

**Inuit Knowledge and Adaptations to Sea Ice Change in the Belcher Islands,
Nunavut**

By

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A Thesis
Submitted to the Faculty of Graduate Studies
In Partial Fulfillment of the Requirements
For the Degree of

Master of Natural Resources
Management

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Devin D. Imrie @ 2009

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ABSTRACT

Reduction in the thickness, extent, and duration of sea ice has become reality for Inuit in the community of Sanikiluaq, Nunavut. Residents believe the combined effects of climate change and hydro-electric development in the Hudson Bay watershed are driving the changes, which present challenges for Inuit choosing to continue subsistence based livelihoods.

Using semi-directive interviews and extensive participant observation, this thesis documents the observations and insights of hunters and elders from Sanikiluaq on sea ice change. A discussion of coping mechanisms and adaptations that are being emerging in the community to address profound change follows. The limitations and barriers to effective adaptation within the community are explored in order to provide recommendations for local and government initiatives to mitigate the impacts of sea ice change. In addition, this research complements and provides recommendations to ongoing community-based monitoring of sea ice by ArcticNet scientists and the community of Sanikiluaq.

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Chapter One: Introduction

Climate change in the Arctic has attracted large amounts of attention in recent years, as even small changes in global climate have noticeable effects on weather, sea ice, animals and people who depend upon this environment for survival. Driven by rising CO₂ levels, global temperatures have risen an average of 0.74°C in the last 100 years, with a warming trend of 0.13°C per decade in the last 50 years (IPCC, 2007). Due to a phenomenon known as polar amplification, this warming trend is greatly exaggerated at high latitudes (Gagnon & Gough, 2005; Langden & Alexeev, 2007; Masson-Delmotte et al., 2006). Evidence suggests that the resulting warming could occur at a rate of 1°C per decade in the Canadian Arctic (Tynan & DeMaster, 1997). Sea ice, a major component of the Arctic marine environment and an influence on global weather systems, has been receding and thinning throughout much of the Arctic (Carmack et al., 2006; Gearheard et al., 2006). Reductions in the extent and density of sea ice due to global warming cause a decrease in the albedo, or reflectivity, of northern oceans. The result is a positive feedback cycle, where more solar energy is absorbed by areas of open water than by snow or ice, raising the water temperature and exacerbating ice melt (Carmack et al., 2006; Gagnon & Gough, 2005; Holland & Blitz, 2003).

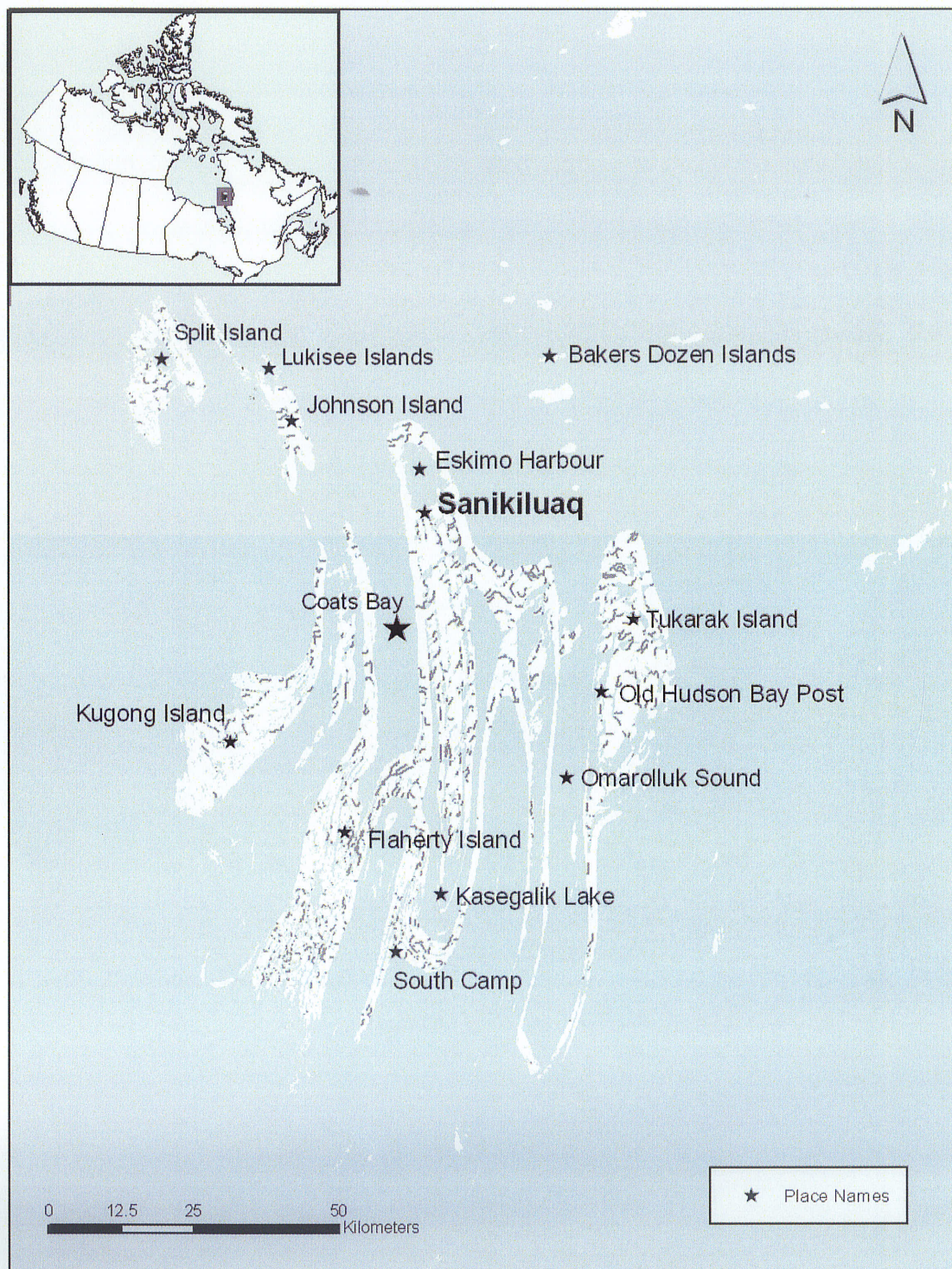
The Inuit people of the Belcher Islands, in southeastern Hudson Bay (Figure 1), rely on sea ice for travel and harvesting traditional foods. Hunters and elders in the community of Sanikiluaq, Nunavut (NU), have already noticed major changes in the characteristics of sea ice, including slower freeze up, early and rapid spring thaw, increasing amounts of rough ice, and inability to predict ice safety using Inuit Knowledge (IK). The risks associated with hunting on sea ice are therefore increasing, since

unpredictable conditions make Inuit Knowledge less dependable, particularly when hunters rely on this knowledge to navigate safely on sea ice (Ford, 2005; Ford & Smit, 2004). Ice conditions are making hunting more difficult and dangerous; travel speed must be reduced on rough and/or unpredictable ice. Ringed seals (*Phoca hispida*) are the primary traditional winter food source of the Belcher Island Inuit and are hunted at breathing holes, polynyas, and landfast ice edges (floe edges). Seal hunting has become more difficult due to rough ice making breathing holes harder to locate and an increasingly unstable floe edge. Hunting for beluga whales (*Delphinapterus leucas*), polar bears (*Ursus maritimus*), Canada geese (*Branta canadensis*), snow geese (*Chen caerulescens*), and common eider ducks (*Somateria mollissima*) also involves utilization of sea ice, and access to some of the hunting areas for these species is becoming more difficult, particularly during spring (Mallory et al., 2006). The amount of open water can play a role in hunting success; open areas that are small or few in number tend to concentrate animals, but this applies primarily to eider ducks, as seals are widespread in the Belcher Islands (Gilchrist & Robertson, 2000). Unpredictable ice conditions make hunting near open water areas very dangerous. It has become relatively common for floe edges to break off without warning, leaving hunters stranded; such an incident occurred near Sanikiluaq in January 2007. Thin ice or open water hidden by snow has resulted in numerous hunters falling through the ice in recent years and is widely agreed to have been a factor in the tragic disappearance of a young hunter in February 2008.

In the community of Sanikiluaq, NU, and several other locations in the Arctic, ArcticNet scientists have been collecting data on snow, ice, wind, and meteorological conditions for several years through community-based monitoring approaches. While this

scientific data is helpful in determining short-term trends and will provide a climate record over the long term, its practical applications are limited unless the findings can be incorporated into the lives of local people, which so far has not occurred (Alex Langlois, pers. comm.). Numerous researchers have stressed the need for more climate change research to be taken to the community level and involve local people in studying the human implications of climate change (Ford et al., 2006; Jolly et al., 2002; Nickels et al., 2006). Studies of local observations and Inuit Knowledge, such as this thesis, can document what local people are seeing and experiencing, how this compares to past conditions, and how climate change is affecting their daily lives. The compilation of Inuit Knowledge regarding sea ice change and a discussion of the resulting adaptations will help the community of Sanikiluaq adapt to further climate change by highlighting areas of improvement in the adaptation process. This study will be useful to guide future scientific research on sea ice change in eastern Hudson Bay, particularly in the area of community-based monitoring, by communicating the knowledge of local residents to scientists and identifying local priority areas for research.

Figure 1. Map of the Belcher Islands, Nunavut.



1.1 Purpose

The intent of this research is to document Inuit Knowledge on sea ice change occurring in the vicinity of Sanikiluaq, NU, which will then facilitate a discussion of the challenges that changing sea ice conditions pose to Inuit harvesting activities and the local adaptations that are being made to cope with change.

1.2 Objectives

- 1) Describe local Inuit observations of sea ice change in traditional hunting areas surrounding the Belcher Islands.
- 2) Describe hunters' observations and experiences concerning how their daily and seasonal activities are affected by changes in sea ice.
- 3) Document and discuss how hunting practices and seasonal harvesting activities are adapting in response to changes in local sea ice conditions.

1.3 Limitations and Delimitations

The amount of time I spent in Sanikiluaq was limited for financial reasons (70 days in total), but the design of the project was such that I was able to experience two representative times of the year: mid-winter and spring. Ideally, an entire winter would be spent in the community so that a full range of sea ice conditions and the corresponding hunting activities could be documented. As this time investment was not possible, interviews and informal discussions with hunters and community members were used to cover not only ice conditions I personally observed, but conditions throughout the entire fall-winter-spring cycle.

The availability and willingness of local people, specifically elders and hunters, to be interviewed was a potential limitation of the project, even though consent was

obtained from the Sanikiluaq Hunters and Trappers Association (HTA) to conduct the research. Although some community members declined to be interviewed, the majority of people approached were happy to participate; therefore, this was only a minor limitation.

This research was conducted by a single researcher as opposed to a research team; therefore, a highly detailed study of sea ice conditions throughout the Belcher Islands was not possible. Instead, the goal was to gain a holistic view of sea ice changes in the area, citing specific examples from interviews, discussions, and personal observations made during on-ice travel with local hunters. All travel on sea ice is dependent upon uncontrollable variables such as weather and the inherent unpredictability of sea ice itself; fortunately, the on-ice participant observation aspect of this research occurred during a period of relatively good weather, with only three major blizzards occurring during my stay in Sanikiluaq in March 2008.

Chapter Two: Literature Review

The Belcher Islands, located in southeastern Hudson Bay, were observed by the explorer Henry Hudson in 1610-1611. Their true shape and extent remained unknown to Europeans until the islands were mapped by Robert Flaherty in 1915 (Schwartz, 1976). Inuit and their ancestors have inhabited the Belcher Island archipelago for thousands of years, with early Dorset sites in the region dating back to 2500-1000 B.C. (Maxwell, 1985). The Dorset were supplanted by the Thule people in the fourteenth century, and their descendants became the modern day Ungava Inuit (Damas, 1984; Maxwell, 1985). The islands' residents were largely isolated; infrequent trade was conducted with the nearest Inuit villages on the Quebec mainland, Kuujjuarapik and Umiujaq, by kayak in periods of open water and by dogsled or foot over the ice in winter. In 1928, the Hudson Bay Company established a post on the southwest coastline of Flaherty Island, the largest island in the Belcher archipelago (Schwartz, 1976). For the next several decades, the majority of the Inuit on the Belcher Islands lived in Itidliao, or South Camp, a settlement on the southern tip of Flaherty Island, near the outlet of Kasegalik Lake. In 1970, the Canadian Government relocated the Belcher Island Inuit from Itidliao to the site of present day Sanikiluaq, on the shores of Eskimo Harbour at the north end of Flaherty Island (Schwartz, 1976) (Figure 1). The current population of Sanikiluaq is approximately 745 people, 95% of whom are Inuit (StatsCan, 2006). Soapstone carving, fur sales, school teaching, and local government positions represent the main sources of employment; there is no major industry in the area (Quigley & McBride, 1987).

2.1 Hunting and Traditional Foods

Traditional foods, particularly marine species, continue to be a staple in the diet of Belcher Island Inuit. A land use study by Riewe (1991) calculated the area hunted by the Belcher Island Inuit to be 33,000 km², 88 percent of which is marine habitat dominated by sea ice for much of the year. Harvesting, preparing, and eating country foods contributes to a sense of cultural identity, good health and nutrition, and represents a significant financial savings as store bought foods are very expensive in Sanikiluaq (Fast & Berkes, 1994; Wein et al., 1996). Ringed seals are the most commonly consumed marine mammal species. During early winter while ice remains thin, seals are hunted primarily at breathing holes on Coats Bay (Figure 1), which is near the community and one of the first areas to develop safe ice (Johnny Takatak, pers. comm.). In mid-winter, seals may be hunted at breathing holes, polynyas, or the floe edge, where they are typically shot in the water and then retrieved with a gaff or by boat (Schwartz, 1976). During the time of maximum ice extent the floe edge is typically about 30 km from Sanikiluaq, close enough that hunters can hunt seals during the day and return to the community at night. In the spring, ringed seals are frequently stalked while they bask on the ice near breathing holes or near open water (Schwartz, 1976). During summer, boats are used to hunt seals, which are curious animals and can be lured closer by scratching the side of the boat with a metal object (Johnny Kudluarok, pers. comm.). Bearded seals (*Erignathus barbatus*) are also common in the vicinity of the Belcher Islands, although less common than ringed seals. They are harvested in lower numbers than ringed seals, one reason being they are much heavier and harder to handle (Johnassie Ippak, pers. comm.).

Polar bears are hunted each year in February and March, with the hunt beginning on a date agreed upon by the Sanikiluaq Hunters and Trappers Association and ending when the 25 allotted bears have been harvested (Paul Prefontaine, pers. comm.). Unlike other communities in Nunavut, none of the polar bear licenses allotted to Sanikiluaq are sold to non-resident sport hunters. Polar bears are hunted primarily for their hides, which can bring a significant financial return, and for the large amount of meat they provide (Freeman & Wenzel, 2006). During the polar bear hunt, bear meat is a staple food that is shared widely throughout the community.

The larger marine mammals, walrus (*Odobenus rosmarus*) and beluga whales, have historically been important to the Belcher Island Inuit (Damas, 1984; Riewe, 1992; Schwartz, 1976). Walrus were typically hunted in summer and fall, usually at known haul-outs in the Bakers Dozen Islands, King George Islands, Sleeper Islands, and southern parts of the Belcher Islands (Riewe, 1992; Schwartz, 1976). In recent years, however, few walrus have been hunted (Paul Prefontaine, pers. comm.). Walrus hunts are large undertakings, involving many hunters aboard a large community boat equipped with a winch to retrieve the large animals (Daniel Apawkak, pers. comm.). Beluga whales, hunted in and around the archipelago during spring and summer, typically enter the area when cracks start to appear in the sea ice (McDonald et al., 1997; Riewe, 1992; Schwartz, 1976). The majority of whales taken, sometimes 30-40, are harvested from the edge of the ice when it breaks away from Kataaluk and Kattuk, two of the entrances to Eskimo Harbour during the months of June and July (Johnny Takatak, pers. comm.).

Arctic fox (*Alopex lagopus*) and red fox (*Vulpes vulpes*), though not eaten (Cameron & Weis, 1993; Wein et al., 1996), have been trapped for their furs, particularly

when prices were high. However, a decline in fur prices since the late 1980's has resulted in fewer foxes being trapped. (Paul Prefontaine, pers.comm.).

Caribou (*Rangifer tarandus*), once present on the Belcher Islands, are said to have disappeared in the 1870's (McDonald-Fleming, 1992). In 1978, 60 reindeer were relocated to the Belcher Islands from the Reindeer Reserve near Tuktoyaktuk with the hope of establishing a herd that could be harvested by Inuit from Sanikiluaq (McDonald-Fleming, 1992; Riewe, 1992). The herd ranges on the southern parts of the Belcher archipelago and has grown to approximately 500 animals. The reindeer have been sustainably managed and hunted by the community since 1983. Two harvests, regulated by the Sanikiluaq Hunters and Trappers Association, occur every year, during which a total of 40-60 animals are taken (Lucassie Arragutainaq, pers. comm.).

Waterfowl comprise a large part of the traditional diet in Sanikiluaq, especially during the peak migration periods in spring and fall. Canada goose, common eider, and snow goose are the most commonly consumed species (Cameron & Weis, 1993; Wein et al., 1996). Eggs of ducks and geese are also harvested and eaten (Riewe, 1992). During the spring hunt, many people travel from the community to cabins located throughout the islands or at South Camp. This travel is done by snowmobile on the sea ice; traveling overland to these camps is possible, but much rougher, more time-consuming and harder on people and equipment (Charlie Takatak, pers. comm.). Common eiders overwinter in the Belcher Islands in large numbers (Gilchrist & Robertson, 2000; Heath et al., 2006), and can be harvested during winter at polynyas and the floe edge. Traditionally, eider down and skins were used to make winter parkas, a unique clothing item found only in the Belcher Islands (Joel Heath, pers. comm.; Oakes, 1991).

Fish, especially arctic char (*Salvelinus alpinus*), are a major part of the Belcher Island Inuit diet (Cameron & Weis, 1993; Wein et al., 1996). Char can be caught by hook and line or netted through the ice in early spring, in rivers during the spring and fall, or in saltwater during summer (Johnny Kudluarok, pers. comm.; Schwartz, 1976). Kasegalik Lake and the river draining it, the mouth of which is near South Camp, is a favorite char fishing location (Elijah Oqaituk, pers. comm.). Greenland cod (*Gadus ogac*) and shorthorn sculpin (*Myoxocephalus scorpius*) are also eaten and are usually caught by jigging with a baited spoon through holes cut in the ice or cracks that form during the spring (Caroline Meeko, pers. comm.). Capelin (*Mallotus villosus*) are eaten infrequently and are most often caught when spawning on sandy beaches in July (Elijah Oqaituk, pers. comm.) or when removed from the stomachs of ringed seals (Peter Kattuk, pers. comm.).

Saltwater invertebrates such as mussels (*Mytilus sp.*), sea urchins (*Strongylocentrotus sp.*), and sea cucumbers are also favorite foods (Cameron & Weis, 1993; McDonald et al., 1997; Wein et al., 1996). These are collected in every season, even during winter through holes cut in the ice near Kataapik, a narrow channel at the northwest corner of Eskimo Harbour (Daniel Apawkak, pers. comm.).

2.2 Sea Ice in Hudson Bay

For many months of the year, ice is the dominant feature of the northern environment. The survival of Arctic animals and Inuit are inextricably linked to both saltwater and freshwater ice (Henshaw, 2003; Nickels et al., 2006). Hudson Bay is unique in that a large influx of freshwater from numerous rivers creates an estuarine environment, with relatively fresh surface waters overlying water of higher salinity (Nakashima & Murray, 1988; Prinsenbergh, 1986). Hudson Bay is typically covered with

ice from December to early June (Markham, 1986; Shirasawa & Ingram, 1991). In the Belcher Islands, as with other places in the Arctic, landfast ice is the first ice to form and continues to grow throughout the winter while remaining solidly fixed to the shoreline (Ferguson et al., 2000; Nakashima & Murray, 1988). Landfast ice is the most important type of ice to the activities and lifestyle of Arctic peoples, as it provides them with a platform to access and hunt animals that inhabit open water during winter (George et al., 2004; Mahoney et al., 2007). In mid-winter, landfast ice typically extends about 30 km offshore from the Belcher Islands, often incorporating the Bakers Dozen Islands as well (Joel Heath, pers. comm.). During severe winters, solid landfast ice may form an ice bridge between the Belcher Islands and the Nunavik shoreline in late January, allowing safe travel across to the mainland (McDonald et al., 1997; Nakashima & Murray, 1988). In this situation, the landfast ice edge typically extends from the south end of the Belcher Islands to Long Island on the northeast corner of James Bay and east from the Bakers Dozen Islands to the Quebec mainland (Markham, 1986; Nakashima & Murray, 1988). In the early 1990's, the ice bridge between the Belcher Islands and the Quebec (Nunavik) mainland froze solid enough to facilitate safe travel. This phenomenon reportedly occurred occasionally in late winter prior to 1950, but became common throughout the 1970's, and 1980's (McDonald et al., 1997).

During winter, the most biologically productive areas in the Arctic are those with open water, namely floe edges and polynyas (Gilchrist & Robertson, 2000; Henshaw, 2003; Stirling, 1997). At this time of year most of Hudson Bay is filled with moving pack ice that is circulated by winds, currents, and tides (Ingram et al., 1996). At the interface of moving pack ice and solid landfast ice, areas of open water frequently occur, usually

resulting when wind or tidal currents move the pack ice away from the landfast ice (Gilchrist & Robertson, 2000; Henshaw, 2003; Laidler & Elee, 2008). This is known as a floe edge or flaw polynya. Through discussions with Sanikiluaq hunters, Nakashima and Murray (1988) reported that constantly moving pack ice was found to the west of the Belcher Islands and among the areas of landfast ice extending from the mainland and surrounding the major archipelagos in the area: the Belcher Islands, the Sleeper Islands, and the King George Islands. Open water persists in these areas during all but the coldest winters.

Recurring polynyas differ from flaw polynyas in that they occur within landfast ice, typically in shallow waters between islands or near shoals. These polynyas recur year after year due to winds, tidal currents, upwellings, or a combination of these, which prevent the formation of ice (Gilchrist & Robertson, 2000; Stirling, 1997). The majority of polynyas in the Belcher Islands occur in water less than 12 m deep, with currents that can exceed 1.5 m/s (Gilchrist et al., 2006). In general there are two types of recurring polynyas: those which are open year round and those that freeze over for one or two of the coldest months and then re-open in early spring (Nakashima & Murray, 1988; Stirling, 1997). Polynyas in the Belcher Islands are important wintering areas for animals such as walrus, seals and common eider ducks (Gilchrist & Robertson, 2000; McDonald et al., 1997). Common eiders use the shallow, open water to feed on marine benthic invertebrates (Heath et al., 2006).

The locations of the major polynyas around the Belcher Islands were mapped using Inuit Traditional Knowledge in *Voices from the Bay* (McDonald et al., 1997). The consultations for this book were completed in 1993, a year that happened to be near the

end of a major cooling trend in the Eastern Arctic. This trend is believed to be a direct result of the Mount Pinatubo eruption in June 1991, which lowered the global mean temperature by 0.2°C in 1992 and 1993 (Fiocco et al., 1996; Gagnon & Gough, 2005). During the years 1992 and 1993, this cooling trend caused many of the polynyas in the Belcher Islands to freeze over, decreasing the number of polynyas from thirteen previous to 1990, to only three in the winter of 1992-1993 (McDonald et al., 1997). The extended ice cover and decreased number of polynyas during this period caused a major die-off of eider ducks due to the freezing over of important feeding areas (Gilchrist et al., 2006; Joel Heath, pers. comm.). Many of the Belcher Island Inuit felt that the increased ice cover in the early 1990's was a result of weakening ocean currents, possibly resulting from hydro development in Quebec altering the flow regimes of rivers entering Hudson and James Bay. Currents play a major role in maintaining open water areas among the Belcher Islands, and it is well known that freshwater influx into Hudson Bay is a major driver of these currents (Ingram et al., 1996; McDonald et al., 1997; Nakashima & Murray, 1988). Generally, currents in Hudson Bay circulate counter-clockwise, forcing water through the Belcher Island archipelago and creating strong local currents that increase or decrease in strength due to the tidal cycle (Gilchrist et al., 2006; Prinsenberg, 1986).

The cooling trend reported by McDonald et al. (1997) appears to have ended in the mid-1990's. For the last ten years, warming trends similar to those reported in other regions of the circumpolar Arctic have been reported in the Hudson Bay and Nunavik regions (Tremblay et al., 2006). During the winters of 1998 and 1999, Gilchrist and Robertson (2000) recorded 16 polynyas in and around the Belcher Islands. Sanikiluaq

hunters report that ice conditions have not been safe enough to allow travel to the mainland for several years (Elijah Oqaituk, pers. comm.). In general, communities throughout the Arctic are reporting thinner ice, rougher ice, later freeze-up and earlier break-up (Nickels et al., 2006).

2.3 Inuit Qaujimaningit

Inuit Qaujimajatuqangit (IQ) is a term commonly used in Canada to encompass all forms of Inuit knowledge and ways of knowing (Thorpe et al., 2002). However, Quajimajatuqangit is a reference to old or historical knowledge, implying knowledge that is historical or outdated in nature, when in reality IQ is dynamic and relevant, and more accurately described by the term Inuit Quajimaningit, which translates directly into Inuit Knowledge (Leduc, 2006). Traditional Knowledge (TK) and Traditional Ecological Knowledge (TEK) can be included under the umbrella of IQ, which incorporates not only environmental knowledge, but attitudes, values, behaviors, and world view as well (Wenzel, 2004). IQ will be considered synonymous with Inuit Knowledge for the purpose of this discussion.

Inuit Knowledge and insights are based on experience and ongoing, first-hand observation of nature and natural phenomena (Huntington, 2000; Pierotti & Wildcat, 2000). IQ incorporates an acute awareness of the dynamic relationships between Inuit and their environment, passed on orally through songs, stories, myths, and experience-based lessons from generation to generation (Huntington, 1999; Nichols et al., 2004). Essentially, IQ is the synergy of knowledge, practices, and beliefs into a unified body of knowledge (Berkes et al., 2000; Stevenson, 1996). Although based on the cumulative learning of past generations, Inuit Knowledge is dynamic and is ever evolving to

integrate present day changes in environment and socio-economic context (Keith et al., 2005; Stevenson, 1996; Usher 2000). Experience-based knowledge systems are place-specific and specific to the individual knowledge holder; knowledge can therefore be modified based upon the experiences of that individual (Nichols et al., 2004; Wenzel, 1999).

Numerous differences distinguish IQ from western scientific ways of knowing, specifically its holistic nature, existence as a qualitative oral record, emphasis on practical application of skills and knowledge, trust for inherited wisdom, respect for all things, practical experimentation, and local verification (Barnhardt & Kawagley, 2005; Nadasdy, 1999). This contrasts with western scientific knowledge, which is typified by skepticism, an emphasis on understanding how and why, quantitative records, a reductionist approach, and an approach based on procedure, evidence, and theory (Barnhardt & Kawagley, 2005; Nadasdy, 1999). Despite inherent differences between the two knowledge systems, many similarities can be found. Both IQ and western science rely upon repeated observations that are verified and improved upon by peers, namely the community in the case of IQ. Therefore, Inuit Knowledge has both rigor and confidence when describing the local environment (Laidler, 2006). Both knowledge systems involve the identification of patterns through inquisitiveness, open-mindedness, and the making of predictions based on observed patterns (Barnhardt & Kawagley, 2005). As stated by Nakashima (1991:66, in Wenzel, 1999) there are “striking similarities in intellectual process” between scientists and Inuit, despite the different types of knowledge produced. Similar to western science, IQ is a large stable body of knowledge that is constantly being modified as technologies and environments change, and as new discoveries are made

(Barnhardt & Kawagley, 2005; Usher, 2000). Although similarities are numerous between science and IQ, any researcher must be aware of the limitations of each body of knowledge. Both IQ and science are constructed in terms of their own cultural objectivity; as such each are value laden and authoritative in their respective cultural context (Poirier & Brooke, 2000). IQ, though accurate on a local scale, often does not apply to other areas of the Arctic where conditions differ. The compartmentalization of Inuit Knowledge in a typically scientific approach is a mistake commonly made by non-Inuit researchers (Stevenson, 1996). The problem is that the interrelated nature of IQ is such that isolating one small piece of information would be taking that information out of context as a part of a complex system (Nadasdy, 1999). Researchers must therefore be careful not to merely insert Inuit Knowledge into a scientific approach, but study it as an equal, complementary body of knowledge with its own rules and characteristics.

2.4 Inuit Knowledge of Sea Ice

Although many Inuit communities are no longer completely reliant on hunting for subsistence, Inuit people retain strong ties to sea ice travel and hunting as a part of their culture, identity, livelihood, and socio-economic well-being (Nickels et al., 2006; Riewe, 1991; Robards & Alessa, 2004). In order to travel and hunt safely on sea ice, Inuit have developed remarkable knowledge and understanding of sea ice, its properties, and its processes (Laidler & Elee, 2006; Nichols et al., 2004). This knowledge is passed on from elders to youth through observation, stories, rules, and warnings (Riewe, 1991). The ability to predict the safety of ice in a given area is critical to weighing the potential risks and benefits associated with traveling or hunting. Frequently the best hunting occurs near open water, where ice conditions are inherently dangerous (Ford et al., 2006; Laidler,

2006). Hunting on sea ice is a dangerous game of chance; excessive caution may result in an unsuccessful hunt, yet poor decisions may leave hunters stranded, result in loss of equipment, or even loss of life (George et al., 2004). Forecasting sea ice safety and minimization of risk requires knowledge of the many interrelated factors involved in sea ice formation and decay, movement, composition, thickness, density, and strength (Nichols et al., 2004). Riewe (1991) notes that knowledge of crystalline formation, temperature, salinity, wind, currents, and shoreline and seabed topography are necessary to navigate with some degree of safety on sea ice. Of equal importance is the ability to predict weather conditions, particularly wind, which plays a large role in determining the safety of sea ice travel. Changing wind strength and direction can cause whiteout conditions and ice breakup or movement (Ford et al., 2006; George et al., 2004; Jolly et al., 2002).

In Sanikiluaq, McDonald et al. (1997) identified five main phases of the yearly sea ice cycle that are considered significant by the local Inuit for determining local utility of the ice. A large number of Inuktitut terms associated with different types of ice at each phase were documented, clearly demonstrating the depth of understanding of sea ice by the local Inuit.

- 1) Early ice formation: from shoreline to points of land and peninsulas, in bays and inlets
- 2) Development of landfast ice
- 3) Development of floe-edge ice
- 4) Spring cracks
- 5) After break-up from spring to early summer

2.5 Climate Change and Inuit: Impacts and Adaptations

Inuit people live in an area of high natural variability in terms of weather, climate, and sea ice. The capacity to adapt to these conditions has become embedded within Inuit culture (Berkes & Jolly, 2001; Nickels et al., 2006). Adaptive capacity is enhanced by such factors as the in-depth knowledge and skills of the Inuit in relation to their environment, strong social networks of community sharing, and flexibility in the seasonal harvesting cycle (Ford et al., 2006). Ingenuity and inventiveness in Inuit culture have been necessities for survival in unpredictable Arctic conditions in the past and remain important adaptive skills today (Blakney & Suluk, 2006). Berkes and Jolly (2001) make a distinction between coping mechanisms and adaptive strategies in relation to climate change issues. Coping mechanisms are short-term emergency responses to threatening situations, such as a bad winter, and are usually at the level of the individual or the household. Adaptive strategies are ways in which entire communities or social groups change the way they do things, shift the type of activities they are involved in, or modify local rules and institutions owing to long-term change in the local environment. Coping mechanisms may develop into adaptive strategies over time if adverse environmental conditions are sustained.

In a rapidly changing climate where some scientists predict an ice-free late-summer Arctic in the latter part of this century (IPCC, 2007), Inuit people will be forced to adapt at a pace much faster than historical rates. Impacts of climate change will be felt in all aspects of Inuit life, but for the purpose of this research, discussion here will focus on impacts and adaptations specific to hunting and travel on sea ice. In general, Inuit hunters will have to adapt to longer summers and shorter winters, thinner ice, more snow,

more unpredictable weather, and changing wildlife distributions (Berkes & Jolly, 2001). Depending on the nature of the activity, changes in sea ice may have either positive or negative implications.

Diversity and flexibility in the annual harvesting cycle is one way that Inuit have adapted to adverse situations in the past. As a matter of necessity, hunters must master the skills for harvesting many different species of game and fish, during all seasons of the year (Ford et al., 2006). Therefore, the substitution of one species for another is possible if access to one species is limited by sea ice conditions or a change in numbers or distribution of that species. An example of this occurred in the Belcher Islands relatively recently, involving the disappearance of caribou from the Islands around 1870, as mentioned earlier in this chapter (McDonald-Fleming, 1992). At this time the local Inuit people were forced, essentially overnight, to switch from caribou as a source of food and clothing, to relying completely upon marine species for survival, a shift that resulted in the increased use of common eider skins and down to create winter clothing (Oakes, 1991). Without the adaptability to change practices so rapidly, continued habitation on the Belcher Islands may not have been possible. Flexibility in timing of hunts and hunting techniques ensures successful harvest under many different conditions (Berkes & Jolly, 2001; Nickels et al., 2006). For example, ringed seals may be harvested from the ice or from boats in open water. People can change the timing of spring and fall goose hunts if migration timing changes, spending this time char fishing instead. The availability of non-traditional store bought foods can also be seen as increasing the capacity of northern peoples to adapt to climate change and traditional food shortages (Berkes & Jolly, 2001).

Risks associated with travel on sea ice have increased and will continue to increase with climate change. These risks are a result of thinning ice and increasing unpredictability in both the ice and the weather (Laidler & Elee, 2006). Social changes are also increasing risk, as younger generations are spending more time in school, on computers, or watching television. Less time spent outside the community has caused the erosion of skills necessary for safe travel and hunting, such as navigation, igloo building, dressing appropriately, choosing supplies for trips, and identifying hazardous conditions, all of which are best learned by observation and first hand experience (Ford, 2005). Nickels et al. (2006) note that unpredictable conditions are in some cases causing elders to share less of their knowledge with younger generations for fear of giving inaccurate advice.

Numerous adaptive strategies are already being employed by Inuit across the Arctic to minimize these risks. Unpredictable weather requires that hunters carry more gear while on the land to enable them to survive in any conditions that they might encounter. In the community of Arctic Bay, hunters now carry small boats with them to avoid being stranded if ice should break free (Ford, 2005). Other strategies include avoiding travel during risky times of the year (e.g. spring break-up), being more vigilant when traveling on the ice, using technology such as global positioning systems (GPS), satellite phones, VHF radios, and consulting weather stations and satellite images to determine ice safety (Ford, 2005). Due to an increased number of hunters being stranded on sea ice in recent years, search and rescue operations have been more active than ever before, but concerns have been raised regarding the length of time required to mobilize rescue missions (Nickels et al., 2006). When ice conditions are dangerous, many hunters

do not travel as far afield, creating the potential for fish and wildlife populations to be over-pressured near communities (Nickels et al., 2006). Modes of transportation have changed in some areas as well. Instead of traveling over sea ice by snowmobile, it may be necessary to travel by all-terrain vehicle over land (Berkes & Jolly, 2001). Overland travel is possible in some areas of the Arctic, but is much rougher, slower, uses more gas, and is harder on people and equipment (Laidler & Elee, 2006; Nickels et al., 2006). For the Inuit people of the Arctic, adaptation to the rapidly changing environment is a process already underway. If changes continue to accelerate as many scientists predict, Inuit and scientists will likely need to combine their knowledge to understand and arrive at solutions to problems caused by climate change in Arctic regions.

Chapter Three: Methodology and Methods

3.1 The Nature of Qualitative Research

This project is based on the qualitative research paradigm and the ethnographic research design. Ongoing interaction with the people and communities involved in the research is necessary for the qualitative researcher to develop a true understanding of the people and issues in the study. To be truly successful, the researcher must try to feel the motives and emotions of the study subjects regarding the issue in question (Chadwick et al., 1984). Creswell (2003) describes qualitative research as taking place in the natural setting, meaning the home or town of the subject. This approach allows the researcher to develop a better understanding of the issues by sharing the experiences of the subjects. It is the objective of the qualitative researcher to describe reality from the perspective of the subject, not that of the researcher (Chadwick et al., 1984). Creswell (2003) emphasizes the emergent nature of qualitative research, as understanding of the subject matter evolves and unforeseeable developments often occur. For this reason, flexibility must be built into any qualitative research project.

The ethnographic research design builds upon the ethnographic research tradition that emerged from the field of anthropology (Creswell, 2003). The intent of the ethnographic research design is to obtain a holistic picture of the subject of study with an emphasis on portraying the everyday experiences of individuals. It includes in-depth interviews in conjunction with continual and ongoing participant observation. The ethnographic research design attempts to portray the whole picture and reveal how people describe and structure their world (Creswell, 2003).

3.2 Role of the Researcher

The collection and interpretation of qualitative research data is in part influenced by the personal values, biases, and assumptions of the researcher; therefore, it is important to identify these at the outset the study (Creswell, 2003).

I hold a four year Bachelor of Science Degree in Zoology from the University of Manitoba. My interest in zoology, wildlife, and nature primarily stems from my rural upbringing. Living in the Whiteshell Provincial Park in Manitoba, I have always been in close proximity to wildlife and the land. Wild and remote places are those in which I feel most at home. My family and I hunt, fish, and raise all of the meat we consume, and have done so since I was very young. In addition, my father and I are commercial trappers, operating Registered Trapline #2 in the Whiteshell Provincial Park.

My upbringing and education have shaped my personal values, one of which is a close connection to the land. The lifestyle of subsistence harvesting is one that I believe is truly important and will try to protect in the future. For this reason I can identify with the desire of the Inuit people to continue traditional harvesting activities in a changing environment.

At the outset of this project I had no prior experience with sea ice travel or with Inuit people, but I felt my skill set was such that this would not present a major obstacle. Previous experience on the land and freshwater ice, hunting, fishing, trapping, winter travel, and survival were major assets in helping me establish a relationship of trust and understanding with Inuit hunters, facilitating a meaningful exchange of knowledge. My past experiences have increased my understanding of the specific skills, knowledge, and adaptations that enable the Inuit to thrive in their environment; this experience also

allowed me to accompany hunters on the land without being too great a hindrance. I firmly believe that hunters and harvesters are the true experts in their local areas and possess a wealth of knowledge that has the potential to enhance scientific understanding. With respect to working with Inuit people, no prior experience may cause me to have fewer biases and therefore approached this new working relationship with an open mind. My fieldwork in Sanikiluaq has been filled with unanticipated challenges, surprises, and changes of plan, but I quickly learned that patience and flexibility are keys to success in northern research. I believe that my own background contributed positively to this research, as I have lived on the land but also have scientific training. My previous experiences will hopefully allow me to draw conclusions and frame my results in such a way as to be useful to both local people and the scientific community.

3.3 Bounding the Study

This research was conducted entirely in the community of Sanikiluaq, including on-ice travel with local hunters in and around the Belcher Islands. The actors in this study included the researcher, two local interpreters, Inuit hunters represented by the Sanikiluaq Hunters and Trappers Association, and elders within the community who participated in the study. Events in this study will be consistent with the ethnographic research design, including semi-directive interviews and continual, ongoing participant observation (Creswell, 2003).

3.4 Authorship, Intellectual Property, and Informed Consent

This thesis involves documentation and interpretation of Inuit Knowledge possessed by Inuit elders and hunters in Sanikiluaq. Prior to the commencement of the research, approval was obtained from the Sanikiluaq Hunters and Trappers Association,

the University of Manitoba Joint Faculty Research Ethics Board, and the Nunavut Research Institute (Appendix A). To some extent, ethnographic research on traditional knowledge in the form of interviews and participant observation is always intrusive, but the rights of the subjects can be protected if proper steps are taken (Creswell, 2003).

Throughout the project, it was ensured that all interviewees were fully informed of the purpose and objectives of the study, understood why they are being interviewed, and had given oral and signed consent (Appendix B) of their willingness to participate in the study. Informed oral consent was obtained from hunters who were willing to share their knowledge in an informal setting during hunting excursions; obtaining written consent in these circumstances would have been impractical. All information gathered and shared throughout the duration of this research will be considered the property of the individual knowledge-holder (Wenzel, 1999). As such, any further use of this knowledge will recognize and reference the owner using the APA referencing style. All knowledge gathered and used in this Master's Thesis has been verified by the individual knowledge holders to ensure that the knowledge is accurate and has not been misrepresented or taken out of context. Individual participants were returned their transcribed and edited interviews, encouraged to make any necessary changes or comments and then gave written approval via a signed interview review form.

Materials recorded on audiocassette are considered the property of the interviewee; such material will be acknowledged as edited by the researcher and authored by the participant. Any further use or replication of this material will be subject to the approval of the author. Upon completion of the project, audiocassettes will be returned to the community and stored at Nuiyak School, pending the consent of the interviewees.

Any data generated solely by the researcher, such as research logs and journals, will be considered to be authored by the researcher and thus the property of the researcher.

Interview participants were compensated for their time with a monetary gift of \$50.00 CDN per interview, following recommendations of the Sanikiluaq Hunters and Trappers Association (after Ellerby, 2001).

Dissemination of raw or edited data within the community will be at the discretion of the participants. Ownership and dissemination of the final thesis, as approved by the participants, will be the property of the researcher.

3.5 Data Collection Procedures

Data for this study was collected on three trips to Sanikiluaq. Fieldwork was planned to allow the observation of both mid-winter and spring conditions. The first fieldwork session was May 13-June 7, 2007; it was during this time that the majority of interviews were conducted, and several trips on the land were possible. A second visit to Sanikiluaq was made possible by an unrelated two-week contract that involved initiating fieldwork for a community-based monitoring program of marine forage fish in August 2007. Two additional interviews were conducted at this time, and transcripts of previous interviews were approved by and returned to the interviewees. The third and final visit was March 18-April 16, 2008, coinciding with the period of maximum sea ice extent. On this visit, one semi-directive interview was conducted; the primary focus was participant observation and discussions with hunters in an informal setting. Numerous trips were made on the sea ice accompanying seal hunters, eider duck hunters, fishermen, and mussel gatherers. An unexpected opportunity arose during this time that allowed me to volunteer for two days in an aerial eider duck survey encompassing the entire Belcher

Islands and surrounding area. During these flights I was able to make observations of polynyas and sea ice conditions. This experience greatly enhanced my understanding of sea ice characteristics in the region. In total 70 days were spent in the community, which was advantageous for developing an in-depth understanding of the uses of sea ice by the community and the changes that are occurring. Developing meaningful relationships and trust with local people further lends credibility to the research (Creswell, 2003).

At my request, the Sanikiluaq Hunters and Trappers Association graciously provided a list of locally recognized experts as potential interview participants, in a purposeful sampling strategy (after Laidler & Iqummak, 2008; Mallory et al., 2006; Tremblay et al., 2006). These people were then approached with the assistance of an interpreter and asked if they would be willing to participate in the project. A total of 18 individuals were interviewed for the project. Consenting individuals were interviewed in their homes, and interviews were conducted in Inuktitut in all but five instances. Interviews were between one and two hours in length and followed a semi-directive format. A 1:250,000 scale map of the Belcher Islands was provided during each interview to stimulate conversation, record information, and allow interviewees to elaborate on the discussion through the use of illustrations (after Gagnon & Berteaux, 2006; Mallory et al., 2006; Usher, 2000).

Semi-directive interviews, in which the conversation is guided by the researcher but led by the interviewee, have proven to be an effective way to conduct traditional knowledge research (Huntington, 1998; Nakashima & Murray, 1988). Laidler and Elee (2006) used this method with success to research Inuit observations of sea ice conditions in Cape Dorset, NU. The interview format allows the direction and scope of the

discussion to follow the interests, expertise, and experiences of the individual knowledge holder (Nakashima & Murray, 1988). I entered each interview with a list of topics to be discussed, beginning with broad questions and then focusing in on specific areas of expertise that emerged from the discussion. If the interviewee was not comfortable or familiar with a particular subject, they were not pressed, but encouraged to elaborate on the topics they were most familiar with. Group interviews or workshops have been employed by some researchers; these have the advantage of facilitating more thorough discussion of an issue by allowing individuals to prompt each other to remember specific events, possibly reaching a consensus on the topic, and providing support for individuals not comfortable in the presence of the interviewer (Huntington, 1998). However, a possible disadvantage of group interviews is that participants can feel pressured to agree and vote with the majority, or the interview might be controlled by a small number of dominant individuals (List, 2001). In this project all interviews were done individually in a comfortable and relaxed setting, the home of the participant.

Participant observation was conducted during travel with Inuit hunters on regular hunting excursions and constitutes a second and equally important means of data collection for this project. These outings provided the opportunity to observe and discuss specific situations and ice conditions with the hunters being accompanied and other hunters who were encountered on the ice. During these trips I was able to learn firsthand and better understand the sea ice environment as well as the information gathered during interviews. Participant observation as a research tool is ideal for gathering information on phenomena or processes that are observable within everyday situations and are grounded in the realities of daily existence (Jorgensen, 1989). Jolly et al. (2002) state that

participant observation is very important in community-based research for strengthening relationships with local people and for developing a deeper understanding of climate change issues, particularly how these issues are perceived in the context of the Inuit way of life. I agree with Jolly et al. (2002) in that the more time I spent with hunters getting to know them, sharing country food, drinking tea, traveling, hunting and laughing with them, the easier discussion became, not only with the people I was traveling with but with others that we regularly encountered. In Sanikiluaq, the area of huntable floe edge is often relatively small; hunting is therefore a social activity involving numerous stops for tea with other hunters, short visits with hunters who are encountered, and travel to and from the floe edge in groups. Research out on the ice became easier as this small group of hunters got to know, trust, and respect me. Gearheard et al. (2006) used this technique with great success when studying sea ice changes in Barrow, Alaska, and Clyde River, NU. They note that the study would have overlooked certain key points had the researchers not been able to share firsthand experiences with hunters on the ice. This is in part due to the fact that many subtleties about sea ice and its use by Inuit are difficult to explain verbally in an interview setting. Confidence in the results of the study can be greatly increased by ground-truthing ideas on the land through the use of participant observation (Wenzel, 1999).

Semi-directive interviews and participant observation were the ideal complement as data collection procedures. By conducting the majority of interviews on my first trip and primarily participant observation on a subsequent trip, I had a much better idea of what questions to ask, what things to look for, and what areas additional explanation was needed during my travels on the sea ice. Interviews provided me with the opportunity to

meet many of the hunters and elders and to get to know them. A pre-existing relationship gave me a head start during my second visit when trying to find hunters willing to have me accompany them on hunting excursions. The interview process also gave me a basic knowledge of local place names, something that I found to be an important aspect of participant observation research. Discussions on the land always made use of local place names and having no prior knowledge of these would have been a great disadvantage. I soon learned that some of the ideas and impressions I had formed during interviews differed significantly from the reality of the situation, causing me to concur with Gearheard et al. (2006) in saying that considerable inaccuracy and misunderstanding would occur if research of this type failed to include participant observation.

3.6 Data Recording

Observational data, such as data recorded during travels with the hunters (e.g. time, location, setting, dialogue, specific ice conditions, and particular events or activities) were recorded in the form of daily journal entries (Jorgensen, 1989). These entries also included reflective notes such as speculations, ideas, and perceptions (Creswell, 2003). Photographs of the setting, ice conditions, activity, and participants (with their permission) were taken to create a truly detailed account and provide a means for me to visually and mentally return to the moment during analysis of the results. Most middle-aged hunters spoke sufficient English to make an interpreter unnecessary on these trips.

All interviews were tape recorded, and hand written notes were taken to accompany the tape recordings. During the process of informed consent, participants were given the option to decline a tape recorder; however, none did. A local interpreter

was present during all interviews with people who spoke limited English, providing sentence-by-sentence English translation. I later transcribed tape recorded data verbatim (Wengraf, 2001), recording the interviewee's name, interpreter's name, key interview questions, responses to the questions, and my own ideas and impressions, which were included in brackets. Wengraf (2001) stresses the importance of recording ideas and impressions during the transcription process, as important ideas and memories frequently occur when interviews are heard for a second time.

3.7 Data Analysis

As stated by Creswell (2003), qualitative data analysis does not stand apart from data collection or other research activities. It is instead an ongoing process of reflection on the data in order to move toward deeper understanding. In addition to this, six major steps were followed in the process of data analysis.

- 1) Data, once typed and transcribed, was organized and sorted into groups of related information (after O'Connor & Gibson, 2003).
- 2) Data was read thoroughly to develop a general sense of what the data meant or the over-arching theme of the data. Further ideas and impressions of the researcher were recorded at this stage (after O'Connor & Gibson, 2003).
- 3) Data was then broken into specific subject areas that could be encompassed by a simple term. This involved fragmentation of sentences or paragraphs to isolate a specific thought or point (after Creswell, 2003).
- 4) The organized data was used to create a description of particular events and settings, and then divided into several sub-themes. Each sub-theme includes a description of the topic in my own words, and the perspectives of multiple

interviewees. Interconnections between themes were later described, creating a holistic description addressing the overall research question (after Chadwick et al., 1984; Creswell, 2003).

- 5) Description and themes are presented in the form of a qualitative narrative, with a diagram to summarize findings in each theme (after McDonald et al., 1997; Nickels et al., 2006).
- 6) A summary was written of the lessons learned in the course of the research. This includes my personal interpretation based on the knowledge and experiences I bring to the study, a description of how this research confirms or diverges from other similar studies, and further questions the research raises (Creswell, 2003).

Fox (2002) notes that Inuit often prefer to communicate knowledge on topics such as environmental change in the form of stories. These stories give more information about subtle linkages between people and the environment than a general statement. Inuit stories and observations can be drawn together to create generalized statements regarding climate change, but this can only be achieved through careful study of all the individual accounts. Nickels et al. (2006) discuss how the interrelated nature of Inuit observations can make distinguishing between observations and impacts very difficult for researchers, as numerous changes are often linked. This is due in part to the in-depth knowledge of Inuit about the relationships between key environmental variables (Nichols et al., 2004).

3.8 Validating the Findings

To ensure accuracy in the research findings, the commonly used techniques of triangulation and member-checking were used. Additionally, information that counters

the themes of the project is included in the results section of the thesis to produce an unbiased account.

Triangulation involves using several sources of information to describe a single phenomenon, process, or situation (Creswell, 2003). This meant comparing statements by several interviewees regarding a single topic and comparing interview data with information obtained through participant observation on the land. In either case, convergent data will be viewed as an indication of accuracy. However, there is significant spatial variation in sea ice conditions, so personal preference in hunting areas and travel routes can result in hunters answering the same question differently. Neither hunter is necessarily incorrect; there are merely differences in their personal experiences. For this reason differing perspectives will be presented instead of being considered mutually exclusive.

The research design made it possible to triangulate data collected during interviews with data collected during participant observation; this increased my confidence in both the accuracy and validity of the information being collected.

Member-checking involved taking a draft of the transcribed interviews back to the individual knowledge holders to determine whether or not they felt the interpretation of their knowledge was done accurately and making any necessary changes or additions (Creswell, 2003; Thorpe et al., 2002). Member-checking is especially important in Inuit Knowledge research for both verification and ethical reasons, as IQ is often location and context specific, and therefore is subject to misinterpretation by researchers (Huntington, 2000). As the owners of the knowledge, each interviewee has the right to ensure that their

knowledge is being represented accurately and that the true meaning has been preserved (Huntington, 1998).

3.9 Reporting the Findings

Qualitative research findings are most effectively reported in the form of narrative text, allowing the reader to understand the issues from the perspective of the research participants (Creswell, 2003). In the context of this project, detailed description appeared to be the best means of communicating a holistic picture of sea ice changes in the Sanikiluaq area and the effects on Inuit hunters. Diagrams are used to summarize the specific themes that emerge.

The community will receive several copies of the thesis, posters summarizing the project, and an oral/visual presentation by the researcher. It is one of the goals of this project to facilitate communication of knowledge on sea ice changes from the older generation to the youth, so a poster will be presented to Sanikiluaq's Nuiyak School. Furthermore, a community book is currently being compiled using much of the same information presented in this thesis. The book will include additional photographs and quotations from local residents; this will be a more appropriate and effective means of presenting the research findings to the community than an academic thesis.

The findings of this research will be published in the primary literature, as this project will be relevant to numerous qualitative methods, indigenous, and Arctic research journals.

Chapter Four: Inuit Knowledge of Sea Ice Change in the Belcher Islands

At the outset of this project, it was immediately apparent that the Inuit of Sanikiluaq possess an enormous amount of knowledge on the local sea ice environment. This knowledge is relied upon heavily on a routine basis, allowing hunters to be safe and successful during hunting excursions. It would be impossible to fully communicate the breadth and depth of knowledge that was shared by community experts over the course of this project, but this chapter represents my attempt to convey an overview of this information to the reader. Interview participants and hunters whom I met on the ice were eager to share their knowledge and observations with me, a privilege for which I am very grateful.

Some of the following information will be presented in my own words as a synthesis of what I learned during my visits to Sanikiluaq. Information was gathered while conducting interviews, during participant observation, and during casual conversations with local people. As such, any errors in interpretation, fact, or other aspect of the presented information are entirely my own. Complementing my interpretations will be the voices of local experts, presented as indented paragraphs, which are excerpts taken from the semi-directive interviews.

Although the expertise of the participants covered a broad range of topics, the focus of the interview discussions was sea ice change, and this is what I will present in this chapter. For ease of understanding I have divided the results into three sections reflecting three general stages of the annual sea ice regime under which I feel the majority of discussion topics can logically be placed. These sections are 1) freeze-up, 2) winter, and 3) spring.

It is important to note that no definite boundary exists between the three sections. In reality, the changes and observations discussed in each are highly interconnected and part of a continuous cycle; I have only separated them here to allow the reader to better understand the situation.

Table 1 lists the names of the interview participants and whether they are active hunters or elders. The majority of these interviews, save five, were conducted in Inuktitut with the help of an interpreter. Some of these participants spoke English, but felt that they would be better able to communicate their knowledge in detail if they responded in Inuktitut. Caroline Meeko and Dinah Kavik provided interpreting services for the interviews.

Table 1. Sanikiluaq residents who participated in the semi-directive interviews.

Participant Name	Occupation
Apawkak, Daniel	Hunter
Arragutaina, Joe	Elder
Arragutaina, Lucassie	SHTA* President
Ekidlak, Paulossie	Elder
Eyaituk, Davidee	Elder
Ippak, Allie	Elder
Ippak, Johnassie	Hunter
Ippak, Louisa	Elder
Iqaluk, Johnassie	Elder
Kattuk, Peter	Hunter
Kittosuk, Sarah Sr.	Elder
Kudluarok, Johnny	Hunter
Meeko, Johnny Sr.	Elder
Meeko, Samson Sr.	Elder
Oqaituk, Elijah	Hunter
Takatak, Emily	Elder
Takatak, Lucassie	Hunter
Tookalook, Johnny	Elder

*Sanikiluaq Hunters and Trappers Association

4.1 Individuality of Inuit Knowledge

As discussed earlier in this thesis, Inuit Knowledge, or Inuit Qaujimaningit (IQ), is a synthesis of individual experience, first-hand observation, acute awareness of the dynamic relationships between Inuit and the environment, and cultural practices and beliefs (Berkes et al., 2000; Huntington, 2000; Pierotti & Wildcat, 2000; Stevenson, 1996). As IQ is passed on from one generation to the next through songs, stories, myths, and lessons, each generation and each individual contributes according to his or her own experiences and observations, thus adding to a dynamic and evolving body of knowledge (Huntington, 1999; Nichols et al., 2004).

By this definition, the knowledge held by an individual may cover a range of topics in varying degrees of depth. Similar to western scientific knowledge, repeated observations and discussion of a phenomenon can lead to the general acceptance of that topic as fact. Knowledge of these facts is held by individuals and also shared by the community; therefore, depending on the topic many people may give similar answers to the same interview question. For example, a person may have in-depth, precise knowledge of ocean currents in an area of the Belcher Islands where they frequently hunt or camp. This knowledge is unlikely to be shared in such detail by anyone else in the community. Conversely, an individual may possess much general historical knowledge, such as local legends passed on by parents, grandparents, and great-grandparents. I found that many people shared this type of knowledge to a great extent, and I will call this general IQ; however, differences arose between the knowledge of individuals when discussion focused on the details of specific locations or processes.

Study participants seemed to be honest regarding specific knowledge of a place or some other feature of the environment. If asked a question they did not know the answer

to, or were not completely sure, they would readily say so. In an environment where relying on false information could have serious life-or-death consequences, people who share their knowledge are very careful not to overstep the bounds of what they personally know to be true.

Different individuals hold different expertise based on where they or their ancestors have personally lived and traveled and what activities they partake in. Discussions on polynyas illustrated this perfectly. Most hunters do not hunt all of the polynyas in the Belcher archipelago over the course of a winter; rather, they will visit a small number of their favorite polynyas repeatedly. People can and will readily answer questions on the polynyas they are familiar with, but will not comment in detail on others. Some hunters prefer to focus their efforts at the north end of the islands, while others prefer to hunt in the south; in either case, hunters would only give detailed information about the areas they were most familiar with.

Knowledge differences also arose based on gender and the extent to which men and women participate in different activities. For example, women tended to be very knowledgeable about predicting weather, spring camping, ice fishing through cracks near the shore, and the condition of animals. On the other hand, men were more likely to be knowledgeable about sea ice, polynyas, the floe edge, and hunting activities. These differences reflect the relative roles of men and women in Inuit society. To properly study Inuit Knowledge of changes to the sea ice environment it is important to include the expertise of both men and women, thereby ensuring that input is given by the true experts on a given topic.

Age influences the type and detail of knowledge held by an individual. Middle-aged participants tended to be active hunters who could give the most detailed and recent information on sea ice conditions and changes over approximately the last decade. Elders by comparison were more likely to discuss broad changes that have occurred in the environment or the community over their lifetime. Keith et al. (2005:v) point out that elders possess the “greatest breadth of inherited knowledge and the longest time spent assimilating new experiences using their IQ framework”. Elders spoke more of their ancestors and were able to put the current changes into historical context. However, many elders still travel on the land and are active within the community, keeping up to date with current conditions through both direct observations and discussions with active hunters.

4.2 Changes Occurring During Freeze-up

This section encompasses changes that are occurring from the beginning of the freeze-up to the time when the sea ice is safe enough to use for travel and hunting purposes. Generally, this is the period from October through to the end of December. Starting with fall weather, changes occurring throughout the development of sea ice are discussed, including timing of the freeze-up, crossing to the old Hudson Bay Post site, weaker ice, and the formation of several specific types of ice: *irmanisait*, *qaanittaq*, *aputainnaq*, *maaniituit*, *maaniituk*, and *maaniikala*. Freeze-up is an important topic when discussing sea ice because the ice conditions at this time of the year will influence ice characteristics throughout the winter and into the spring.

4.2.1 Fall Weather

To explore changes occurring to sea ice during the freeze-up period, it is logical to start with changes in fall weather, as weather plays a primary role in the formation of sea ice. In general, residents of the Belcher Islands feel that fall weather is much warmer than it used to be, likening it to mild spring weather rather than to cold, windy weather typical of the region in the past. Numerous interviewees noted that the freeze-up period is less windy than in the past and is accompanied by less snowfall. Snow, cold weather, and wind combine to cool the surface of the water and facilitate freeze-up; the absence of one or more of these factors will influence the timing and dynamics of ice formation.

“Fall would be cold and windy with the first snow happening in September. Until the ice formed, the weather would be fall. Fall on and on. There would be little breaks here and there, but they wouldn’t last. This would continue until the ice formed. And a lot of snow fell. There seemed to be snow clouds that came in and it really, really snowed. But nowadays in the fall, it is almost like spring weather, while the ice is trying to form. The ice forms without the weather really getting cold. In the fall because it was so windy, the ice would form on the rocks and it would be really high. It would keep piling on because the waves were so big. The ice would just be forming on the beach, on the rocks” (Samson Meeko Sr.) (in translation).

“In the fall, there used to be snowfalls usually. Nowadays the snowfalls don’t come. Long ago when the snowfalls used to really activate the land and the sea and make it freeze fast. Nowadays because there is no snow in the fall the ice does not form as well as it used to. It takes a whole lot longer now for the sea ice to form because there is no snow in the fall. The snow in the fall used to work together to form the ice. Now that it is not there it takes a whole lot longer to form sea ice” (Johnny Meeko Sr.) (in translation).

Mild fall weather is frequently resulting in numerous freeze-thaw cycles during the freeze-up period, disrupting normal sea ice formation. This is a new phenomenon to residents of the islands.

“In fall, even when the ice starts to form, it dissolves. Even when it looks like it is going to stick, to be solid, it melts away. That didn’t used to happen. In December, nowadays the climate is warm. Before it used to be very, very cold. It used to be freezing cold. Anything that was freezable used to freeze solid” (Sarah Kittosuk Sr.) (in translation).

“Before, freezing would start in October. It doesn’t make any sense anymore. Today it will freeze up, then melt again, then freeze up. The weather doesn’t make any sense anymore” (Davidee Eyaituk) (in translation).

4.2.2 Timing of the Freeze-up

The pattern of freezing has not changed significantly in the Belcher Islands. Some areas freeze before others and this has always been the case. For example, Coats Bay (Figure 1), to the west of the community is one of the first areas to freeze, and the entrance always freezes before the back of the bay. What has changed is the timing of freeze-up. Sea ice frequently remains too thin for travel into late December and sometimes January. This is approximately one month later than what was considered common as little as thirty years ago.

“It takes longer to form ice, and this is creating more dangers than before. There are times, just before Christmas comes, when you start to wonder if it is going to freeze at all” (Louisa Ippak) (in translation).

“We get late ice in the fall” (Elijah Oqaituk).

“It was solid by December. Solid. It used to be very rare that the ice didn’t completely freeze in December, but most of the time it was safe to travel and the ice was solid enough to hold everything” (Sarah Kittosuk Sr.) (in translation).

4.2.3 Crossing to the Trading Post

The annual trip to the Hudson Bay Post on Tukarak Island (Figure 1) was noteworthy for Belcher Island Inuit during the period that the post was in operation (ca. 1928-1950). Elders recall families crossing Omarolluk Sound (Figure 1) from Ulutsatuuk

to the Hudson Bay Post before Christmas in order to trade for Christmas gifts. Hudson Bay Company journals from the Belcher Island Post provide a unique situation in which two independent sources can confirm exactly how much freeze-up timing has changed over the last 100 years. Journal entries closely match the stories told by the interview participants, confirming the accuracy of both sources. In recent years, Omarolluk Sound remains unsafe until after Christmas.

“We used to travel for Christmas to the old post here [Tukarak Island]. Dog teams would travel on sea ice to get to the trading post to spend their Christmas. We’d travel through land, in some parts there was enough snow to travel on, and we would go to Ulutsatuuk if the ice was still dangerous to travel on, but as soon as it got safe to travel on we’d cross over to the trading post” (Johnny Tookalook) (in translation).

“The freeze up would start in late September, and by October you could sometimes cross over to the trading post. But for sure you could cross any area of ice, whether it was freshwater or saltwater, in November. Now November can come and go, and the sea ice and freshwater lake ice is still dangerous to travel on” (Johnassie Iqaluk) (in translation).

“The bays around the post are freezing over, winter is now definitely established” (HBC Records, Belcher Post, Nov. 25, 1938).

“Peter Sala, with his dog team came in this morning” (HBC Records, Belcher Post, Dec. 12, 1938).

4.2.4 Weaker Ice

Changes have occurred in the characteristics of ice that forms in fall. For example, ice that forms overnight remains too weak for people to walk on. According to Inuit Quajimaningit in Sanikiluaq this is very unusual; ice that freezes overnight should be, and always has been, safe to walk on the next day. Even when the ice was so thin that a person walking would create waves or ripples in the ice, it would not break.

“When it froze overnight then we knew it was safe to travel on”
(Johnny Tookalook) (in translation).

“There were times I remember when I was just starting to go out on hunting trips, when we would travel by dogteam on ice that was water yesterday, because it was safe enough. I haven’t done that many times, but I do remember going on ice that was water the day before. Now you can’t do that. Because when the ice was forming then it would be really, really cold” (Samson Meeko Sr.) (in translation).

“Before, we used to walk on top of the ice even when it was wavy. I never used to be scared of it because I knew it would hold me. Even if you would make waves when you walked on it, you wouldn’t fall through” (Emily Takatak) (in translation).

4.2.5 *Irmanisait, Qaanittaq, and Aputainnaq*

It was mentioned previously that fewer snowfalls occur during the fall; however, due to the slow freeze-up, snow frequently falls on very thin ice or ice that is in the process of forming. Snow insulates the thin ice, causing it to remain very dangerous even though it may appear safe on the surface, and in some cases actually causing the ice to erode from underneath (Laidler & Elee, 2008; Laidler & Iqummak, 2008). In other cases, blowing snow covers open cracks before they have a chance to freeze. These places, known locally as *irmanisait*, are occurring because open water seems to be taking longer to freeze.

“I think that when it is starting to freeze, drifted snow is covering the thin ice. When it gets cold it stays the same, and it is the same color. With the warmer weather, it doesn’t freeze right away, so that is why it looked safe but it was thin” (Peter Kattuk).

“You get lots of places where the water is covered by blowing snow. That happens quite a bit now” (Johnassie Ippak) (in translation).

“One of the changes is that when the sea and the currents make rough ice, sometimes the rough ice makes open water. That open water should freeze right away, but it doesn’t do that anymore because of the freshwater making the water less salty. It doesn’t freeze, it only forms very thin ice, which gets covered by snow so it doesn’t indicate

whether it is solid. We will try to go around it and find ourselves in danger because it is too thin” (Johnny Meeko Sr.) (in translation).

“These are cracks where you get into accidents thinking that they are solid. Peter Alugiak, he fell through the ice recently because of what you mentioned, *apputainaq*. There was a crack during the night and it formed snow on top and he fell through, thinking it was the same as yesterday, but because it was a crack you don’t notice it because snow has piled over the crack already” (Lucassie Takatak) (in translation).

Joe Arragutaina mentioned that under the right conditions, a layer of drifted snow on top of the ice might actually make ice stronger; this layer is called *qaanittaq*. However, this never seems to be the case anymore, and *qaanittaq* is merely hiding dangerous thin ice underneath.

“Adding this to the ice should be strengthening it, but it is not strengthening it anymore, it is making it more into a danger area” (Joe Arragutaina) (in translation).

Snow that falls while ice is forming can result in the formation of weak ice, composed of frozen slush. Locally this ice is known as *aputainna* or *aputainnaq*, which means “snow-ice”, or “snow covering the top” when translated into English. *Aputainnaq* is not only weaker than ice of a similar thickness formed in the absence of snow, but melts rapidly and becomes dangerous early in the spring. Many people mention an increase in the amount of *aputainnaq* they are encountering, which is contributing to the formation of new and hidden dangers in traditionally safe areas.

“The fall freeze up ice affects the condition of the ice in the springtime. This winter the ice didn’t freeze up, open areas especially had trouble freezing over. Then snow fell, and that was the kind of ice that formed, snow-ice; it turns dangerous without looking like it is dangerous” (Johnny Tookalook) (in translation).

“Aputainnaq means snow covering the top. It sometimes causes the men to fall though because they think it is solid” (Emily Takatak) (in translation).

“I have noticed that there seems to be more snow-ice than there used to be, making for more dangerous areas. Because it is not ice-ice, it is snow-ice” (Davidee Eyaituk) (in translation).

4.2.6 *Maaniituit, Maaniituk, and Maaniikala*

An increase in the prevalence of rough ice has resulted from changes occurring during the freeze-up period. Rough ice, called *maaniituit* when it is seen at a distance or *maaniituk* when the observer is close to it, is caused by wind and current action forcing ice against a body of land or against the floe edge, causing the ice to shatter and be uplifted into piles which then re-freeze at odd angles (Laidler & Iqummak, 2008) (Figure 2). If the colliding ice is relatively thick, large piles of ice exceeding 5 m in height may form. The broken ice eventually becomes a part of the *tuvaq* (landfast ice) surface, remaining rough throughout the winter. *Maaniikala* forms by the same processes, but the pieces of ice forming it are much thinner than the thick slabs and blocks comprising *maaniituit*, therefore *maaniikala* that is usually not more than 30 cm in height. *Maaniituit* and *maaniikala* are not new phenomena, particularly in parts of the islands where strong currents exist or in areas exposed to prevailing winds. The floe edge to the west of Sanikiluaq, for example, is never hunted because the ice is too rough to access the area.

“This area [east of Uvilurluk and Nuasurnait] is rough, but not as rough as other parts of the islands. That could be due to the fact that these islands [to the northeast] protect it from the wind” (Davidee Eyaituk) (in translation).

“In the south there used to be a lot of rough ice because there is more current in those areas. Here there is less current so there is less rough ice” (Johnny Meeko Sr.) (in translation).

Figure 2. *Maaniituk* blocking access to the floe edge north of Sanikiluaq, March 2008. Note the dark cloud, which indicates the presence of open water.



Some study participants say that *maaniituit* is more widespread now because freeze-up is occurring more slowly; therefore, ice remains thin for a longer period of time. This means there is a larger window of opportunity for winds and currents to break up the thin ice, which then re-freezes to form *maaniituit* (Laidler & Iqummak, 2008). Rough ice seems to be forming in larger amounts, and is especially prevalent along west, northwest, or north facing shorelines and floe edges, reflecting the prevailing wind directions (Laidler & Iqummak, 2008) (Figure 3).

“The ice is rougher in the wintertime, due to the fact that it doesn’t freeze over as soon as it used to. The ice breaks up when the winds come, and then we have rougher ice” (Allie Ippak) (in translation).

“Because the ice doesn’t freeze as fast as it used to, roughness is forming on the surface of the ice. You see a lot more rough areas” (Louisa Ippak) (in translation).

“The sea ice is much rougher now because it doesn’t freeze over as fast. The ice keeps breaking up then coming together. The first freeze over gets broken up” (Johnny Tookalook) (in translation).

Not everyone agrees that rough ice has become more common. Since each individual usually has his or her own favorite hunting areas, it is likely that in more sheltered or slower current areas ice conditions have remained relatively unchanged in regards to roughness, possibly explaining this difference in opinion. Most people who say that ice remains smooth or has gotten smoother cite slower currents as the reason.

“The ice has been a lot smoother. For the past three or four years now the ice has been smooth because it has been mild, then got cold really fast. The ice froze and it was nice and flat. The only places [where it is rough] are where the currents are” (Johnny Kudluarok).

“It was more rough before, but now it is more smooth. It still bumpy, but not as bumpy as before” (Davidee Eyaituk) (in translation).

“The currents don’t run like they used to. Around the open area up there [the floe edge to the north] the ice would turn up and break up and there would be a big pile of ice broken up on top of each other, by the currents. That doesn’t happen anymore” (Johnassie Iqaluk) (in translation).

Lucassie Takatak explains that since ice is much thinner now, it forms *maaniituit*, but the piles of ice that form are not nearly as high as they would have been in the past, when the ice was not crushed into small pieces so easily, but remained in larger chunks.

“The floe edge, that is what it is supposed to consist of, just piles and piles of that rough ice. That tells me that the ice is very thick there, that surrounding it the ice is very thick and stable, but there are only small parts of that rough piled up ice, and all around it the ice is not as rough as it used to be” (Lucassie Takatak) (in translation).

Figure 3. Tidal currents push thin ice against the floe edge to create piles of *maaniituk*.



4.3 Changes Occurring During Winter

This section will include a discussion of changes in sea ice during the period when sea ice is used extensively for hunting such species as ringed seals, polar bears, and eider ducks. For the purpose of this chapter, winter will be defined as beginning in January and lasting until late April when the weather begins to warm. The changes that will be discussed here are largely a carry-over from, or are heavily influenced by, fall conditions, including thin ice, the ice bridge to Nunavik, salinity, the floe edge, and polynyas.

4.3.1 Thin Ice

The topic of thin ice, which clearly carries over from the previous section on freeze-up, remains a concern for hunters throughout the winter season. It follows that a late freeze-up will contribute to thinner ice during the winter. The majority of hunters and elders in Sanikiluaq agree that during winter, landfast ice is much thinner than it was in the past, an observation consistent with findings of other Inuit Knowledge research

throughout the Canadian Arctic (Keith et al., 2005; Nickels et al., 2006; Nichols et al., 2004). Milder-than-normal winter temperatures were reported by many participants as being associated with ice thickness over the course of the winter. Participants of Nichols et al. (2004) stated that over the course of the year, the most noticeable increase in temperature in Sachs Harbour has also occurred during the winter months.

“I know that the ice is not as thick as it used to be, but I haven’t done any major winter hunting since 1994. I was already noticing that the ice didn’t get as thick, even then, but I have heard it is worse now” (Allie Ippak) (in translation).

“The ice is thinner now. I think it is because of the temperature; it is not as cold as it used to be. The ice used to get very thick but now it is not as thick. I think it is because of the late freeze-up and warmer weather” (Peter Kattuk).

Kataapik, a popular mussel gathering and picnic destination near the community (Figure 4), is used as a common reference point for ice thickness. Kataapik is a narrow channel at the northwest corner of Eskimo Harbour (Figure 1), which remains open as a polynya during early winter and early spring due to tidal currents, but freezes over in mid-winter. Several local families camped frequently at Kataapik prior to the formation of Sanikiluaq in 1970; therefore, there is a large amount of local knowledge on this location from both past and present. There tends to be much spatial variability in sea ice conditions, so it is convenient to use a single location such as Kataapik to compare changes over time, similar to the Hudson Bay Post example used in the previous section. Hunters Johnny Takatak and Johnassie Inuktaluk both recall using ice bars to chip holes for mussel gathering when they were teenagers. At that time the person chipping the hole would stand inside the hole and ice would be taller than their head. In early April 2008, ice at Kataapik was less than 1 m thick. A cod fishing trip in March 2008 to the small bay

near Kataapik revealed that ice was less than 1m thick in an area with little current, remarkably thin compared to past conditions.

“The ice in mid-winter when we went mussel gathering [at Kataapik] was much thicker than what I hear it is now” (Allie Ippak) (in translation).

“I was hearing stories that the ice auger did not even need the addition [approx. 1 m]. At Kataapik, where there is a current the ice used to be as tall as my eyes [approx. 1.75 m]. Now it barely passes your leg. At the thickest point this winter, where people would go mussel gathering it only passed a hunters knee” (Samson Meeko Sr.) (in translation).

Figure 4. Elder Johnny Tookalook scoops mussels from the sea bed at Kataapik, March 2008.



Seal breathing holes provide another common reference point for ice thickness.

Breathing holes are closely monitored by hunters throughout the winter, so changes over time are readily noticed.

“The breathing holes of the seals used to be very solid, and very deep. The ice used to be very thick. Nowadays it is very thin at the breathing holes of the seals” (Emily Takatak) (in translation).

“In the wintertime when you peeked down a breathing hole, the breathing hole would seem like a chimney because the ice was so thick. This was especially true for ice that was not in a current area. It used to get really thick, but the current areas would be a little thinner” (Samson Meeko Sr.) (in translation).

“About 4 or 5 feet [was the thickness of a breathing hole], and that was near the shoreline. Nowadays I hear it is not as thick as it used to be, because the water is not as cold as it used to be” (Johnny Meeko Sr.) (in translation).

Although freeze-up is occurring later each year, many people feel that the decrease in ice thickness is more than can be explained by a shorter winter season alone. Numerous people mention that even when the weather gets cold, the ice doesn’t get as thick as Inuit Knowledge predicts that it should. Participants put forth many explanations for thin ice conditions including changes in salinity, water temperature, and current speed.

“I used to observe the weather and know when it would get really, really cold. That caused the thickness of the ice to be steady. Nowadays even when it does get really cold in wintertime, the ice stays very thin” (Paulossie Ekidlak) (in translation).

“From what I hear today, even when it is cold outside, the ice stays very thin” (Emily Takatak) (in translation).

“Even in the winter when it gets cold, the sea ice doesn’t get as thick as it used to” (Johnassie Iqaluk) (in translation).

There continues to be large variability in climatic conditions in the Belcher Islands; there are warm winters and cold winters, years with thicker ice and years with thinner ice. Hunter Johnny Kudluarok describes variability in sea ice thickness that he has witnessed.

“Last year it was pretty thin; this year it is a lot thicker” (Johnny Kudluarok).

“Last year at this time of the year the ice was about 1 foot thick. This year breathing holes are about two feet thick. It has been staying cold, since you got here right, but the ice is going fast right now, because of the weather” (Johnny Kudluarok).

4.3.2 Ice Bridge to the Mainland

A third reference point among residents of Sanikiluaq for sea ice change is the sea ice bridge that historically formed between the Belcher Islands and the eastern coast of Hudson Bay (McDonald et al., 1997; Nakashima & Murray, 1988). In the past, Sanikiluaq residents commonly traveled across this bridge to the Nunavik communities of Kuujjuarapik, Umiujaq, and Inukjuak during late winter. In recent years, the ice has not been solid enough to allow travel across the ice bridge, or when solid ice has formed, it was much later in the winter and only for a very short period.

“We used to get really cold north winds and this would make the bridge to the mainland. Over the past few years, this only happens once in a while. Last year you couldn’t, this year I heard maybe you could go to Umiujak, but nobody went. I used to cross all the time when I was young. Every winter I used to cross. These days no, it doesn’t freeze anymore. It looks like it does, but it is not thick enough so it is always moving now. We used to get these really cold winters and every year it used to freeze when I was young. People would go over to the mainland and do some shopping once a year” (Daniel Apawkak).

“We crossed over to the mainland around Easter because hunters knew that is when the ice is most stable” (Davidee Eyaituk) (in translation).

“Only around the inlets and bays in the islands does the ice seem to freeze completely. But in the open Hudson Bay, the ice doesn’t freeze anymore. Back when we were still using dog teams as our transportation, we used to be able to travel to the mainland at Great Whale River, Kuujjuarapik. Even up to Inukjuak, further north from here. The ice conditions during those years were solid. Even the skidoos were able to cross over. Now we are not able to do that because it doesn’t freeze anymore. The ice is always broken in that area” (Paulossie Ekidlak) (in translation).

4.3.3 Salinity

One of the important drivers of sea ice change, according to many elders and hunters, is reduced salinity. This has been attributed to a larger influx of freshwater into Hudson Bay during winter as a result of Hydro-Québec development in the James Bay region. Reduced salinity causes changes in the strength and properties of sea ice, causing it to behave much differently than normal saltwater ice to which Inuit are accustomed.

“Before the seawater used to be very, very salty, but nowadays it seems to be less salty. The forming of the ice, when it is just starting used to be different than it is now” (Louisa Ippak) (in translation).

“On the islands here we are getting lots more freshwater. The taste of the salt is not as strong. I think we are getting too much freshwater. There is a difference between freshwater and saltwater. We are getting more freshwater and it makes things unpredictable and the ice is not as strong as it used to be” (Daniel Apawkak).

“The saltiness of the water seems to have been reduced. If the La Grande River keeps pouring lake water into the seawater, the seawater is going to change even more. This will affect a lot of hunters. In the future we feel we will have a lot of work to do with the government regarding these matters” (Joe Arragutaina) (in translation).

“I suspect that the hydro projects around the bay have something to do with the amount of freshwater that is coming into the bay. This could be affecting the ice freeze over in the fall and early winter, and the ice breakup in the spring” (Johnassie Iqaluk) (in translation).

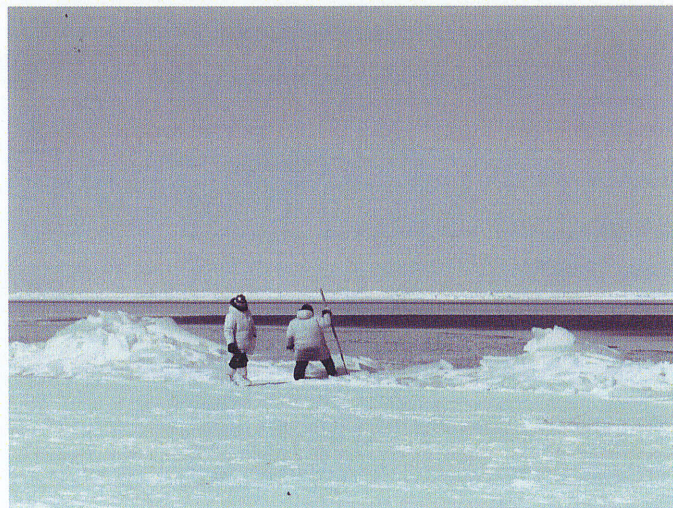
4.3.4 Floe Edge

The floe edge, particularly to the north of Sanikiluaq, is the primary mid-winter seal hunting area for local hunters (Figure 5). There is considerable annual variability in the position of the floe edge, but many hunters agree the floe edge is as much as 11-13 km (7 -8 miles) closer to the community than it was approximately thirty years ago (Johnny Takatak, pers. comm.; Johnassie Inuktaluk pers. comm.). Lucassie Takatak explained how in the past, the floe edge was typically very thick due to the presence of

rafted ice. As the landfast ice extended outwards over the course of the winter, these areas of rafted ice would extend further and further back from the floe edge. This overlapping is seen less frequently now, resulting in less stable floe edge conditions.

“We used to have to go way down, travel miles and miles to find that floe edge, but right now it is very close by because of the formation of the ice that I was talking about, overlapping each other making it solid. So it is very, very close compared to what it used to be before” (Lucassie Takatak) (in translation).

Figure 5. Hunters using a harpoon to check the thickness of floe edge ice, March 2008.



Changes have occurred at the floe edge making hunting more difficult including thinner ice, *aputainnaq*, and *maaniituit*. Changes in the characteristics of the ice are causing the floe edge to break off unpredictably, and as a result hunters may become stranded.

“The floe edge is very unpredictable. It can be cut off and there you go. You are stuck on some ice floe. This has happened a few times since I’ve been back” (Daniel Apawkak).

“Usually at the floe edge you see the edge of the ice going straight down. Nowadays it seems to be slanted back underneath the ice. This is making the edge of the ice very dangerous to walk on” (Emily Takatak) (in translation).

“I didn’t even know but my ski-doo went through and the guys behind me had to turn. It was snowing and the ice was moving so the open area was covered. It wasn’t in a polynya, it was out on the floe edge” (Elijah Oqaituk).

4.3.5 General Observations on Polynyas (*Ikirasait*)

Polynyas are areas of fast moving water that occur in predictable locations in and around the Belcher Islands each year and remain open for all or part of the winter. The polynyas are a result of tidal currents that increase in speed when they are funneled through narrow channels, between islands, around points of land, or over shoals (Laidler & Elee, 2008). Currents in the polynyas switch direction with the ebb and flood tides: the greater the height of the tide, the stronger the current. For this reason, some polynyas freeze over for part of the winter and then re-open during full moon phases when tides are the highest (Laidler & Iqummak, 2008; Nakashima & Murray, 1988). Polynyas are areas of major biological importance, used by seals, bears, whales, over-wintering eider ducks, and therefore by Inuit as well (Figure 6).

Figure 6. Seal hunter at the edge of Ikirasaaluk polynya, March 2008.



Due to their great importance and frequent use, detailed knowledge of polynyas exists, and people readily notice changes in the polynyas. Each polynya has its own distinct characteristics, so changes are often very localized. A map of the major polynyas in the Belcher Island archipelago can be found in Figure 7. Many people made broad statements concerning polynyas in general, which I will summarize here.

“All the polynyas that I know change currents with the tides. They are usually open at full moon phases” (Allie Ippak) (in translation).

“They are open, especially during the moon phases, they close up when there is no phase going on [before full moon]. These polynyas over here [Uvilurluk and Nuasurnait], after it has been windy for a while, like a few days, the currents just run in one direction, the currents just run out. Whereas normally the currents would switch at high tide and low tide. All polynyas have currents in them, and all currents go one way when it is high tide, and another way at low tide. Even when there is no moon phase. It is the strength of the current that is affected by the moon phase” (Davidee Eyaituk) (in translation).

“There is not really any area around the islands that is unsafe in the wintertime, because the polynyas and the dangerous sea ice conditions that happen, happen annually and people know where they are. Therefore they know in winter to keep an eye out, in mid-winter” (Davidee Eyaituk) (in translation).

Sometimes polynyas with strong currents can freeze over, depending on the nature of the freeze-up period or the severity of the winter. Freezing can occur if slush is blown into a polynya and then freezes, or if a large ice floe drifts in and covers a polynya before the landfast ice surrounding the polynya becomes stable. Neither of these scenarios is uncommon.

“I think that happens too [slush ice can blow in and cover them up during freeze-up]. This year it has been cold, so most of the polynyas were frozen over” (Johnny Kudluarok).

“This polynya here [Ikirasaaluk] is usually open all year, but this year a big piece of ice came in and covered it right away, just as it was starting to freeze” (Johnassie Ippak) (in translation).

At other times, rough ice can shelter a polynya from the wind, enabling ice to form, provided there are periods of extreme cold. Some interview participants report that some polynyas are freezing up more frequently. The polynyas mentioned by Davidee Eyaituk, Uvilurluk and Nuasurnait (Figure 7), froze over during the winter of 2006-2007, an extremely rare event. In March 2008 Uvilurluk was frozen again, and only a small pool of open water remained at Nuasurnait.

“Lots [of polynyas] are freezing up nowadays. In the past they used to stay open, now they freeze over” (Johnny Kudluarok).

“Even though these have very strong currents in them [Uvilurluk and Nuasurnait], if the wind blows from the east in the fall and makes rough ice, then the polynyas can close up, because there is wind protection from the rough ice” (Davidee Eyaituk) (in translation).

The majority of participants report changes such as thinner ice surrounding the polynyas, new polynyas that are forming but are hidden under snow, and most commonly polynyas that are opening up much sooner in the spring.

“There are some new polynyas now. These are the ones that people talk about all the time. People warn over the radio that these polynyas, you can’t see them but they are there. Years ago they weren’t there. These are around polynyas that were already there” (Daniel Apawkak).

“The polynyas used to form ice and go solid in the winter in many places. Now they seem to be staying as open water, with only snow on top of them” (Emily Takatak) (in translation).

“The ice is getting thinner even though the currents are not as strong. It is hard to figure out, when it should be getting thicker, due to less current” (Davidee Eyaituk) (in translation).

“I haven’t heard that the polynyas are closing up more, but I have heard that they are getting larger sooner” (Allie Ippak) (in translation).

Figure 7. Map of commonly used polynyas in and around the Belcher Islands.



4.4 Changes Occurring During Spring

This section will cover all changes occurring during the remainder of the season during which sea ice exists. There is no multi-year ice in the Belcher Islands, so this period will include the months of May, June, and part of July. Winter weather breaks and spring begins in late April or early May. At this time of year a major shift occurs in hunting patterns as people switch from seal hunting to goose hunting, char fishing, and beluga whale hunting. Many people move out into their spring camps after being confined to the community for the duration of the winter. Long days, warm weather, and solid ice conditions make spring a favorite time of the year to be out on the land for many people. Topics discussed in this section will include spring weather, snow, rapid ice melt, pattern of break-up, and near-shore cracks.

4.4.1 Weather

The majority of interviewees agree that spring has undergone major changes in recent memory. Springtime in the past used to be an extended period of warm weather that arrived gradually, allowing people to travel abroad easily on sea ice that remained solid for many weeks (Nichols et al., 2004). Now spring arrives quickly, melting snow and ice rapidly and shortening the much-anticipated spring travel period.

“You could tell it was early spring by the way the weather was warming up gradually. It didn’t warm up right away, but it gradually warmed up. It used to be much better when the weather behaved that way, because nowadays it is quite unpredictable, with spring coming with a bang” (Allie Ippak) (in translation).

“Back in those days, even not so long ago, the springtime would stretch on longer than it does now” (Johnny Tookalook) (in translation).

Other people mention that although spring comes suddenly, the weather is not as pleasant as they remember typical spring weather to be. Cloudy weather is more common, as is windy and stormy weather. An example of this is the snowy spring weather referred to by Emily Takatak below; there had been warm weather throughout May 2007 until May 17, when temperatures fell below zero and several inches of snow fell.

“Those used to be nice spring days when the sun would shine and it used to be nice and hot. Nowadays the sun barely comes out, and when it does come out it hardly even warms up the air before clouding over again. It only comes out now with enough heat to melt away a lot of the snow and ice” (Johnny Tookalook) (in translation).

“It used to be really, really cold in wintertime, then when spring came, hot weather used to come along with it. This doesn’t happen anymore. This month it should be spring weather outside, but this is not what we are seeing” (Emily Takatak) (in translation).

4.4.2 Snow

The presence of snow on the land and on the sea ice is an important feature of the spring environment for Inuit. Snow on the land allows rapid travel by snowmobile instead of the slower alternative, all-terrain vehicles. Snow on land is important because it allows people to travel over land to reach bays or inlets by a more direct route than following the shoreline on the ice. With some areas of sea ice becoming unsafe early in spring, hunters must detour around on the land to stay safe and reach desirable hunting areas (Figure 8). Such detours are not possible unless sufficient snow cover remains. Snow also insulates sea ice and reflects solar energy, prolonging the length of time that sea ice remains safe and solid for travel. In recent years snow has been melting much sooner in the spring, creating precisely the challenges mentioned above.

“Back in the earlier years we used to have longer springs and snow stayed longer during the spring months. Now the snow is gone before June” (Elijah Oqaituk).

“There would still be lots of snow at this time of the year, at this time of the month. It has been getting earlier every year” (Johnny Kudluarok).

“There used to be packed snow on the surface of the land. That is going very fast, faster than it used to” (Sarah Kittosuk Sr.) (in translation).

Figure 8. Lack of snow on the land during spring causes difficulties for goose hunters detouring around unsafe ice, June 2007.



4.4.3 Rapid Ice Melt

Spring comes earlier to the Belcher Islands with each passing year, and most interviewees agree that the rapidity with which sea ice melts has significantly increased. A short period of warm weather is enough to make the ice dangerous; this was not previously the case. Interestingly, Nichols et al. (2004) report similar observations by Inuit in the community of Sachs Harbour.

“These days we have shorter winters. Spring comes earlier now. The ice is gone earlier in the springtime” (Peter Kattuk).

“There has been a lot of change. The ice melts much faster. Springtime used to last a lot longer” (Davidee Eyaituk) (in translation).

“When the weather starts warming, even though it is not nice outside, the sea ice is getting dangerous to travel on already” (Johnassie Iqaluk) (in translation).

The most obvious reason for faster spring melt is reduced ice thickness, as discussed in the winter sea ice section.

“Ice breakup happens much faster now. This could be due to the fact that when the weather used to be at its coldest in the winter months, in January, the weather is not cold at all. That may be why the ice doesn’t get as thick as it used to, therefore the sea ice breaks up easier and gets dangerous to travel on” (Johnassie Iqaluk) (in translation).

“People that are saying the climate is changing; that is very, very true because the climate is changing. In May, the ice used to be solid with no dangers whatsoever occurring. Right now it is not usable anymore because it isn’t as thick as it used to be” (Paulossie Ekidlak) (in translation).

Many people observed that ice thaws or dissolves more quickly than in the past. Some people mentioned that the ice melts so rapidly it seems to be melting from within. Others believe that warmer water is causing stronger melting from underneath the ice, a process that is known to Inuit in other areas of the Arctic (Laidler & Elee, 2008; Laidler & Iqummak, 2008).

“These days I have problems with the ice. It seems to melt from within, so it melts really fast. It is really hard to see what is good ice, and what is bad ice” (Daniel Apawkak).

“It is normal for the ice to be melting from beneath and from the surface, but it seems to be stronger melting from beneath now than from the surface” (Louisa Ippak) (in translation).

“Ice is not reliable anymore. The ice used to be solid from underneath, and even in the spring when there were potholes we wouldn’t be scared to walk around them because we knew the ice was solid” (Emily Takatak) (in translation).

4.4.4 Pattern of Break-up

When discussing spring ice conditions, it is important to distinguish between the terms “break-up” and “thaw” or “melt”, as these are distinctly different. Each spring in the Belcher Islands, the landfast ice will break away in relatively predictable locations. Depending on the severity of the winter and the amount of wind during the break-up period, the timing may change, but the pattern of break-up remains similar from year to year (Laidler & Iqummak, 2008).

“The way the ice breaks up has always been the same” (Johnny Kudluarok).

“Sometimes it breaks at the cracks along the beaches of these islands [the west side of the Bakers Dozen Islands] and opens up that way” (Davidee Eyaituk) (in translation).

“First it will break off here [west of Eskimo Harbour], then there will be open water here [Kataaluk]” (Davidee Eyaituk) (in translation).

“It always depends where the wind is coming from. When it breaks up, the wind has to come from the north first, and break everything up, then the wind starts coming from the south and the ice blows away. The ice is going to be here for quite a while. You could usually see the open water from here, you can’t even see that yet. It hasn’t gotten close yet” (Johnny Kudluarok).

During the break-up in past years, large chunks of ice, called *annisa*, would remain around the islands for a longer period of time. Many of these chunks drifted into the archipelago from the periphery of the islands. One of the only changes in ice break-up that was mentioned was the absence of many of these large ice floes and the presence of mainly smaller pieces of ice during break-up.

“Now the breakup of the ice comes in very early. It breaks up at a time when it shouldn’t be breaking up. When it does break up, the ice floes are scattered around, but they don’t stay here as long as they used to stay. Back then the ice used to stay solid for a long time until it was

ready to go. Nowadays it melts very fast, and even when it is around it is not as thick as it used to be” (Paulossie Ekidlak) (in translation).

“In the springtime when the ice finally started to break up, it would break up in large batches of ice and you would find a lot of seals on that one piece of ice, basking. But nowadays it is only small chunks of ice that break up. There are no big pieces left” (Allie Ippak) (in translation).

4.4.5 Cracks

Cracks that form near shore and between points of land and islands (Laidler & Elee, 2008), known as *quunik*, are important fishing sites for Inuit in springtime, where people catch sculpins and cod. However, in recent years near-shore cracks have not lasted for long; they soon begin to widen, a process known as *aaroguk*, which shortens this fishing season. People have also noticed that ice along beaches has been melting rapidly, making it difficult to access the more solid offshore ice.

“One of the big differences that I have seen these days is, before, the ice used to melt first, before the coastline melted. The beach area used to thaw only after the other ice had melted. You used to still have ice on the beach when the sea ice had melted. Nowadays this has reversed and the beach ice is melting away faster than the sea ice. That is one of the biggest changes that I have seen” (Sarah Kittosuk Sr.) (in translation).

“On the shoreline the ice does not stick to the shore, so all the shore ice goes away as soon as it starts melting. Before it wasn’t like that” (Johnny Meeko Sr.) (in translation).

“You can see people working around trying to get onto the solid ice. There is a lot of ice, and it is solid, but if there is no ice on the beach, you can’t get onto it” (Sarah Kittosuk Sr.) (in translation).

4.4.6 Development of Dangerous Areas

As the spring thaw progresses, dangerous areas begin to form in relatively predictable locations. For example, narrows, points, shoals, and groups of small islands cause increased current speeds (Gilchrist & Robertson, 2000; Joel Heath, pers. comm.),

which may not be sufficiently strong to result in polynya formation during mid-winter; however, these places rapidly develop open water when spring weather arrives and must be traveled around with extreme caution (Laidler & Iqummak, 2008) (Figure 9). With a warming climate and thinning ice, these are the areas that major changes will occur, and are already being seen. Areas such as this were traditionally safe in wintertime, but some are now remaining unsafe year round, or becoming unsafe earlier each spring.

“The channels between the bays are dangerous to travel on by May, the end of May, but the open areas are still safe to travel on, even when the polynya areas are not safe to travel on anymore” (Allie Ippak) (in translation).

“It is the islands and the points that open up in the springtime earlier than the other places” (Davidee Eyaituk) (in translation).

“It used to be predictable that open polynyas would happen in the same area year after year but nowadays, you can see open water in areas that didn’t used to be open. It is hard to make sense of that. These are things that I have seen” (Johnassie Iqaluk) (in translation).

“All channel areas become dangerous. If you are inexperienced you shouldn’t even try to go around them” (Johnny Tookalook) (in translation).

Figure 9. Kataapik in early June, 2007. Rapid currents cause this location to open earlier than the surrounding areas.



The influx of freshwater from streams and rivers weakens sea ice in bays and inlets where they enter Hudson Bay. This freshwater runoff is warmer than the seawater and the lower salinity ice at the mouths of such streams melts at a lower temperature, causing sea ice to quickly decay in these areas (Laidler & Iqummak, 2008). Figure 10 illustrates locations that were mentioned by study participants as rapidly becoming dangerous during spring.

Figure 10. Map of dangerous locations on the sea ice occurring during spring in the Belcher Islands, as indicated by interview participants from the community of Sanikiluaq.



4.5 Summary Diagrams of Environmental Changes, Impacts, and Adaptations

To illustrate the close relationship between Inuit and the northern environment and thereby demonstrate how environmental change can impact humans and bring about adaptation, I constructed the diagrams shown in Figure 11a, b, and c. During the process of conceptualizing the diagrams, I came to the realization that not all observations of environmental change were equal, and the study participants would frequently point out the relationships between various components of the environment. For example, the formation of *maaniituit* is related to thin ice, wind, and currents during freeze-up. Thin ice is in turn related to warmer fall temperatures and lack of snowfall. To represent these relationships diagrammatically I created a series of nested circles, beginning in the center with primary observations followed by secondary observations. Outside these, the third circle contains human impacts of the central environmental changes, and finally the outer circle contains adaptations. Continuing the previous example, warmer temperatures and lack of snowfall would be primary observations, while thin ice and *maaniituit* would be secondary observations. The concept behind the diagrams follows the analogy of a pebble dropped into a pool of water. If we think of environmental change as the pebble or disturbance, the effects of a change in one feature of the environment ripple outwards, causing further change, and eventually impacting the people who live in close relation to that environment. For this reason the human aspects of the diagrams were placed in the outer circles, emphasizing the reliance of Inuit on the environment and therefore their sensitivity to the changes that are occurring, particularly in the sea ice. As with the outer ripple formed by the pebble in the pool of water, the size of the outer ring, adaptation, must correspond to the size of the disturbance, sea ice change.

Figure 11a. Freeze-up period: Diagram of relationships between environmental changes, impacts, and adaptations.

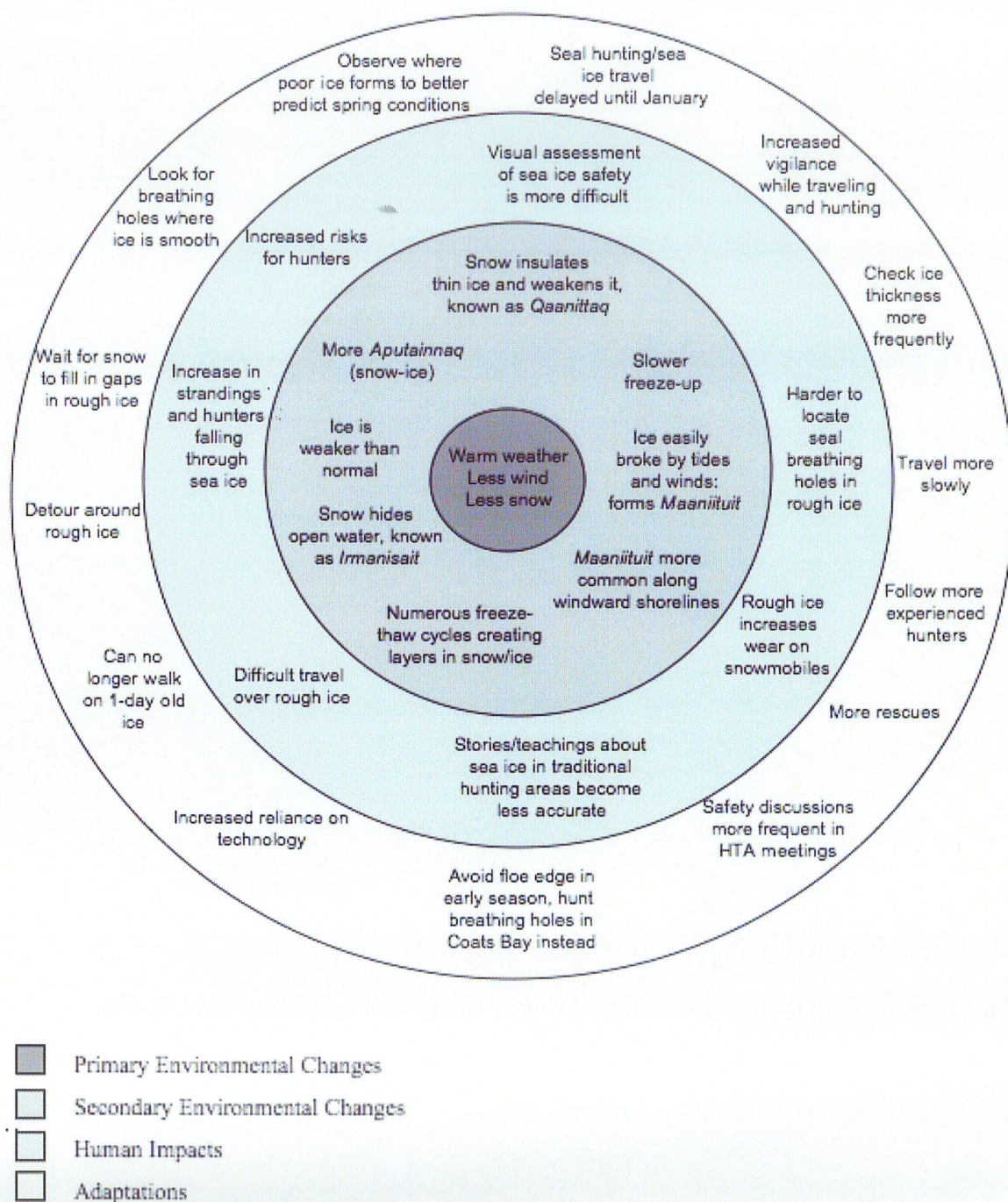


Figure 11b. Winter period: Diagram of relationships between environmental changes, impacts, and adaptations

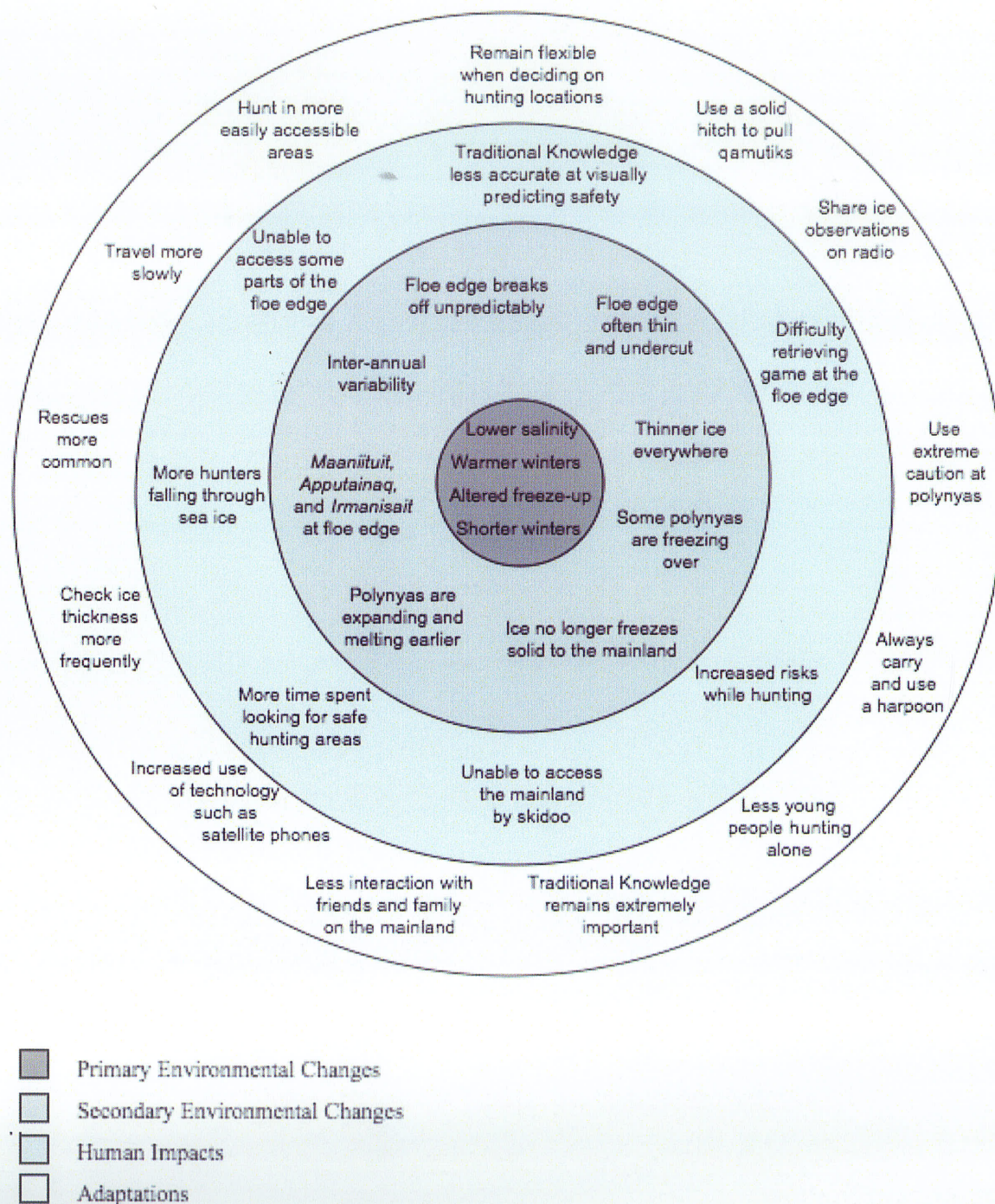
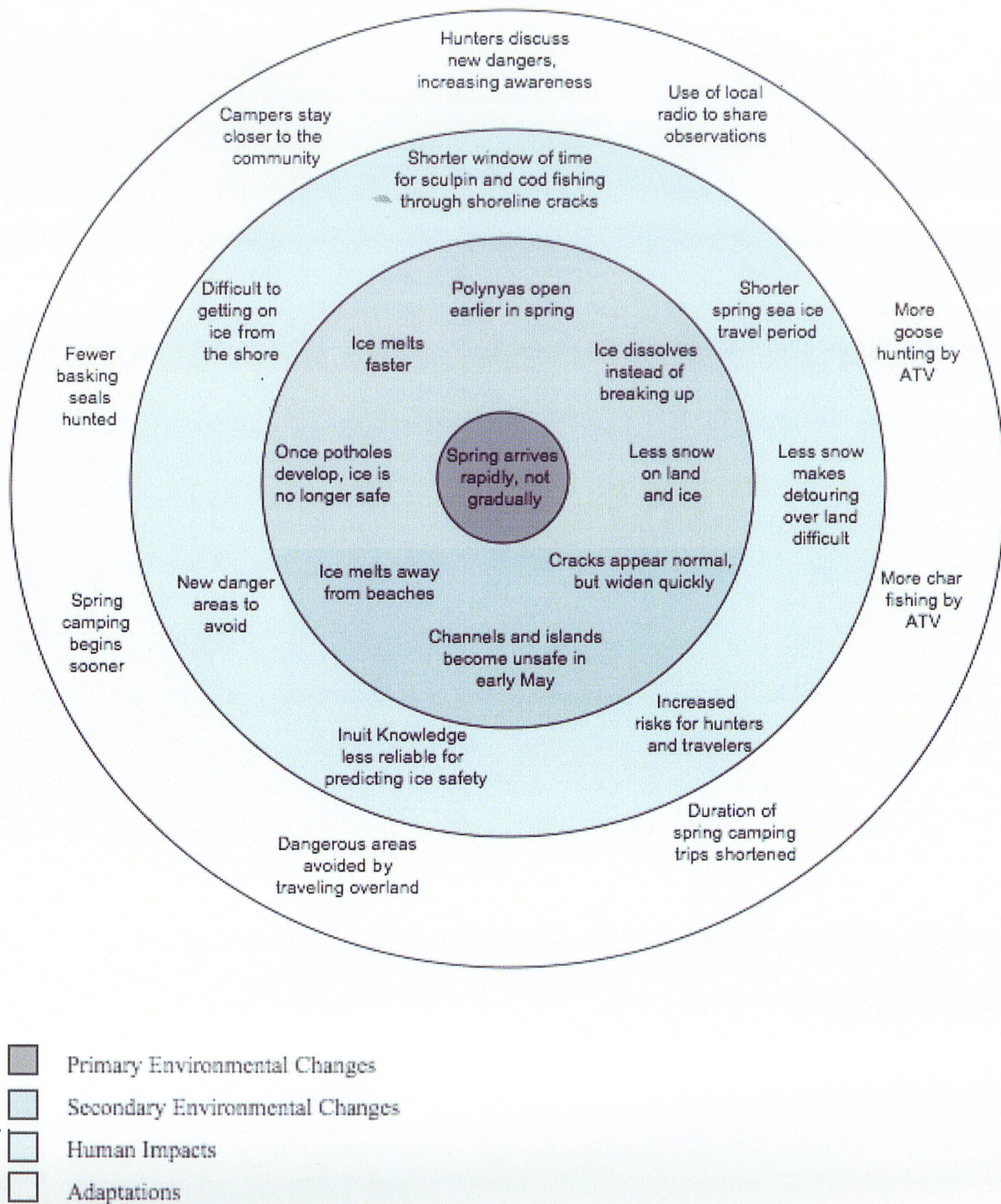


Figure 11c. Spring period: Diagram of relationships between environmental changes, impacts, and adaptations.



Chapter Five: Coping with and Adapting to the New Realities of the Sea Ice Environment

One of the central objectives of this project is to document the adaptations that Inuit in the Belcher Islands are making in response to changes in the sea ice environment. Berkes and Jolly (2001:19) define adaptation in the ecological sense as “any response that increases a population’s probability of survival”. The authors further subdivide adaptation into coping mechanisms, which are short term responses occurring at the individual level, and adaptive strategies, which occur at the household and community level and involve fundamental changes in activities and institutions over longer periods of time. Coping mechanisms and adaptive strategies are often employed simultaneously, and a coping strategy can evolve into an adaptive strategy if adverse conditions persist. For the purpose of this discussion, these are the definitions that will be employed.

The concept of adaptation is a relatively easy one to grasp for researchers and other individuals who live in relatively stable and predictable environments such as southern Canada. Our economy and society is structured to buffer us from changes in the environment and keep our lives stable, an example of which would be the importing of food to reduce or negate the impacts of local crop failure. We are therefore very sensitive to any departure from what we consider “the norm”, and must consciously make changes to our lifestyle in order to adapt and return our standard of living to where we deem it should be. Adaptation can be thought of as a change in a system in response to some form of perturbation, such as a change in sea ice conditions. For the purpose of this discussion, the terms adaptation and adaptive response will be used interchangeably to encompass all responses whether they are reactive or proactive, technological or behavioral, despite ongoing debate in the scientific community over the details of these varying responses

(Smithers & Smit, 1997). Adaptive responses occur to buffer the impacts of environmental change on current activities or to enable people to switch to new activities (Smithers & Smit, 1997).

Adaptation is a much different topic to discuss with Inuit; they do not view it in the same way. Change and variability are basic characteristics of natural systems, and nowhere is this more pronounced than in Arctic regions (Huntington, 2002). The concept that nature exists in a stable equilibrium is inaccurate, as natural systems are dynamic and constantly involved in cycles of “boom or bust” (Ives et al., 2000). As Krupnik (1993:156) puts it, “nowhere in the Arctic is there such a thing as a stable, normal, or typical environment. Any normal or average state is simply a transition from ‘good’ to ‘bad’ or back again”. In order to survive in such a variable environment, Inuit have continued in what some researchers term the “Thule Tradition” (Langdon, 1995). This involves maintaining flexibility and diversity in resource use, amassing a body of traditional knowledge, readily adopting new technology, remaining highly mobile, and relying upon strong social networks and organization (Ford et al., 2006; Krupnik, 1993). Adaptation to a changing environment does not consist of a discrete number of sudden, concrete changes in culture or practice; rather, it is a continuous process and a way of life for Inuit people. Therefore, quantitatively measuring adaptation through risk reduction or the benefits of exploiting a new opportunity resulting from an adaptive response to environmental change would be extremely complex (Orlove, 2005). It would be difficult, if not impossible to clearly pinpoint the exact moment an adaptive response is implemented or all the variables that influence the effects of this response on the

population in question. When asked if hunting practices have been altered in any way because of climate change, Davidee Eyaituk's response illustrates this point:

“We are doing it the way we have always done it, catching what is available at the time of the season” (in translation).

To someone who is a part of the natural system, such as an Inuit hunter, conscious decisions are made everyday about what to hunt, where to hunt, when to hunt, and how to hunt, based on environmental variables such as weather, ice conditions, time of year, or time of day just to name a few. These decisions may be either reactive or proactive (anticipatory), but both will fall under the category of adaptations for the purpose of this thesis, provided the decision is influenced by an environmental stimulus (Orlove, 2005). A reactive decision might be choosing to hunt seals at Ikirasaaluk polynya (Figures 6 & 7) because newly formed cracks have made the stability of the floe edge unpredictable, as observed during March 2008. A proactive decision might be choosing to hunt eider ducks at the Agiaraaluk polynyas (Figure 7) because elders predict a south wind, which closes up the open water at the southern floe edge, forcing eiders into the polynyas. To the hunter, while these decisions are made consciously, they are not seen as adaptations, but merely routine choices that determine the safety and/or success of an outing. In this situation, someone external to the system may be better suited to identify adaptive responses objectively. In the following section I will discuss which adaptations, both coping mechanisms (short term) and adaptive strategies (long term), fall within the realm of routine variability and which have been altered enough to be considered adaptations to climate change.

5.1 Coping Mechanisms

A coping mechanism is any short-term response to adverse environmental conditions that occurs at the individual or household level (Berkes & Jolly, 2001). Three primary coping mechanisms emerged from this project: (1) patience, (2) flexibility in travel routes, and (3) utilization of Traditional Knowledge and skills.

5.5.1 Patience

Patience is a part of life for Inuit hunters, whether it is the patience to wait motionless at a breathing hole while hunting, or the patience to wait for safe ice conditions before venturing out to hunt seals in early winter. The decision to go out on the ice for the first time each winter is made by carefully balancing risks versus rewards. The rewards of a successful hunt do not outweigh putting yourself at unnecessary risk by traveling on thin ice. The availability of store bought food makes this period of waiting easier. People no longer face a starvation situation as their ancestors did; however, they must bear the increased expense of eating store bought food (Ford et al., 2006). A shortage of preferred and nutritious country food impacts both the health and finances of local residents. There is no widely agreed upon date when ice conditions are safe for travel; this decision is made by each hunter individually and varies from year to year. Therefore, these year-by-year decisions constitute a coping mechanism rather than a long-term adaptive strategy. In Sanikiluaq, people must now delay the start of their on-ice seal hunting until late December or early January, as indicated by the following respondents when asked what time of year they begin traveling on the sea ice.

“December, before or after Christmas” (Elijah Oqaituk).

“Nowadays, it is not until after Christmas when you are able to go out on the ice to go hunting. I know that because every

Christmas I am one of the men who has to catch seals for the feast, so I know it is only after Christmas that I am able to get seals that I used to get before Christmas” (Lucassie Takatak) (in translation).

“Hunters used to be in Coats Bay in December, now it is usually January before we can go to Coats Bay” (Johnny Kudluarok).

This is much later than in the past, a full month later by the estimation of some study participants.

“We used to start ski-dooing in October or November” (Elijah Oqaituk).

“We used to go out in October. It didn’t freeze all the ice everywhere, just the ponds and the lakes. They would freeze up first, and then the ocean” (Davidee Eyaituk) (in translation).

Hunters must also wait until later in the season to access some areas due to the presence of *maaniituit*, which is difficult to travel through, but gets smoother as the season progresses and drifted snow accumulates in the rough ice.

“You have to wait for snow to cover up the rough ice” (Elijah Oqaituk).

“Sometimes when there is no snow on top of the ice, it is very rough, but when there is snow on the ice it gets smoother” (Peter Kattuk).

“It is rough right now but it can always get smooth after warm weather. When the slush and the snow come, the rough patch can turn to nice smooth ice. Not all of them disappear, but they get better to work around” (Louisa Ippak) (in translation).

The patience to wait for the right conditions in both of these situations is ingrained in hunters and continues to be a necessity for coping with yearly variability.

5.1.2 Flexibility in Travel Routes

Flexibility in travel routes is another routine coping mechanism employed in Sanikiluaq, similar to what has been reported in other Arctic communities (Berkes &

Jolly, 2001; Ford et al., 2006; Ford et al., 2007; Fox, 2002). The increasing prevalence of thin, unsafe ice conditions and *maaniituit* often dictates where hunters can and cannot travel. Hunters cannot always hunt where they originally planned; therefore, they must always be prepared to avoid unsafe areas and hunt where safe and/or smooth ice dictates they must, even if this means hunting in a less desirable place.

“We are not able to go to some of the areas that we used to hunt before. We have to look for new places that are at least close to the area that we want to hunt, so we have had to make a few changes in our hunting grounds. We are not able to go to some areas because of the dangers appearing in the areas where we want to go. When we know that there are dangers in the ice we try to avoid that as much as possible and try to find a better, solid place to hunt” (Paulossie Ekidlak) (in translation).

Maaniituk/maaniituit is difficult and slow, if not impossible, to travel through (Laidler & Iqummak, 2008), increases wear and the likelihood of damage to snowmobiles and *qamutiks*, and increases the risk of accidents. Hunters therefore avoid rough ice as much as possible, often detouring around it, which increases the distance and travel time required to reach desirable hunting areas. Sometimes hunters must travel through *maaniituk*, which is a time consuming process not unlike trying to work ones way through a maze, usually requiring back-tracking and numerous attempts at various routes until a hunter reaches the desired destination.

“Right here, the open water area [the northern floe edge], and this area here [northwest side of Kugong I.]. In mid-winter when I was traveling through there my ski-doo tipped over three times” (Johnny Tookalook) (in translation).

“You’ve always just tended to avoid the rough areas. Why go to a rough area when you can go on smoother ground?” (Allie Ippak) (in translation).

“We drive by snowmobile and in some parts it was too rough to get close to the floe edge” (Johnassie Ippak) (in translation).

Rough ice is an inconvenience, increasing the mileage and wear hunters put on their snowmobiles, but people can generally reach the areas they want to go, providing the ice is safe enough. If there is a route to bypass or travel through rough ice, hunters will find it and continue on to their desired destination.

5.1.3 Traditional Knowledge and Skills

Utilizing traditional knowledge and land skills allows hunters to negotiate variable ice conditions. This is not a case of older generations falling “behind the times” so-to-speak, but quite the opposite; older and more experienced hunters possess more knowledge on sea ice travel, have more first-hand experience, and are therefore better able to travel safely in the rapidly changing environment of today (Ford & Community of Igloolik, 2006). Experienced hunters have the knowledge to adapt quickly to changes in the ice and deal with new challenges as they occur in order to stay safe. Patience, caution, and flexibility are a few of the virtues found in those experienced in hunting and traveling the sea ice. Now more than ever, these virtues must be exercised during outings on the ice.

“The older people notice these changes, but they have to live with it. They know things are different now, but they have to adapt to it right away. Older people have knowledge from their time, and it is different now, but I know that they are adapting to the changes that are occurring” (Peter Kattuk).

“If a hunter has knowledge from his past, he can always just work around the conditions that he sees and get as far as he wants. It is the more inexperienced hunters who are more afraid to go where the experienced hunters still can go” (Johnny Meeko Sr.) (in translation).

Johnny is saying that when conditions are dangerous, a hunter who is more experienced can discern the subtle signs that tell him where he can and cannot go, knows from past experience just how far he can go, and knows when it is time to turn back.

Younger hunters who are unable to recognize these signs will either avoid these areas altogether in order to minimize risk or will continue traveling, unaware of the danger until it is too late. Traditional skills such as checking ice thickness using a harpoon are very important now that ice conditions have become more difficult to assess visually. Many study participants emphasized the importance of carrying a harpoon at all times and using it frequently to check the ice whenever there is any doubt as to the condition of the ice (Figure 12).

“Nowadays, if you see ice that is black, you use the harpoon to check if it is safe to go there. If you use the harpoon once and the ice doesn’t break you know that it is safe” (Davidee Eyaituk) (in translation).

“I always carry my harpoon to check the ice” (Peter Kattuk).

Testing the ice more frequently, particularly near polynyas or near the floe edge, is one coping mechanism that can help reduce the risks posed by increasingly unpredictable conditions. Hunters often have to avoid good hunting areas in search of safer ice, as safety is always the primary concern.

“Three hits with a harpoon in the same hole; that’s where you can drive a ski-doo. Three or two” (Elijah Oqaituk).

“You use a harpoon. You have to do more checking, so it takes longer. Checking is a waste of time. You are not hunting. You have to go further, you have to check more. By the time you have done that you have wasted half a day.” (Daniel Apawkak).

“Because of the thin ice around some breathing holes, we try to go to more solid breathing holes where the currents aren’t as strong. Currents in the areas where there are seal breathing holes cause the ice to decay rapidly from underneath. That is what is causing the thin ice near the breathing holes, so we try to find breathing holes that aren’t near the strong currents” (Paulossie Ekidlak) (in translation).

Figure 12. Hunter Johnny Takatak using a harpoon to cross recently formed ice at the floe edge, March 2008.



Accumulation of traditional knowledge and skills can be viewed as a long-term adaptive strategy of the Inuit people. However, when the application of this knowledge is safely dealing with localized sea ice conditions on an individual basis it will be considered a coping mechanism.

5.2 Adaptive Strategies

Adaptive strategies are ways in which people, households, or communities change their activities or local rules and institutions to respond to environmental change over time (Berkes & Jolly, 2001). Adaptive strategies may evolve from coping mechanisms when changes persist and coping practices become commonplace. For this reason, drawing a definite boundary between coping mechanisms and adaptive strategies is not entirely straightforward. This section will discuss the adaptations that I feel are more permanent within the community of Sanikiluaq and that have moved beyond what should be considered coping with yearly variability. First, I will discuss adaptive strategies that are general and well-known aspects of Inuit culture, such as amassing and constantly revising a large body of knowledge and maintaining flexibility in all aspects of harvesting

activities. These strategies continue to be employed in Sanikiluaq. Second, I will discuss specific changes that have been made to hunting and travel practices, such as increased use of technology. This section will conclude with an overview of the current search and rescue protocol and lessons learned during the extensive search conducted in February-March 2008.

5.2.1 Maintaining Traditional Knowledge Systems

Likely the most important adaptive strategy that has allowed Inuit people to thrive in the Arctic is an intimate knowledge of the natural environment accumulated over many generations that is constantly being added to and revised. This body of knowledge is passed on in detail both orally and through observation of others and the environment, teaching hunters the skills, practices, and codes of behavior that will allow them to be safe and successful while out on the land. Many traditions involving the utilization and teaching of this knowledge are still used today and are of great importance in the context of adapting to climate change. Use of traditional knowledge, skills, and practices was mentioned in the discussion on coping mechanisms, but the maintenance and transmission of this knowledge could also be considered an adaptive strategy. For example, one way that knowledge is passed down occurs when younger hunters follow and observe more experienced hunters. Johnny Kudluarok talked about how young men follow senior hunter Peter Kattuk, who is particularly knowledgeable about the floe edge to the north of Sanikiluaq:

“Some young guys will follow him [Peter Kattuk] when he goes out, into the north area. He is usually the first guy to go out to the north area” (Johnny Kudluarok).

“We follow our elders or a guy who is guiding. They show us which ice is safe, or not, and which way to go. From there, we pick up their way of hunting out on the ice, that is how we learned” (Elijah Oqaituk).

Lucassie Takatak is an example of another such person who provides expertise to many young hunters about sea ice and safe hunting practices. Lucassie is a senior hunter and a bachelor who hunts seals throughout the year, sharing his catch throughout the community. Lucassie is always willing to take along younger hunters; by his count he has taught over forty different hunters in the community to date (Lucassie Takatak, pers. comm.). The adaptive strategy of the young hunters following the old hunters has been employed by Inuit for generations and is extremely important today for two reasons. First, travel becomes safer for young hunters when they are following the lead of a more experienced person. Second, learning through experience and observation is invaluable and cannot be replaced by orally transmitted knowledge alone; therefore, it is important for young hunters to learn first-hand about ice conditions under the guidance of a local expert. Following a senior hunter allows this, because the dangers might be too great for a younger person to risk traveling alone. In the long term, knowledge might be lost concerning characteristics of sea ice and the nuances of sea ice travel unless young hunters continue in this tradition (Figure 13).

Figure 13. Younger hunters follow elder Lucassie Takatak across newly formed ice to hunt eider ducks, March 2008.



Experienced hunters know that if they can observe the ice conditions early in the winter (immediately after freeze-up), they will be able to predict the areas that will remain safe throughout the winter and into the spring and the areas that have the potential to become dangerous. This knowledge can then be shared with other hunters. This practice constitutes an adaptive strategy to deal with increasingly unpredictable sea ice conditions, allowing all community members to remain safer throughout the entire winter.

“I go out before Christmas. I like to go out early because I want to know what it is going to be like in springtime. When there is rough ice, or broken up ice, it is slushy in springtime. When the ice is nice and smooth, it is nice and hard in the springtime, so I try to check on what it is going to be like in springtime, during freeze up in the fall. Then I will know the condition of the ice in the springtime” (Peter Kattuk).

5.2.2 Flexibility in the Annual Harvesting Cycle and Timing of Land-Based Activities

Flexibility in travel routes was mentioned in the section on coping mechanisms, but here flexibility will be discussed as it relates to the annual harvesting cycle. It has

been well documented that Inuit employ flexibility in harvesting as an adaptive strategy, specifically by harvesting a range of species throughout the year, harvesting over large areas, and changing the timing of harvesting activities according to species availability and environmental conditions (Ford et al., 2006; Krupnik, 1993; Riedlinger, 2001). In Sanikiluaq, this flexibility enables people to harvest country food at virtually every time of the year. It should be noted that the relocation of Inuit to permanent settlements greatly reduced the ability of people to harvest game over large geographical areas. To compensate, Inuit in some areas began to harvest previously undesirable species such as sculpins and cod when large animal species were unavailable near communities (Robards & Alessa, 2004). Every year, species are harvested at a slightly different time depending on environmental conditions and species availability, which constitutes a routine coping mechanism. For example, if sea ice conditions become unsafe in early spring, people can switch from seal hunting to hunting geese on land, picking berries, harvesting mussels and urchins, or fishing char, sculpins, and cod. Significant and sustained shifts are occurring in the timing and duration of certain specific harvesting seasons and hunting practices, a topic that arose frequently during interviews. These shifts have become so routine that I suggest they can be classified as the following adaptive strategies: (a) hunting closer to town, (b) avoiding the floe edge in early winter, (c) avoidance of consistently rough areas (d) changing use of polynyas, (e) shifts in spring harvesting activities, and (f) altering the timing, duration, and location of spring camping.

a) Hunting Closer to Town

Inuit Knowledge gives hunters many tools to assess ice conditions and remain safe while traveling on sea ice (Riewe, 1991); unfortunately, changing conditions are

making these visual assessments less reliable (Figure 14). There is therefore growing uncertainty among hunters as they become less confident in their own skills and the advice of others concerning ice conditions.

“Nowadays younger generations and white people will look at top of the ice and say “hey that’s good ice, its solid ice, it must be OK to walk, I’ll go down there”, but when they go down there it is a danger area. We can’t recognize anymore whether the ice is solid or a dangerous patch of ice” (Joe Arragutaina) (in translation).

“We used to be able to tell just what the ice conditions were, but ice is not dependable now just from what we observe on the surface” (Louisa Ippak) (in translation).

“You hear more and more often of hunters getting caught in dangerous ice” (Johnny Meeko Sr.) (in translation).

Figure 14. Snowmobile and *qamutik* stuck after breaking through a thin crust covering deep slush, June 2007.



Thinner ice makes for more dangerous travel at all times. Drifted snow often covers the thin ice or open cracks forming *aputainnaq* and/or *irmanisait*, making it difficult for hunters to assess ice thickness by looking at the surface as they travel. During the winter of 2007-2008, three separate incidents occurred where hunters broke through *aputainnaq*; fortunately, all these hunters survived the experience.

“Over the years a lot of changes have occurred, both in the snow conditions and the ice conditions. The hunters are having a harder time trying to hunt on solid ice, because it is not like that anymore” (Joe Arragutaina) (in translation).

Uncertainty about ice conditions, especially among younger hunters, is resulting in a reduction in the length and duration of hunting trips. With increasing unpredictability in ice conditions, less experienced hunters are forced to concentrate their efforts in the areas they know best and therefore feel the safest. Some people feel that for this reason more hunters are staying close to the community to hunt.

“Because of the changes in the ice conditions, hunters are not going as far from the community as they used to” (Joe Arragutaina) (in translation).

“From what I hear they are hunting in areas that are closer than where they would normally be hunting in years before. Because of the dangers they say” (Louisa Ippak) (in translation).

“Normally I always hunt north of the community, but there were less seals last year, so we had to look around different hunting areas for seal hunting. To me there are more people hunting close to the community when they go seal hunting in the wintertime” (Peter Kattuk).

Uncertainties about sea ice travel are reinforced repeatedly throughout the winter by stories of hunters encountering thin ice in areas that appear to be safe. The following story is a perfect example. Experienced hunter and Member of the Legislative Assembly for Hudson Bay, Peter Kattuk tells how he was stranded in January 2007 when the floe edge that he was hunting along broke off. Peter knows the sea ice to the north of Sanikiluaq intimately and is usually one of the first hunters to travel out to the north floe edge in early winter.

“I like seal hunting for food. I like seal in the wintertime. Last year I was out hunting when the floe edge broke off and I drifted away.”

“It wasn’t windy so I continued looking for the floe edge. I got to the floe edge and I shot maybe three seals, so I cut them up, then when I looked up I noticed that there was dark water. It was a good thing I had a satellite phone. I called home and they picked me up by canoe. I was drifting away. I think they got to me in about twenty minutes.”

“Normally the ice breaks in the nighttime, when the weather is colder, but that time I didn’t see any cracks so I continued to the floe edge. It never cracked at that time so I think it broke when I was at the floe edge. I usually don’t go over any cracks because I know the ice is going to drift away, but that time I didn’t see any cracks or broken ice but it broke up after me.”

“I was coming from here [Kataapik], but it was rough so I had to go that way. I continued without seeing any cracks [north towards the floe edge] and next thing I knew it broke off.”

“Last winter it happened to me twice, but the next time I wasn’t alone, and the ice was touching the shoreline so we were OK. But the ice keeps breaking up. I have noticed that the ice conditions are different these days. Like one time I fell through. I was walking and I ran into thin ice, it was the same color, but it was soft and I fell through.”

“I was walking along the floe edge and I ran into thin ice. So that is different now too. Usually I know what is safe and what is not safe. I thought everything around me looked normal.” (Peter Kattuk)

b) Avoiding the Floe Edge in Early Winter

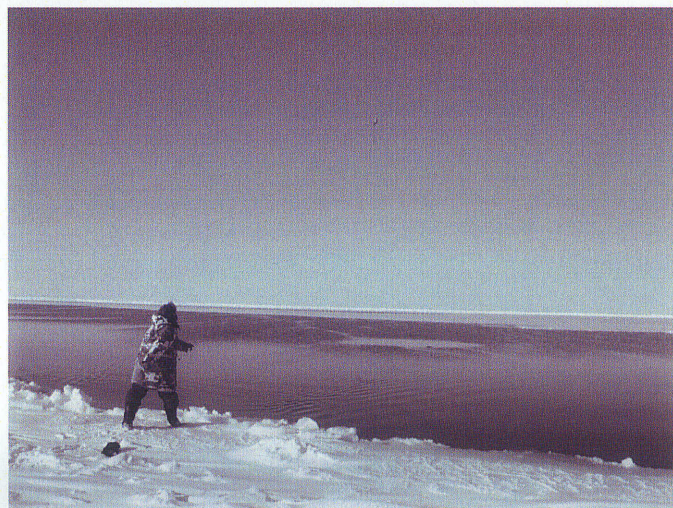
Due to the increasingly unpredictable nature of the floe edge during the freeze-up period, as demonstrated above, the majority of hunters are focusing their early season seal hunting efforts in Coats Bay. Coats Bay is one of the first areas to freeze and has no major currents; therefore, it is generally quite safe and solid. The ice in Coats Bay is usually smooth, making seal breathing holes easy to locate at this time of the year (Johnny Takatak, pers. comm.). It is now rare for people to venture out to the floe edge during freeze-up.

“Sometimes on Coats Bay in fall, there are a lot of people that go out to hunt the breathing holes, because the floe edge is more dangerous during freeze up” (Peter Kattuk).

Such an adjustment in hunting areas, though seemingly minor, could be significant in the long term. The decision to hunt in Coats Bay is based primarily on the issue of safety, so this is a positive change in the sense that hunters are exposed to less risk. However, if hunters eventually cease all travel to the floe edge early in the season, important knowledge on the ice processes in that area may eventually be lost. Furthermore, concentrating hunting efforts in safe areas close to the community may result in overexploitation of resources in those areas or cause seals to move elsewhere.

When near the floe edge where ice is frequently thin, hunters must use extreme caution. They are now forced to spend more time looking for suitable areas from which to hunt. Seals are shot in the open water and then retrieved from the ice edge (Figure 15); therefore, dangerous ice can make retrieval of game more difficult, resulting in a greater loss rate and/or decreased hunting success.

Figure 15. Hunter Johnny Takatak retrieving a seal at the floe edge using a floating hook attached to a throwing line, March 2008.



Difficulty retrieving seals can be partially mitigated by the use of watertight sleds and small boats that can be paddled out to retrieve seals (Figure 16). During on-ice travel

the boat is strapped to the *qamutik* and doubles as a storage box, but can be untied and used to retrieve game if the need arises (Lucassie Takatak, pers. comm.). These boats also provide insurance in the event of the floe edge breaking off and stranding a hunter, in which case the individual can abandon his snowmobile and paddle back to solid ice. Ford (2005) reports that hunters from Arctic Bay, NU, now haul boats while they are hunting for many of the same reasons.

Figure 16. Lucassie Takatak using his floating sled to retrieve seals, March 2008.



“The floe edge is not as strong or solid as it used to be. You will often hear of a hunter who shot a seal on the floe edge, but he wasn’t able to get it because the ice conditions on the floe edge are too weak. I am hearing more of the seals get away because the ice is too thin” (Johnny Meeko Sr.) (in translation).

“Now they have to check to see what condition the ice at the floe edge is in. If it is too dangerous they go elsewhere to find more solid areas” (Emily Takatak) (in translation).

Unstable floe edge conditions are not isolated to the fall; they can occur throughout the winter, as was observed in March 2008. Following several days of blizzard conditions, a large crack developed between the community and the northern floe edge. The following week, hunters were hesitant to cross this crack, worried it might widen and trap them at the floe edge (Figure 17). After 4-5 days, hunters gradually decided that the crack was stable enough and began crossing to hunt the floe edge.

Figure 17. Hunters assess the stability of a newly formed crack that blocks access to the floe edge, March 2008.



During this time, Ikirasaaluk polynya (meaning big polynya) (see Figures 6 and 7) in the Lukisee Islands acted as the back-up hunting area for most seal hunters and received heavy hunting pressure. The Belcher Islands are unique in this respect; the presence of numerous polynyas allows hunters to minimize risk throughout the winter by switching hunting pressure to polynyas when the floe edge is deemed too dangerous. Polynyas are generally considered inferior to the floe edge for seal hunting because seals are fewer in number and when a seal surfaces it moves with the current, thus making it harder to shoot (Johnny Takatak, pers. comm.). Although care must be taken at the edge

of polynyas, ice en-route to and from most polynyas remains solid for most of the winter. Thus, hunting these polynyas is a viable alternative to hunting the floe edge.

Typically, only a small section of floe edge will be accessible or open at one time; therefore, hunting the floe edge is a social activity, involving frequent encounters with other hunters. Hunters use these opportunities to keep each other up to date on conditions they have observed that day. An added benefit of this situation is that hunters can look out for each other, and each man usually has a general idea of where everyone else is, allowing a search to be focused quickly on a place where a hunter was last seen if necessary. At the end of each days hunting, hunters returning from the floe edge often stop for tea on a high hill at Kataapik; here they wait for those behind them to catch up before returning to the community. In this way, hunters look out for one another to ensure that everyone returns home safely.

c) Avoidance of Rough Areas

Shifts in hunting areas are influenced by rough ice, which is often impassable and generally avoided. The presence of *maaniituit* and *maaniikala* makes it difficult to locate breathing holes to hunt, causing hunters to search for areas of smoother ice. Seal breathing holes are most often found along cracks, but if an area is covered with rough, broken ice, breathing holes become harder to find.

“You can still find seals, but it’s hard because rough ice makes it hard to look for seal holes. Without the dogs it is hard” (Daniel Apawkak).

“Seals like the rough ice. When pups are born in the spring they keep them under the snow, that is why they like rough ice” (Peter Kattuk).

Hunters are usually not deterred and can locate breathing holes elsewhere, causing a gradual shift in hunting areas. In this case, areas avoided are generally coastlines with a

north or northwest exposure, although rough ice can form along any coastline and is always present along floe edges to some extent. In March 2008, hunters had to negotiate large areas of *maaniituit* and *maaniikala* north of the community in order to reach their favorite hunting areas. Most *maaniituit* was too rough for travel and had to be detoured around, but *maaniikala* can be traveled through, a slow, rough, time-consuming activity.

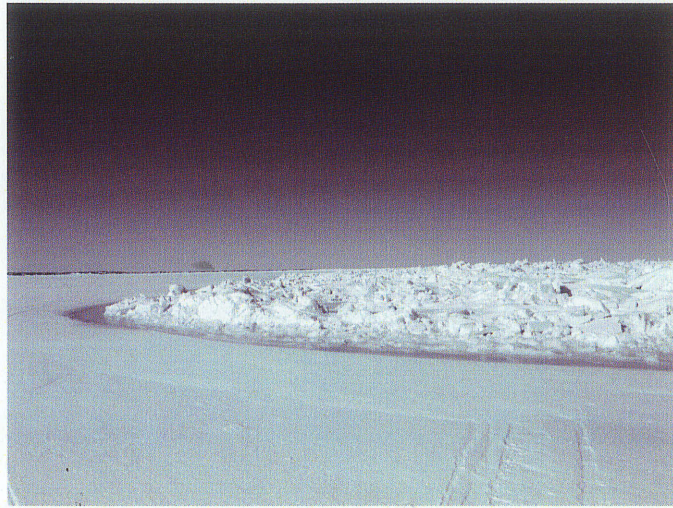
“I haven’t heard or haven’t seen people staying closer to the community for seal hunting because of rough ice or something. People like to go out hunting, and I haven’t seen that people aren’t going out hunting because the ice conditions are rough” (Peter Kattuk).

“Seals like rough ice; it is their hiding place, so sometimes it is very hard to find the breathing holes when it is rough. Some people are out hunting at the south end where the ice is smoother” (Peter Kattuk).

When *maaniituit* and *maaniikala* occur along the floe edge, such as in the important seal hunting area on the floe edge north of Sanikiluaq, hunters may be unable to reach parts of the floe edge they wish to hunt and may have to travel elsewhere in search of more suitable ice. In March 2008, only about two kilometers of the northern floe edge was accessible by snowmobile, access to the remainder of the floe edge was blocked by a large field of *maaniituit* (Figure 18).

“When the ice freezes, it is smooth, then there will be a floe edge. Then it will freeze and there will be another floe edge. Now sometimes when there is a floe edge there are too many ice packs to get to it. The ice is not thickening enough, and this is causing more ice packs. You don’t get a smooth floe edge” (Johnassie Ippak) (in translation).

Figure 18. From open water to inaccessible overnight; freshly formed *maaniituk*/*maaniituk* blocks the floe edge, March 2008.



A specific adaptation many hunters have made to enable easier snowmobile travel through *maaniituk* is the use of solid metal hitches, equipped with a shock absorbing spring, to pull *qamutiks*. In many regions of the Arctic, Inuit pull their *qamutiks* with long ropes, a system that works very well on relatively flat sea ice and has many advantages such as improved shock absorption, and allowing a snowmobile to pass through slush or over an obstacle before being weighed down by the *qamutik* and increasing the chances of becoming stuck (Rick Riewe, pers. comm.). However, a *qamutik* pulled by a rope tends to track slightly to the side of a snowmobile, and also cuts corners when turning. Both of these tendencies result in the *qamutik* quickly becoming stuck when a hunter is maneuvering his way through *maaniituk*, where the snowmobile must often pass through narrow openings between ice blocks and make sharp turns. A solid hitch causes the *qamutik* to track directly behind the snowmobile and allows a hunter to drive through rough ice without getting stuck (Figure 19).

Figure 19. Hunter negotiating *maaniituk*, pulling a *qamutik* equipped with a solid hitch, March 2008.



d) Changing Use of Polynyas

Expanding polynyas and newly forming polynyas are creating problems for hunters. Considerable caution must be used when approaching any polynya. Polynyas quickly become dangerous when warm weather arrives in spring, cutting short the window of opportunity for hunting these areas. People driving snowmobiles are at greater risk when driving in areas with currents, as polynyas are appearing in new, although relatively predictable locations.

“Years ago we could go right to the edge of the polynyas and hunt for game. These days you can’t always do that anymore because the polynyas are expanding and are hidden. The ice is thinner, where it wasn’t before” (Daniel Apawkak).

“It is easier with dogs. The dogs know, with their feelings. They won’t go. But with a snowmobile you go. Your snowmobile will not tell you that there is a problem. In the last few years, almost every year someone’s snowmobile goes down because we don’t know of the hidden polynyas. We don’t know anymore” (Daniel Apawkak).

Hunters begin avoiding polynyas in early spring and detour around areas where they know or suspect polynyas may be developing such as shoals, narrows, groups of

small islands, or points of land. The degree of difficulty in detouring around a polynya varies, depending primarily on the amount of snow present on the land and whether it is sufficient for snowmobile travel (Figure 20). As previously discussed, polynyas may receive heavy hunting pressure during early and mid-winter if floe edge conditions are dangerous.

“Because of the new polynyas that are occurring, people are having to travel around them, more on the coastline. Even when the ice looks solid on the surface it is not as solid as it used to be” (Emily Takatak) (in translation).

“You only need so much space to get through some areas. If the ice is only this wide then we’ll go on that. Experience can help you do that, it is the inexperienced hunters that we worry about because they don’t know these things. Pretty soon you’ll have to go through Kataapik and around all the points to get there because there will be no more snow to travel on” (Johnny Tookalook) (in translation).

Figure 20. Using the shoreline to detour around open water at Kataapik on a spring goose hunt, June 2007.



e) Shifts in Spring Harvesting Activities

In spring, rapidly deteriorating ice conditions are causing less people to pursue basking seals. By the time the seals start to bask in large numbers, most hunters are avoiding travel on sea ice because conditions are unsafe. This spring activity seems to

have been largely replaced by goose hunting and char fishing. Allie Ippak and Peter Kattuk recall how things have changed from when they were younger.

“Wintertime, you hunted seals; spring, you hunted basking seals; you didn’t think about geese” (Allie Ippak) (in translation).

“Less people are seal hunting in springtime. But we have seasons: wintertime seal hunting, springtime beluga and goose hunting, summertime fishing” (Peter Kattuk).

There are several factors contributing to this change in harvesting activities. First, and most important in the context of this project, changes to sea ice are causing more hunters to minimize risk by participating in activities that are land-based, allowing the use of all-terrain vehicles to access hunting and fishing areas instead of snowmobiles. However, many people still use snowmobiles to goose hunt, and do so for as long as possible in the spring, because snowmobile travel is quicker and smoother than travel by all-terrain vehicle.

“When I started to go hunting, when I was younger, we used to have long spring hunts, camping and goose hunting in May. Now we have only two weeks now of goose hunting [by snowmobile] because the ice has started breaking away already” (Peter Kattuk).

Second, there are more snow geese migrating through the Belcher Islands every year, and these geese arrive earlier each year. Thus, geese can be hunted successfully close to the community, requiring less time, effort, and fuel investment in contrast to seal hunting. Goose hunting provides more action than seal hunting, so it may be more appealing to young hunters, and is an ideal activity for children to participate in with their parents or other mentors.

Char fishing, whether through lake ice or open water, is similar to goose hunting in that people can travel over land to reach several char fishing lakes close to Sanikiluaq,

and it is an activity that everyone in the family can take part in. Char fishing seems to be more popular now than in the past, while the window of opportunity for fishing sculpins and cod through cracks in the sea ice has been shortened (Figure 21).

“One difference we have from the generation before is that they only fished during fish season [the char run] and caught a lot of fish, then stopped fishing. Now we go fishing day-in and day-out” (Allie Ippak) (in translation).

“The cracks on the sea ice, in the beach areas, we used to check for cod and sculpins. Those cracks used to melt away gradually. Now they just dissolve. Before the cracks used to stay and spread out until the ice is ready to break. The cracks on the ice are widening much faster than they used to” (Sarah Kittosuk Sr.) (in translation).

Figure 21. Fishing through cracks in the sea ice for sculpins and cod is a favorite spring activity, June 2007.



My research indicates that whether the change has been a conscious one or not, the shift to goose hunting and char fishing is an adaptive strategy that simultaneously minimizes the risks posed by travel on sea ice in springtime and maximizes the amount of hunting people can afford to do from both a financial and time management standpoint.

f) Changes to Spring Camping

Spring camping is another important activity for many residents of Sanikiluaq. With warm weather and longer days, spring traveling conditions are ideal. Entire families move out of the community to their favorite camping areas to hunt geese, ice fish, and pick berries that are exposed by melting snow. The arrival of spring is greeted with anticipation, as it is the first opportunity to get out on the land for an extended period after spending the winter in the community (Figure 22). Many people who no longer hunt in winter become active hunters and fishermen in spring (Minnie Takatak, pers. comm.). This camping season is generally about one month in length, lasting until the sea ice begins to become unsafe, at which point people return to the community. In response to earlier springs and more rapid melting of sea ice, there have been significant changes to the nature of spring camping.

Figure 22. A typical spring camp in the Belcher Islands.



One result of more rapidly thawing sea ice is a shortened spring travel period. Until the early 1990's, people were able to travel on the ice until July. Ice was thick and solid enough that people could travel even once holes began to form. Now the ice in

many places becomes unpredictable and dangerous by the end of May or early June.

Families leave the community sooner each year to begin camping, because they know that spring arrives very rapidly.

“We traveled on the sea ice even into July, to the end of July, even though we had to keep an eye out as to what sea ice conditions we were traveling on. Nowadays it is dangerous way sooner” (Johnny Tookalook) (in translation).

“June is the time people used to start going out camping, but they have been going out a lot earlier nowadays” (Johnny Kudluarok).

The duration of spring camping trips has become much shorter. People have to watch ice conditions closely and return to town at the first signs of poor ice conditions to reduce the risk of becoming stranded.

“Spring camping is shorter perhaps by a whole month. It depends on the ice, and if they need to go through land, how much snow was on the ground” (Allie Ippak) (in translation).

“That prevents a lot of people from wanting to stay out longer on the land, because of the rapid changes in the conditions they are not able to stay out as long as they wish they could” (Louisa Ippak) (in translation).

“Last year, at this time of the year we went camping and we had to come back to the community because there were too many dangers around and the ice wasn’t holding” (Louisa Ippak) (in translation).

Third, with a great deal of uncertainty surrounding ice conditions, many campers are choosing locations closer to the community. When the ice begins to deteriorate, they are able to return to the community quickly. Similar changes to spring camping patterns have been observed in Clyde River, NU, where it was noted that social and economic factors, in conjunction with climate change, were contributing to this shift (Wenzel, 1999).

“People that want to go out camping have to stay closer to the community because the ice is melting so quickly. There are more dangers than there used to be, which is causing the campers to stay in closer to the community. Even if they want to stay out longer in their camping grounds they are not able to do that because of the conditions” (Sarah Kittosuk Sr.) (in translation).

“People aren’t even able to go camping very far, because the sea ice is not safe. That is the kind of world we live in now” (Johnassie Iqaluk) (in translation).

Changes made to spring camping activities can be viewed as another adaptive strategy that has emerged through the accumulation of numerous coping mechanisms. Incremental changes to timing, location, and camping practices have accumulated over time, resulting in spring camping practices that are significantly different than those of the previous generation.

5.2.3 An Issue of Concern: Polar Bear Hunting

Polar bears are wide ranging animals, and it is often necessary to travel long distances to hunt them. Considerable financial return results from the harvesting of a polar bear (Freeman & Wenzel, 2006) (Figure 23), and significant prestige is awarded to the successful hunter based upon the large amount of meat that they are able to distribute within the community (Keith et al., 2005). For these reasons, some hunters are willing to take much greater risks to pursue polar bears than they would to hunt other species. During the course of my research, several hunters, primarily younger men, told me about venturing onto thin ice or breaking their snowmobiles by driving excessively fast through rough ice in pursuit of bears. On a seal hunt in March 2008, we were traveling along a wide crack south of the floe edge, which none of the seal hunters were crossing for fear the floe edge might break away. We stopped to talk to a man who was hunting at a breathing hole along the crack. When I asked him if anyone was hunting on the other side

of the crack, he replied, “just the father and the son who are looking for polar bears”, neglecting to mention their names.

Figure 23. Polar bear hide being freeze-dried, March 2008.
This hide may bring up to \$5000.00 CDN for the lucky hunter.



Hunters are under pressure to harvest a polar bear in part because of the tag allotment system currently being used in Sanikiluaq. The community is allotted 25 bear tags in total. When the HTA decides the hunt should commence, anyone in the community can begin hunting. This continues until 17 or 18 bears have been harvested, at which point every person who wants to continue hunting bears enters their name in a draw with the HTA. Each day the HTA draws the same number of hunters as there are tags; these are the hunters for that day. The next day new names are drawn. This continues until the quota of 25 bears has been filled, meaning a hunter will likely only be allowed to hunt 5 or 6 days for bears. Late in the season, hunters may only have one day to hunt, and then it is another hunter's turn. Therefore, many hunters are pressured to travel fast and far in search of bears, which, combined with current ice conditions, is a risky practice. The tragic disappearance of a young hunter in March 2008 at the floe edge north of Sanikiluaq was attributed by some people to the fact that this individual likely

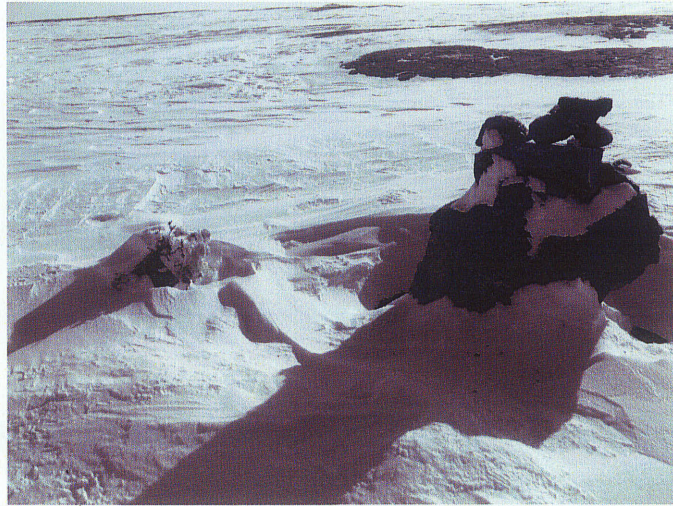
ventured onto dangerous ice searching for polar bears (Figure 24). Only days prior to this incident, two young hunters were skinning a polar bear they had shot near the floe edge when they spotted a second bear. They began to follow this bear, but had not traveled far when their snowmobile plunged through the ice. Luckily the skis caught on the ice and saved them and the snowmobile from completely submerging. The area they broke through looked safe on the surface but was dangerously thin (Paul Mickyuk, pers. comm.). A nearby hunter saw the incident and was able to help the two men pull out their snowmobile using a long rope (Johnny Takatak, pers. comm.). Three weeks later, two young hunters fell through the ice in two consecutive days; one was polar bear hunting, the other seal hunting. The first hunter was driving his snowmobile through rough ice when he broke through an area of open water that was hidden by drifted snow. The second hunter was walking along a crack in the ice looking for seal breathing holes and did not notice another crack that was covered with snow. He fell through to his waist and was saved when the gun he was carrying hung up on the ice (Peter Alugiak, pers. comm.). Fortunately, both hunters made it safely back to the community.

“Teenagers these days hunt differently or have different priorities than the older people did. They get much further distances in a shorter amount of time, so sometimes the younger generation do go far when they go hunting, especially during polar bear hunting season” (Johnassie Iqaluk) (in translation).

“If you are going out hunting for polar bears, not only are you looking for bears but you are looking for dangerous sea ice” (Samson Meeko Sr.) (in translation).

“The hunters only go long distances when they are polar bear hunting, and then they have to keep watch on the condition of the ice they are traveling on. They have to keep an eye on the ice conditions that are where they are” (Johnassie Iqaluk) (in translation).

Figure 24. Memorial for Jasonie Kautainuk near where he was last seen while polar bear hunting on February 28, 2008.



Money and prestige may cause people to take risks in pursuit of polar bears, but it seems likely that the tag allotment system also contributes. The inflexible set of rules governing management of large mammal species such as polar bears and beluga whales conflicts with the flexibility, patience, and adaptability that are required to safely navigate on sea ice. Ford and the Community of Arctic Bay (2006) report a similar increase in hunting effort and increasingly risky hunting behavior in relation to the quota system during the spring narwhal hunt in that community. Berkes and Jolly (2001) describe how inflexible polar bear hunting season dates were beginning to conflict with unsafe sea ice conditions, putting hunters at risk in the community of Sachs Harbour. As a result, the local HTA's were given more power to decide when polar bear seasons should begin. Hunters and Trappers Associations and policy makers should perhaps examine this issue more closely to further improve the flexibility of the quota system with respect to both season timing and harvest numbers. The goal of such changes should be to put less pressure on each individual hunter to be successful, theoretically causing individuals to take fewer risks. Further changes to be explored at the community level could include

implementation of a partner system in which younger hunters would be paired with more experienced hunters. Even pairing two younger hunters together would increase the chances that one could rescue the other should one person fall through the ice.

5.2.4 Technological Advances

Rapid adoption of new technology has been a common adaptive strategy throughout the history of the Inuit people (Krupnik, 1993). Snowmobiles and firearms are examples of technological advances (arguably) that were incorporated rapidly into Inuit culture. Radios, GPS units, and satellite phones are being readily adopted by Inuit as navigational aids and safety tools (Figure 25). The Sanikiluaq Hunters and Trappers Association can provide these new technologies for hunters at a discounted rate through their hunters assistance program (Lucassie Arragutainaq, pers. comm.). Users of this technology are hoping to partially mitigate the risks of an increasingly dangerous sea ice environment. A hunter who gets stranded or falls through the ice now has the ability to call the community for help, an occurrence that is becoming increasingly common. GPS units allow people to navigate in poor visibility or mark dangers to be avoided in the future, thereby allowing them to remain safer during future excursions or share this knowledge with other people. GPS may also be used to mark areas where large numbers of breathing holes were found, making these locations easier to find after a snowfall. The trend toward increased technology use can be seen in Sanikiluaq as it has been seen in other areas of the Arctic (Ford et al., 2006), but this change comes at a cost. A false sense of security, erosion of traditional travel and way-finding skills, and increased amounts of travel without the presence of senior hunters have all become causes for concern,

stemming directly from the incorporation of modern technologies into the hunting culture (Aporta & Higgs, 2005).

Figure 25. Making use of new technology; a hunter uses a plywood boat to transport his gear. Note the satellite phone in the stern.



The community radio station is an important means of rapidly communicating the location of dangerous areas to everyone in the community. When a hunter falls through the ice or encounters some other dangerous situation, the event will usually be mentioned on the radio to inform the entire community. This keeps everyone in town up to date on ice conditions and is therefore a common practice in most northern communities (Ford et al., 2006). This efficiency in knowledge sharing is essential if hunters are to adapt in a timely fashion to rapidly changing and unpredictable ice conditions.

“Just recently someone announced on the radio that there is a dangerous area on the north side right now. The conditions are not reliable there as of today, so people were warned not to hunt in that area, or be very observant if they were going in that area. Because of this I think the hunters are going more on the south side” (Emily Takatak) (in translation).

“People warn over the radio all the time now that these new polynyas, you can’t see them but they are there” (Daniel Apawkak).

Some people lament that hunters do not go on the radio as frequently as they previously did to speak about their day's hunting experiences. This is detrimental to effective adaptation, since not everyone learns about dangerous areas as quickly as is possible.

"The people that used to talk on the public radio station about their days hunting experience are all gone now, so we don't hear a whole lot of men talking about their hunting experiences today" (Johnny Meeko Sr.) (in translation).

5.2.5 Search and Rescue

Rescuing stranded hunters from the floe edge has been an increasingly common operation in Sanikiluaq. The increase in the number of rescue operations has coincided with increased use of GPS, satellite phone, and radio technology by hunters (Lucassie Arragutainaq, pers. comm.). Technological advances make rescue missions easier to conduct; conversely, Inuit recognize that increased dependence on this technology is in some cases displacing their own traditional knowledge and may be contributing to the problem.

"In the past we wouldn't know what had happened to these people. In the modern times they will have a phone or a radio and will say 'hey, we are floating away, come and get us'" (Daniel Apawkak).

"We get a boat going, put it on a sled, and go after them" (Daniel Apawkak).

On February 28, 2008, a young hunter named Jasonie Kautainuk went missing while polar bear hunting north of Sanikiluaq. Jasonie was hunting alone near the floe edge during the late evening, when most other hunters had returned to the community. Although an extensive search was conducted over a period of two weeks, no trace of Jasonie or his snowmobile was found.

During an interview several weeks after the tragedy HTA president Lucassie Arragutainaq described the search in detail, and reflected on some of the lessons learned by those involved with the search effort. Searches initially start small. When a family notices a hunter is missing, they contact the HTA, who immediately call a meeting and begin to coordinate the search effort. Once the last known location of the missing person has been determined, a few searchers are sent out. These initial searchers report their findings and travel routes back to the HTA. Meanwhile, the HTA meets with a representative from the hamlet office and another from the RCMP to activate a search and rescue fund in order to reimburse searchers for such necessities as gas, oil, and food. The ground search continues non-stop for twenty-four hours, but if nothing is found, search and rescue in Trenton, Ontario is contacted and a Hercules is dispatched to conduct an air search. All information and proceedings of the search are documented and reported promptly to a search and rescue coordinator in Iqaluit, NU, who officially records how the search is conducted for government records. In the search for Jasonie, the Hercules search was unsuccessful, but the community remained unsatisfied. An Air Inuit Twin Otter was chartered, and local people continued the air search as well as the ground search for several more days.

There were several lessons learned by the community searchers in February and March 2008; these will hopefully contribute to making the next search a successful one. First of all, the priority of the initial search group needs to be locating the tracks of the missing individual. Other hunters had seen Jasonie on the evening he went missing, so his approximate location was known. As a result, the first searchers used snowmobiles to look for him in that area, thinking that he may have had mechanical trouble. By the time

it was realized that Jasonie was truly missing, the tracks of the searchers had greatly complicated the job of locating the correct track. To address this issue, the searchers devised a way to differentiate individual tracks by measuring and recording each hunters' ski widths, track widths, and *qamutik* runner widths; it was also noted whether each *qamutik* was being pulled with a rope or a solid hitch (the two are easily distinguishable by how closely they follow the snowmobile track). In this way, a searcher armed with a tape measure and the list of measurements can identify the owner of any track that is encountered. An updated version of this list will be kept by the HTA and should greatly improve the efficiency of future search efforts. Lucassie Arragutainaq mentioned that hunters following tracks over freshly formed ice had to keep in mind that tracks expand over time due to the growth of crystals on the surface of the ice.

Other areas of improvement came to mind during interviews and casual discussions with community members that were directly and indirectly involved in the search effort. Most noticeably, there appears to be a lack of continuity between ground and air search efforts. The Hercules from Trenton does not take on board any local searchers who know the area, and they do not have any direct contact with the ground searchers or search coordinators in the HTA office. All communications with the community are relayed through a third party in Trenton. There are two negative outcomes of this arrangement. First, the air search does not benefit from the knowledge of local experts who know the lay of the land, the tendencies of the person being searched for, and the ways in which hunters travel. Second, when the air search is complete, local people have little faith in the findings. Due in part to their lack of involvement, most

people in Sanikiluaq thought that Trenton called off the search prematurely; this is why the Air Inuit plane was chartered.

The evolution of search and rescue techniques and protocols in Sanikiluaq, and Nunavut in general, is an important adaptive strategy addressing the increasing risks hunters face during their daily lives. When governments and other organizations contemplate what can be done to help northern peoples adapt to climate change and where their money is best spent, improved search and rescue should be near the top of the list. Search and rescue requires equipment and trained personnel, both of which are lacking in northern communities like Sanikiluaq. Greater commitment by provincial and federal governments is required in this area to prevent further loss of life due to dangerous sea ice.

5.3 Adaptive Capacity and Barriers to Adaptation

Adaptive capacity refers to the potential of a community to address, avoid, mitigate, or respond to climate-change related exposures, through such avenues as modified behaviors, practices, and institutions (Ford et al., 2006). Previous research has identified many factors that contribute to the adaptive capacity of northern communities. These include the extent to which proven traditional adaptive strategies (e.g. flexibility in resource use, age/gender/occupational roles, transmission/application of IQ, and strong social networks of sharing) remain intact within the community (Robards & Alessa, 2004; Woollett, 2007). The speed at which feedback and communication occurs within bodies governing resource use, such as co-management institutions, also plays a role (Berkes & Jolly, 2001). In my opinion, the most important tool the Inuit people have for adapting to changing sea ice conditions is their knowledge of the environment. This is

more important than technology or any assistance that scientists or government may provide. Throughout the history of the Inuit people, including the Thule and Dorset cultures that preceded them, knowledge of the environment was what ensured survival (Langdon, 1995). As the environment changed or people migrated from one area to the next, their knowledge necessarily evolved in parallel with the changes in their surroundings. The shorter the time lag between a change in the environment and the corresponding addition of new information to the knowledge base of the people, the safer and more successful they would be. I believe that the same basic principle can be applied to the current situation of Inuit adapting to climate change. In order to adapt successfully, the body of Inuit Quajimaningit must evolve at a similar pace to changes in the environment. As climate change accelerates changes in the sea ice environment, IQ must grow and evolve at the same accelerated pace. If change in the environment outpaces changes to the body of knowledge held by Inuit, people will be exposed to greater risk, as the knowledge necessary to cope with the new challenges would simply not have been created yet.

The rate at which IQ on sea ice evolves is dependent upon several factors, including, but not limited to, the number of active hunters in the community, the amount of hunting that is occurring, and the speed, amount, and efficiency of knowledge sharing/transfer between peers and between generations. I will argue that there has been a decline in all of these factors; therefore, instead of evolving to keep pace with sea ice change, IQ on sea ice travel and hunting is lagging ever further behind the environment and greatly increasing the risks to which hunters are exposed.

The increased cost of snowmobiles, fuel, and supplies has hindered the ability of many people in northern communities to be full-time hunters (Oakes & Riewe, 1997). Frequently, it is only those individuals with employment that can afford to hunt, which means that hunting is in many cases occurring only on weekends and evenings (Ford et al., 2006). Many younger men are uninterested in hunting, choosing community life and employment instead. Therefore, there are far less active hunters in Sanikiluaq now than there were in the past. A shorter winter season and increased fuel costs also contribute to hunters spending less time on the land. Fewer hunting trips are taken, and these trips tend to be shorter in duration than what was common in the past. Ford (2007) cites financial strain as a major barrier to effective adaptation in the community of Arctic Bay, where some hunters have difficulty affording necessary repairs to equipment. In Sanikiluaq, it is common for some full-time hunters to be unable to hunt for weeks, or months due to lack of resources needed to repair a mechanical problem. Families who rely upon traditional foods rather than cash income are having difficulty coping when access to their hunting areas becomes increasingly limited, and men are unable to spend enough time afield to provide for their families' food requirements.

Knowledge transmission, particularly between generations, is a vital component of the adaptive capacity of an Inuit community. Facts become incorporated into the communal body of IQ through information sharing and discussion, allowing this body of knowledge to evolve and keep pace with environmental change. Sharing knowledge at home or in the community is a poor substitute for discussing sea ice conditions while experiencing them firsthand. I applied this learning technique by making use of both interviews and participant observation as research methods, and found that the lessons

learned during participant observation were invaluable assets in developing my understanding of sea ice. This lesson holds true for both researchers and young Inuit aspiring to be hunters. If youth do not hunt with older family members or other mentors, they will have a difficult time learning the necessary skills to be a safe and successful hunter. Due to various social changes such as school, work, technology, and other influences of Western style culture, fewer young people than ever are learning to be hunters (Condon et al., 1995). Consequently, it tends to be young, inexperienced, and/or part-time hunters that are experiencing the greatest difficulties in adapting to sea ice change (Ford et al., 2006).

“We don’t take them out as much as we want to because they have to go to school. In my time, there was no school. I used to go out almost every day. When my father went out, I had to follow him. School is here now so less fathers are taking their young people seal hunting in the wintertime” (Peter Kattuk).

To this point, the discussion of adaptation has focused on knowledge transmission between older, more experienced hunters and younger hunters, both of which are generally understood to be male. It should not be overlooked that the transmission of knowledge from elder women to younger women is equally as crucial to the adaptive capacity of Inuit facing climate change related challenges. The success and safety of any hunter relies upon the skill of his wife, mother, or grandmother to provide him with the necessary clothing for survival in a harsh environment (Oakes & Riewe, 1997). An increased incidence of hunters falling through *aputainnaq* for example underscores the importance of waterproof footwear, the creation of which is a skill held by only the most expert Inuit seamstresses. Intergenerational knowledge transfer amongst women is challenged by many of the same factors being discussed for hunters.

Storytelling is another way that Inuit Knowledge on sea ice is shared between generations (Fox, 2002; Jolly et al., 2004). Stories teach hunters which areas have traditionally been safe and which areas are known to be dangerous. Rapidly changing conditions are causing some of these stories to be less accurate, a problem that is putting hunters in dangerous situations more frequently. As mentioned previously, ice that has frozen overnight is no longer safe to travel on. An increase in the prevalence of *aputainnaq* and the presence of thin ice hidden by drifted snow also contribute to the dangerous conditions. Decreased ability to assess ice conditions with certainty leads to a corresponding increase in the amount of risk that hunters face while out on the ice.

“You would always just know. It was passed down to you from your father or your grandfather. They would say “this area is good”, because years ago it was steady. You get spring, summer, fall, winter, it was steady. All of a sudden our stories won’t tell us which places are safe anymore. We still know what it used to be, but it is not like that anymore” (Daniel Apawkak).

“Even places that are not supposed to be dangerous are becoming more dangerous” (Davidee Eyaituk) (in translation).

“From knowledge that is passed down from generation to generation, hunters are very observant of where dangers are. We always try to make sure to keep out of the danger. When we do know of the danger, we try to avoid going to that area” (Paulossie Ekidlak) (in translation).

During a discussion with one hunter on the topic of people getting lost or falling through thin ice, the man brought up the subject of his own brother. He told me how his brother had no interest in hunting while they were young. While he followed his father, his older brother stayed home. Following and observing at a young age is key to becoming a competent hunter, as sea ice is so complex that it takes many years to learn how to hunt safely. Once he got older, the brother decided he would like to be a hunter after all and began hunting on his own. However, he lacks many important years of

experience, so my friend told me he worries that his brother is going to get into trouble some day. For example, less experienced hunters will often try to reduce risk by following the tracks of other hunters, believing this will keep them safe (Ford et al., 2006). On sea ice, safety is never guaranteed, and cracks can occur anytime and anywhere; even following an existing trail, a hunter must be vigilant. Some people attributed the disappearance of Jasonie Kautainuk to this sort of situation and agreed that this is likely going to become more common in the future.

Chapter Six: Conclusions, Recommendations, and Contributions

The bulk of northern climate change research to date focuses on physical processes, modeling, and use of remote sensing technology, in which northern communities are generally considered little more than passive actors (Deurden, 2004). Comparatively little meaningful research has been done within northern communities themselves. Yet logically, community-based research should be both the starting and ending point for all northern research; Inuit people living subsistence livelihoods are being directly impacted by climate change and are knowledgeable about the implications of climate change with respect to other aspects of the Arctic environment. Inuit should therefore be involved in setting the priorities of northern research and should be the first to benefit from the findings. The scientific community is coming to this realization, but there remains much room for improvement in the realm of meaningful involvement of Inuit people in Arctic research. The emphasis of this thesis has been to accurately document Inuit observations of sea ice change and determine the meaning of these changes to local people with respect to their traditional livelihood. The ultimate goals of the thesis are to provide direction for future research in Sanikiluaq, based on the collective concerns of local residents, and to provide a critical assessment of how adaptation to climate change could be improved through both local and government initiatives.

6.1 Conclusions

Most Sanikiluaq residents agree that major changes are underway in their local sea ice environment. These changes are seen as both significant and problematic, posing a major threat to the continuation of the traditional Inuit livelihood in its current form.

Although many areas of change were mentioned and discussed by project participants, the most widely agreed upon themes included late freeze-up, early spring thaw, thinner ice, and ice that has become weaker and increasingly unpredictable.

The impacts of sea ice change are felt throughout the community and are a frequent topic of discussion among hunters and non-hunters alike. A winter season that has been shortened by one month at either end has resulted in significantly less time spent on the sea ice pursuing seals, the preferred traditional food among most Inuit in Sanikiluaq. The impacts of such a shift in the harvesting season are far-reaching. Hunters and their relatives are unable to consume seals if hunters cannot safely access their hunting areas, so consumption of seals decreases along with a shorter winter season. The result is an increased reliance on store bought food, which is more expensive and of less nutritional value than seal. Hunters are financially affected through the loss of income brought in by the sale of seal pelts. The indirect impact of a shorter hunting season is that hunters, particularly young hunters, have less time in which to learn how to safely navigate on the increasingly dangerous sea ice. Inuit children who learn by hunting with their fathers and grandfathers are unable to participate in hunts over their Christmas school break, as the sea ice now remains unsafe until January. The shorter winter hunting season therefore presents a challenge to the successful adaptation of Inuit to environmental change.

Adapting to challenging environmental conditions has been one of the major strengths of the Inuit culture and that of their ancestors for centuries. Flexibility and diversity in resource use, amassing a body of traditional knowledge, readily adopting new technology, remaining highly mobile, and relying on strong social networks are some of

the adaptive strategies that have allowed the Inuit to thrive where others could not. However, never before have the Inuit faced such rapid environmental change; it was therefore one of the objectives of this project not only to document, but to discuss the challenges that Inuit face as they strive to adapt to accelerating climate change. In general, the adaptive strategies of the past continue to be used successfully to buffer the impacts of sea ice change. Although the winter season is shorter and the sea ice is more dangerous, experienced hunters can find species to hunt and places to hunt them. Examples mentioned earlier included use of polynyas in landfast ice as back-up hunting areas when floe edge conditions are unsafe and replacing the hunting of basking seals with the hunting of geese when the ice begins to deteriorate in spring. However, the younger generation of hunters who have not yet gained the experience of their elders find adapting to the changes more difficult and as a result are exposed to increasing risks. There are many barriers to adaptation that challenge the ability of younger Inuit to become safe, successful hunters. Such barriers include sea ice conditions that their elders can no longer predict, a shorter winter season, increased costs of hunting, and pressures of school and work that prevent young people from hunting with and learning from elder family members. The end result of these barriers to adaptation is that less experienced hunters are being exposed to more risk than ever before. Fewer young Inuit are choosing to become hunters, but those that do are frequently finding themselves in dangerous situations. The winter of 2007-2008 demonstrated this problem, with one fatality and three incidents of hunters falling through the ice, all involving young men.

6.2 Recommendations and Contributions

Climate change, possibly exacerbated by hydro-electric development, is accelerating changes in the sea ice in Hudson Bay. As mentioned in the previous chapter, successful adaptation requires IQ on sea ice conditions to evolve at the same accelerated pace. In order to attain this goal, current barriers to adaptation must be overcome through a combination of local and government initiatives.

At the local level, likely through the HTA, a hunter-mentoring program could be organized. There is currently no funding or support for older hunters in Sanikiluaq who are willing to have young men accompany them during hunts. There are numerous young men in the community who have the desire to become hunters but lack the financial means and the guidance of an experienced mentor. Such a program would require snowmobiles, guns, and safety equipment for student hunters to borrow, compensation in the form of gas and possibly a wage for the mentors, and a program organizer who would pair mentors with youth. This sort of mentoring occurs within the community on an informal basis but participation could be increased if it were facilitated through the HTA. A mentoring program would simultaneously address two significant barriers to adaptation; a lack of knowledge transfer between generations and a lack of firsthand experience that is vital to learning about sea ice travel.

With certain sectors of Inuit society struggling to adapt to challenging sea ice conditions, additional avenues to reduce the risks of hunting must be explored. As discussed previously, the polar bear hunt is associated with the majority of hunting accidents that occur each year in Sanikiluaq. Under the current system, polar bear hunting is basically a free-for-all competition to get a bear before the quota is filled. This system,

along with the financial gains associated with being successful, cause some hunters to take unnecessary risks. One simple way the polar bear hunt could be made safer would be to implement a mandatory partner system, similar to those that exist elsewhere in Canada for some big-game species. Hunters would apply for tags in pairs and hunt within eyesight of each other. Even if hunters chose to travel over risky ice, the likelihood of a major accident would be reduced, as a hunter would always be nearby to rescue his partner or provide assistance in the case of mechanical trouble. A partner system could easily be set up by the HTA if local hunters and elders supported the idea. To take this concept one step further, an ambitious HTA could make it mandatory for inexperienced hunters to be paired with experienced hunters to further minimize the chances of accidents occurring.

An improved safety net for hunters in the form of better search and rescue should be considered as a way that governments could help northern communities adapt to climate change. Improved search and rescue through increased local participation in air searches would be a good start, as discussed in the previous chapter. Another relatively cheap technology that is now available and could be of great use are personal satellite tracking units. Smaller and less expensive than GPS, these units send regular updates on a person's location to an email address of their choice via satellite. A distress function allows a person to communicate that they are in trouble at a certain location. All locations show up both as coordinates and as a marked point on a GoogleEarth satellite image. Tracking units could be issued to all hunters, and a computer would be set up at the HTA office that would track the movements of all hunters. If this technology were in use, the

response time and cost for search and rescue operations would be reduced to a fraction of what it is now.

I do not intend to suggest that these local level recommendations be instituted as formal rules. Rather, support for the ideas would have to come from within the community if any lasting change in local practice were to occur. From my experience in Sanikiluaq, support of elders in the community is the primary factor in determining whether an idea is put into practice and supported by the remainder of the community. To this end, a copy of my thesis will be given to the HTA, and my suggestions put forward in an oral presentation, but any further action must be an initiative of Sanikiluaq residents.

At the government level, major changes to the Nunavut school curriculum are necessary if the next generation of Inuit children wish to maintain aspects of a traditional Inuit lifestyle. To properly discuss this topic would require a thesis of its own, but I feel it is too important to neglect here. Many participants of this project mentioned that the commitment of school keeps their children at home when they would prefer to take them hunting to learn in the traditional Inuit way. Inuit youth now finish school to find they are lacking many years of important experience on hunting, travel, and sea ice processes. Learning to read and write is very important in modern society, but just as many schools allow students to focus on a vocation in high school, so too should Nunavut schools offer a traditional knowledge stream, allowing students to focus on learning traditional knowledge and skills if they so choose. If a portion of every week involved lessons on the land from local elders and participation in hunting trips with experienced mentors, there would not exist such a disconnect between school and daily life. This disconnect is a

cause for concern to many Inuit who fear the loss of their traditional skills and culture, and likely has implications for such issues as school attendance and drop-out rates. One such initiative is already underway in Nunavut: Clyde River has recently been chosen as the location of Piqqusilirivvik, the Nunavut Cultural School, to be completed by 2011. The goal of the school is to foster Inuit culture and language and teach traditional skills. The school curriculum is currently being developed with input from Inuit educators and Inuit elders to properly reflect Inuit values and address important issues in modern Inuit society (Flaherty, 2008). If Piqqusilirivvik realizes the success that many anticipate, it could act as a model for all schools in Nunavut to begin incorporating Inuit teachings into their own programs.

Recommendations also emerge from this project on the topic of meaningful interaction between scientists and Inuit, particularly in the community-based monitoring (CBM) of environmental change. The existing approach of many CBM programs, including the existing ArcticNet funded project in Sanikiluaq, has been for scientists to hire local people to collect data relevant to scientists, to be analyzed by scientists. In my opinion, this cannot be considered true community-based environmental monitoring, as scientists determine what information is collected and how it is analyzed. In the case of the ArcticNet sea ice monitoring station, local people maintain the station and in part determine the monitoring location although this is subject to many limitations. I suggest a reversal of this situation, incorporating true two-directional knowledge transfer, for the benefit of both scientists and local residents. I will explain this position using examples from my research in Sanikiluaq.

Culturally and locally relevant indicators of sea ice change must be used to measure change, rather than indicators determined by scientists. Such indicators must be measured in locations determined to be important by local people. This will ensure that the primary goal of community-based monitoring research - to provide information on environmental change for the benefit of local residents - is met. An added benefit of using community-identified indicators is that local people will be more likely to support and participate in the research. In Sanikiluaq, possible indicators that emerged during the course of this project included freeze-up/break-up dates for high use polynyas, thickness of seal breathing holes in areas of heavy current and minimal current, and ice thickness in areas used for ice fishing or mussel gathering. Other indicators that are locally relevant but would be more effectively measured by scientists on a large scale include mapping the amount and location of areas of *maaniituit*, particularly north of Sanikiluaq; satellite imagery of the ice bridge to the Quebec mainland; and satellite imagery of the floe edge. Due to the relative skill sets of the Inuit and the scientific community, Inuit are better suited to monitor fine scale changes occurring at the local level, while scientists are better suited to monitor large scale environmental change through remote sensing technology (Jolly et al., 2004). Measuring climate change over different scales offers Inuit and scientists the opportunity to combine their findings in order to create a detailed description of environmental change, setting the stage for two-way knowledge-sharing. Continuing this line of reasoning, analysis of all the data should be done simultaneously, quantitatively by scientists and qualitatively by local experts. The purpose of such dual analysis would not be to question the validity of the others' work, but to provide a holistic documentation of changes, which would be of relevance and interest to both

scientists and local people. Carmack and MacDonald (2008) conducted scientific research on environmental phenomena that were identified and studied by Inuit experts in the vicinity of Tuktoyaktuk, Northwest Territories. The authors noted that Inuit Knowledge was very useful in providing direction to the research, and the science was most useful in modeling and making predictions. I commend the authors' conclusion that "by not requiring agreement between indigenous knowledge and Western science, or ranking one above the other, we can realize the values of each approach" (Carmack & MacDonald, 2008: 265).

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GLOSSARY OF INUKTITUT TERMS

Aaroguk. The process by which cracks in the sea ice widen during spring.

Annisa. Large pieces of ice that were once common during the spring break-up, but are less common now.

Aputainnaq. Weak, dangerous ice formed of frozen slush when snow falls during freeze-up or when snow drifts across an open crack.

Ikirasait. An area of open water in winter; a polynya.

Inuit Quajimajatuqangit. A term commonly used in Canada to encompass all forms of Inuit Knowledge and ways of knowing, but referring to knowledge that is primarily historical in nature.

Inuit Quajimaningit. Translates directly into Inuit Knowledge without implying that the knowledge historical or outdated.

Irmanisait. Open water, typically a fresh crack, covered with drifted snow.

Maaniikala. Rough ice formed when currents, winds, and/or tides crush thin ice, forming rough ice that does not exceed 30 cm in height. *Maaniikala* is very rough to travel through, but not impassable.

Maaniituk. Rough ice formed when currents, winds, and/or tides crush thick ice into large piles of broken ice blocks. This rough ice may cover large areas and is often impassable. Referred to as *maaniituk* when the observer is close to the rough ice.

Maaniituit. Same as *maaniituk*, but called *maaniituit* if the rough ice is being viewed from a distance.

Qaanittaq. A layer of hard drifted snow covering ice. This layer can strengthen ice, but can also insulate ice and allow it to be eroded from beneath.

Qamutik. An Inuit sled, built by lashing boards across the top of two long, narrow runners. A qamutik can be pulled with a rope or with a solid hitch built of steel tubing.

Quunik. Cracks in the sea ice that form along the shoreline or between points of land and/or islands. These cracks are used for ice fishing in spring.

Tuvaq. Landfast ice; ice that remains solidly fixed to the shoreline throughout the winter.

APPENDIX A:

Nunavut Research Institute Licence

Nunavummi Qaujisagtulirijikkut / Nunavut Research Institute

Box 1720, Iqaluit, NU XCA 0H0 phone: (867) 979-7279 fax: (867) 979-7109 e-mail: csparon@nri.nu.ca

SCIENTIFIC RESEARCH LICENCE

LICENCE # 0100208R-M

ISSUED TO: Devin Imrie
University of Manitoba
Box 179
Falcon Lake, MB
R0E 0N0 CA
204 349-2410

TEAM MEMBERS:

AFFILIATION: University of Manitoba

TITLE: Traditional Knowledge on Sea Ice Change in Sanikiluaq -Impacts on Inuit Hunters

OBJECTIVES OF RESEARCH:

The purpose of this project will be to document local observations on traditional knowledge on sea ice change and variability to provide a holistic view of how changing sea ice conditions are affecting Inuit harvesting and travel in the vicinity of Sanikiluaq, NU. The objectives of the project are: 1) Document local and traditional knowledge, insights, and perspectives on how and why sea ice conditions have changed in recent years. 2) Assess the perceived impacts of sea ice change on hunting practices, harvest success, and safety. 3) Look for similarities between local knowledge and scientific data to provide a holistic assessment sea ice changes in and around the Belcher Islands. 4) To work cooperatively with local people so as to accurately and respectfully record their knowledge, ideas, and perspectives in the research. 5) Present to the findings of the research back to the community in the form of posters and a book, to aid in the transfer of knowledge from elders and hunters to the youth in Sanikiluaq.

TERMS & CONDITIONS:

DATA COLLECTION IN NU:

DATES: April 01, 2007 - June 2008

LOCATION: Sanikiluaq

Scientific Research Licence 0100208R-M expires on December 31, 2008

Issued at Iqaluit, NU on January 21, 2008

Mary Ellen Thomas
Science Advisor

Nunavummi Qaujisaqtulirijikkut / Nunavut Research Institute

Box 1720, Igloolik, NU, X0A 0H0 phone: (867) 979-7279 fax: (867) 979-7109 e-mail: cspavor@nri.nu.ca

January 21, 2008

NOTIFICATION OF RESEARCH

PLEASE BE ADVISED THAT SCIENCE RESEARCH LICENCE No. 0100208R-M HAS BEEN ISSUED TO:

Devin Imrie
University of Manitoba
Box 179
Falcon Lake, MB
R0E 0N0 CA
204 349-2410

TO CONDUCT THE FOLLOWING STUDY:

Traditional Knowledge on Sea Ice Change in Sanikiluaq -Impacts on Inuit Hunters

SUMMARY OF RESEARCH:

The purpose of this project will be to document local observations on traditional knowledge on sea ice change and variability to provide a holistic view of how changing sea ice conditions are affecting Inuit harvesting and travel in the vicinity of Sanikiluaq, NU. The objectives of the project are: 1) Document local and traditional knowledge, insights, and perspectives on how and why sea ice conditions have changed in recent years. 2) Assess the perceived impacts of sea ice change on hunting practices, harvest success, and safety. 3) Look for similarities between local knowledge and scientific data to provide a holistic assessment sea ice changes in and around the Belcher Islands. 4) To work cooperatively with local people so as to accurately and respectfully record their knowledge, ideas, and perspectives in the research. 5) Present to the findings of the research back to the community in the form of posters and a book, to aid in the transfer of knowledge from elders and hunters to the youth in Sanikiluaq.

THE STUDY WILL BE CONDUCTED AT: Sanikiluaq

BETWEEN: April 01, 2007 - June 2008

Carrie Spavor
Research Liaison

DISTRIBUTION: NTL, Social Cultural Department
QIA, Social Policy
Mayor/ SAO, Sanikiluaq
HTA, Sanikiluaq

January 21, 2008

Devin Imitic

University of Manitoba

Box 179

Falcon Lake, MB

R0B 0N0 CA

RE: 2007 Science Research Licence

Please find enclosed your 2007 Research Licence No. 0100208R-M which was prepared under the *NUNAVUT SCIENTISTS ACT*. Should you require further support from the NRI Research Centre, please contact the Manager to discuss your research needs.

Please be advised that this multi-year licence is subject to all criteria established in the *Nunavut Land Claim Agreement* and will be subject to any future changes that may occur in the *Nunavut Land Claim Agreement*. A multi-year licence may also be revoked for any of the following:

- the researcher fails to submit an Annual Summary Report
- the researcher breaches any term or condition set out in the licence
- the researcher fails to renew associated licences
- complaints with just cause are received concerning the project or any project team member
- the researcher fails to notify the NRI of any changes to the project

Important Renewal Information
Multi-year licences are granted for the duration indicated on your application form. All NRI licences however, expire at the end of each calendar year. To renew your licence each year, according to the *Scientists' Act*, researchers must submit a 500-1000 word non-technical *Annual Summary* of your research activities and findings in English and Inuktitut or Inuinnaqtun. The translation ensures maximum accessibility of your research results to Nunavut residents. A list of translators is available from the NRI.

Upon completion of your fieldwork in Nunavut, please ensure that you submit a *Final Report* with an English and translated executive summary. Copies of papers that you publish are appreciated. Electronic copies of reports (Microsoft Word or Adobe PDF) would be most appreciated for posting on the NRI web site (www.nri.nu.ca).

Thank-you in advance for assisting in the promotion and development of a scientific research community and database within Nunavut. The reports and information you provide are utilized to prepare an annual research compendium, which is distributed to communities and organizations in Nunavut as well as to researchers across Canada.

Please accept our best wishes for success in your research project.

Sincerely,

Carrie Spaver
Research Liaison

APPENDIX B

Interview Consent Form

Research Project Title Traditional Knowledge on Sea Ice Change in Sanikiluaq-
Impacts on Inuit Hunters

Researcher: Devin Imrie, Natural Resource Institute, University of Manitoba

Address: Box 179, Falcon Lake, Manitoba, Canada

Phone: 204-349-2410

Email: devimrie@yahoo.ca

Sponsor: ArcticNet

Informed Consent

This consent form, a copy of which will be left with you for your records and reference, is only part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. If you would like more detail about something mentioned here, or information not included here, you should feel free to ask. Please take the time to read this carefully and to understand any accompanying information.

Purpose of the Research

The purpose of this project will be to document local observations and traditional knowledge on sea ice change and variability to provide a holistic view of how changing sea ice conditions are affecting Inuit harvesting and travel in the vicinity of Sanikiluaq, NU.

This knowledge can then be used within the community to create more awareness of changing sea ice conditions, especially in the younger generation. This study will also be useful to communicate the changes being seen in Sanikiluaq to the rest of Canada, helping to guide and focus future scientific research.

Objectives

The objectives of the project are:

- 1) Document local and traditional knowledge, insights, and perspectives on how and why sea ice conditions have changed in recent years
- 2) Assess the perceived impacts of sea ice change on hunting practices, harvest success, and safety.
- 3) Look for similarities between local knowledge and scientific data to provide a holistic assessment sea ice changes in and around the Belcher Islands.
- 4) To work cooperatively with local people so as to accurately and respectfully record their knowledge, ideas, and perspectives in the research.

- 5) Present to the findings of the research back to the community in the form of posters and a book, to aid in the transfer of knowledge from elders and hunters to the youth in Sanikiluaq.

Methods

I intend to use an ethnographic research design, including semi-directive interviews and continual and ongoing participant observation. The format of the interviews will allow the conversation to be guided by the interviewee, to explore issues often unforeseeable to the researcher. This will enable the researcher to obtain a holistic picture of the subject of study with an emphasis on portraying the everyday experiences of individuals.

Interviewees will be given the opportunity to verify their knowledge as it is represented by the researcher before the research is completed or published.

The community of Sanikiluaq was chosen because of the gap in research regarding the effects of climate change in the region.

I. A description of the Interview

- The interview will be on the subject of sea ice changes seen in the last 10-15 years, and the effects of these changes on hunting and travel on the ice.
- The interview will be between 30 minutes and 2 hours in duration.
- The interview will be conducted with the help of an interpreter, will be tape recorded, and notes will be taken
- A photograph will be taken with the consent of the interviewee

II. Confidentiality

- The researcher will request signed permission before releasing the names, photographs, or information shared by the interviewee.
- Recorded conversations will be considered the property of the interviewee, and signed permission will be asked before the release of this property.

III. Details of any form of credit or remuneration.

- Credit will be given by referencing any thoughts or ideas put into any publications created as a result of this research.
- Payment for interviews will be offered by the researcher

I, the undersigned, have been fully informed of the objectives of the project being conducted. I understand the objectives and consent to being interviewed for the project. I understand that steps will be undertaken to ensure that this interview will remain confidential unless I consent to being identified. I understand that this form in no way waives my legal rights nor releases the researchers, sponsors, or involved institutions from their legal and professional responsibilities. I also understand that, if I wish to withdraw from the study and /or refrain from answering any questions I prefer to omit, I may do so at any time, without any repercussions.

This research has been approved by the Joint Faculty Research Ethics Board. If you have any concerns or complaints about this project you may contact any of the above-named persons or the Human Ethics Secretariat at 474-7122, or e-mail margaret_bowman@umanitoba.ca. A copy of this consent form will be given to you to keep for your records and reference.

Participants's Name _____

Participant's Signature _____

Date _____

Researcher and/or Delegate's Signature _____

Witness Signature _____