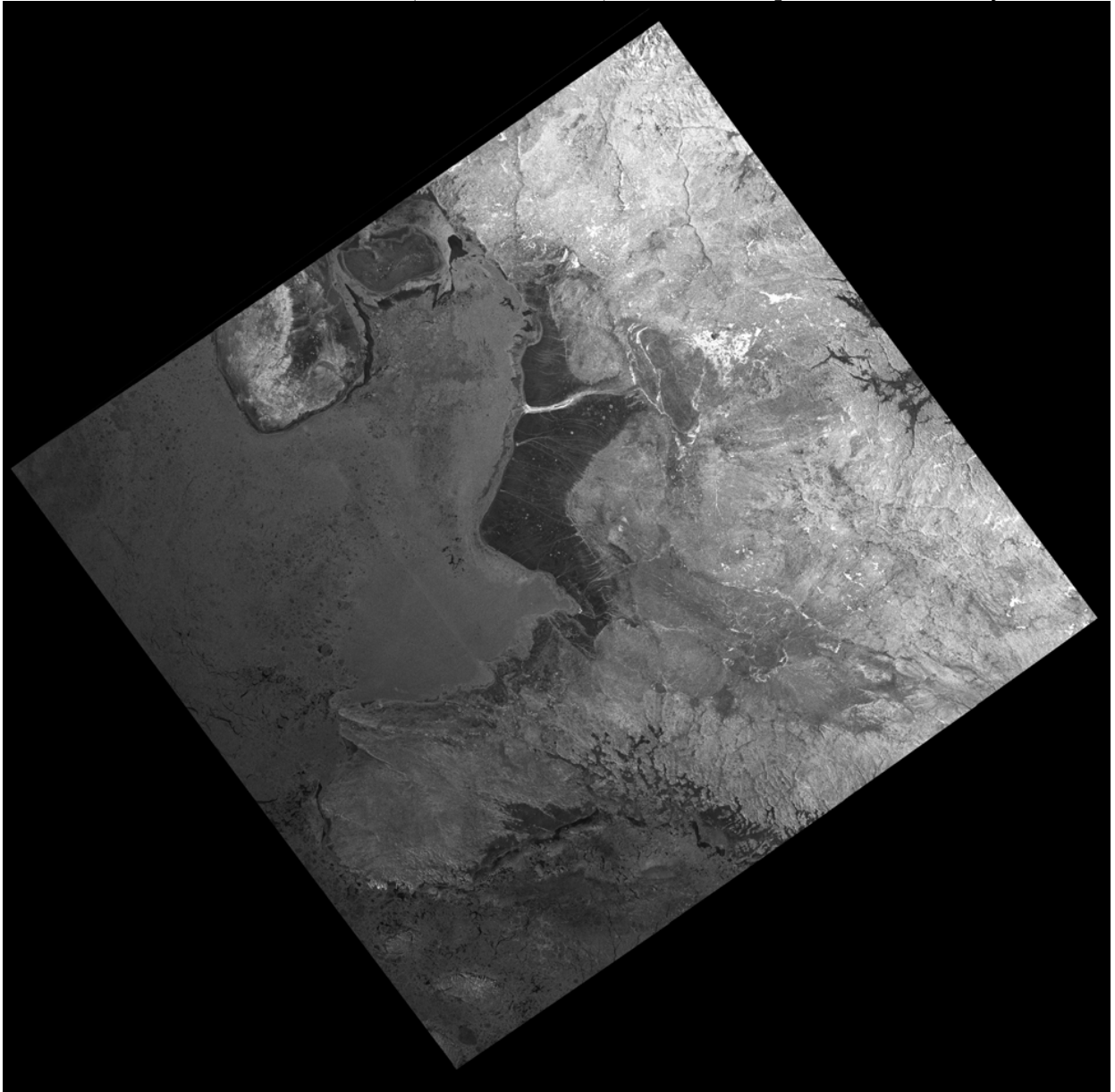
## Appendix 13

### *Satellite imagery used in interviews*

(N.B. these images are smaller than what was used in the interviews)

RADARSAT1 Scansar Wide Mode (100m resolution)

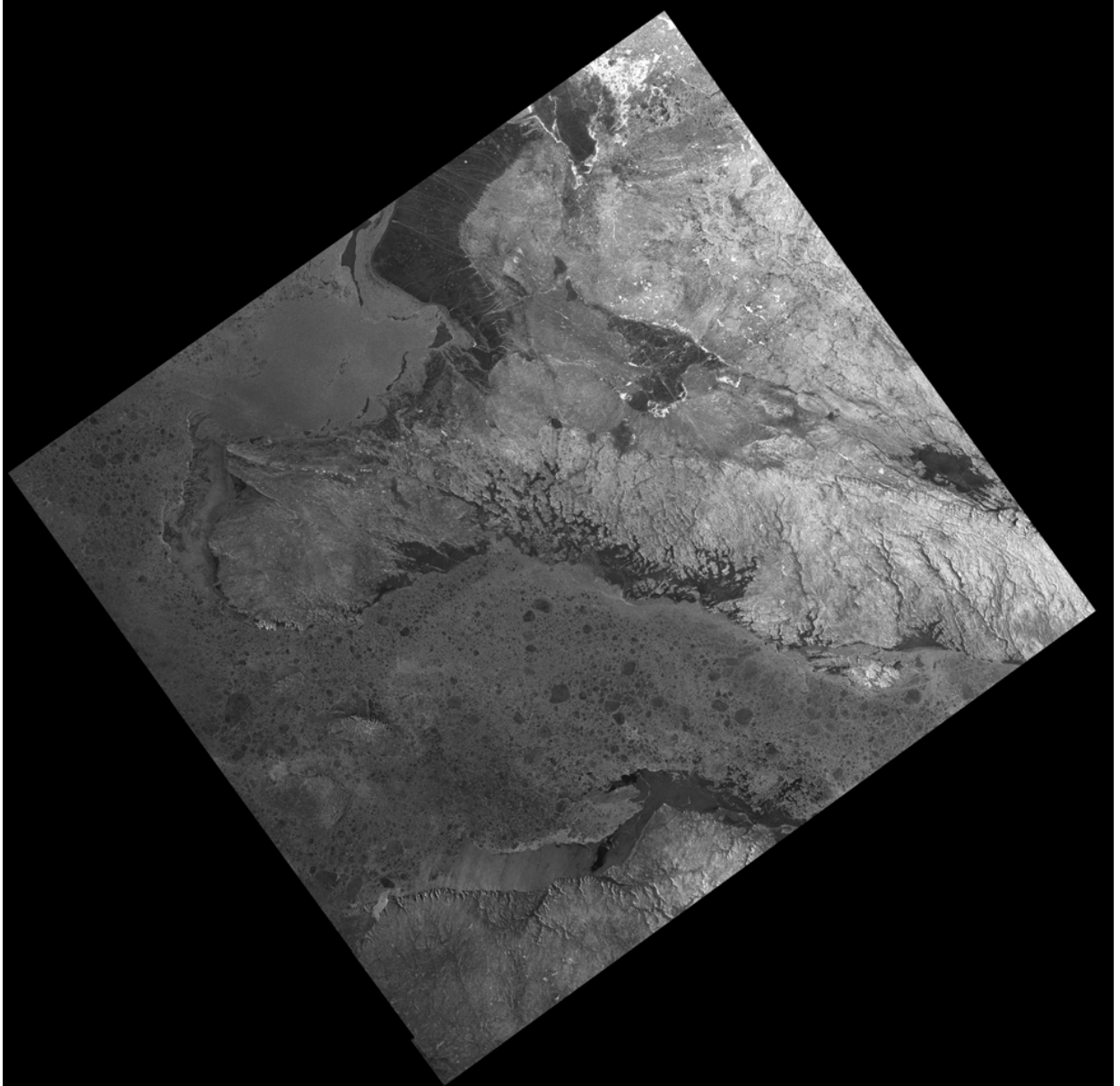
Cape Dorset, February 23, 2004



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RADARSAT1 Scansar Wide Mode (100m resolution)

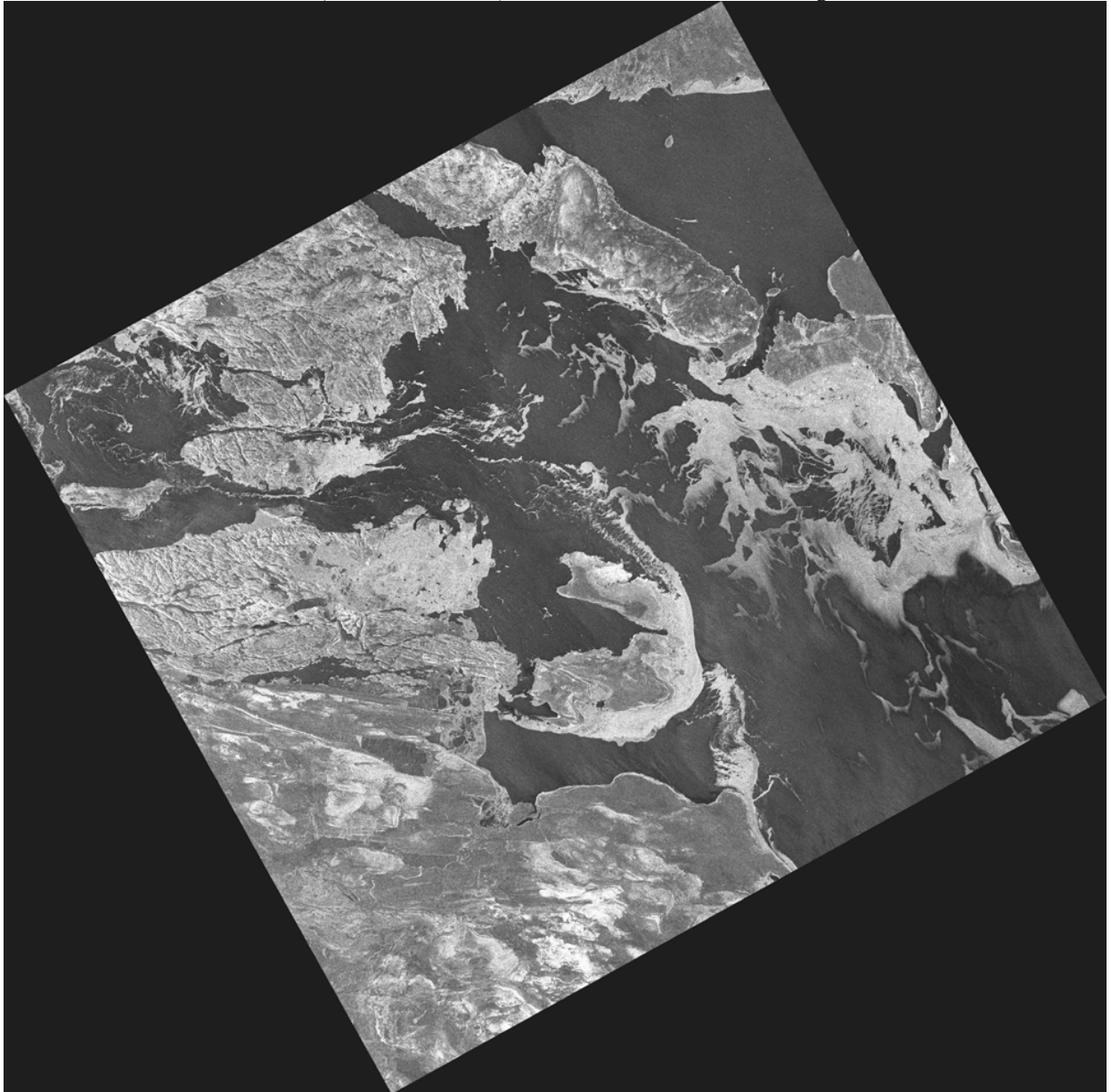
Cape Dorset, April 28, 2004



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RADARSAT1 – Fine mode (10m resolution)

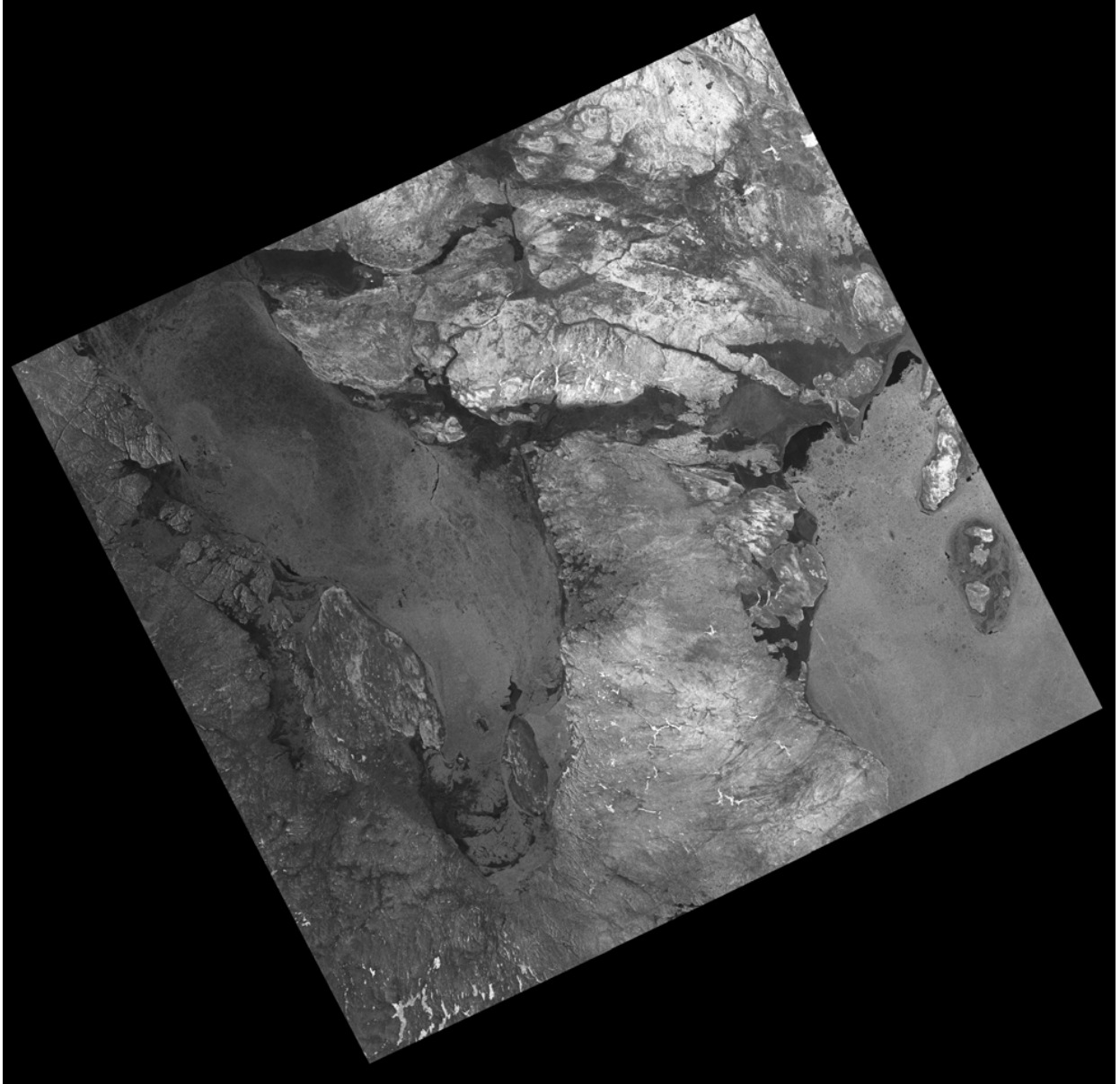
Igloolik, October 19, 2004



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RADARSAT1 Scansar Wide Mode (100m resolution)

Igloolik, May 14, 2004

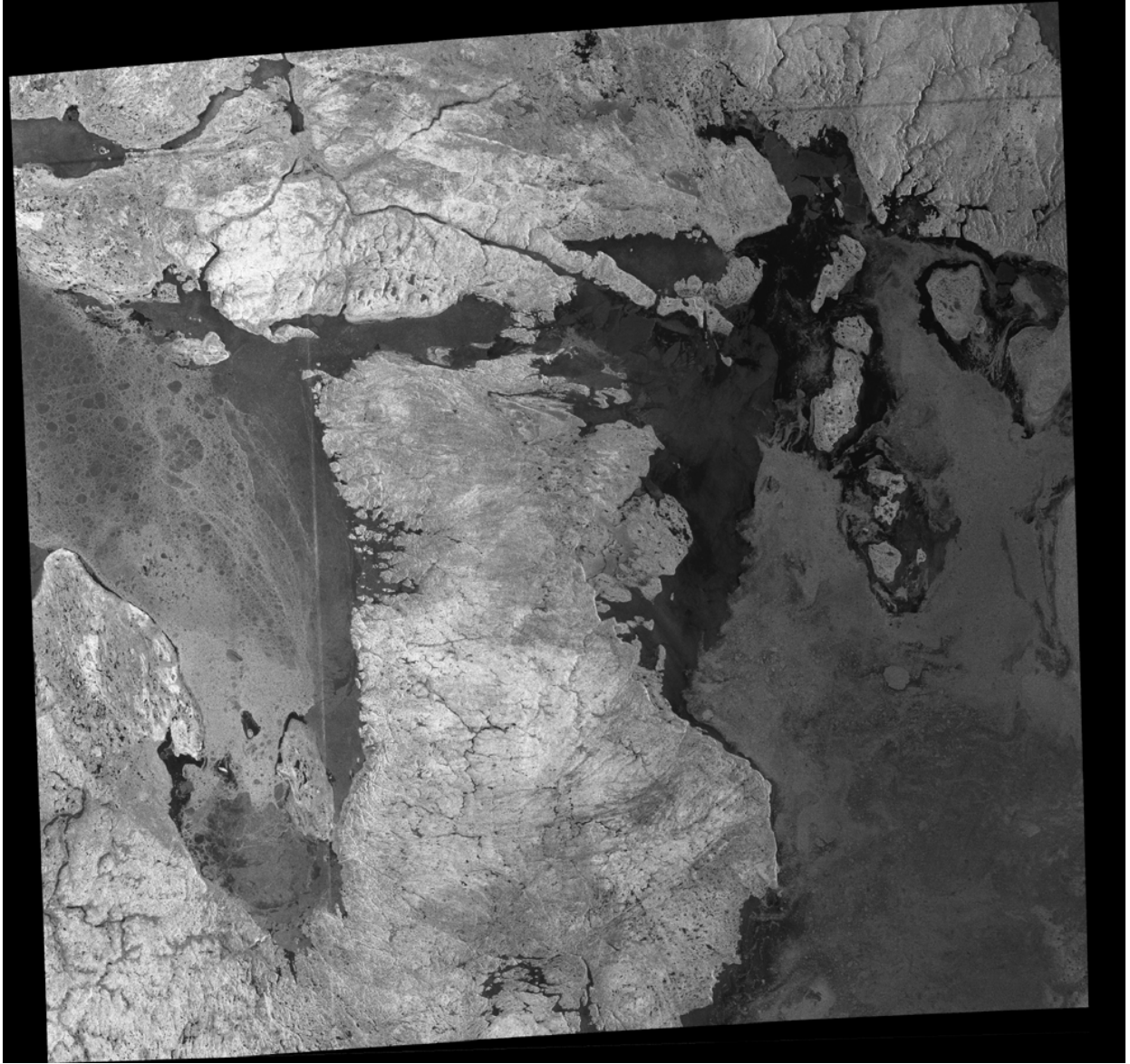


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RADARSAT1 Scansar Wide Mode (100m resolution)

Igloolik, July 27, 2004

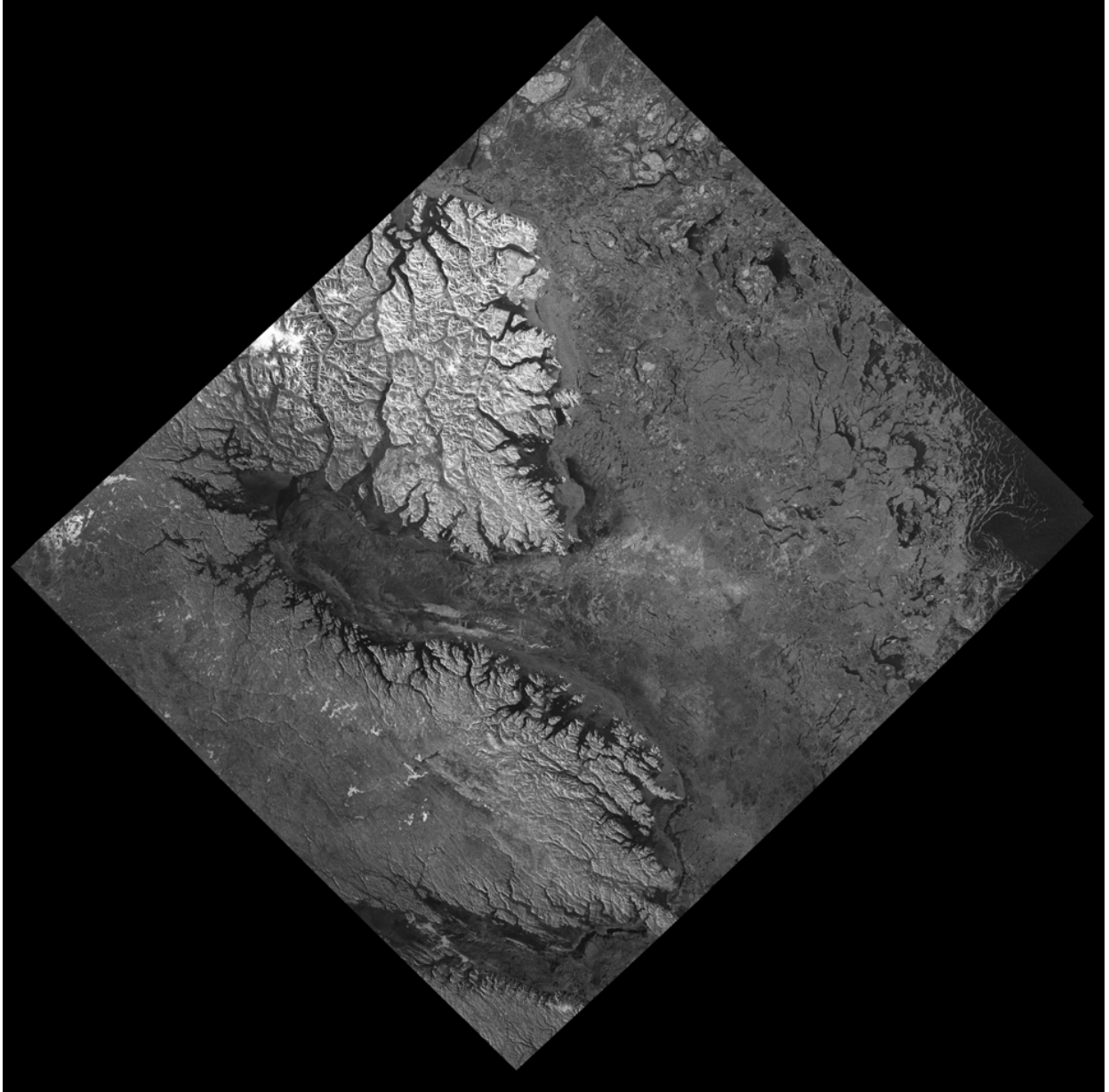


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RADARSAT1 Scansar Wide Mode (100m resolution)

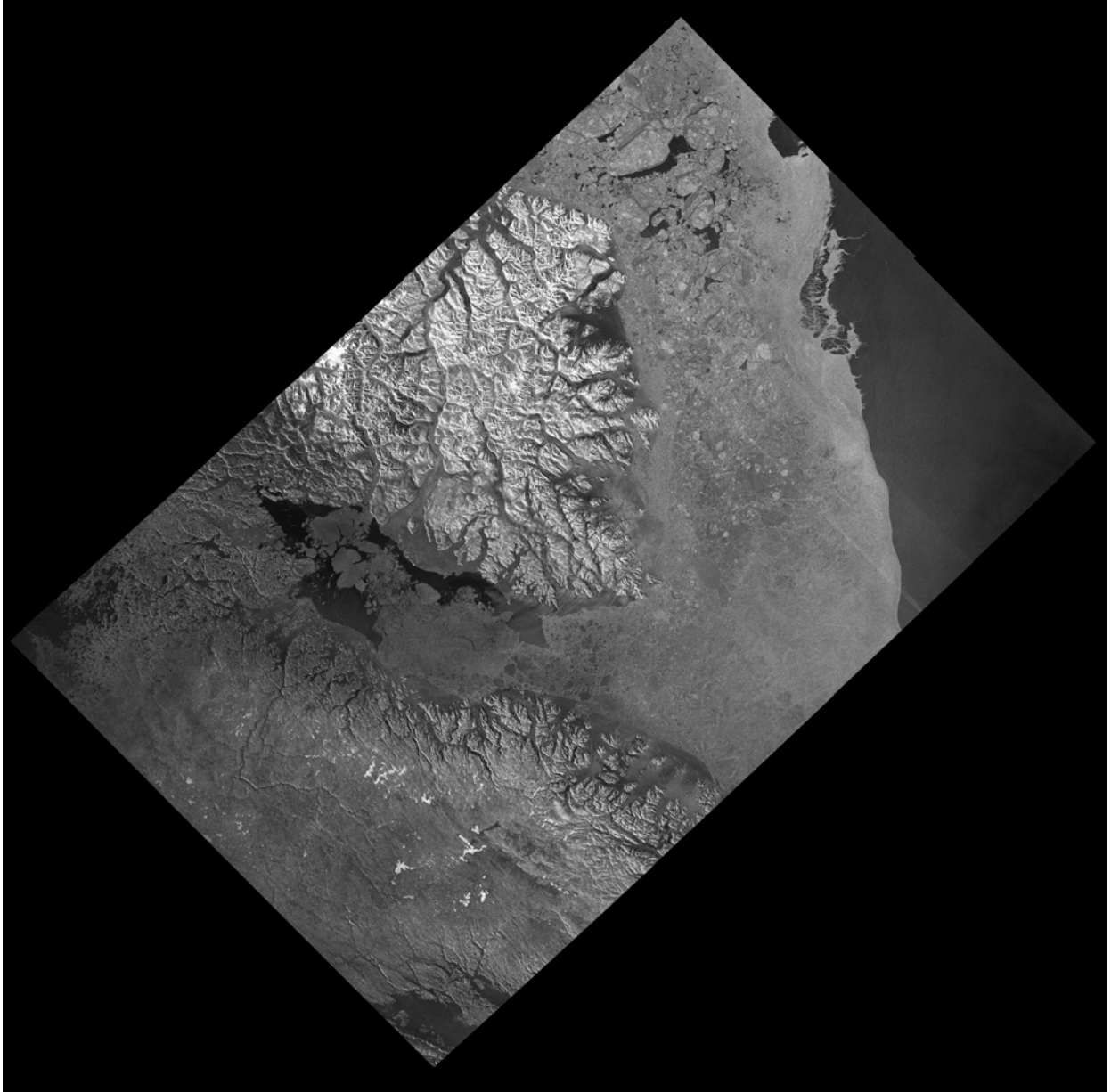
Pangnirtung, March 9, 2004



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RADARSAT1 Scansar Wide Mode (100m resolution)

Pangnirtung, May 20, 2004



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## Appendix 14

### *Cape Dorset Inuktitut Terminology*

*Quick reference for sea ice terms in Chapter 4 (alphabetical order)*

Term	Feature	Description
agguttituq	Ice condition	Ice formed with the direction of the wind
ajuqpaliajuq	Action, ice break-up	ice breaking off where the cracks are widest
ajuraq	Crack/lead, spring	tidal crack that does not re-freeze, open water remains within it
aniquasai	Moving ice	ice that moves with the currents
aputlariq	Ice condition, ice deterioration	when the snowfall, or snowmelt, in the spring contributes to ice melt
asaluaan	Moving ice	rounded ice in open water
aukaaniq	Ice condition, ice deterioration	areas that open or melt earlier than others in the spring
aukaaq	Action, ice break-up	when the ice is breaking up/off in the spring
aukajuq	Action, ice deterioration	very early melt stage
aulaniq	Moving ice	general term for moving ice
ijjusijuq	Action, freezing	ice is thickening
ikiqtuq	Action, cracking	a widening crack that would require a boat to cross
ikiqtusijuq	Action, cracking	a crack that is widening
ilaupalia	Action, ice formation	process of <i>ilu</i> forming
ilu	Fall ice condition, near shore	early freezing in the low tide area
immatinniit	Spring ice condition	melt puddles on the ice
immatuqtuq	Action, ice deterioration	process of meltwater formation
ivuniit	Rough ice	ice ridges
kuiviniq	Fall ice condition, near shore	ice frozen over rocks along the shore
kuvvilukajuq	Fall ice condition	ice that will not be breaking off
manguqtuq	Action, ice deterioration	general process of the beginning of ice melt
marruluin	Moving ice	broken ice with debris, from other areas
matsaaq	Spring ice condition	when water drains through the ice
millutsiniq	Ice condition	a slushy patch of ice caused by snowfall
nagguti	Tidal crack	a crack that forms in the winter and re-freezes
nigajutaq	Fall ice condition	a hole that remains in newly formed ice
nipittupaliajuq	Crack	a crack that you have to jump over to cross
nunniq	Ice condition	an area that freezes, which does not normally freeze over
pattituq	Spring ice condition	when there is no more ice along the tidal zone
puktaan	Moving ice	small pieces of ice moving in open water
qaarniku	Action, mid-winter	'ice explosion'
qaikuin	Fall ice condition, open water	chunks of ice forming after <i>qinnu</i>
qaikut	Fall ice condition, near shore	ice is freezing to the ground
qalligirtuq	Action, ice formation	overlapping sea ice
qalluit	Spring ice condition	holes formed in the ice by sunken seaweed or other material on the ice
qamittu	Fall ice condition	ice with a little bit of water on it
qangitarniq	Spring ice condition	when the ice has popped up from the bottom and is floating
qanguqtuq	Sound	'peeling off' sounds make when a strong tide pushes ice upwards

Term	Feature	Description
<b>qangutaituq</b>	Action, ice formation	process of forming <i>qanguti</i>
<b>qanguti</b>	Fall or early spring ice condition	Ice with crystal-like snow formation on top
<b>qapvaq</b>	Moving ice	multi-year ice
<b>qillait</b>	Spring ice condition	melt holes
<b>qinningijuq</b>	Spring ice condition	soft wet snow on top of solid ice
<b>qinnu</b>	Fall ice condition	early stage of ice formation, slush
<b>quginiit</b>	Spring ice condition	like little creeks on top of the ice
<b>qullupiaqtuq</b>	Action, ice breaking up	ice colliding and being pushed on top of other ice
<b>qullupiarniq</b>	Crack	a crack in the ice that opens, freezes, and then re-opens
<b>qunni</b>	Moving ice	ice that will not crack
<b>sallivaliajuq</b>	Action, ice thinning	ice thinning due to rain, wind, or snowfall influences
<b>saqvaq</b>	Open water	polynya
<b>savittuq</b>	Moving ice	a small piece of ice that broke off
<b>siggia</b>	Spring ice condition	when the ice is breaking up
<b>sijja</b>	Ice condition, near shore	ice that forms along the edge of land, the mainland or islands
<b>sijjaviniq</b>	Spring ice condition	used to be <i>sijja</i>
<b>siku</b>	Ice condition	general term for solid sea ice
<b>sikuaq</b>	Fall ice condition	the first thin layer of frozen ice
<b>sikuaqtuq</b>	Action, ice formation	the process of <i>sikuaq</i> forming
<b>sikuijaqtuq</b>	Moving ice	ice moving with the wind
<b>sikujuq</b>	Fall ice condition	ice that is travelable
<b>sikuliaq</b>	Fall ice condition, open water	newly formed ice in open water
<b>sikuliaqta</b>	Fall ice condition, moving	ice taken away by currents from where it had formed
<b>sikuqaq</b>	Fall ice condition, near shore	ice that is a few weeks old, covering inlets
<b>sikuqsasitarivuq</b>	Fall ice condition, near shore	ice forming outward from the edge of the land
<b>sikurasaan</b>	Moving ice	small pieces of ice moving as one
<b>sikurtusijuq</b>	Fall ice condition, near shore	ice that has formed just past the low tide area
<b>sikuvaliajuq</b>	Action, ice formation	when the ice is starting to form
<b>sikuviniq</b>	Spring ice condition	used to be <i>siku</i>
<b>sinaaq</b>	Ice formation	floe edge
<b>tuvaq</b>	Ice condition	landfast ice
<b>tuvatuqaq</b>	Ice condition	after snow has accumulated on <i>tuvaq</i>
<b>tuvaviniq</b>	Spring ice condition	used to be <i>tuvaq</i>
<b>uiguaq</b>	Ice formation, floe edge	new ice forming at the floe edge
<b>uqaq</b>	Action, floe edge	when the ice breaks off at the floe edge
<b>uqaqtuq</b>	Action, floe edge	the process of <i>uqaq</i> happening
<b>uqakuti</b>	Ice condition, moving ice, floe edge	ice that has broken off the floe edge ( <i>uqaq</i> ), and is now free floating

*Alphabetical listing and full description of all Inuktitut terms in Chapter 4*

*aguttituaq* – ice formed with the direction of the wind (MK1)

*aiviq* – walrus

*ajuqpaliajuq* – where the cracks are widest the ice starts breaking off (EE2)

*ajuraq* – tidal crack that stays open in the spring time; like a *nagguti* but with open water remaining in the crack; mainly occurs between April and June (AE1; AN1; AP1; EE2; JM1; NP1; MJ1; MK1; OM2; OO1; PP1; QP1; QT1; SS1; SK1)

*alanguaq* – narwhal

*aniqsai* – ice that moves with the ebb and flow of the current, without breaking up or melting (MK1; OM1) [variations: *aniqsag*]

*aputlariq* – when the snow melts the ice; a lot of snow falls in April and May, which insulates the ice and thus helps it to melt (*uqurusirtuq*) (EE2; MS1)

*aquanaq* – a shallow area that is somewhat like a reef, which creates stronger currents (EM1)

*arqak* – murre

*asaluaan* – sea ice formed into a ball-like shape in open water (OM2)

*atluan* – seal breathing holes

*atuksavuk* – meaning that a person with a harpoon can walk on the ice, but it is not thick enough to travel on with a dog team or snowmobile (PP1)

*aukaaniq* – areas where the ice starts wearing out, melting, earlier than others in the spring time (April or May); these areas quickly become unsafe to travel through; often located near or around a *saqvaq* or other areas with stronger currents (AE1; EE2; NP1) [variations: *aukaan*, *aukarniq* – sometimes referred to as a *saqvaq*, depending on dialect or context]

*aukaaq* – when the ice starts breaking away/up, usually caused by winds; when it starts getting dangerous on the ice (EP1)

*aukajuq* – identification of a very early stage of melting (AA1; JM1; MK1; OO1) [variations: *aukasijuq*; *autsajuq*]

*aulaniq* – general term for moving ice (OM2) [variations: *auraniq*]

*ijjusijuq* – the ice is thickening, so it is safe to travel on (AA1; PP2) [variations: *ijjusivaliasigivuq*]

*ikiqtuq* – a crack that is widening, that would require a boat to cross it (OM2)

*ikiqtusijuq* – a crack that is widening a little (OM2)

*ilaupalia* – the process of ice forming at low tide (where it is shallow, along the rocks) and breaking off at high tide (process of *ilu* formation) (OM1)

*ilu* – early ice formation during low tidal stages, freezing from the bottom (AP1; EE1; MK1; MS1; OM1; QP1; QT1) [variations: *ilujuq*]

*immatinniit* – melt puddles that form on top of the ice, the water remains on the ice until it can drain through or off the ice (EE2; NP1; QT1) [variations: *tasiaruq*]

*immatuqtuq* – an early melting process, when water is starting to form on top of the ice (QT1) [variations: *tikpaqtuq*, not used frequently in recent times]

*ivuniit* – ice formation caused by winds or currents pushing thick ice on top of other ice, and it re-freezes into rough ice (like ridges) (AA1; AN1; MK1; SK1)

*kamik* – general term for boots made of skin (often seal skin)

*kamotik* – general term used to refer to a sled made of wood, tied together with rope or sinew, that is pulled behind a dog team or snowmobile

*kuiviniq* – ice frozen over top of rocks in shallow areas, although it is attached to the rocks it breaks off at high tide (EP1) [term not used frequently in recent times]

*kuvvilukajuq* – sea ice that will not be breaking off anymore; the ice has solidified and is safe for dog team or snowmobile travel without having to constantly test the ice with a harpoon (OM1)

*manguqtuq* – general process describing the onset of ice melt beginning with snowmelt and influencing the sea ice underneath (AA1; PP2; QP1) [variations: *manguqtaliqpaliajuq*]

*marruluin* – when there is a lot of broken ice from different areas, with seaweed or other ocean debris on top (MS1)

*matsaaq* – when water starts draining through the ice (e.g. through *ajurait* or *atluan*) (EP1) [term not used frequently in recent times]

*millutsiniq* – a patch of ice where it is mushy, usually caused by snowfall over thin ice (e.g. if snow had fallen over where a crack had recently formed); the snow melts the ice due to *uqurusirtuqsimajuq*, rendering it more of a slushy consistency; a dangerous condition where people can easily fall through, it cannot be easily seen due to the snow cover (EE1; EP1; QP1) [variations: *milutsinilaag*]

*mitik* – eider duck

*nagguti* – tidal cracks that form during the winter and re-freeze after opening; they re-occur with the influence of tidal stages (AA1; AE1; AN1; AP1; EE2; JM1; MK1; NP1; OM2; QT1; SK1) [variations: *naggut*, *aniugaq*]

*nangianaituq* – the ice is safe to travel on (PP1)

*nangiarnaqisuq* – when the ice is no longer safe to travel on (QP1)

*nanuq* – polar bear

*natsian* – ringed seal pup

*natsiq* – ringed seal

*naujaq* – seagull

*nigajutaq* – a hole in newly formed ice; can be different sizes from small to basketball or barrel size; can be safe to travel on as long as it is tested with a harpoon; seals and walrus sometimes use these holes to breathe (EE2)

*nipittupaliajuq* – a crack that is not wider than jumping distance (OM2)

*nirliq* – Canada Goose

*nunniq* – ice condition where an area freezes over that does not normally freeze (e.g. a *saqvaq* or the mouth of an inlet) (PP2)

*pattituq* – when there is no more ice along the tidal zone (OM2)

*pitseolak* – guillemot

*puktaan* – small pieces of floating ice in moving in open water (MK1)

*qaarniku* – a type of ‘ice explosion’ that is caused by very strong currents (usually at a full moon) creating pressure deep under thick ice; once the pressure gets too high the ice is forced upwards to create an action like an explosion (EE1)

*qaikuin* – chunks of ice that form after *qinnu* in open water or at the floe edge (*sinaaq*), winds form batches of rough ice and they move with the currents (AE1; OM2; SK1) [variations: *qaikuit*]

*qaikut* – early stage of ice formation, the ice is frozen to the ground but will eventually pop up after several tides (AP1; NP1; QT1)

*qalligirtuq* – in the fall, when the ice is forming, some pieces of ice may break off and go on top of one another due to winds or currents; this can be dangerous when newly formed, but after these overlapping pieces have frozen together they can actually be safe because the area will be thicker than surrounding smooth ice (AA1; EE1) [variations: *kaliagittinni*]

*qalluit* – holes formed in the ice by seaweed or something on the ice that sinks downwards; it melts the ice because of faster heat absorption, thus water forms around the sunken seaweed (or other material) (EE2; OM2)

*qamittu* – ice with a little bit of water on it (MK1)

*qangitarniq* – when the ice is floating on top of the water, it is not broken up, it has just popped up from the bottom and is floating (AA1; OM2) [variations: *puggaqtuq*]

*qanguq* – Snow Goose

*qanguqtuq* – the sounds made at the peak of a very strong tide (usually at full moon) when the currents push the ice upwards and it is peeled off the ground (JM2)

*qangutaituq* – the process of *qanguti* forming (AA1; EE1)

*qanguti* – ice condition in fall or beginning of spring that looks like little snowflakes on the ice even though no snow has fallen; little points or little chunks on top of the ice that looks almost like plants growing from the ice; an indicator that it will be nice and smooth ice in that area when all the ice has thickened; it may all look the same but in some areas it is possible to travel and while in others it will be dangerous, so always use a harpoon to test the ice (AA1; EE1) [also a general word for frost-like formations in tents, cabins, porches, parka hoods, etc.]

*qapvaq* – large moving ice that comes from far away, usually from the north, considered like multi-year ice; when they congregate close to the *sinaaq* the prevent boat travel (OM1; JM2; MS1; NP1; PP2;)

*qillait* – holes that form as the ice has melted right through, allowing for the drainage of meltwater (EE2)

*qilalugaq* – beluga whale

*qinningijuq* – condition where the snow is very soft and wet, but the ice is still solid below the layer of snow (EE2) [variations: *qinnirijuq* used as well in recent times]

*qinnu* – early stage of ice formation, a slushy consistency in the water, the ice particles are soft and never really freeze (AA1; AE1; MJ1; OO1; SK1) [variations: *qinnujuq*]

*quginiit* – like little creeks on top of the ice; they show up after the snow or ice has been melting for a few days; the water will start draining into seal holes or cracks (AA1; NP1) [this word can even be used in the middle of winter if it warms up enough to cause melting]

*qullinaq* – the south side of a *saqvaq* (AA1)

*qullupiaqtuq* – when the ice collides and is pushed on top of other ice as it breaks up (AA1) [term not used frequently in recent times]

*qullupiarniq* – a crack that opens, freezes, and then cracks open again in the same spot, sometimes leaving a peaked formation (QP1)

*qunni* – ice that will not crack, floating in open water (MK1)



*saataviniq* – when a person is on ice that was *uqaqtuq* from the *sinaaq* (MJ1)

*sallivaliajuq* – ice is thinning, could be caused by rainfall, snowfall, or wind, which helps melt the ice; it could apply to either freezing (i.e. snow, wind, or rain affecting new thin ice) or melting processes; used in the spring time to refer to a period where the ice is thinning and seals start having their pups (around April or May) (MS1; QP1) [variations: *salluvaliajuq*]

*saqvaq* – an area “where there are currents”, that does not usually freeze over in the winter (AA1; AE1; AP1; EE1; EE2; EP1; JM1; MK1; MS1; NP1; OO1; OM1; PP2; QP1; QT1; SK1) [variations: *saqpaq*]

*savittuq* – a small piece of ice that broke off and is floating away (OO1)

*siggia* – when the ice is breaking up (MS1; QT1; OO1) [variations: *siruqtiq*]

*sijja* – ice that has formed around the edge of land, either along the mainland or island coastlines, also where the ice tends to start thickening outwards to form *siku* and then *tuvaq* (AN1; EE1; MK1; QT1)

*sijjaviniq* – used to be *sijja*; after the shoreline ice has broken off and is free-floating; characterized by rough ice conditions due to the continual movement of ice near the shoreline throughout the winter (EE2)

*siku* – ice that is a week or a month old, it can be used for any kind of travel because it is more solid than *sikujjuq* (AE1; AN1; EP1; MJ1; NP1; QT1; SK1; SS1)

*sikuaq* – the first layer of frozen ice, it is has just formed so it is thin, shiny, and approximately  $\frac{1}{4}$  inch thick; it is attached to the *sijja*; it is possible to stand on it but a harpoon must be used to test its strength (if it takes two harpoon strikes to puncture a hole it is strong enough to stand on) (AA1; MJ1; SS1)

*sikuaqtuq* – the process of *sikuaq* forming, it takes approximately two or three nice cold days, without wind (or three to four days with wind) (AA1; MK1; OO1)

*sikuijaqtuq* – when the sea ice is moving with the wind, in open water (OO1)

*sikujjuq* – ice that has thickened more than a few inches, and can be used for travel (EE1; MK1; OO1) [variations: *sikugai*]

*sikuliaq* – newly formed flat ice in open water (AE1; AN1; IN1; QT1)

*sikuliaqsirtuq* – the first people to be walking on the ice in the fall, using harpoons to continually test the safety (thickness and stability) of the sea ice (EE1)

*sikuliaqta* – frozen, piled ice that has been taken by currents to an area away from where it formed (MK1)

*sikuqaq* – ice formed more solidly, closer to land and covering inlets, it is no longer moving; it is possible to walk on the ice and look for seal holes; ice that is a few weeks old when you start walking on it (AE1; EE1; EP1; NP1; OM2)

*sikuqsasitarivug* – ice that forms outwards from the edge of land, forming with cold winds from the land (OO1)

*sikurasaan* – small pieces of ice gathered in one area, moving as one (MK1)

*sikurtusijuq* – ice that has formed a little past the low tide area (QT1)

*sikuvaliajuq* – when the ice starts freezing in the fall, it is hardening, but not safe to walk on (IN1; OM1; PP1; PP2; QP1) [variations: *sikuvalia*, *ukiuqpaliajuq*]

*sikuviniq* – used to be *siku*; former sea ice that was attached to land, closer to shore; floating, usually smaller and rougher pieces than *tuvaviniq* (MJ1)

*sinaaq* – floe edge, the edge of the landfast ice (*tuvaq*) (SK1; SS1) [also used to delineate an edge of anything]

*tunuvia* – weather that comes from the mainland (OO1)

*tuvaq* – solid, landfast ice; older than *siku* (AE1; EP1; MJ1; QT1; SK1)

*tuvatuqaq* – old, mid-winter ice, after snow has accumulated on thick ice (*tuvaq*) (EP1; NP1)

*tuvaviniq* – used to be *tuvaq*; former land-locked ice (if it breaks off with no one on it); floating flat ice that is big and thick (MJ1)

*ugaq* – cod fish

*uiguaq* – new ice that forms at the *sinaaq*, meaning an “add on” either as the edge of the *tuvaq* becomes established or after a piece has broken off (*uqaqtuq*) and it is re-freezing; it is usually thin and dangerous, but can sometimes be walked on if it is cold enough (AN1; EE1; JM1; MJ1; MK1; NP1)

*ujjuq* – bearded seal

*ukuarujaq* – when a person is stranded on ice that is moving away in open water (JM1; OO1) [variations: *uqarujaugutaq*]

*unaaq* – general term used for a harpoon, an instrument used to test the ice and also used as a hunting implement

*uqaq* – when strong winds break off *tuvaq* at the *sinaaq* (NP1; JM1; OM2; PP1 QT1)

*uqaqtuq* – the action of *uqaq* occurring, the ice is breaking off and floating away; usually happens where a *nagguti* or *ajuraq* had formed, often caused by a strong tide (JM1; MK1; OO1)

*uqakuti* – a piece of ice that broke off in the process of *uqaqtuq* and is now free-floating (MK1)

*uqurusirtuq* – around May when everything starts getting warmer and snowfall melts the ice – like insulation on top of the ice (*uqurusirtuqsimajuq*) (EE2)

*uqurusirtuqsimajuq* – when snow falls on newly formed, or thin ice, at any time of year, it insulates the ice similarly to how a down jacket insulates a person from cold air, it will usually cause melting or thinning of new ice, and will prevent thicker ice from increasing in thickness (EE1)

*uttuniaqtuq* – when people go hunting for walrus or seals on the ice (MJ1)

*uttuq* – a walrus or seal sitting on top something, often on a rock or on the ice (EP1) [more common reference today is *qaqimajuq*]

## Appendix 15

### *Igloolik Inuktitut Terminology*

*Quick reference for sea ice terms in Chapter 5 (alphabetical order)*

Term	Feature	Description
<i>aajuraq</i>	Lead	tidal crack that opens in the spring and does not re-freeze
<i>aggurtipaliajuq</i>	Action, freezing	ice forming in an upwind direction
<i>Agiupinniq</i>	Rough ice	recurring rough sea ice feature caused by a grinding and piling action
<i>aksajutak</i>	Moving ice	circular ice pans with a rough edge and smooth middle
<i>aktinniq</i>	Ice condition, melting	area that melts early and quickly due to freshwater influx
<i>atirriaruti</i>	Floe edge	narrow edge of ice forming at the <i>sinaaq</i>
<i>aukkarniq</i>	Polynya	polynya
<i>aulajuq</i>	Moving ice	the whole moving ice
<i>aulaniq</i>	Moving ice	moving ice near the <i>sinaaq</i>
<i>iijaujuq</i>	Polynya	ice being swallowed by the current
<i>iilikulaak</i>	Ice condition	small scale rough ice
<i>ijaruvauijat</i>	Snow condition, melting	crystallized small balls of ice
<i>ijukkaqquti</i>	Moving ice	broken ice frozen into moving ice
<i>immaktinniit</i>	Ice condition, melting	melt puddles
<i>immaktipaliajuk</i>	Action, melting	the second stage of <i>immaktittuq</i>
<i>immaktittuq</i>	Action, melting	the process of melt puddles forming
<i>itisiuraq</i>	Ice condition, melting	deep sections caused by ice melt
<i>kaniq</i>	Polynya	mound created by ice accumulation at one end of an <i>aukkarniq</i>
<i>killaq</i>	Ice condition, melting	melt hole
<i>maniilaq</i>	Rough ice	rough ice
<i>manguqtuq</i>	Snow condition, melting	the softening and melting of snow
<i>minuirniq</i>	Moving ice	"ground" ice
<i>nagguti</i>	Crack	tidal crack in <i>tuvaq</i> that opens and re-freezes
<i>nanirlijuk</i>	Snow condition, melting	snow thinning
<i>napakkuti</i>	Crack	tidal crack in <i>tuvaq</i> that runs from land to the <i>sinaaq</i>
<i>nigajutaq</i>	Ice condition, freezing	areas that take longer to freeze over
<i>nigajutaviniq</i>	Ice condition, freezing	used to be a <i>nigajutaq</i>
<i>nilaruqtuq</i>	Snow condition, melting	thin film of ice on top of melting snow
<i>nipititaaq</i>	Floe edge	rough ice frozen in at the edge of the <i>sinaaq</i>
<i>niuma</i>	Ice condition, freezing	snow-like ice crystals on new ice
<i>niumakjuaq</i>	<b>Ice condition, freezing</b>	large <i>niuma</i>

Term	Feature	Description
<i>nunguppaliajuq</i>	Action	ice wearing out from underneath
<i>patikjiuqtuq</i>	Ice condition, melting	process of melt water seeping through the ice under snow cover
<i>pilagiatinniq</i>	Crack	the continuation of a <i>nagguti</i>
<i>piqalujaq</i>	Moving ice	iceberg
<i>puimajuq</i>	Ice condition	slushy sea ice surface caused by snowfall or snow melt
<i>puktaa</i>	Moving ice	free-floating ice
<i>puktailaq</i>	Snow condition, melting	white patches of snow seen above <i>immaktinniit</i>
<i>qaangajuq</i>	Floe edge/ moving ice	when <i>aulaniq</i> is touching the <i>sinaaq</i> for a period of time
<i>qaattuq</i>	Floe edge/ moving ice	<i>aulaniq</i> moving away from the <i>sinaaq</i>
<i>qaingu</i>	Ice condition, fall	ice formation along the tidal zone
<i>qaliriiktinniit</i>	Rough ice	overlapping layers of sea ice
<i>qangusirsimajuq</i>	Ice condition, freezing	no <i>qanguti</i> forming
<i>qanguti</i>	Ice condition, freezing	ice crystallization or compact snow layer on newly formed ice
<i>qimaruutisimajuq</i>	Moving ice	when the <i>aulaniq</i> has moved away
<i>qinallatut</i>	Snow condition, melting	snow softening
<i>qinu</i>	Ice condition, fall	slush-like consistency
<i>qirsuqqaq</i>	Snow condition, melting	temporary freezing and hardening of snow after melting has begun
<i>quasalimajuq</i>	Ice condition, fall	ice that has frozen over smoothly
<i>quglukniq</i>	Crack	Tidal crack that opens and closes in a peaked formation
<i>quppirniq</i>	Crack	crack formed outwards from the <i>sinaaq</i> in moving ice
<i>quvviquat</i>	Ice condition, fall	smooth thin ice in open water, highlighted by wind
<i>sagliurtuq</i>	Action, melting	ice thinning in certain spots
<i>saluraq</i>	Ice condition, melting	where drainage occurred quickly and there is widespread snow/ice visible
<i>sanimuangniq</i>	Moving ice	ice moving sideways, grinding along the <i>sinaaq</i>
<i>siku</i>	Ice condition, freezing	sea ice
<i>sikuaq</i>	Ice condition, fall	new, thin film of ice
<i>sikuqaq</i>	Ice condition, fall	new ice, a few days old
<i>sikuriaq</i>	Ice condition, fall	thin sea ice that can be walked on, but is still moving and flexible
<i>sikusaaq</i>	Ice condition, fall	newly formed landfast ice
<i>sikutuqaq</i>	Moving ice	multi-year ice
<i>sikutuqqijuq</i>	Moving ice/floe edge	when <i>aulaniq</i> solidifies into the <i>sinaaq</i>

Term	Feature	Description
<i>sikuvalliajuq</i>	Action, freezing	freeze-up
<i>sikuvik</i>	Ice condition, freezing	solid ice that is travelable
<i>sinaaq</i>	Floe edge	edge of the <i>tuvaq</i>
<i>sinaaviniq</i>	Floe edge	used to be a <i>sinaaq</i>
<i>siruttiq</i>	Action, melting	break-up
<i>tikpaqtuq</i>	Ice condition, melting	water draining and the ice surface becoming smooth
<i>tatijaujuq</i>	Floe edge/moving ice	ice that is dislodged as <i>aulaniq</i> moves out
<i>tuvaiaqtuq</i>	Action, melting	<i>tuvaq</i> breaking off
<i>tuvaiautiit</i>	Ice condition, melting	pieces of <i>tuvaq</i> that broke off
<i>tuvaq</i>	Ice condition, freezing	solid, landfast ice
<i>tuvarliqtuq</i>	Action, melting	<i>tuvaq</i> deteriorating
<i>tuvaruajjuqtuq</i>	Ice condition, freezing	sea ice that is becoming solid landfast ice
<i>uiguaq</i>	Floe edge	new ice forming at the <i>sinaaq</i>
<i>uiguaviniq</i>	Floe edge	used to be <i>uiguaq</i>
<i>ukkuartinniq</i>	Moving ice	when part of the <i>aulaniq</i> is temporarily touching the <i>sinaaq</i>
<i>ukpittuq</i>	Polynya	process of ice hitting and sinking at the edge of a polynya
<i>uukkaqtaqtuq</i>	Floe edge	ice constantly breaking off from the <i>sinaaq</i>
<i>uukkaqtuq</i>	Floe edge/moving ice	ice breaking off from the <i>sinaaq</i>
<i>uukkaruti</i>	Moving ice	the ice that became free-floating due to <i>uukkaqtuq</i>

*Alphabetical listing and full description of all Inuktitut terms in Chapter 5*

*aajuraq* – a *nagguti* that opens in the spring and does not re-freeze (HP1; JA1; NQ1; TI1; ZA1)

*agglu* – general term for seal breathing hole (plural, *aggluit*)

*aggurtipaliajuq* – the process of ice freezing upwind, usually forming from where free-floating ice becomes stuck to the sea floor, a reef, or rock, because it is no longer moving the ice freezes/accumulates towards the wind; meaning “it’s progressing towards the wind” (AI1; DI1; EI1; EK1) [variations: *nuamitti*]

*Agiuppiniq* – a recurring sea ice feature referring to rough ice created by a continual grinding and piling action that results in a large, long, often sheer face of ice; used as a placename to refer to an area near Igloolik where “it grinds”, but the condition can be found anywhere where the same process occurs; created by the action of the currents as the ice is forming (DAq1; EK2; GQ1; HP1; LU1; MA1; TI1)

*aksajutak* – circular ice pans formed by movements in open water, usually where the current is stronger, where the edges are rough and the middle is smooth; the rim is rougher due to constant contact with other ice pans or solid ice (EK2; NQ1) [variations: *maniqqariktug*]

*aktinniq* – an area in the sea ice that wears out early, and quickly, due to an influx of freshwater, found near river and stream outlets where they reach the ocean (AT1)

*angajuq/iq* – general term for older (AT1; DI1; DQ1; EK2; MA1; SA1)

*apulliq* – accumulation of snow on sea ice; “it has snow on top” (DI1; DQ1; LQ1; MA1; TI1) [variations: *apusiniq*]

*aputaittuq* – no snow has accumulated on the sea ice; “it does not have any snow” (DI1)

*atirriaruti* – the very first narrow portion of new sea ice forming along the *sinaaq*, before the formation of *uiguaq*; extending approximately 5 – 10 feet from the *sinaaq* (AT1; DI1; EK2; MA1) [variations: *uigutarniq*]

*atuksaujuk* – expression used to describe the ice as being thick enough to walk on (AU1; EI1)

*aukkarniq* – area of open water that lasts throughout the winter; it is created and maintained by strong currents; sea ice wears away from underneath due to strong currents; can temporarily freeze over depending on current strength; plural *aukkarniit* (AQ1; DAq1; DQ1; HP1; JP1; LU1; MA1; NQ1; SA1; TI1; ZA1)

*aulajuq* – the whole collection/process of moving ice; the moving ice far into the main waters (i.e. not close to the *sinaaq*) that never stabilizes (AI1; DI1; JP1; SA1; ZA1) [variations: *aurajuq*]

*aulaniq* – the area of moving ice that is constantly grinding, piling, moving, and opening at the *sinaaq*; the edge of the moving ice; used to hunt walrus (DI1; JP1; LQ1; TI1; ZA1) [variations: *auraniq*]

*ijajaujuq* – the process of ice vanishing underneath the edge of an *aukkarniq*; the ice is “swallowed” by the current, but this can also create thicker edges around the *aukkarniq* (EI1)

*ililikulaak* – when the ice is thin and it stands upright after hitting other ice; ice condition that has piled up more vertically (i.e. jagged) than horizontally (i.e. overlapping); can be caused by wind or current influence; it is noticeable when traveling, but still possible to travel over; low, small rough ice (DAn1; EI1; LU1; MA1; SA1)

*ijaruvauijat* – crystallized ice formed into a little ball, meaning “the likeness of an eyeball” (AI1)

*ijukkaquti* – thick ice that has broken off from the *sinaaq* and frozen into larger moving ice; it is noticeable because it sticks up higher than surrounding ice; smaller pieces than *uukkarutiit*; important freshwater and safety source when stranded on moving ice (AT1; EI1; TI1; ZA1)

*Ikiq* – Inuktitut term used to refer to Fury and Hecla Strait (meaning “a major crossing”) (TI1)

*immaktinniit* – the water that accumulates on the sea ice due to snowmelt; puddles of water on the sea ice (AI1; SA1)

*immaktipaliajuk* – the second stage of *immaktittuq*, when the water accumulation is caused by the melting of the sea ice itself (AI1)

*immaktittuq* – the process of water accumulating on sea ice due to snowmelt; “water has accumulated” (AI1; HP1; LQ1; MA1)

*itisiuraq* – deep sections created in the ice once it begins to melt, after *immaktipaliajuk*, prior to *killait* forming; makes traveling difficult (AI1; EI1; LQ1; MA1)

*ivuit* – pressure ridges caused by the process of *ivujuq* (GQ1; SA1) [variations: *ivuniku*]

*ivujuq* – the creation of *ivuit* from ice being pushed into other ice, and piling up (AI1; EK2; GQ1)

*Ivunirarjuq* – a recurring ice feature created where pressure ridges pile up on a reef or shallow areas underneath; meaning “a place where ice piles up”; the current is constantly grinding ice along these areas, creating a large mound of ice that is anchored to the reef; the most prominent one is located on the northwestern portion of Melville Peninsula (AI1; DAq1; DI1; EK1; EK2; GQ1; HP1; MA1; NQ1; SA1)

*kamotik* – general term used to refer to a sled made of wood, tied together with rope or sinew, that is pulled behind a dog team or snowmobile

*kaniq* – a mound of sea ice created at one end of an *aukkarniq* due to sea ice accumulation underneath the ice cover, pushing it upwards; does not form solidly and is thus dangerous to travel on or around; rises gradually and so is hard to identify (AU1; DAq1; DI1; EK1; JP1; MA1; NQ1)



- kikiak* – meaning “a nail”; *Ivunirarjuq* acts as a *kikiak* because it prevents the ice from moving out or breaking off (EK1; TI1)
- killaq* – a hole formed in the ice where it had melted right through; holes in the ice caused by wear, usually where *itisiuraq* had formed (DAq1; LQ1; MA1; SA1)
- maniilaq* – a general term for rough ice (AT1; EK1; NQ1; SA1)
- manguqtuq* – the process of the snow softening and evening out in early melt stages; the beginning of snowmelt; snow gives way when walked on (AI1; LQ1; MA1; SA1)
- minuirniq* – ground ice left behind by the continual motion and grinding of the *aulaniq* against the *sinaaq* or the edge of land; unstable ice created from constant motion, can lead to the formation of *qinu* (AT1; HP1; JP1; LU1; NQ1; SA1)
- nagguti* – tidal crack that opens once or twice monthly (influenced by new and full moons, and thus stronger currents) and re-freezes; forms within the *tuvaq*, usually from points of land to other points of land; usually form in the same locations annually; useful for hunting seals because the seals will use the thinner ice where it had re-frozen to make breathing holes (AQ1; AT1; DAn1; DA1; DI1; DQ1; EK2; HP1; JA1; JP1; MA1; NQ1; TI1; ZA1)
- nalianaqtuq* – dangerous ice conditions, caution must be practiced at all times (EK2)
- nanirlijuk* – the snow thinning on top of the ice in early melt stages; the process of the snow cover shrinking (AI1)
- napakkuti* – a crack that forms in *tuvaq*, it originates from a point of land or multi-year ice lodged into the *tuvaq* and ends at the *sinaaq*, otherwise it has similar properties to a *nagguti*; a crack that goes from land to sea (AQ1; AT1; DI1; EK2; GQ1; LU1; MA1; NQ1; ZA1) [variations: *napata*]
- nigajutait* – plural for *nigajutaq*, referring to small pockets of open water that remain as the ice is freezing up; kept open by wind, wave, or current action, where there is more water movement so it takes longer to freeze; seals tend to congregate in these areas (AT1; AU1; HP1; JP1; SA1; TI1)
- nigajutaviniq* – a former *nigajutaq*, “it used to be a *nigajutaq*”; a *nigajutaq* that has frozen over (TI1)
- nilaruqtuq* – a thin film of crystallized snow/ice that is created on top of the melting snow as the water seeps down to the surface of the sea ice (AI1)
- ningijaqtuq* – ice that is moving as you travel on it, *ningi* meaning “curvy” or “wavy” (EK2)
- nipititaaq* – where *aulaniq* piles up on the *sinaaq* and becomes stuck/frozen in; rough ice that is left behind on the *sinaaq* after *uukkaqtuq*; hard to travel over (AQ1; EK2; SA1)
- niuma* – little lumps of “snow” on the ice; it looks like snow but it is not; it occurs in overcast conditions during the freezing process, due to condensation of water vapour on the ice;

white crystallization on sea ice that is blotchy, if it is easy to remove then the sea ice is not very frozen and is still dangerous (HP1; JA1; JP1; MA1; TI1) [variations: *patuuti*]

*niumakjuaq* – “big *niuma*”; found more often on *uiguaviniq* (AQ1; NQ1; SA1; TI1)

*nunguppaliajuq* – sea ice wearing out from the action of currents underneath without any surface melting; can also be created by overcast conditions (EI1)

*nuqaq/iq* – general term for younger/newer; “it is younger” (AT1; DQ1; EK2; MA1; SA1; ZA1)

*nutaq* – new ice that is just forming (AT1; DQ1)

*nutaaviniq* – it used to be new ice, older than *nutaq* (AT; DQ1)

*patikjiuqtuq* – the process of melt water seeping through the ice underneath the snow; very thin ice underneath the snow where this process occurs, very dangerous and hard to identify (JP1)

*pilagiatinniq* – a *nagguti* that stops and starts/continues in a different location (NQ1)

*piturniq* – new/full moon period, when the currents are strongest as influenced by the moon (LU1)

*piqalujaaq* – glacial iceberg, comes from further north and usually only seen in the Gulf of Boothia, does not usually come through Labrador Narrows because it is too shallow (TI1)

*puimajuq* – slushy, wet ice surface caused by snowfall on new ice, water seeps through and soaks the snow; also an early stage of snowmelt in the spring where the surface of the ice becomes wet; when snow is melting the ice due to its insulating properties; makes travel difficult and/or dangerous (MA1; NQ1)

*puktaa*q – a free-floating piece of ice; “it’s floating”, could refer to almost anything floating (DI1; LQ1; SA1)

*puktailaaq* – the white, relatively “dry” sections of snow that can be seen above *immaktinniit* that have accumulated on the sea ice (HP1)

*putlaujaraq* – air pocket underneath the ice (ZA1)

*qaangajuq* – the process of *aulaniq* stopping at the *sinaaq*, when it is sustained touching the *sinaaq* by winds for several days, resulting in no open water at the *sinaaq* (DQ1; JP1)

*qaattuq* – the action of *aulaniq* moving away from the *sinaaq*; ice breaks away from where the *sinaaq* had been (DAq1; DI1; DQ1; EK2; MA1; SA1)

*qaingu* – sea ice that has formed along the tidal zone, at the edge of the shoreline, in the early process of freezing; it freezes during low tide after being covered with water at high tide (DAq1; DI1; DQ1; EK1; EI1; JA1; JP1; LQ1; MA1; NQ1; SA1)

*qaliriiktinniit* – ice that has been forced on top of other ice by wind or current forces, and is overlapping (horizontal piling) (AI1; DQ1)

*qangusirsimajuq* – smooth ice formation with no snow or ice crystallization (*qanguti*) on the ice (DI1)

*qanguti* – crystallization on the ice, very thin compact layer of snow; can be used for making a shelter in an emergency (DI1; SA1)

*qimaruutisimajuq* – when the *aulaniq* has moved away from the *sinaaq* a bit, usually caused by winds; “the moving ice has moved away a bit” (DI1)

*qinallatut* – early melt stage when the snow begins to soften, semi-melting (AI1)

*qinu* – early ice formation that is not solid, it is slush-like in the water; can also be caused by ice grinding together and granules of ice falling into the water; dangerous for travel and difficult to distinguish from safe ice when it is covered by snow (DI1; EK1) [variations: *qinuaq*]

*qirsuqqaq* – snow that freezes smooth and solid temporarily (with cooler conditions) after melting has begun, usually only for a week or two, after which the melt stages continue until break-up; a snow condition that is very hard and good for traveling (AI1; EI1; SA1)

*quasalimajuq* – ice that has frozen smoothly without any snowfall, “it is slippery” (LU1)

*qugluartuq* – ice that cracks and opens up very fast (EK2)

*quglukniq* – a *nagguti* that has opened, and frozen over, and the crack will suddenly close together, hitting the other side of the ice with so much force that the ice is forced upwards; this action forms a type of peak over the crack; it can be open underneath this type of crack formation (AQ1; AT1; DAq1; DQ1; EI1; EK2; HP1; JP1; LQ1; LU1; TI1; ZA1)

*quppirniq* – a crack that forms in moving ice (plural *quppirniit*); meaning “it opens” or “it parts”; created by moving ice hitting land, the *sinaaq*, or a reef and causing part of it to open, usually in line with points of land; they are narrow, and they do have a beginning and end within the ice (AI1; AT1; DI1; DQ1; EK2; LQ1; NQ1; SA1; TI1) [variations: *quppirtirniq*]

*quvviquat* – smooth, narrow formations (striations) on open water that follow the direction of the wind; very thin ice that has formed on the open water, but is not noticeable without a bit of wind creating little waves in the water, highlighting the smooth areas; they often form downwind from points of land (AU1; DI1; EK1; NQ1) [variations: *quvviquarniit*, *qinnualuqtuq*; not used frequently in recent times]

*sagliurtuq* – the process of ice wearing out, thinning in certain spots (HP1)

*saluraq* – where meltwater had drained quickly and more ice/snow is visible than water; similar to *puktailaq* but can be more extensive (SA1)

*sanimuangniq* – the action of ice grinding along the *sinaaq*; ice moving sideways along the *sinaaq* (AT1; DI1; DQ1)

*siku* – general term for sea ice, solid and travelable but snow has not yet accumulated and it is still thickening (AI1; DI1; EK1; JA1; MA1; NQ1; TI1)

*sikuaq* – early stage of ice formation; new, very thin ice that is still moving, but continuous cover; still possible to break through it with a boat; useful for hunting because it creates a smooth cover for the water if there is any wind (AI1; AQ1; AU1; DI1; DQ1; EI1; EK1; JP1; LQ1; MA1; NQ1; SA1; TI1; ZA1)

*sikuqaq* – relatively new ice that has formed over a few days; thicker than *sikuriaq*; young ice (AT1; LQ1; SA1)

*sikuriaq* – sea ice that is thicker than *sikuaq*, but it still has some give; it is possible to walk on, but it moves as you walk on it, it can be punctured with a harpoon; you cannot drive a dog team or snowmobile on it; approximately 1.5 inches thick (AQ1; AT1; AU1; LU1; MA1)

*sikusaaq* – newly formed landfast ice, thick enough for travel (AQ1; LQ1) [variations: *sikurisijuq*]

*sikutuqaq* – old ice that does not melt completely in the summer; “it has been ice for some time”; this ice comes from elsewhere, usually further north; salt has drained from this ice due to it’s age, so it can be used as a source of freshwater (DI1; GQ1; HP1; LQ1; TI1)

*sikutuqqijuq* – when parts of the *aulaniq* become frozen into the *sinaaq* because they were pushed in by winds; “the ice has grown old”; rough ice condition which prevents travel; bad for walrus hunting because the animals move out to where there is more open water (AQ1; DQ1; HP1; MA1)

*sikuvalliajuq* – the process of the ocean freezing over (DI1)

*sikuvik* – general term for solid ice that is travelable, and some snow has accumulated; approximately 1 foot thick (could refer to landfast or moving ice); ideal for hunting walrus because they can no longer penetrate through the ice (AQ1; EI1; LQ1)

*sinaaq* – the edge of the *tuvaq*, bordering on open water or moving ice; the floe edge; meaning “the edge” (AT1; DQ1; EK2; LQ1; MA1; TI1)

*sinaaviniq* – “it used to be a *sinaaq*”; an old *sinaaq*; delineated because of its roughness, caused by ice moving back and forth all the time; where the *sinaaq* froze over (DAn1; DQ1)

*siruttiq* – the ice is “breaking up” (MA1; SA1) [variations: *sirumittuq*]

*tatijaujuq* – ice that becomes dislodged as the *aulaniq* moves out, broken off from the *aulaniq* and carried out (EK2)

*tikpaqtuq* – the process of meltwater draining (through *aajurait* or *aggluit*) and the ice becoming smooth, without water (EI1; HP1; MA1; SA1) [variations: *tikpaqsimajuq*]

*tuvaiaqtuq* – the *tuvaq* is breaking off (MA1; SA1)

*tuvaiautiit* – pieces of *tuvaq* that broke off and are now free-floating (AQ1; SA1) [variations: *tuvaiviniq*]

*tuvaq* – solid, thick landfast ice that is no longer moving; snow can accumulate without causing ice thinning; relatively smooth ice (AQ1; DAq1; DI1; EI1; GQ1; LQ1; LU1; MA1; NQ1; SA1; TI1; ZA1)

*tuvarliqtuq* – the process of *tuvaq* wearing out, deteriorating (AI1)

*tuvaruajjuqtuq* – sea ice that is becoming solid landfast ice; “it is now partly *tuvaq*”; no snow has accumulated on this ice; approximately 6 – 7 inches thick (AQ; DI1)

*ugliit* – places where walrus haul out (JP1)

*uiguaq* – any ice forming, “adding on to”, the *sinaaq*; it can form out a fair distance, up to 75m or so; generally thin, smooth ice because it is newly formed; used for seal hunting (AQ1; AT1; DAq; DI1; DQ1; EI1; EK1; EK2; GQ1; HP1; LQ1; MA1; TI2; ZA1)

*uiguaviniq* – “it used to be *uiguaq*”; older *uiguaq*, no longer the leading edge at the *sinaaq*; more solid ice than *uiguaq* (DI1; DQ1; EK2; GQ1; LQ1)

*ukkuartinniq* – when part of the *aulaniq* is temporarily stable, touching the *sinaaq*; can be used to cross from the *aulaniq* to the *sinaaq* (AT1; DI1)

*ukpittuq* – the process of ice being pushed into the edge of an *aukkarniq*, when it hits some of the ice breaks off and is pulled underneath by the weight of the water going on top (DI1)

*uukkarutjaujuq* – when a person is stranded on ice that *uukkaqtuq* (DQ1)

*uukkaqtuq* – the action of breaking off; “it breaks off”; when part of the *sinaaq* breaks off – *tuvaq* or *uiguaq* – but usually referring to thicker ice breaking off (DAq1; DI1; DQ1; MA1; SA1)

*uukkaqtaqtuq* – the ice is constantly breaking off the *sinaaq*; cycle of freezing over and breaking off throughout the winter (DI1; EK2)

*uukkaruti* – relatively large piece of *tuvaq* that has *uukkaqtuq* from the *sinaaq*, becomes free-floating ice; used for safety when stranded on *aulaniq*, for stability and drinking water (because of snow accumulation) (AT1; DI1; DQ1; EK2; SA1)

## Appendix 16

### *Pangnirtung Inuktitut Terminology*

*Quick reference for sea ice terms in Chapter 6 (alphabetical order)*

Term	Feature	Description
aggutittuq	Action	rough ice formation caused by wind
aijuq	Crack	crack within a crack
aajuraq	Crack/lead, spring	tidal crack that opens and does not re-freeze
apputailiqqaqtuq	Action, melting	when the snow is melting on the ice
apputaniuliqtuq	Ice condition	snow accumulation on sea ice
apputtattuq	Ice condition	snow that fell on newly formed ice
atuqsaruqtuq	Ice condition, fall	the ice is now travelable, it will hold a person
aulajuq	Moving ice	general term for moving ice
aukkaturliit	Ice condition, melting	areas that open/melt earlier than others
aukkaavaliajut	Ice condition, melting	when the ice is first starting to melt
aumasijuq	Ice condition, melting	when there is water under the snow, on the ice
ikiartirtuq	Ice condition, melting	brittle thin layer of ice over <i>immatinniit</i>
ikirniq	Crack/lead	the area of water within an <i>aajuraq</i> or between ice pans
iluvaliajuq	Ice condition, freezing	the first film of ice forming along tidal flats
immatinniit	Ice condition, melting	melt puddles from snow melt
immatillarittuq	Ice condition, melting	melt puddles from sea ice melt
immatittuq	Action, melting	the process of melt puddles forming
ittanilapaat	Ice/snow condition, freezing	wet spots on the snow
ivuquq	Action, rough condition	ice forced on top of other ice, creating pressure ridges
kavvaq	Multi-year ice	large multi-year ice that move in from further north
killait	Ice condition, melting	melt holes
killiminiq	Multi-year ice	rough multi-year ice from the edge of ice further north
kiviniq	Ice condition, freezing	wet snow that sinks into the ice and becomes part of it
kujjirtuq	Ice condition, melting	melt rivers
manguqtaliqtuq	Snow condition, melting	sticky snow consistency
manguqtuq	Snow condition, melting	the process of snow softening
masaq	Snow condition, melting	wet, mushy, snow
maujaraq	Ice condition, melting	shoreline ice break-up
nagguti	Crack	tidal crack that opens and re-freezes
naggutiminiq	Crack	an old tidal crack that does not re-open
nigajutaq	Ice condition, freezing	last spots of open water during freeze-up
nipittuq	Ice condition, freezing	ice becomes stuck to the land
nunniq	Ice condition	when Cumberland Sound is frozen over
nutaaminiq	Ice condition, freezing	newly formed ice
nuttaq	Crack	a crack
piqalujat	Multi-year ice	iceberg
puttaijaq	Ice condition, melting	water-logged ice
qainngu	Ice condition	ice ledge along the shore
qainnguijaluqtuq	Ice condition, melting	the <i>qaingu</i> is detaching from land

Term	Feature	Description
qalliriittipalliajuq	Action	overlapping ice
qanguqtuq	Action	prying ice off the land, from the force of water underneath the ice
qanngut	Ice condition, freezing	frost flowers
qattuattinniq	Ice condition	the thick edges of a <i>saqvaq</i>
qillirusijuq	Action, freezing	early ice formation along the shore
qinnuaq	Ice condition, freezing	first slush-like ice formation
qiqsuqaqtuq	Snow condition, melting	snow that freezes/hardens at night
quppirkuaq	Ice condition, freezing	very thin sheet of new ice
saallijuq	Action, melting	thinning sea ice
saqvalariq	Polynya	<i>saqvaq</i> that does not freeze over
saqvaq	Polynya	open water maintained by currents, and surrounded by sea ice
sijja	Ice condition	rough ice formed along the shore
sijjaijaluqtuq	Ice condition, melting	the <i>sijja</i> is becoming detached
sijjamineq	Ice condition, melting	<i>sijja</i> that has broken off and is free-floating
siku	Ice condition	general term for sea ice
sikuallaajuq	Ice condition, freezing	collection of <i>sikuaq</i> , new pans of ice
sikuaq	Ice condition, freezing	first thin sheet of ice to form
sikuaqtuq	Action, freezing	the process of <i>sikuaq</i> forming
sikujuq	Ice condition, freezing	the ice has formed
sikuluqtuq	Ice condition	improper, thin ice
sikurataaq	Ice condition, freezing	recently formed sea ice
sikurinittuq	Ice condition	soft ice consistency
sikutiaqtuq	Ice condition, freezing	well formed, solid sea ice
sikuvaliajuq	Action, freezing	ice is starting to form well
sikuvaluti	Ice condition, freezing	the first ice to form and stay
sikutaq	Ice condition, freezing	ice that forms in the bays, inlets, and fiords
sinaaq	Ice condition	floe edge
surattuq	Action, melting	sea ice break-up
sivaujanguaq	Ice condition, freezing	pancake ice
tikpaqtuq	Ice condition, melting	the dry ice after melt water has drained
titirtuq	Ice condition	ice created by the freezing of snow that has absorbed water
tuvaiajliqtuq	Action, melting	<i>tuvaq</i> deteriorating and breaking off
tuvamineq	Ice condition, melting	<i>tuvaq</i> that has broken off, and is floating
tuvaq	Ice condition, freezing	solid, landfast ice
tuvallariuliqtuq	Ice condition, freezing	solid sea ice, maximum thickness
tuvarluqtuq	Action, melting	<i>tuvaq</i> deteriorating
tuvaruqpalliajuq	Action, freezing	ice is becoming <i>tuvaq</i>
uiguag	Ice condition	new ice formation at the <i>sinaaq</i>
uiguatuqaq	Ice condition	old <i>uiguag</i>
ujutillaq	Action	ice “explosion” created by winds
uukkaqtuq	Action	ice that breaks off from the <i>sinaaq</i>

*Alphabetical listing and full description of all Inuktitut terms in Chapter 6*

*aggutittuq* – the action of the wind breaking up the ice and piling it in another location; rough ice condition (MoK1)

*aijuq* – a crack that forms within a crack; where a *nagguti* has formed already it will re-crack and re-freeze within the original crack; also common around pressure ridges (JN1; LI1)

*aajuraq* – a *nagguti* that has opened in the spring, and does not re-freeze; there is open water within the crack (AY1; EN1; JaM1; JaM2; JP1; JS1; LI1; MaN1; MiK1; PQ1)

*allu* – seal breathing hole

*apputailiqqaqtuq* – when the snow is melting on the ice in the spring (MaN1; PQ1)

*apputaniuliqtuq* – when the snow has formed on top of the sea ice; “there’s a good amount of snow there now”, the snow has been there for a while (JQ1)

*apputtattuq* – when snow falls on newly formed, thin ice; it prevents the ice from thickening and this ice stays dangerous for a long time (AY1; JoM1) [variations: *apittautigijuminiq*, *apijuq*]

*atuagaq* – an expression used to describe following a *nagguti*, usually to look for seals, but referring to a crack that can be followed by animals or humans; “a path that you can follow”, *atuaq* meaning to follow a track of some kind (JaM1; LN1)

*atuqsaruqtuq* – when the ice is thick enough for a person to walk on it; “it is strong enough to hold a person”; the ice is safe to walk on, but a harpoon should be used to test the ice; the ice is travelable (JaM1; JI1; JN1; JP1; LN1; MM1; MoK1) [variations: *atuqsauluqtuq*]

*aulajuq* – general term for moving ice (JP1; PQ1) [variations: *auraniq*]

*aukkaturliit* – areas in the sea ice that open up (melt) earlier than surrounding sea ice in the spring, usually associated with areas of strong currents, at the mouth of a fiord, or near a *saqvaq*; *aukkaturlik* is the singular version (JaM1; JP1; MaN1; MoN1; MoN2) [variations: *aukkarniit*]

*aukkaavaliajut* – early stage of melting, when the sea ice is first starting to melt and become dangerous in certain areas (JoM1)

*aumajsijuq* – when there is water underneath the snow, but on top of the ice (LN1)

*auttuq* – general term for melting (JN1; JS1) [variations: *aujuq*]

*ikiartirtuq* – melt water forming in the spring will sometimes re-freeze at night creating a thin, brittle layer of ice over *immatinniit*; this condition will make cracking sounds when walked on, it will break easily over the water or air underneath, but there will usually still be solid ice further below (MaN1; MoN1)



*ikirniq* – the area of open water within an *aaajuraq*; the area of open water between two moving ice pans; a crack formed in a moving ice pan (JP1; ME1) [variations: *nuttarniq*]

*iluvaliajuq* – the first film of ice that starts forming, extending over the tidal flats (LI1)

*immaq* – general term for water

*immatinniit* – melt puddles formed by melting snow on top of the ice; the ice becomes slushy on top, and it is hard to travel (AY1; EN1; JQ1; JS1; MiK1)

*immatillarittuq* – melt puddles formed by the sea ice melting, the second stage of *immatinniit* forming; “really *immatittuq*”; the ice itself is wearing out and is thus more dangerous (MaN1; PQ1) [variations: *immatilliqtuq*]

*immatittuq* – the process of melt ponds forming as the snow melts on the sea ice (JQ1; MaN1; PQ1; PV1)

*inirqanirusiit* – minor currents (PV1)

*isirsangaq* – winds that come from the mouth of a fiord, or from Cumberland Sound in towards the fiord; *isirq* meaning “to enter” (JoM2)

*ittanilapaat* – wet spots on the snow where water has seeped up from underneath (MoK1)

*itilliq* – to go inland, an inland travel route (JaM1; LE1; MaN1) [variations: *ikuq*]

*ivujuq* – the action that occurs when winds or currents force solid ice on top of other ice, can create pressure ridges where pans of ice collide; common occurrence near the *sinaaq*; creates rough ice where the ice meets or is forced over top of other ice; *ivu*, “to go on top” (JI2; JP1; LE1; LI1; ME1; MM1; MoK1; MoK2; PQ1)

*kakki* – an expression used to describe pulling oneself out of the water, or jumping crossing from moving ice to solid land or ice (ME1)

*kamik* – general term for boots made of skin (often seal skin)

*kamotik* – general term used to refer to a sled made of wood, tied together with rope or sinew, that is pulled behind a dog team or snowmobile

*kavvaq* – large, thick (high) pans of multi-year ice that come from further north and move into Cumberland Sound with the influences of currents and winds; they are a clear blue colour due to their age and are relatively flat on top; not to be confused with *piqalujat*, they do not come off a glacier (EN1; JA1; JaM1; JoM2; MiK1; MoK1; MoN1; PV1) [variations: *kapvaq*, *qappa*, *qapvaq*, *qavvaq*]

*killait* – holes that have melted all the way through the sea ice, usually where water has accumulated in *immatinniit*; water from melting snow or ice drains through these holes; they can quickly become large in the spring, and can be dangerous (EN1; JaM1; ME1; PQ1) [variations: *killaanik*, *qillait*]

*killiminiq* – moving, multi-year ice that “used to be an edge” (*killiq* meaning “edge”), they came off a thick floe edge or ice pan further north, and are identifiable because they are jagged (rough) due to collisions with other ice, or from wave action; they are generally not as thick as *kavvaq* (JA1; JaM2; MiK1; MoK1)

*kiviniq* – ice condition created by wet snow accumulation on the sea ice, which then melts and sinks into the ice (literally referring to “the sunken”), becoming part of the sea ice and actually strengthening it (JoM1)

*kujjirtuq* – water that accumulates into little melt rivers, and is flowing into *qillait*; literally “it’s creating drainages” (MaN1)

*manguqtaliqtuq* – early stage of snowmelt in the spring, where the snow becomes the consistency that it will stick together and it would be possible to make snowballs (ME1)

*manguqtuq* – the process of the snow softening, and beginning to melt; it can be *manguqtaliqtuq* during the day and then *qirsuqaqtuq* when it hardens again at night (JQ1; MaN1; MM1) [variations: *mangumajuq*]

*maniilaq* – general term referring to rough ice (JA1; PV1) [variations: *maniilaaqtuq*]

*masaq* – wet snow with a mushy consistency and darker spots within it (JN1)

*maujaraq* – when the ice along the shore breaks up, and it is possible to jump from cake to cake of ice (PV1)

*mittiq* – king eider duck

*nagguti* – a crack that forms in solid ice, due to tidal variations, and re-freezes after it opens; usually forms at points of land, and runs from land to land; usually forms in the same place from year to year; used to set seal or fishing nets, or to follow looking for *alluit* (AY1; EN1; JaM1; JaM2; JI2; JoM1; JP1; JS1; LI1; LN1; MM1; MaN1; MiK1; MoK1; MoK2; PQ1) [variations: *naggut*]

*naggutiminiq* – an old *nagguti*, “it used to be a nagguti”, that has frozen over and will not re-open with the tides until the ice begins melting (JaM1; LI1) [variations: *naggutituqaq*]

*nangiarngnangittuq* – an expression used to describe the ice as “not dangerous” (EN1; LN1) [variations: *nangiarngnarunirtuq*]

*nattiq* – ringed seal

*nattiaq* – baby ringed seal

*nattiaminiq* – a young seal after the white fur has come off, “used to be a baby seal”

*nattiarajaaq* – baby ringed seal where the white fur is starting to come off

*nigajutaaq* – areas in the ice that take longer to freeze, which can create soft spots where they do start freezing over; the last spots of open water during freeze-up, associated with the influence of winds or currents; areas where seals can be hunted as the ice is freezing over (JaM1; MaN1)

*nipittuq* – when the ice “locks up”, it stops moving around because it becomes stuck to the land (PQ1)

*nunniq* – when Cumberland Sound freezes over and the floe edge is far away; the ice extent would cover nearly all of Cumberland Sound that was shown in the maps used in interviews (AY1; JI1; JaM2; JoM2; LN1; MaN1; ME1; MM1; MoN2; PQ1)

*nutaaminiq* – newly formed ice in the fall, before snow has fallen on it; “it used to be new”, it is about a week old; generally flat and large expanses of ice; good for *allu* hunting (JoM1; JP1; MiK1; PV1)

*nuttaa* – general term for a crack, but it does not open like a *nagguti* (JoM1; ME1; PQ1)

*piqalujat* – iceberg, a large chunk of ice that fell off a glacier and is floating in the ocean (MiK1)

*piturniq* – the effect of the full moon on tides (much higher and lower than daily tides) and current strength (much stronger than regular ocean circulation); with a new or full moon cracks open up wider, ice thins where the currents are strongest, *saqvaqs* get larger, more ice is moved around; a monthly cycle/effect on the sea ice (EN1; JaM1; JaM2; JI2; JoM1; LE1; LN1; MiK1; MoK2)

*piturnirusiq* – effects similar to *piturniq* but weaker, so the tides are not as high and the currents not as strong (EN1; JaM2) [variations: *piturniilaag*]

*piturnivijjuaq* – an extreme high and low tide, stronger effects than a regular *piturniq*; occurs about twice a year (EN1; JaM2) [variations: *piturniilaavijjuaq*]

*pujji* – an animal coming up from the water to breathe (PV1)

*pulattuq* – seals moving into fiords to be on the ice (MoN2)

*puttaijuq* – when all the snow has melted on top of the ice at the same time and the ice is covered in water (ME1; PQ1) [variations: *immatirutarajuq*]

*qainngu* – the ice that “touches the land”, it is a type of flat ice ledge that is attached to the shoreline; used for travel to get around dangerous areas; created from tidal variations and water continually overflowing at the edge, and then re-freezing (EN1; JoM2; LI1; LE1; MaN1; PQ1; PV1)

*qainnguqijaliqtuq* – the *qainngu* is becoming detached from the land (LI1)

*qalliriittipalliajuq* – when the wind forces thin ice to go under one another, forming overlapping layers; these layers thicken faster and can become travelable sooner than thin ice formations (multiple layers vs. one layer) (ME1)

- qanguqtuq* – during the strongest tides, in the spring, the water can force the ice along the land upwards, prying it off from the land as water gets underneath; this process can break off the *qaingu* (EN1)
- qanngut* – a snow-like crystallization that occurs on new or thin ice; caused by the exchange of moisture between the ocean and air (AY1; EN1; JaM1; LN1; MoK1; PV1) [variations: *qanngutilliq*]
- qattuattinniq* – the edge of a *saqvaq* that is made thicker because of water continuously splashing over the edge and re-freezing (MoK1)
- qillirusijuq* – an early stage of ice formation, when ice begins forming along the edge of the shoreline, this will eventually become *qaingu* (MaN1)
- qillisauti* – barrier rocks that are seen at the low tide line; where sea ice thickens along shore because of the continuous water movement during tidal stages (PQ1)
- qinnuaq* – the first time the ice begins to come together, in a slushy suspension in the water; can be formed from the ocean cooling with fall temperatures or from snow falling in the water; it is still very fluid and flexible; good for hunting because it is still possible to boat in these conditions, but also moderates the wave action (AY1; JS1; MaN1; MM1; MoK1; PQ1)
- qiqsuqaqtuq* – the process of snow freezing/hardening during the evening/night in the spring; part of the process of *manguqtuq*; excellent for traveling in the spring (ME1; MaN1) [variations: *qiqsirqangajuq*]
- quppirkuaq* – very thin sheet of ice that looks like an oil slick on top of the water; they are easier to see when there is a slight breeze, they will look like flat dark spots on the water (PQ1)
- saallijuq* – process of the ice thinning (*saatuq* meaning “thin”), linked to dangerous ice conditions (MiK1; MoK1) [variations: *saalaajuq*]
- saqvalariq* – a *saqvaq* where the ice will never freeze; it is possible to hunt at the edge of a *saqvalariq* and not be in too much danger (EN1)
- saqvaq* – an area of open water surrounded by sea ice, created and maintained by the movement of water, usually in areas with strong currents (refers to “where there are currents”); it can occasionally freeze over in the winter in areas or times when currents are weaker; popular areas for hunting seals; can be dangerous to travel around; surrounding sea ice tends to wear out earlier and faster in the spring than solid ice (AY1; EN1; LE1; JA1; JaM2; JI1; JoM1; LN1; MaN1; ME1; MiK1; MM1; MoK1; MoK2; MoN2; PQ1; PV1) [variations: *sijujuittuq*, also sometimes referred to as *aukkarniq* depending on dialect]
- sijja* – shoreline ice (broader extent than *qaingu*) that is continually shifting with tidal movements, thus creating rough ice conditions; difficult for travel; seals like to make their

dens in this ice where snow has accumulated between rough ice (JI1; JaM2; LI1; MaN1; MoK1; PQ1)

*sijjaijaliqtuq* – the process of *sijja* becoming detached from the land; the old pressure ridges along the tidal flats start to go in the spring (LI1)

*sijjaminiq* – the *sijja* has broken off and is floating in the water, “it used to be *sijja*” (LI1)

*siku* – a general term for sea ice; used for ice that is travelable and solid in areas that have frozen over (AY1; JP1; JQ2; LI1; MaN1; MiK1; MM1; MoK1; PV1)

*sikuallaajuq* – a collection of *sikuaq* in places; big plates of new ice; more traditional term for *sivaujanguaq* (likened to pancake ice) (PQ1) [variations: *kaikkuit*]

*sikuaq* – new, thin, brittle sheet of ice; the first continuous layer of ice to form (AY1; EN1; JaM1; MaN1; MiK1; MoK1; MoK2; PQ1)

*sikuaqtuq* – the process of *sikuaq* forming, the water is starting to freeze over (JaM1)

*sikujuq* – the water has frozen over, the ice has joined together and there is no more open water (JS1; PQ1)

*sikuluqtuq* – “bad” or “improper” sea ice, where it is quite thin and dangerous; a harpoon would go through the ice easily (MiK1)

*sikurataaq* – sea ice that has just recently formed; it is possible to walk on it if checking the ice with a harpoon (JI1; JP1; MaN1)

*sikurinittuq* – areas of sea ice that are thinner due to winds or snowfall; softer consistency than the surrounding sea ice; can apply to any soft ice condition regardless of ice thickness (MoN1)

*sikutaq* – the first ice to form, covering bays, inlets, and the heads of fiords before the larger bodies of water begin to freeze; where seals congregate in the fall (LE1; LI1; MaN1; PV1) [variations: *sikusirtuq*]

*sikutiaqtuq* – solid, well formed sea ice; “the ice has formed properly” (MaN1; MoN1)

*sikuvaliajuq* – early process of ice formation when the ice is “starting to form well”; first layers of ice are starting to form (JaM1; JI1; JQ1; JS1; LI1; ME1) [variations: *sikuvalialiqtuq*, *sikurisivaliajuq*, *sikualuqtuq*, *sikusaluqtuq*, *sikuliquqtuq*]

*sikuvaalluuti* – the first ice that forms and stays until the following year (EN1)

*sinaaq* – the edge of the *tuvaq* that borders on open water; the floe edge (JaM2; JI2; LE1; LN1; MaN1; MM1)

*surattuq* – sea ice break-up in the spring (“it’s broken”), due to the influence of winds (JS1; MM1; PQ1) [variations: *siqummai*, *surappuq*]

*sivaujanguaq* – ice that “looks like a cookie”, pans of new ice in circular shapes; a more modern term for *sikuallaajuq* (likened to pancake ice) (EN1) [variations: *kaikkuit*]

*tikpaqtuq* – the water-free ice after all the *immatinniit* have drained into *ajurait* or *killait* (MaN1; ME1; PQ1) [variations: *kinirijuq*, *saluraruqtuq*, *tijjurtuq*]

*titirtuq* – an ice condition created by snow absorbing water around a *saqvaq*, or area where currents are wearing away ice from underneath, which re-freezes into a crust that can be safe to travel on (ME1)

*tuuq* – ice chisel

*tuvaigaliqtuq* – the process of *tuvaq* deteriorating and coming off (JI1; LE1; MaN1; MoN1; PV1) [variations: *tuvaigapaliajuq*, *tuvaigtuq*, *tuvaungirtuq*]

*tuvaminiq* – ice that “used to be *tuvaq*”, once *tuvaq* has broken off and is floating in the water (EN1; LI1; MoK1; PV1)

*tuvaq* – solid, thick ice that is attached to the land; referring to a foundation, and staying thick for a long time; safe to travel almost anywhere (EN1; JI1; JoM1; JQ1; LE1; LI1; MaN1; MiK1; MoK1; MoN1; PV1)

*tuvallariuliqtuq* – solid sea ice, maximum thickness; it is safe to travel anywhere (JI1; JQ1)

*tuvarluqtuq* – *tuvaq* is deteriorating, thinning; becoming “bad” ice; becoming dangerous (LI1; MaN1) [variations: *tuvarlulirtuq*]

*tuvaruqpalliajuq* – sea ice is getting thicker, “it is turning into *tuvaq*” (JI1; LE1)

*uiguaq* – new ice that forms along the *sinaaq*; “an addition” (EN1; MaN1; ME1; MM1)

*uiguatuqaq* – old *uiguaq* (ME1)

*ujjuq* – bearded seal

*ujutillaq* – a type of ice “explosion” created by a shockwave when winds cause the ice to collide (MM1)

*unaaq* – general term used for a harpoon, an instrument used to test the ice and also used as a hunting implement

*uukkarujjaq* – when a person is stranded on sea ice that broke off (*uukkaqtuq*) from the *sinaaq* (ME1)

*uukkaqtuq* – when a piece of *tuvaq* breaks off from the *sinaaq*, usually caused by the influence of winds or currents (ME1)

*uttuq* – expression to describe a seal or walrus sitting on top of the ice (AY1; JoM1; MiK1; MoK2)

## Appendix 17

### *Compilation of interim research reports for each community*

#### Cape Dorset Trip Report (April 12 – 29, 2004) *Summary of Gita Laidler's First Research Trip for "Ice, Through Inuit Eyes"*

Purpose of the trip: to meet and interview community members (elders, active hunters, and other local experts) about sea ice, and to experience the ice myself through trips on the sea ice, to the floe edge.

Purpose of this report: to update the community members of Kinngait on: i) who I interviewed; ii) topics discussed in the interviews; iii) interview highlights; and, iv) my future research plans.

#### **Who I interviewed →**

*With the help of Pootoogoo Elee translating, the following people consented to being interviewed, and provided a valuable contribution to this research project (shown in alphabetical order).*

- |                                       |                                       |
|---------------------------------------|---------------------------------------|
| ○ Atsiaq Alasuaq (2 interviews)       | ○ Oqsuralik Ottokie                   |
| ○ Mangitak Kellypalik (2 interviews)  | ○ Paulassie Pootoogook (2 interviews) |
| ○ Elijah Mangitak                     | ○ Kanayuk Solomonie                   |
| ○ Iqadluq Nunguisuituq (2 interviews) | ○ Simigak Suvega                      |
| ○ Adamie Nuna                         |                                       |

#### **Topics discussed →**

- Previous experience with researchers, or results of previous research
- Experience with sea ice
- Inuktitut terminology linked to sea ice conditions, travel, and use
- Place/seasonal ice feature names
- Wind directions and influence on sea ice formation and movement
- Currents and influence on sea ice formation and movement
- The importance, and uses, of sea ice
- Weather prediction techniques
- Wildlife uses of the sea ice
- Hunting on sea ice
- Noticeably warm or cold years
- Rare or notable sea ice features/events
- Scientific methods of studying the ice, and how (or if) Inuit and scientists should work together
- The meaning of *Inuit Qaujimajatuqangit*

#### **Interview highlights →**

- Approximately 60 Inuktitut words relating to sea ice were described and explained
- Much of the Inuktitut sea ice terminology is no longer being used and/or is not being passed along to the younger generation
- Noticeable sea ice changes:
  - the floe edge is closer to town, throughout the winter
  - the ice is thinner than it used to be
  - the ice is more watery
  - the ice takes longer to freeze, forms about a month later, and breaks up sooner
  - the snow on top of the ice is softer, and seasonal cracks are forming earlier
- It is hard to answer some questions because ice conditions have changed so much
- Open water is maintained throughout the winter by strong currents
  - these can be dangerous areas to travel near, or around
- A harpoon is the most reliable way of gauging ice safety, but other methods may include:

- evaluating the wetness of the snow on the sea ice
- checking ice thickness through a seal hole
- note – it is hard to assess ice safety from a snowmobile
- It is hard to predict weather conditions/changes today
- It is very important to have first-hand experience on the sea ice
- Ice is a bringer of animals
- There is dissatisfaction with the use, and intended meaning, of *Inuit Qaujimajatuqangit*
- It would be good for Inuit and scientists to work together – to improve access to information for Inuit, and for scientists to learn from those most experienced with sea ice (there is interest in working together, at an equal level)
- It is very important to bring back research project results, through means such as:
  - written report and/or posters (bilingual, Inuktitut and English)
  - video
  - radio show
  - individual updates to each person interviewed

#### **Future research plans →**

- **July – October, 2004** → I will transcribe the interviews and begin organizing and analyzing them. I will copy all the audio and video files to tape to be deposited in Kinngait on the next research trip. I will digitize the maps drawn in interviews, and acquire satellite imagery to investigate ice conditions/changes in different areas around Kinngait and the Hudson Strait area. I will plan and organize future research trips.
- **November, 2004** → return to Kinngait for a 3-week field research trip.
- **January, 2005** → return to Kinngait for a 1-month field research trip.

*Thank you for hosting me in your community, and for supporting this research project. A special thanks is extended to all those who participated in the interviews and sea ice trips. I am very grateful to the Mayor and SAO for allowing the use of the Hamlet Council Chambers for interview space when needed. I would also like to thank Kristiina and Timmun Alariaq for the hands-on learning opportunities provided by a dog team ride to take pictures and video of sea ice conditions.*

I once again enjoyed my time in Kinngait, and I look forward to returning and working with you in November. Feel free to contact me any time with comments, questions, or suggestions.

Sincerely,

Gita J. Laidler

### **Pangnirtung Trip Report (April 29 – May 19, 2004)** *Summary of Gita Laidler's First Research Trip for "Ice, Through Inuit Eyes"*

Purpose of the trip: to meet and interview community members (elders, active hunters, and other local experts) about sea ice, and to experience the ice myself through trips on the sea ice, to the floe edge.

Purpose of this report: to update the community members of Pangnirtung on: i) who I interviewed; ii) topics discussed in the interviews; iii) interview highlights; and, iv) my future research plans.

#### **Who I interviewed →**

*With the help of Andrew Dialla and Eric Joamie translating, the following people consented to being interviewed, and provided a valuable contribution to this research project (shown in alphabetical order).*



- Lazarusie Ishulutak (2 interviews)
- Enosie Nashalik (2 interviews)
- Joanasie Maniapik (2 interviews)
- Mosesee Nuvaqirq
- Jamesie Mike (2 interviews)
- Joanasie Qappik (2 interviews)

### Topics discussed →

- Previous experience with researchers, or results of previous research
- Experience with sea ice
- Place/seasonal ice feature names
- Wind directions and influence on sea ice formation and movement
- Currents and influence on sea ice formation and movement
- The importance, and uses, of sea ice
- Weather prediction techniques
- Wildlife uses of the sea ice
- Hunting on sea ice
- Noticeably warm or cold years
- Rare or notable sea ice features/events
- Scientific methods of studying the ice, and how (or if) Inuit and scientists should work together
- The meaning of *Inuit Qaujimajatuqangit*

### Interview highlights →

- Approximately 91 Inuktitut words relating to sea ice were described and explained
- It is hard to answer some questions because ice conditions have changed so much
- Noticeable sea ice changes:
  - the freezing process is different, sea ice takes longer to form and is forming later
  - the ice is thinner and softer
  - the cold water under the ice is now deeper
  - seals are not getting enough time to moult on the sea ice (affecting fur colour and quality) and it is harder to hunt seal pups
  - the ice breaks up sooner and faster
- A harpoon is the most reliable way of gauging ice safety, but other methods may include:
  - checking ice thickness through a seal hole
  - note – it is hard to assess ice safety from a snowmobile, more guesswork is involved and there is concern for people traveling at high speeds
- Ice formation and safety depend on currents, winds, moon stage, and amount of snow that fell while the ice was forming (strong winds around Pangnirtung result from a funneling effect produced by fiord formation)
- Glacier calving influences ocean temperatures and freeze-up timing
- River flow influences sea ice deterioration (especially when it has a high sediment load)
- It is hard to predict weather conditions/changes today
- It is very important to have first-hand experience on the sea ice, especially to use and understand Inuktitut sea ice terminology
- Sea ice is a bringer of life
- There is dissatisfaction with the use, and intended meaning, of *Inuit Qaujimajatuqangit*
- It would be good to work with scientists, but there must be a fair sharing of knowledge
  - it is important to record Inuit knowledge and observations for future generations
  - scientists should have more hand-on experience
- It is very important to bring back research project results, through means such as:
  - written report (bilingual, Inuktitut and English)
  - public forum
  - audio/visual materials
- There is interest in learning more about scientific sea ice studies, and results (changes area getting so dramatic that hunters need and want extra knowledge and assistance)

**Future research plans →**

- **July – October, 2004** → I will transcribe the interviews and begin organizing and analyzing them. I will copy all the audio and video files to tape to be deposited in Pangnirtung on the next research trip. I will digitize the maps drawn in interviews, and acquire satellite imagery to investigate ice conditions/changes in different areas around Pangnirtung and Cumberland Sound. I will plan and organize future research trips.
- **December, 2004** → return to Pangnirtung for a 3-week field research trip.
- **February, 2005** → return to Pangnirtung for a 1-month field research trip.

*Thank you for hosting me in your community, and for all your support. A special thanks is extended to all those who participated in the interviews and sea ice trips. I am very grateful to the Nunavut Arctic College, the Angmarlik Visitor's Centre, and Parks Canada for providing interview space when needed. I would also like to thank Joanasi Maniapik and Eric Joamie (among others we met up with later) for a very informative and adventurous sea ice trip to Nasauya Point.*

I once again enjoyed my time in Pangnirtung, and I look forward to returning and working with you in December. Feel free to contact me any time with comments, questions, or suggestions.

Sincerely,

Gita J. Laidler

**Igloolik Trip Report (October 27 – November 15, 2004)**

*Summary of Gita Laidler's First Research Trip for "Ice, Through Inuit Eyes"*

Purpose of the trip: to meet and interview community members (elders, active hunters, and other local experts) about sea ice, and to experience the ice myself through trips on the sea ice, to the floe edge.

Purpose of this report: to update the community members of Igloolik on: i) who I interviewed; ii) topics discussed in the interviews; iii) interview highlights; and, iv) my future research plans.

**Who I interviewed →**

*With the help of Theo Ikummaq translating, the following people consented to being interviewed, and provided a valuable contribution to this research project (shown in alphabetical order).*

- |                               |                               |                       |
|-------------------------------|-------------------------------|-----------------------|
| ○ Samuelie Ammaq              | ○ Eugene Ipkanak              | ○ Daniel Qattalik     |
| ○ David Angutikjuaq           | ○ David Irngaut               | ○ Anthony Qrunnut     |
| ○ David Aqiaruq               | ○ Enuiki Kunuk (2 interviews) | ○ Augustine Taqqaugak |
| ○ Zacharias Aqiaruq           | ○ Herve Paniaq                | ○ Abraham Ulayuruluk  |
| ○ Maurice Arnatsiaq           | ○ Nathan Qamaniq              | ○ Louis Uttak         |
| ○ Theo Ikummaq (2 interviews) |                               |                       |

**Topics discussed →**

- Previous experience with researchers, or results of previous research
- Inuktitut terminology linked to sea ice conditions, travel, and use
- Wind and current influences on sea ice formation and movement
- The importance, and uses, of sea ice
- Wildlife uses of the sea ice
- Hunting on sea ice
- Noticeably warm or cold years and/or rare or notable sea ice features/events
- Scientific methods of studying the ice, and how (or if) Inuit and scientists should work together
- The meaning of *Inuit Qaujimagatuqangit*

### Interview highlights →

- Approximately 155 Inuktitut words relating to sea ice were described and explained
  - Moving ice conditions and characteristics have more names than landfast ice
- Tendencies towards later freeze-up and earlier break-up were observed; however, it was noted frequently that no two winters are the same, and that ice conditions/timing are closely linked with lunar cycles
- The presence of multi-year ice can impact summer temperatures, and ice conditions throughout the year
- Open water is maintained throughout the winter by strong currents
  - these can be dangerous to travel around, but are also good hunting areas
- This fall, stronger southeast winds, more overcast conditions, and increased snowfall have created unique ice conditions (i.e. taking longer to freeze, rougher ice, and more dangerous due to snow accumulation among the rough ice)
- A harpoon is the most reliable way of gauging ice safety and traveling by dog team is considered safer, and easier to get out of dangerous situations, than traveling by snowmobile
- Hunting, and traveling to hunting/harvesting locations, are the main uses of the sea ice today and are considered crucial to community life
  - It is also noted that hunting may occur less often because there isn't the same need for marine mammal fat for heat, light, and food (for both dogs and humans)
- It would be beneficial to both if Inuit and scientists work together – hunters know the ice as it is day to day, and scientists can “see” the ice where people may not travel
- Satellite imagery is used quite a bit by hunters for planning summer boat routes
- Documenting Inuit knowledge of the sea ice is considered an important to help youth learn, but could never replace the essential learning that comes through constant use
- The use, and intended meaning, of the term *Inuit Qaujimagatuqangit* is not well understood, and varies considerably for each person
- It is very important to bring back research project results, through means such as:
  - written report and/or posters (bilingual, Inuktitut and English)
  - radio show and/or community presentation
  - individual updates to each person interviewed

### Future research plans →

- **January – April, 2005** → transcribe, organize, and analyze interviews from November trip; copy original audio and video files to be deposited in Igloolik on the next research trip; digitize the maps drawn in interviews; acquire satellite imagery of the Fury and Hecla Strait area; plan and organize future research trips.
- **June, 2005** → return to Igloolik for a 3-week field research trip, and to collaboratively revise Inuktitut terminology and interview gaps.
- **July – December, 2005** → transcribe, organize, and analyze interviews from June trip; finalize transcripts and digitized maps; begin detailed analysis of information collected
- **Spring, 2006** → make final results available; undertake a reporting trip to Igloolik once results have been fully reviewed (with Theo Ikummaq and my committee members).

*Thank you for hosting me in your community, and for supporting this research project. A special thanks is extended to all those who participated in the interviews and sea ice trips. I am very grateful to the Department of Environment for allowing the use of their biology research lab for interview space. I would also like to thank Theo Ikummaq for the hands-on learning opportunities provided by two sea ice trips to take pictures and video of sea ice conditions.*

I really enjoyed my time in Igloolik, and I look forward to returning and working with you in June. Feel free to contact me any time with comments, questions, or suggestions.

Sincerely,

Gita J. Laidler

**Cape Dorset Trip Report (November 19 – December 2, 2004)**  
**Summary of Gita Laidler's Second Research Trip for "Ice, Through Inuit Eyes"**

Purpose of the trip: to meet and interview community members (elders, active hunters, and other local experts) about sea ice, and to experience the ice myself as it is forming.

Purpose of this report: to update the community members of Kinngait on: i) who I interviewed; ii) topics discussed in the interviews; iii) interview highlights; and, iv) my future research plans.

**Who I interviewed →**

*With the help of Pootoogoo Elee translating, the following people consented to being interviewed, and provided a valuable contribution to this research project (shown in alphabetical order).*

- |                                 |                         |                            |
|---------------------------------|-------------------------|----------------------------|
| ○ Matthewsie Joanasie           | ○ Aleka Parr            | ○ Ningeoseak Peter         |
| ○ Sandy Kelly                   | ○ Etidlouie Petaulassie | ○ Mikisiti Saila           |
| ○ Oqutaq Mikigak (2 interviews) | ○ Qatsiya Petaulassie   | ○ Quvianaqtuliaq Tapaungai |

**Topics discussed →**

- Previous experience with researchers, or results of previous research
- Inuktitut terminology linked to sea ice conditions, travel, and use
- Wind and current influences on sea ice formation and movement
- The importance, and uses, of sea ice
- Wildlife uses of the sea ice
- Hunting on sea ice
- Noticeably warm or cold years and/or rare or notable sea ice features/events
- Scientific methods of studying the ice, and how (or if) Inuit and scientists should work together
- The meaning of *Inuit Qaujimagatuqangit*

**Interview highlights →**

- Approximately 52 Inuktitut words relating to sea ice were described and explained, on top of the 60 words already discussed in the spring, 2004 research trip
- It is hard to predict weather conditions/changes today, and even weather forecasts are not consistently accurate enough to be reliable
- Sea ice continues to be a very important travel platform ("highway") to access hunting grounds and harvesting areas – for both marine and terrestrial wildlife
- Sea ice travel safety is a concern, more accidents seem to be happening
  - Always bring a harpoon to check ice thickness
  - The radio should be used more to communicate dangerous ice conditions
  - Hunters are not familiar with conditions or changes around traditionally dangerous areas because they were instructed to avoid such areas
  - Snowfall hides dangerous ice conditions, and contributes to such conditions by insulating newly formed ice so it is worn out from the currents underneath
  - Moon cycles and tidal stages have a strong influence on ice conditions and safety
- Noticeable changes
  - Winds are coming from all directions (instead of predominantly northwest winds) and seem to be stronger, which creates rougher ice conditions
  - Some areas do not freeze as solidly as they used to, and thus some trails are no longer safe to be traveling on – people are forced closer to the mainland
  - Air temperatures do not seem to be warming, but perhaps warmer ocean temperatures are influencing ice to form later and break up earlier
  - Less ringed seals seem to be caught these days
  - More bears are noticed around town, potentially linked to the limitations imposed by quota systems (hunters used to catch any animal they see)
  - Soap stone mines are accessible (by boat) a month early, in July instead of August

- Over 50 years ago elders were saying that ice and weather conditions would change drastically in the future, so for some people current changes are expected
- Concern was expressed for submarine testing or military activity effects on wildlife
- There is considerable interest in working with scientists to study the sea ice
  - Studies like this one should have been done 10 or 20 years ago
  - More frequent interaction between community members and scientists is desired
- There is dissatisfaction with the use, and intended meaning, of *Inuit Qaujimajatuqangit*
  - There should be more interaction between elders and youth

#### **Future research plans →**

- **January, 2005** → third research trip to Kinngait (January 10 - February 1...completed)
- **January - April, 2005** → transcribe, organize, and analyze interviews from November and January trips; copy original audio and video files to be deposited in Kinngait during the spring research trip; digitize the maps drawn in interviews; acquire satellite imagery of the Hudson Strait area; plan and organize future research trips.
- **May, 2005** → return to Kinngait for a 2-week field research trip, and to collaboratively revise Inuktitut terminology and interview gaps.
- **July - December, 2005** → finalize transcripts and digitized maps; begin detailed analysis of information collected.
- **Spring, 2006** → make final results available; undertake a reporting trip to Kinngait once results have been fully reviewed (with Pootoogoo Elee and my committee members).

*Thank you for hosting me in your community, and for supporting this research project. A special thanks is extended to all those who participated in the interviews and sea ice trips. I am very grateful to the Nunavut Arctic College and The Hamlet Office for allowing the use of their buildings for interview space. I would also like to thank Mangitak Kellypalik and Atsiaq Alasuaq for the hands-on learning opportunities provided by two "walking interviews" around town and on the newly formed ice to take pictures and video of sea ice conditions.*

I really enjoyed my time in Kinngait, and I look forward to returning and working with you in May. Feel free to contact me any time with comments, questions, or suggestions.

Sincerely,

Gita J. Laidler

#### **Pangnirtung Trip Report (December 2 - 17, 2004)**

##### *Summary of Gita Laidler's Second Research Trip for "Ice, Through Inuit Eyes"*

Purpose of the trip: to meet and interview community members (elders, active hunters, and other local experts) about sea ice, and to experience the ice myself as it is forming.

Purpose of this report: to update the community members of Pangnirtung on: i) who I interviewed; ii) topics discussed in the interviews; iii) interview highlights; and, iv) my future research plans.

#### **Who I interviewed →**

*With the help of Andrew Dialla translating, the following people consented to being interviewed, and provided a valuable contribution to this research project (shown in alphabetical order).*

- |                                 |                    |   |
|---------------------------------|--------------------|---|
| ○ Joavee Alivaktuk              | ○ Manasie Maniapik | ○ Joopa Soudluapik                              |
| ○ Manasa Evic                   | ○ Manasie Noah     | ○ Paulosie Vevee                                |
| ○ Jaco Ishulutak (2 interviews) | ○ Lootie Nowyook   | ○ And one hunter who wished to remain anonymous |
| ○ Mosesee Keyuajuk              | ○ Peterosie Qappik |   |
| ○ Michael Kisa                  |                    |   |

### Topics discussed →

- Previous experience with researchers, or results of previous research
- Inuktitut terminology linked to sea ice conditions, travel, and use
- Wind and current influences on sea ice formation and movement
- The importance, and uses, of sea ice
- Wildlife uses of the sea ice
- Hunting on sea ice
- Noticeably warm or cold years and/or rare or notable sea ice features/events
- Scientific methods of studying the ice, and how (or if) Inuit and scientists should work together
- The meaning of *Inuit Qaujimajatuqangit*

### Interview highlights →

- Approximately 75 Inuktitut words relating to sea ice were described and explained, on top of the 91 words already discussed in the spring, 2004 research trip
- It is hard to predict weather conditions/changes today and the weather seems to shift more frequently
- Sea ice travel safety
  - Always bring a harpoon to check ice thickness, it is hard to tell only by sight
  - Snowfall hides dangerous ice conditions, and contributes to such conditions by insulating newly formed ice so it is worn out from the currents underneath
  - Moon cycles and tidal stages have a strong influence on ice conditions and safety
  - Wet or dark spots on the ice are cause for caution, and checking with a harpoon
  - Rushed travel or hunting leads to more accidents on the sea ice
- Tidal cracks are found at almost every point of land, and are great locations for seal nets
- Sea ice is very important for seal moulting, denning, and raising the young pups
- Noticeable changes
  - The floe edge is closer to town, Cumberland Sound is not *nunniq* (frozen over) as much; therefore, some of the best commercial fishing areas are not accessible
  - Winds are coming from all directions (instead of predominantly northwest winds); warming trends may be linked to changing wind directions
  - More polar bears are noticed around the community
  - Some areas are not freeze as solidly as they used to, which affects travel routes
  - Melt stages are happening much quicker, highly influence by windy conditions
- Learning about sea ice and terminology is most effective when actually traveling on, and experiencing, difference ice conditions
- There is considerable interest in working with scientists to study the sea ice
  - Increased access to satellite imagery is desired
  - Scientists should spend more time in the community, working with hunters over a longer period of time
  - Study results must be returned to the community
- There is dissatisfaction with the use, and intended meaning, of *Inuit Qaujimajatuqangit*
  - The term is used too often, and is not well understood

### Future research plans →

- **February, 2005** → third research trip to Pangnirtung (February 1 – 21...*completed*)
- **January – April, 2005** → transcribe, organize, and analyze interviews from December and February trips; copy original audio and video files to be deposited in Pangnirtung during the spring research trip; digitize the maps drawn in interviews; acquire satellite imagery of the Cumberland Sound area; plan and organize future research trips.
- **April, 2005** → return to Pangnirtung for a 2-week field research trip, and to collaboratively revise Inuktitut terminology and interview gaps.
- **July – December, 2005** → finalize transcripts and digitized maps; begin detailed analysis of information collected.

- **Spring, 2006** → make final results available; undertake a reporting trip to Pangnirtung once results have been fully reviewed (with Andrew Dially and my committee members).

*Thank you for hosting me in your community, and for supporting this research project. A special thanks is extended to all those who participated in the interviews and sea ice trips. I am very grateful to The Hamlet Office and the Hunters and Trappers Association for allowing the use of their buildings for interview space. I would also like to thank Joavee Alivaktuk for the hands-on learning opportunities provided by a "walking interview" on the newly formed ice to take pictures and video of sea ice conditions.*

I really enjoyed my time in Pangnirtung, and I look forward to returning and working with you in April. Feel free to contact me any time with comments, questions, or suggestions.

Sincerely,

Gita J. Laidler

**Cape Dorset Trip Report (January 10 – February 1, 2005)**  
*Summary of Gita Laidler's Third Research Trip for "Ice, Through Inuit Eyes"*

Purpose of the trip: to meet and interview community members (elders, active hunters, and other local experts) about sea ice, and to experience the ice myself through sea ice trips.

Purpose of this report: to update the community members of Kinngait on: i) who I interviewed; ii) topics discussed in the interviews; iii) interview highlights; and, iv) my future research plans.

**Who I interviewed →**

*With the help of Pootoogoo Elee translating, the following people consented to being interviewed, and provided a valuable contribution to this research project (shown in alphabetical order).*

- |                                  |                            |
|----------------------------------|----------------------------|
| ○ Etulu Etidlouie (2 interviews) | ○ Paulassie Pootoogook     |
| ○ Ashevak Ezekiel                | ○ Quvianaqtuliaq Tapaungai |
| ○ Jimmy Manning                  |                            |

**Topics discussed →**

- Previous experience with researchers, or results of previous research
- Inuktitut terminology linked to sea ice conditions, travel, and use
- Wind and current influences on sea ice formation and movement
- The importance, and uses, of sea ice
- Wildlife uses of the sea ice
- Hunting on sea ice
- Noticeably warm or cold years and/or rare or notable sea ice features/events
- Scientific methods of studying the ice, and how (or if) Inuit and scientists should work together
- The meaning of Inuit *Qaujimajatuqangit* (IQ)

**Interview highlights →**

- Approximately 30 Inuktitut words relating to sea ice were described and explained, on top of the 112 words already discussed in the spring and fall, 2004 research trips
- Traveling or hunting by boat is quite frequent due to the nearby open water, year-round
  - Walrus hunting is mainly done by boat, during the fall season
- Cracks in the sea ice will often form between islands, or at most points of land
  - the Inuktitut names for cracks change over the season, as the ice conditions change (i.e. crack re-freezes vs. water remaining in the crack)
- Sea ice travel safety is a concern

- The best way to travel on the sea ice is with a harpoon
- Ice moving through Hudson Strait can be blown into the inlets and around the islands by south winds, preventing travel or hunting by ice or boat
- Moon cycles and tidal stages have a strong influence on ice conditions and safety
  - The full and new moons create stronger currents which tend to wear away the ice from underneath
- Noticeable changes
  - Some areas do not freeze as solidly as they used to, and thus some trails are no longer safe to be traveling on – people are forced closer to the mainland and have less time to use the trails
  - Warmer ocean temperatures may be influencing ice to form later and break up earlier
  - The weather is no longer predictable
  - Over 50 years ago elders were saying that ice and weather conditions would change drastically in the future, so for some people current changes are expected
- It is important that community members are informed of the ice conditions, even if some people are not using the ice at all
- There is interest in getting more traditional teachings into the schools so that the younger generations can learn more about ice conditions, safety, travel, and hunting (but there is also frustration due to lack of government and/or financial support)
- There is considerable interest in working with scientists to study the sea ice
  - Community members would like to get ice forecasts and to be informed of study results
  - Scientists would learn about ice more quickly if they asked, and involved, elders
- There is dissatisfaction with the use, and intended meaning, of IQ
  - IQ means so many things, it depends on the person, and the community

#### **Future research plans →**

- **January – April, 2005** → transcribe, organize, and analyze interviews from November and January trips; copy original audio and video files to be deposited in Kinngait during the spring research trip; digitize the maps drawn in interviews; acquire satellite imagery of the Hudson Strait area; plan and organize future research trips.
- **May, 2005** → return to Kinngait for a 2-week field research trip, and to collaboratively revise Inuktitut terminology and interview gaps.
- **July – December, 2005** → finalize transcripts and digitized maps; begin detailed analysis of information collected.
- **Spring, 2006** → make final results available; undertake a reporting trip to Kinngait once results have been fully reviewed (with Pootoogoo Elee and my committee members).

*Thank you for hosting me in your community, and for supporting this research project. A special thanks is extended to all those who participated in the interviews and sea ice trips. I am very grateful to the Nunavut Arctic College and The Hamlet Office for allowing the use of their buildings for interview space. I would also like to thank Atsiaq Alasuaq and Quvianaqtuliaq Tapaungai for the hands-on learning opportunities provided by two sea ice trips to the floe edge to take pictures and video of sea ice conditions.*

I really enjoyed my time in Kinngait, and I look forward to returning and working with you in May. Feel free to contact me any time with comments, questions, or suggestions.

Sincerely,

Gita J. Laidler



**Pangnirtung Trip Report (February 1 – 21, 2005)**  
*Summary of Gita Laidler's Third Research Trip for "Ice, Through Inuit Eyes"*

Purpose of the trip: to meet and interview community members (elders, active hunters, and other local experts) about sea ice, and to experience the ice myself through sea ice trips.

Purpose of this report: to update the community members of Pangnirtung on: i) who I interviewed; ii) topics discussed in the interviews; iii) interview highlights; and, iv) my future research plans.

**Who I interviewed →**

*With the help of Andrew Dialla translating, the following people consented to being interviewed, and provided a valuable contribution to this research project (shown in alphabetical order).*

- |                    |                    |
|--------------------|--------------------|
| ○ Levi Evic        | ○ Jamesie Mike     |
| ○ Mosesee Keyuajuk | ○ Jackie Nowdlak   |
| ○ Mosesee Nuvaqiq  | ○ Joeelee Papatsie |

**Topics discussed →**

- Previous experience with researchers, or results of previous research
- Inuktitut terminology linked to sea ice conditions, travel, and use
- Wind and current influences on sea ice formation and movement
- The importance, and uses, of sea ice
- Wildlife uses of the sea ice
- Hunting on sea ice
- Noticeably warm or cold years and/or rare or notable sea ice features/events
- Scientific methods of studying the ice, and how (or if) Inuit and scientists should work together
- The meaning of *Inuit Qaujimajatuqangit* (IQ)

**Interview highlights →**

- Approximately 15 Inuktitut words relating to sea ice were described and explained, on top of the 166 words already discussed in the spring and fall, 2004 research trips
- Cracks in the sea ice will often form between islands, or at most points of land
  - the Inuktitut names for cracks change over the season, as the ice conditions change (i.e. crack re-freezes vs. water remaining in the crack)
- Sea ice travel safety
  - Snowfall hides dangerous ice conditions, and contributes to such conditions by insulating newly formed ice so it is worn out from the currents underneath
  - Channels tend to be dangerous due to thinner ice caused by the funneling of the water (i.e. stronger currents)
  - Alternative inland travel routes are required to get around certain areas which have dangerous ice after a snowfall, or in early spring (due to strong currents)
  - Polynyas (areas of open water during the winter) tend to be dangerous to travel around, but are also important hunting areas
  - It is important to know which way to travel if you get stranded on moving ice
- Moon cycles and tidal stages have a strong influence on ice conditions and safety
  - The full and new moons create stronger currents which tend to wear away the ice from underneath, and these moons even affect inland river flow
- Some well-known shoals and small islands are not shown on the topographic maps used in interviews
- Multi-year ice coming from Lancaster Sound is blown closer to Cumberland Sound by northwest winds in the fall, summer breezes push it into Cumberland Sound, and the ice "migrates" out in August (but this is not a yearly occurrence)

- River flow speeds up sea ice deterioration in the spring (especially when it has a high sediment load)
- It is important to be aware of weather and weather changes to know about ice conditions and safety
- Concerns were expressed that submarines and underwater sounders affect wildlife
- There is considerable interest in working with scientists to study the sea ice
  - Inuit knowledge needs to be more recognized and accepted by scientists – this is slowly changing from past attitudes which disregarded Inuit knowledge
- There is dissatisfaction with the use, and intended meaning, of IQ
  - IQ means so many things, it depends on the person, and the community

#### **Future research plans →**

- **January – April, 2005** → transcribe, organize, and analyze interviews from December and February trips; copy original audio and video files to be deposited in Pangnirtung during the spring research trip; digitize the maps drawn in interviews; acquire satellite imagery of the Cumberland Sound area; plan and organize future research trips.
- **April, 2005** → return to Pangnirtung for a 2-week field research trip, and to collaboratively revise Inuktitut terminology and interview gaps.
- **July – December, 2005** → finalize transcripts and digitized maps; begin detailed analysis of information collected.
- **Spring, 2006** → make final results available; undertake a reporting trip to Pangnirtung once results have been fully reviewed (with Andrew Dialla and my committee members).

*Thank you for hosting me in your community, and for supporting this research project. A special thanks is extended to all those who participated in the interviews and sea ice trips. I am very grateful to The Hamlet Office and the Hunters and Trappers Association for allowing the use of their buildings for interview space. I would also like to thank Andrew Dialla for the hands-on learning opportunities provided by a sea ice trip between the stormy February weather we had for most of the trip.*

I really enjoyed my time in Pangnirtung, and I look forward to returning and working with you in April. Feel free to contact me any time with comments, questions, or suggestions.

Sincerely,

Gita J. Laidler

### **Pangnirtung Trip Report (April 26 – May 11, 2005)** *Summary of Gita Laidler's Fourth Research Trip for "Ice, Through Inuit Eyes"*

Purpose of the trip: to meet community members (elders, active hunters, and other local experts) and organizations to discuss research progress, and to revise interview transcripts and Inuktitut sea ice terminology.

Purpose of this report: to update the community members of Pangnirtung on: i) what I did during this last research trip; and, ii) my future research plans.

#### **What I did during this last research trip →**

- Revised unclear or inaudible parts of the interview transcripts with the help of Eric Joamie
- Revised spellings and meanings of certain Inuktitut sea ice terms with the help of Eric Joamie and Andrew Dialla
- Began the process of putting sea ice terms into order based on their sequence of occurrence from freeze-up to break-up

- With the help of Eric Joamie translating I held a revision session for project participants to contribute to the revision process, and to ensure the accuracy of the work
- Enoosie Nashalik, Jamesie Mike, Peterosie Qappik, Michael Kisa, Mosesee Keyuajuk, and Manasie Noah all contributed to these discussions, and identified the need for more detailed revisions and more time to be dedicated to this process
- Dropped off audio and video tapes of individual interviews to Tommy Papatsie at the Angmarlik Visitor's Centre – these are available for community members to view or use
- Met with the Hunters and Trappers Association to update them on the project

#### **Future research plans →**

- **June, 2005** → apply for additional funding to support the full revision of sea ice terminology and the ordering of these terms into seasonal chronology
- **July – December, 2005** → finalize transcripts and digitized maps; begin detailed analysis of information collected.
- **Spring, 2006** → make final results available; undertake a reporting trip to Pangnirtung once results have been fully reviewed (with Andrew Dialla and my committee members).

*Thank you for hosting me in your community, and for supporting this research project. I am very grateful to The Angmarlik Visitor's Centre for allowing the use of their building for meeting space. I would also like to thank Donald and Meeka Mearns, and Eric and Rosie Joamie for the hands-on learning opportunities provided by weekend fishing trips.*

I will provide another update on project funding status, and results progress, by September or October, 2005. Feel free to contact me any time with comments, questions, or suggestions.

Sincerely,

Gita J. Laidler

### **Cape Dorset Trip Report (May 11 – 24, 2005)** *Summary of Gita Laidler's Fourth Research Trip for "Ice, Through Inuit Eyes"*

Purpose of the trip: to meet community members (elders, active hunters, and other local experts) and organizations to discuss research progress, and to revise interview transcripts and Inuktitut sea ice terminology.

Purpose of this report: to update the community members of Kinngait on: i) what I did during this last research trip; and, ii) my future research plans.

#### **What I did during this last research trip →**

- Revised unclear or inaudible parts of the interview transcripts with the help of Pootoogoo Elee
- Revised spellings and meanings of certain Inuktitut sea ice terms with the help of Pootoogoo Elee
- Began the process of putting sea ice terms into order based on their sequence of occurrence from freeze-up to break-up
  - With the help of Pootoogoo Elee translating I held a revision session for project participants to contribute to the revision process, and to ensure the accuracy of the work
  - Atsiaq Alasuaq, Ashevak Ezekiel, Adamie Nuna, and Oqutaq Mikigak all contributed to these discussions, and identified the need for more detailed revisions and more time to be dedicated to this process
- Dropped off audio and video tapes of individual interviews to the Community Learning Centre – these are available for community members to view or use
- Met with the Hunters and Trappers Association to update them on the project

**Future research plans →**

- **June, 2005** → apply for additional funding to support the full revision of sea ice terminology and the ordering of these terms into seasonal chronology
- **July - December, 2005** → finalize transcripts and digitized maps; begin detailed analysis of information collected.
- **Spring, 2006** → make final results available; undertake a reporting trip to Kinngait once results have been fully reviewed (with Pootoogoo Elee and my committee members).

*Thank you for hosting me in your community, and for supporting this research project. I am very grateful to the Hamlet Office and the Community Learning Centre for allowing the use of their buildings for meeting space. I would also like to thank Kristiina and Timmun Alariaq for the hands-on learning opportunities provided by a 3-day land and sea ice trip.*

I will provide another update on project funding status, and results progress, by September or October, 2005. Feel free to contact me any time with comments, questions, or suggestions.

Sincerely,

Gita J. Laidler

**Igloolik Trip Report (June 6 - 27, 2005)**

*Summary of Gita Laidler's Second Research Trip for "Ice, Through Inuit Eyes"*

Purpose of the trip: to meet and interview community members (elders, active hunters, and other local experts) about sea ice, to experience the ice myself through trips on the sea ice, and to review interview maps/transcripts and Inuktitut sea ice terminology.

Purpose of this report: to update the community members of Igloolik on: i) who I interviewed; ii) topics discussed in the interviews; iii) interview highlights; iv) the revisions process; and, v) my future research plans.

**Who I interviewed →**

*With the help of Theo Ikummaq translating, the following people consented to being interviewed, and provided a valuable contribution to this research project (shown in alphabetical order).*

- |                               |                       |
|-------------------------------|-----------------------|
| ○ John Arnatsiaq              | ○ Levi Qaunaq         |
| ○ Arsene Ivalu (2 interviews) | ○ George Quviq Qulaut |
| ○ Jaipiti Palluq              |                       |

**Topics discussed →**

- Previous experience with researchers, or results of previous research
- Inuktitut terminology linked to sea ice conditions, travel, and use
- Wind and current influences on sea ice formation and movement
- The importance, and uses, of sea ice
- Wildlife uses of the sea ice
- Hunting on sea ice
- Noticeably warm or cold years and/or rare or notable sea ice features/events
- Scientific methods of studying the ice, and how (or if) Inuit and scientists should work together
- The meaning of *Inuit Qaujimajatuqangit*

**Interview highlights →**

- Approximately 18 Inuktitut words relating to sea ice were described and explained, on top of the 155 words already discussed in the fall 2004 research trip

- Current strength, wind strength and direction, snowfall, and the presence or absence of multi-year ice are all important determining factors in freeze-up timing and conditions
  - The prevailing wind seems to be shifting from the NW, more towards the North
  - Winds did not used to blow consistently for more than three days, but with the wind shift also comes more prolonged windy, or non-windy, periods of time
- There are three important reefs near Igloolik that play a role in determining the location and stability of the floe edge
- Polynyas are dangerous because the currents can wear out the ice from underneath
  - Currents are believed to be more influential on the melting and break-up of sea ice (i.e. wearing out from underneath, or causing collisions which break the ice) than the heat from the sun
- The number of pressure ridges, cracks, and breathing holes in an area will determine the accumulation of water on the ice as the snow is melting (i.e. presence or absence of drainage options)
- The multi-year ice around the community is mainly coming through Fury and Hecla Strait (i.e. clean, white appearance), and not as much from Foxe Basin (i.e. dirty, sandy, yellowish appearance) anymore
- Hunting, and traveling to hunting/harvesting locations, are the main uses of the sea ice today and are considered crucial to community life
  - The presence of multi-year ice in the summer is an aid for boat navigation, offering some protection from winds (lessening the wave action)
  - The amount of snowmobile, helicopter, airplane, boat, and ship traffic is considered to scare animals (e.g. seal, walrus, etc.) away from the community, or frequent travel/flight routes
- There is recognition that scientists are trying to consider Inuit knowledge in their studies, but it is felt that they do not use the full amount of information shared
- The use, and intended meaning, of the term *Inuit Qaujimajatuqangit* is not well understood, and varies considerably for each person

#### Revisions Process →

- Revised spellings/meanings of Inuktitut sea ice terms with the help of Theo Ikummaq
- Clarified hand-drawn maps to ensure correct labeling, with the help of Theo Ikummaq
- Dropped off audio tapes of individual interviews to John MacDonald at the Nunavut Research Institute – these are available for community members to listen to, or use

#### Future research plans →

- **June, 2005** → apply for additional funding to support the full revision of sea ice terminology and the ordering of these terms into seasonal chronology
- **July – December, 2005** → finalize transcripts and digitized maps; begin detailed analysis of information collected
- **Spring, 2006** → make final results available; undertake a reporting trip to Igloolik once results have been fully reviewed (with Theo Ikummaq and my committee members)

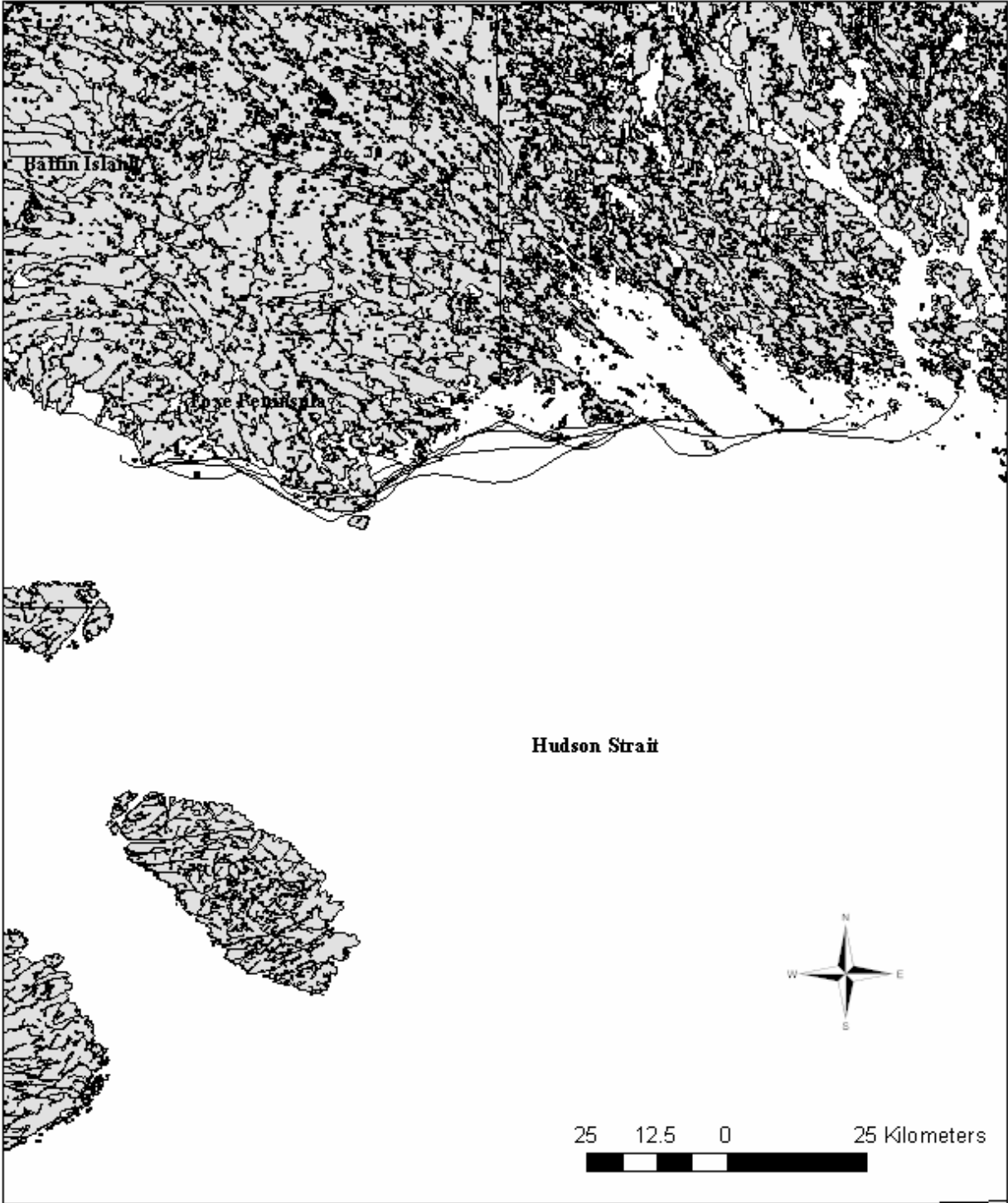
*Thank you for hosting me in your community, and for supporting this research project. A special thanks is extended to all those who participated in the interviews and sea ice trips. I am very grateful to the Department of Environment for allowing the use of their meeting room for interview space. I would also like to thank Theo Ikummaq for the hands-on learning opportunities provided by two sea ice trips to take pictures and video of sea ice conditions.*

I will provide another update on project funding status, and results progress, by November or December, 2005. Feel free to contact me any time with comments, questions, or suggestions.

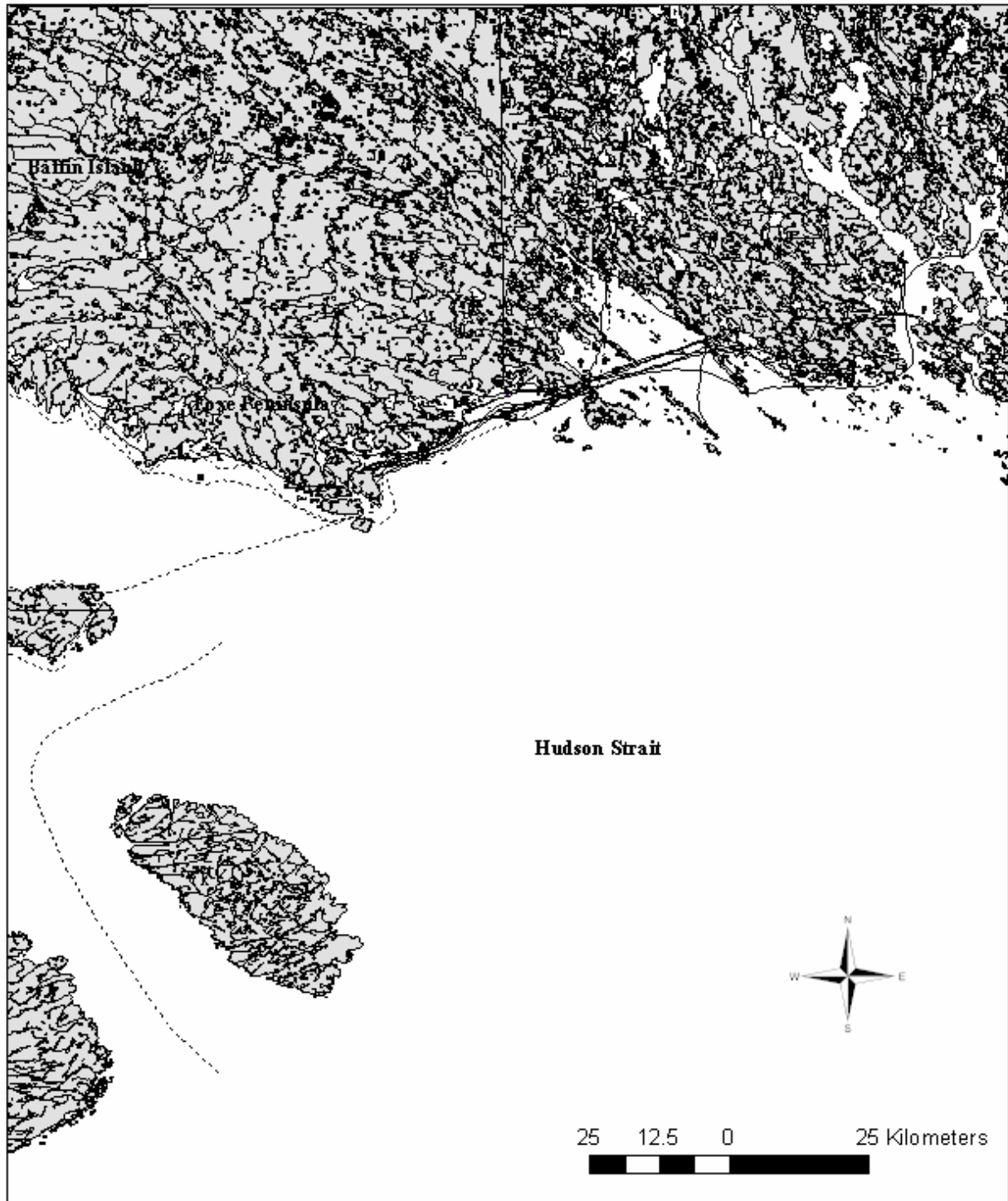
Sincerely,

Gita J. Laidler

# **Appendix 18** *Sinaaq (floe edge) approximation in the Cape Dorset area*



**Appendix 19**  
*Travel routes in the Cape Dorset area*



Where: — = sea ice travel    - - - - = boat travel

January 18, 2007

***Addendum concerning copyright:***

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Kluwer Academic Publishers *Climatic Change* vol. 78, iss. 2-4 (2006) pp.407-444, Figure 4 in “Inuit and scientific perspectives on the relationship between sea ice and climate change: the ideal complement?” by Gita J. Laidler.