Environmental Change and Off-road Transportation in Churchill, MB

By

Justin Gilligan

A Thesis submitted to the Faculty of Graduate Studies of
The University of Manitoba
in partial fulfillment of the requirements of the degree of

Master of Arts

Centre for Earth Observation Science
Department of Environment and Geography
University of Manitoba
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Abstract

The effects of environmental change are significant to the lives of people in the North, especially those with a close connection to and reliance on the land. The implications of environmental change are creating new risks, hazards and opportunities for off-road travel associated with accessing land/water based resources and recreation. This research highlights how environmental change is altering the snowmobile season, the boating season and the all-terrain vehicle season. Consistent with Traditional/Local and Scientific observations, the snowmobile season is decreasing in length and the boating season in increasing in length. While all-terrain vehicles are generally capable of travelling year round there are new and increased hazards associated with this type of transportation during certain seasons. In addition, several new risks and hazards face harvesters travelling on the land as a result of recent changes in the environment.

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Chapter 1: Introduction

Environmental change, including climate change, poses certain changes to the way harvesters in Churchill, MB, travel on the land. Travel in the North is typically done by boat, snowmobile and all-terrain vehicle and environmental changes have disrupted these modes of transportation (Nickels et al., 2006). Although Churchill is a very modern town many Churchillians still live off the land relying on harvesting activities such as hunting, fishing and trapping for monetary income and food sustenance. The town's population is made up of people of very diverse ethnic backgrounds, including Indigenous groups (Cree, Dené, Inuit and Métis), non-Indigenous groups, and mixed groups (those who have Indigenous and non-Indigenous ancestors). As of 2001, of 963 people in Churchill, 485 indicated they were of Aboriginal ethnicity (Statistics Canada, 2006).

While some Indigenous people of Churchill continue to follow the hunting, trapping and fishing way of life in the tradition of their ancestors, there also exist non-Indigenous Churchillians who practice in these activities, some in the footsteps of their ancestors and some for the first time in their family history (Fleming, 1988). In 1971, Koolage refers to a group of Eurocanadians who he calls 'The old Eurocanadian society' of Churchill that originally came to Churchill to trap or act as entrepreneurs during the town's early years. Koolage also describes a group of people "who come 'North' for the purpose of making their fortune and [to] find a new social and economic niche which allows them expanded opportunities for self-fulfillment. They have either joined the ranks of the old Eurocanadian society… or "gone native"." referring to the fact that they would develop a close tie to the land and Indigenous groups through activities such as hunting, trapping and fishing (1971, p. 39).

As environmental change, including climate change, progresses, many scientists are recording changes that are taking place to northern environments. There are also many predictions of how these changes will continue to occur as climate change progresses. The *Impacts of a warming Arctic: Arctic climate impact assessment* states that changes in climate will result in serious changes in the environment such as reduced ice and snow cover, thawing permafrost, diminishing lake and river ice, rising sea level, rising river flows, and increasing precipitation, to name a few (Hassol, 2004). If these predicted trends materialize, as many scientists believe they will, then the way that the people of Churchill, and the entire North, travel on the land will change significantly. Through the presentation of linkages between Local Knowledge (LK) (including Traditional Knowledge (TK)) and 'western' Scientific Knowledge (SK), this study presents an analysis of how changes to the environment have altered how the harvesters in Churchill travel on the land.

Purpose

The purpose of this project was to work with local harvesters to determine how environmental change has altered the way they travel on the land by boat, snowmobile and all-terrain vehicle. Through the study and linkage of Traditional/Local Knowledge and Scientific Knowledge, the anticipated outcome of this research is to present a holistic understanding from both knowledge sets on how environmental change is altering these types of transportation.

Objectives

The objectives of this research are as follows:

1. To connect with local people to determine the focus of the study.
2. To document local harvesters' observed changes to the environment and how they have affected off-road travel.
3. To link the Traditional/Local Knowledge with Scientific Knowledge and present a holistic understanding of the effects of climate change on off-road travel.

Parameters

This study took place in the community of Churchill, MB (including the surrounding areas used by hunters, trappers and fishers) and included local harvesters from the community. Participants have all lived in Churchill for at least 10 years and are from Cree, Dené, Métis, Inuit and non-Aboriginal Canadian ethnic backgrounds. Participants were mostly active harvesters of resources (active meaning someone who partakes in any combination of harvesting activities at least 10 times a year) who as a result have an in-depth knowledge of travelling off-road. Also, 8 of the 9 study participants are men. This research took place during 2006 and 2007 and the data collected is limited to experiences from the study participants lives. Data collection took place during the summer of 2006 and the winter of 2007.

Justification

For thousands of years Indigenous people of the North have relied on traditional/country food for sustenance. Harvesting activities such as hunting, trapping and fishing are extremely important to Northern Indigenous communities for economic, social and traditional reasons as well as personal well-being. Environmental change is an increasingly important issue in northern communities. This is partly due to the fact that environmental change is increasingly limiting the ability of Northern communities to access harvesting resources (Huntington et al, 2005). If the weather continues changing or becomes more unpredictable, as many scientists are indicating (Hassol, 2004, Huntington et al., 2005, Lafortune et al., 2004; Jolly et al., 2002), then this brings into question Northerners' ability to carry out their traditional daily activities. This justifies why studies that work with harvesters to determine the implications of such changes on the people of the North need to be carried out.

Thawing permafrost, timing of freeze-up and break-up, declining snow cover and increasingly unpredictable weather is disrupting travel conditions. In turn, this results in decreased harvests of traditional/country foods (Hassol, 2004, Jolly et al., 2002, Nickels et al., 2006, & Nutall et al., 2005). Decreased harvests have serious implications in Northern communities. Harvesting activities are important for the maintenance of cultural identity, social relationships and personal well-being in Indigenous communities. In fact, when unable to consume traditional/country foods, Indigenous people have indicated decreases in vitality, health and personal well-being (Nutall et al., 2005).

Northerner's ability to access these resources is very important. The chairwoman of the Inuit Circumpolar Conference, Sheila Watt-Cloutier, indicates that the reduced quality and safety of travel conditions in the North is equivalent to closing the roads to Northerner's grocery stores. Watt-Cloutier goes on to indicate that "ice and snow represent transportation, represent mobility" (Blue, 2006). Given the previous, it is disheartening to learn that climate change will bring reduced snow cover, increasingly thin ice conditions, thawing permafrost, decreases in river and lake ice, melting glaciers, increasing sea-levels and retreating summer sea-ice to the North. All of those are environmental variables with serious implications for travel in the North (Hassol, 2004). These facts combine to demonstrate a need for a research project on the implications of environmental change on harvesters' off-road transportation in Manitoba's North. Given that Churchill is a northern community with a proportion of the population who harvest for sustenance, there is a demonstrated need to understand the implications of environmental change on harvester's off-road transportation in Churchill.

Limitations

This study is not without its limitations. One limitation is that participation was voluntary. As a result study participants were hard to recruit at times. In certain instances it was difficult for participants to commit to spending time working with the researcher, which is understandable due to personal time constraints. This research looked at the Local and Traditional Knowledge of one community out of many throughout the Arctic and Subarctic. Also, this research focused on the concept of climate change and given the fact that 2005 had the highest global temperature in over a century, this may have influenced study participants' concepts of climate change (Environment Canada, 2007a). In addition, I had access to a snowmobile and an all-terrain vehicle but not to my own boat or truck. As a result, I was fully able to participate in activities which required a snowmobile or all-terrain vehicle but when travelling by boat or truck, I was only able to participate if space permitted.

Potential Benefits to the Environment, Community and Economy

This project contains several potential benefits for the environment, the community and the economy. Understanding our environment is important in stewardship, sustainability and conservation. By understanding how the actions of people who harvest in Manitoba's North will be altered by environmental change, we can further understand how our environment is changing and how people's way of life is changing in response. The findings from this report will be useful to scientists and policy makers addressing environmental issues in Manitoba's north (see Appendix D). This is because it will help further raise their understanding of the relationship between environmental change and Northern peoples' way of life.

This is an important issue to Churchill because the land surrounding the community has been used for harvesting activities for thousands of years by various Indigenous groups and their ability to access many of these resources is threatened by environmental change. These activities are very important to Northern communities because they promote community and cultural identity as well as healthy lifestyles and increased personal and communal well-being. When a community's ability to access these resources is limited or decreased their ability to harvest traditional/country foods is decreased as well. And as mentioned previously, Indigenous peoples have reported negative psychological and health impacts when decreasing ability to harvest traditional/country foods is experienced (Nutall et al., 2005). Understanding the current situation in Churchill and working with harvesters to increase awareness and safety is of utmost importance to the community.

The economy of Manitoba's North can also benefit from this project. As mentioned previously, understanding how travel on the land, water and ice will change is essential for eco-tourism operators, hunting lodges and fishing lodges who depend on travelling on land, ice and water to provide their customers with the service and experience offered. In order to optimize their outfit and the products and services they offer, it is important for these operators to understand how environmental change will alter off-road travel.

The Importance of Community Relationships and Trust

On my preliminary trips to Churchill, two local active harvesters indicated that too many researchers come to Churchill, get what they need, take off and are rarely heard from again (Fitzpatrick, 2006; G. Lundie, 2006). For this reason, G. Lundie (project mentor and community liaison) suggested that I come to the community and take some time to be with locals, build trust, create relationships and most importantly, follow through with disseminating my research (2006). Relationship building was initiated during the April and June field trips, when no data collection took place. Rather then immediately conducting interviews, relationships were created and strengthened within the community as a preliminary step. This is one of the most important aspects of the project and a cornerstone to the success of this research. Trust and relationship building was, in the eyes of the researcher, successfully carried out during the April, June, July, August and February field trips to Churchill.

Community Profile

In 2006, Churchill had a population of 923, down 4.2% from 963 in 2001 (Statistics Canada, 2007b). While unavailable for the 2006 census data, the following detailed community information is from the Statistics Canada community profile of Churchill, Manitoba in 2001 (Statistics Canada, 2006). Of the total Churchill population in 2001, 800 speak English only. In 2001, 485 residents identified themselves as Aboriginal and this group includes Cree, Métis, Dené and Inuit people (Statistics Canada, 2006). Of these 485, 245 reported North American Indian (i.e. Cree or Dené) single response, 185 reported Métis single response, 35 reported Inuit single response and 15 reported multiple Aboriginal responses (Statistics Canada, 2007a).

There were 590 persons with earnings and the average earnings of this group were $28, 951. There were a total of 250 families and the median family income was $52, 864. Of a total of 563 private dwellings in Churchill, 390 are occupied.

In 2001 there were 585 people in the experienced labor force, 10 of whom were in the 'Agriculture and other resource-based industries', 20 in 'manufacturing and construction industries', 60 in 'wholesale and retail trade', 20 in 'finance and real estate', 150 in 'health and education', 175 in 'business services' and 145 in 'other services'. Figure 1 demonstrates the location of Churchill in relation to Manitoba. Figure 2 highlights common reference points used by harvesters in Churchill in addition to local routes I have traveled during participant observation activities. These maps were created using ESRI ArcView 3.2 with the Manitoba Land Initiative 1:500,000 Manitoba base map (Manitoba Conservation, 2005).

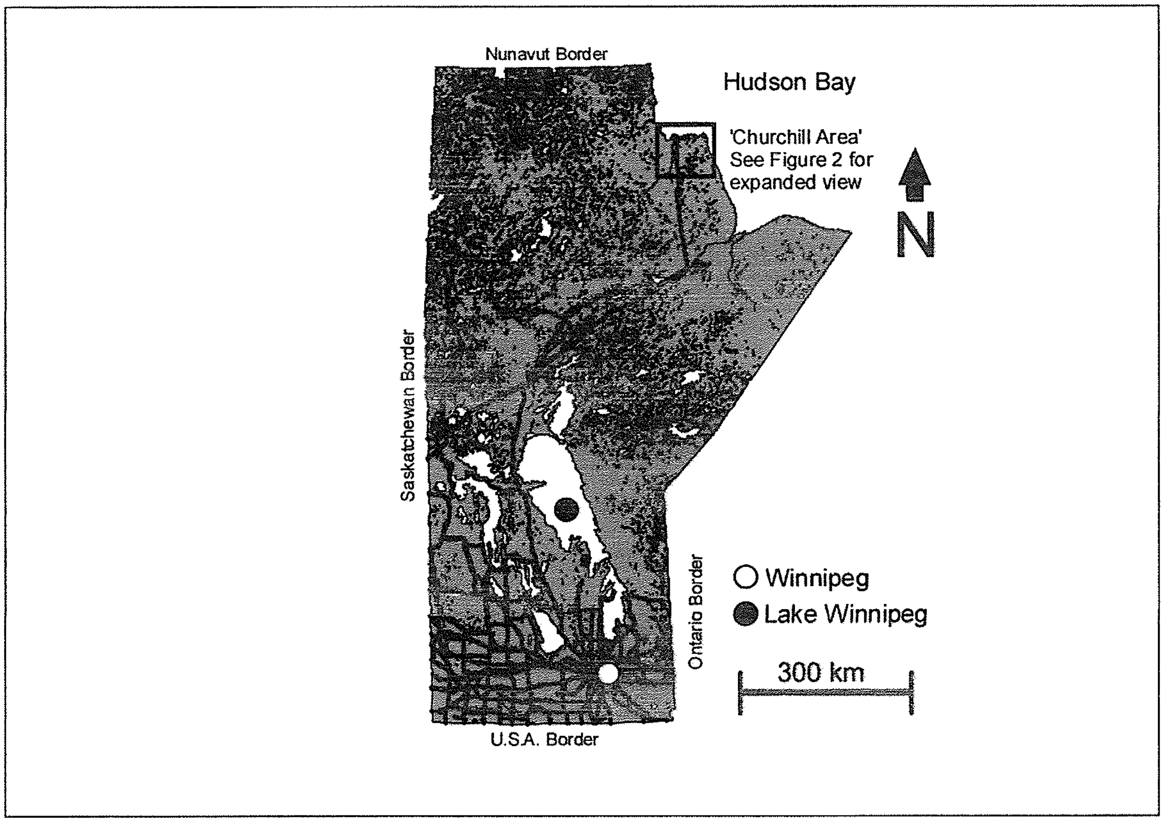

Figure 1: Location of Churchill, Manitoba. Derived from Manitoba Land Initiatives 1:500,000 Manitoba base map. © 2001, Her Majesty the Queen in Right of Manitoba. All rights reserved. Used with permission, permission granted August 15, 2007.

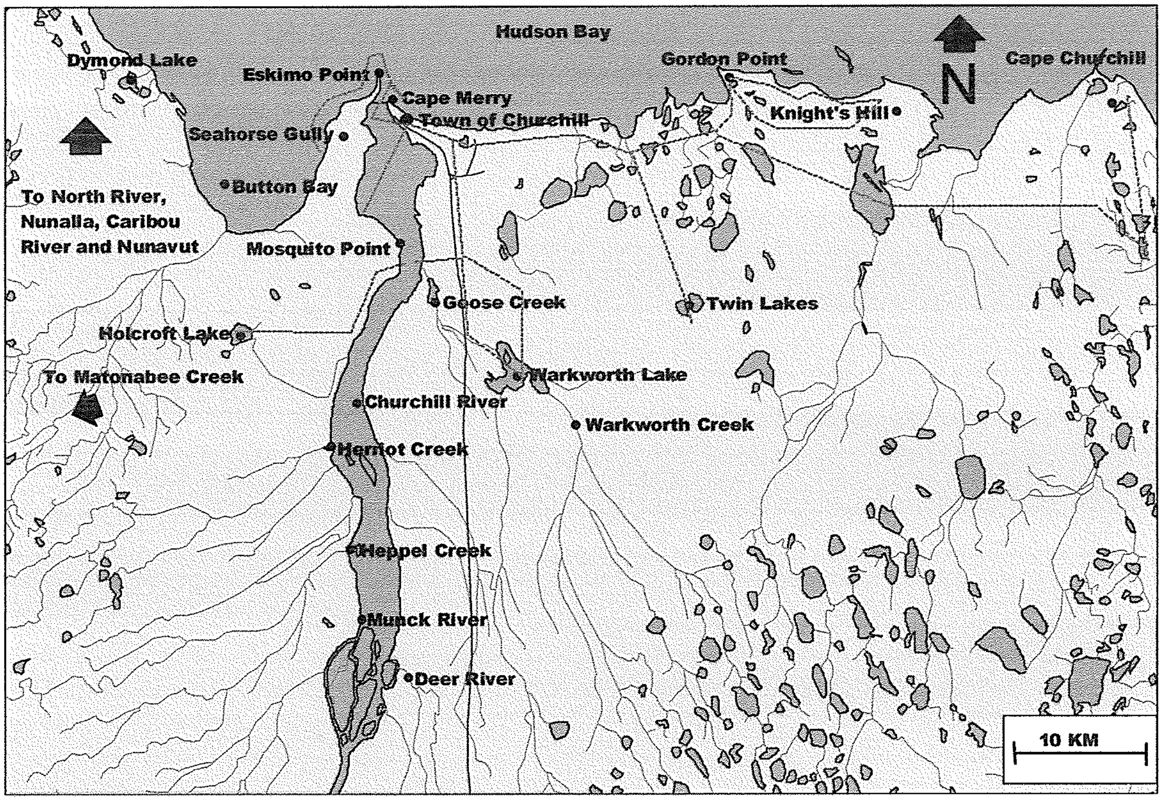

Figure 2: Common geographic reference points used by Churchill harvesters. The dotted lines (red) indicate approximate routes I traveled during this research. Derived from Manitoba Land Initiatives 1:500,000 Manitoba base map. © 2001, Her Majesty the Queen in Right of Manitoba. All rights reserved. Used with permission, permission granted August 15, 2007.

Chapter 2: Methods

In this research I have implemented semi-directive interviews (Edgerton et al., 1974; Huntington, 1998; Nakashima, 1988) and participant observation (Babbie, 1998; Corbetta, 2003; Frankfort-Nachmias, 1996; Jorgensen, 1989; Sanday, 1979; Stocking, 1974) in order to learn from local harvesters. Also, a mentor-apprentice relationship approach (Ellerby, 1999; Gallagher, 2002) was used which helped build meaningful relationships and create significant research connections with in the community. This approach helped to target the research to what best reflects the community and its characteristics. Study participants were selected through a snow ball sampling approach (Babbie, 1998; Coleman, 1958; Erickson, 1979; Flick, 2006; Heckathorn, 1997; Jorgensen, 1989), beginning with the mentor as the first step in the process. And finally, reflexivity (Babcock, 1980; Briggs, 1986; Creswell, 2003; Giddens, 1976) was implemented to help the researcher understand how he has shaped the research through his own individual characteristics. Table 1 demonstrates each of these methods and how they connect to the objectives and the method's relationship to the results of the research

Table 1: Methods

Method	Objective	Relation to results
Semi-directive interview	• Learning from locals • Production of a final report	Document observed changes and what they mean to local harvesters
Participant observation	• Gain trust and build relationships with locals • Learning from locals • Production of a final report	Learn about observed changes and their relevance to local harvesters
Mentor-apprentice relationship	• Gain trust and build relationships with locals • Learning from locals	Further learn about observed changes and their relevance as well as guide the research in a direction appropriate for the community
Snowball sampling	• Gain trust and build relationships with locals • Learning from locals	Enable participants to guide research by recommending which locals should contribute to the research and further learn about observed changes and their relevance.
Reflexivity	• Production of a final report	Enables researcher to understand his role in the research and how his presence uniquely shaped the outcome of the project
Community involvement	• Gain trust and build relationships with locals • Learning from locals • Production of a final report	Incorporating the study participants into the research design, the analyzing or data and the dissemination of results

Semi-directive Interviews

The semi-directive interview method was used when interviewing study participants during this research. A semi-directive interview is a method in which the researcher merely guides the participants through the interview, allowing the interviewee to lead the discussion and identify the subjects of interest and/or importance. However, the interviewer must ensure that the interviewee remains on topic and may use a list of topics as reference (Huntington, 1998; Nakashima et al., 1988). In short, the semi-directive interview is "more a conversation than a question-and-answer session" (Huntington, 2000, p. 1271). This method reflects a combination of two approaches to interviews defined in Edgerton et al. (1974). The informal approach, which incorporates the researcher introducing a set of topics during a natural conversation, and the open-end approach, which is when the researcher puts forth a very general topic or question allowing the interviewee to "talk at length, elaborating, volunteering, and pursuing whatever is of interest to him" (Edgerton et al., 1974, p. 44). While these approaches are structured to a certain degree, they better reflect a conversation then a systematically organized interview (Edgerton et al., 1974). In addition, open-ended questions are very useful as they often reveal certain variables which may not have been uncovered by other methods of study (Hyman et al., 1954).

This method worked well for my project because each interviewee and their knowledge are unique. Some people travel to different areas and as a result travel over different landscapes with different types of off-road transportation. One limitation of this method is that it is not as amenable to statistical analysis, as a structured or scheduled interview would be (Briggs, 1986; Edgerton et al., 1974). In addition, the information collected during a particular interview often cannot be replicated by other researchers (Edgerton et al., 1974).

This method worked well for this research for the following reasons. First, the study-participants were recruited via the snowball method (Babbie, 1998; Coleman, 1958; Erickson, 1979; Flick, 2006; Heckathorn, 1997; Jorgensen, 1989). This means that study participants were recruited as the research was conducted based on recommendations by previous study participants and other knowledgeable community members. By not having a fixed interview schedule and pre-determined set of questions, each interview was tailored to the lifestyle and experiences of the interviewee by the interviewer. For example, one study participant may not have travelled much in the winter but another did. Or perhaps some interviewees may travel south and west while others only travel east. Secondly, because the semi-directive interview is more informal it enabled a more comfortable environment for the interviewee and better facilitate the sharing of knowledge (Huntington, 2000). The semi-directive interview has worked well for other projects. For example, Lafortune et al. (2004) conducted a very similar project on the affects of climate change on access to land and resources in Northern Quebec where they also used semi-directive interviews. In this project the researchers documented the implications of climate change on trail networks that provide access to harvesting activities and traditional territories for four communities in Nunavik. This method enabled the researcher team to change the interview style as the research was carried out in order to best suit their needs and the knowledge of the study participants (Lafortune et al., 2004).

The semi-directive interview has also worked well in Henry Huntington's documentation of Traditional Ecological Knowledge (TEK) in Alaska (1998; 2000). Huntington used the semi-directive interview method in his study on beluga whales in western and northern Alaska. Huntington used this method to document Alaskan indigenous TEK on beluga whales. Huntington reports that the use of this method was successful in his research. In fact, Huntington uses a specific example from this research to demonstrate one of the strengths of this method, the ability for the interviewee to introduce new relevant topics (Hyman et al., 1954). When conducting an interview the discussion turned towards beaver populations in the region. Huntington questioned whether or not to incorporate the "directive" part of the semi-directive interview. However, an elder recognized Huntington's confusion and explained to him that beavers dam streams that salmon spawn in, thus reducing the habitat of one of the beluga whale's prey (Huntington, 1998; Huntington, 2000). The use of semi-directive interviews by Huntington demonstrates certain strength of using this method.

The semi-directive interviews were applied to this research in the following ways. A set of interview topics were developed and these topics provided the direction for the interviews (see Appendix A for the interview topics). The interviews began with general topics, such as the personal background of the individual. As the interview went on, the topics became more specific with questions such as what changes to the snowmobile season have you observed. Throughout the entire interview process, the interviewer was able to steer the direction of the topics yet allowed the interviewee to take control of specific topics. As a result, interviewees were able to spend more time on the topics they had a deeper knowledge on and introduce new and relevant topics. In this regard, the semi-directive interview method proved successful in documenting the Traditional and Local Knowledge of Churchill harvesters on the topic of environmental change and off-road transportation.

Participant Observation

The goal of implementing participant observation into my research was to provide myself with a first hand insight to problems related to travel on the land in order to better relate to the community, and to better understand the data collected. Franz Boas, often considered the father of participant observation, popularized the method through his work with the Inuit of Baffin Island (Sanday, 1979; Stocking, 1974). The participant observation method simply incorporates the researcher participating in the events or phenomena being studied, i.e. travelling by snowmobile, boat or ATV and hunting, fishing and trapping (Corbetta, 2003; Frankfort-Nachmias, 1996; Jorgensen, 1989). Boas believed that "studying the literature from this standpoint I found, that I could not understand the questions and facts without practical experience", a concept applicable to this research that has benefited from practical experience through the participant observation method (Stocking, 1974, p. 60). The method is further acknowledged for its usefulness by Becker et al. who argued that "such a datum gives us more information about the event under study than data gathered by any other sociological method" (1957, p. 28). By participating in travel and resource harvesting on the land with study participants I have created stronger relationships with members of the community and I have a better insight into the problematic implications of environmental change on travel on the land.

Participant observation proved successful in a study performed by Gallagher who used it when studying traditional knowledge in a Northwestern Ontario Anishinaabe community (2003). By living the life of a First Nation commercial fisherman Gallagher slowly earned the respect of the community and he better understood his research as a result of working on the land with community members (Gallagher, 2003). In the following statement Gallagher highlights the importance of participant observation in a Traditional Knowledge project.

> Any project on traditional knowledge is only as strong as the relationships forged between the "researcher" and the elders and community. Trust and respect from the community is paramount for the success of the project, but it does not come automatically; it has to be earned. Plenty of time and hard work needs to be spent in order to accomplish this goal. (Gallagher, 2003, p. 184)

I believe that this research project benefited through the inclusion of the participant observation method.

In my study I have implemented participant observation in the following way. During the June, July, August and February field trips I spent many days on the land with study participants. I participated and observed fishing trips, hunting trips, trapline tours and other related trips such as bringing supplies out to cabins. A highlight of participant observation trips is found in Table 2.

Table 2: Examples of participant observation activities

Participant observation activity	**Building knowledge towards...**
Fishing trips to Button Bay	Understanding marine boat travel and marine fish harvesting
Fishing trips to Goose Creek	Understanding freshwater fish harvesting
Fishing trips to Cape Merry and Eskimo Point	Understanding marine boat travel and marine fish harvesting
All-terrain vehicle trips into the Wildlife Management Area	Understanding overland summer ATV travel
Caribou hunting trips	Understanding caribou harvesting as well as ATV travel
Boat trips on the Churchill River	Understanding open water inland boat transportation and freshwater fish harvesting
Goose and duck hunting trips	Understanding bird harvesting and overland four-wheel drive truck travel
Trips out to trap lines	Understanding snowmobile transportation and the dynamics of a trap line

I have also worked with study participants, especially the project mentor, to complete chores and other day-to-day activities. Participant observation was one of the most important building blocks of this research.

The Mentor Apprentice Approach

The mentor-apprentice approach was implemented and found useful for this research as it allowed a knowledgeable member of the research community to guide the researcher in a meaningful direction (Ellerby, 2000; Gallagher, 2002). Ellerby (1999) defines the mentor-apprentice method in the following way: "The "mentor-apprentice" approach, based on one learning relationship between collaborator and researcher, is a cooperative epistemological approach that is consistent and coherent with both traditional Lakota culture and the social scientific tradition..." (p. 18). However, for the purpose of this research, the mentor-apprentice approach is less epistemological and relates to Cree and Dené culture rather than Lakota. Ellerby indicates that this method is unique and facilitates the development of a unique teaching relationship and that through this approach "the notion of 'research' itself is transformed into 'education'" (1999, p. 23).

Colin Gallagher also used this method in his research on Traditional Knowledge of lake trout stocks on Lake Nipigon (2002; 2003). While he did not include this method per se in his methods section, he does discuss the use and application of this method throughout his thesis (Gallagher, 2002). During his research, Gallagher was put up by a local elder who provided accommodation in a plywood trapper's shack at the back of the man's property. Gallagher indicates that it is through this relationship he was able to create strong relationships within the community and better understand the lifestyle of the study participants, the value of Traditional Knowledge and its possessors and his research in whole (2002; 2003). Gallagher indicates that this experience enabled him to develop mentally and get into a particular "thinking mode" that enabled him to study Traditional Knowledge (Gallagher, 2002, p. 27).

In this research the mentor-apprentice method has been applied in the following way. G. Lundie, a local Cree and Dené man with multi-generational roots in the community, agreed to mentor me throughout this project. G. Lundie and his family have provided me with accommodations throughout the research. This has been an excellent opportunity to create strong relationships with community members. By being involved in the day-to-day activities of a Churchill family I have met many other community members and created strong relationships. Through this mentor-apprentice relationship I have learned many things about Indigenous culture, Churchill culture, harvesting activities, respectful harvesting practices, community dynamics and much more.

Throughout the project, G. Lundie has helped guide this research into a meaningful and successful endeavor.

As part of this relationship, G. Lundie has taken me on the land to work with him and his friends (also part of the participant observation method). He has organized fishing trips, ATV trips and caribou hunting excursions, and trapline tours as participant observation activities. The mentor-apprentice relationship applied to this project has provided an excellent way to learn about the local culture and the research topic by living with a local indigenous family and experiencing off-road transportation and harvesting activities first hand.

Having a mentor that I spent a large majority of my time with in the community did introduce certain biases. First of all, the snowball sampling chain was primarily influenced by the mentor's friends and family members. A lot of my learning, understanding and perception of both the research topic and the community was influenced by the mentor, his views and his opinions. The majority of my participant observation activities took place either with the mentor one-on-one or within a group that included the mentor. In addition, the majority of my social activities within the community took place either with the mentor or within his group of family and friends.

Snowball Sampling Recruitment

The snowball sampling method (Babbie, 1998; Coleman, 1958; Erickson, 1979; Flick, 2006; Heckathorn, 1997; Jorgensen, 1989) was used to recruit study participants in this research project. This method involves interviewing someone within your own broader environment (such as a friend or relative of a friend) and asking them if they know anyone who fits the parameters for the study, essentially 'snowballing' as the research progresses (Babbie, 1998; Coleman, 1958; Erickson, 1979; Flick, 2006; Heckathorn, 1997; Jorgensen, 1989). This method was first introduced by Coleman (1958) (Salganik et al., 2004). Coleman likens this method to the sampling technique of a good reporter who "tracks down leads from one person to another" (1958, p. 29). In being applied to my research, this method began with project mentor, G. Lundie (originally a friend of a friend), who then made recommendations on potential study participants who also made recommendations for recruitment. This method worked successfully in recruiting active harvesters with in-depth knowledge of various types of off-road transportation in the area. However, snowball sampling is not without bias. Erickson (1979) indicates that a snowball sample is not likely to be random and that people considered popular to the original interviewee will be overrepresented and people who are not popular to the original interviewee will be underrepresented.

Reflexivity

Reflexivity is an important step in research where the researcher is involved in the community, creating relationships and connections with community members and collecting data from locals. Creswell defines reflexivity as the process where "the qualitative researcher systematically reflects on who he or she is in the inquiry and is sensitive to his or her personal biography and how it shapes the study" (2003, p. 182). Simply put, reflexivity is the process of recognizing who you are and what characteristics act in shaping the way your research takes place. It also means recognizing that "the personal-self becomes inseparable from the researcher-self" (Creswell, 2003, p.182) and to "regard oneself as an other and to be aware of oneself as his own instrument of observation" (Babcock, 1980). In short, reflexivity involves acknowledging who you are and that you are an instrument of observation in the research and how this shaped the study.

Giddens exemplifies the importance of reflexivity by stating that "Anyone who recognizes that self-reflection, as mediated linguistically, is integral to the characterization of human social conduct, must acknowledge that such hold also for his own activities as a social 'analyst', 'researcher', etc." (1976, p. 8). Everyone has certain aspects of themselves that would shape a research project differently and the goal of reflexivity in this research is to acknowledge these aspects (Babcock, 1980; Briggs, 1986; Creswell, 2003; Giddens, 1976). The use of reflexivity in this research will enable the researcher to recognize his role in the project and enable the reader to understand the characteristics of the researcher that helped shape the project.

Reflexivity has previously been applied to several other research projects in related fields. For example, Andrea Procter applied the method of reflexivity in her 1999 Master of Natural Resources Management thesis titled *Definitions and the defining process: "Traditional ecological knowledge" in the Keewatin region, Nunavut*. Her thesis focuses on the way Traditional Ecological Knowledge is portrayed and perceived by researchers and natural resource managers in the Keewatin (Kivalliq) region in Nunavut. Procter uses reflexivity to show her interpretations of her research, to acknowledge her biases and political views, and accept responsibility for her ideas and her analysis.

Given that a researcher's personal biography will shape the way they interpret, experience and present the research (Briggs, 1986; Creswell, 2003), this section addresses how my personal biography shaped the way I experienced, interpreted and presented this project. I am a young adult male from a western culture with a university background who is an active hunter and fisher, active off-road traveler. I am not critical of hunting, trapping or fishing and I have an in-depth knowledge of snowmobiles, boats and all-terrain vehicles. These aspects have enabled me to interpret and present the research and data differently than other individuals with a different background and different set of interests. For example, when P. Fitzpatrick was discussing the affects of decreased snow cover on the parts of a snowmobile's rear suspension, I steered the interview into a direction that enabled P. Fitzpatrick to elaborate on this topic. As a result, this thesis contains an in-depth section on these phenomena. The above mentioned aspects of my personal biography are the screens in front of my eyes that filtered the shared knowledge as I interpreted and presented it.

Study participants for this project included active hunters, trappers and fishers from the community of Churchill. From first contact with the community, local harvesters have been involved with how this research took shape and moved forward. Their participation also involved having me work with them at their hunting, trapping or fishing activities on the land and also during regular daily activities such as visiting friends/family for coffee, shopping for groceries, cutting firewood or working on general repairs/maintenance in the shop. While doing so, the study participants shared knowledge on the project topic through non-structured interviews. Study participants were also asked to review transcriptions of the semi-directed interviews to ensure that the knowledge shared was understood and represented properly by the researcher.

Through the combination of the above mentioned methods, this research project was able to collect reliable and valid data on the research topic. These methods also provided me with an in-depth insight into my research and allowed for significant input from study participants. However, the collection of data is paralleled in importance to the fact that these methods have helped me forge significant and meaningful relationships with study participants and the community. This is important because I believe that successful and meaningful relationships have helped create successful and meaningful research.

Chapter 3: Literature Review

The following is a review of the key literature that applies to this study. This literature review has been organized into themes. The first theme is 'knowledge systems' and reviews work on defining and applying the different knowledge systems addressed in this study. The next theme reviews the traditional harvesting activities of the Churchill area and discusses the different indigenous groups that have traditionally, and currently, use the area for harvesting purposes. Then the relationship between environmental change and harvesting activities is reviewed. Finally, the next theme reviews the connection between health and harvesting in Northern communities.

Knowledge Systems

There are many different definitions of Traditional Knowledge and Local Knowledge. Gilligan et al. (2006a) uses the work of Crowshoe (2005) to define Traditional Knowledge as "a knowledge system based on tradition that is created, preserved and dispersed. This information is passed from generation-to-generation and is determined by factors such as land use, environment, region, culture and language" (Gilligan et al., 2006a; p. 3). Other important factors of TK are highlighted in the work of Berkes et al. (2000) in the following passage:

> "Traditional knowledge may be holistic in outlook and adaptive by nature, gathered over generations by observers whose lives depended on this information and its use. It often accumulated incrementally, tested by trial-and-error and

transmitted to future generations orally or by shared practical experiences." (p. 1252)

TK has typically been associated with Indigenous groups and is often used synonymously with the term Indigenous Knowledge.

Local Knowledge, on the other hand, is defined by Berkes et al. (2002) as knowledge that is possessed by a particular group of people, i.e. community members, and generated through first hand experiences of one's surroundings. One of the fundamental differences between the TK and LK lies in the fact that "TK is a product of several factors typically associated with Indigenous groups, these factors include but are not limited to spirituality, relationships with the land and other community/family members, oral traditions, story telling, ceremonies, as well as cultural beliefs" (Gilligan et al., 2006a, p. 4). While on the other hand, LK usually falls under "knowledge generated through observation of the local environment and held by a specific group of people" (Berkes et al., 2002, p. 122). The numerous definitions that exist between these two types of knowledge tend to draw on different similarities and differences and as a result one can be quite confused and begin to wonder whether the only difference lies in the fact that one group has Indigenous roots and the other may or may not.

TK and LK researcher R. Brook put the whole situation into context when he indicated that terms such as Traditional Knowledge, Local Knowledge and Scientific Knowledge are terms primarily established by academics that artificially created them to pigeon-hole these knowledge systems (R. Brook, May 23 2006, personal communication). Brook backs this up by referring to Agrawal's argument in *Dismantling* *the divide between indigenous and Scientific Knowledge* (1995), in which Agrawal indicates that theorists "seek to create two categories of knowledge – western and indigenous – relying on the possibility that a finite and small number of characteristics can define the elements contained within the categories" (1995, p. 421), where western refers to SK and indigenous refers to TK/LK in this thesis. Agrawal continues to indicate that "this attempt is bound to fail because different indigenous and western knowledges possess specific histories, particular burdens from the past, and distinctive patterns of change" (1995, p. 421). In this argument change is a key concept. If all knowledge systems are under patterns of change than how can you pigeon hole one definition or categorize a knowledge system that is said to be dynamic? While I am not qualified to answer this question it is an important one to be aware of when undertaking research regarding different knowledge systems. Simpson (1999) builds upon this concept by cautioning on considering TK anything but equal to all other knowledge systems, also good advice for those conducting this type of research.

In this research I am studying both Traditional and Local Knowledge. Interviews are being conducted with both Aboriginal and non-Aboriginal harvesters of Churchill. While I understand there is a difference between these two types of knowledge, as mentioned above, I found that I was not qualified to distinguish between the two in this research. This is because I have not spent enough time with study participants to understand their ethnic background nor did I ask them which knowledge system they would associate themselves with. While I could have made "Would you associate your knowledge base as Traditional or Local?" a standard question in my interview process, I decided not to, in fear of giving off the impression that one is more superior to the other.

As a result, I do not distinguish between TK or LK within this thesis, rather all of the interview data can be considered TK/LK, where a difference exists among each individual study participant but it is not indicated by the researcher.

Traditional/Local Knowledge will be linked with Scientific Knowledge in this study. Scientific Knowledge is quite simply defined as knowledge that results from a Western of European approach to systematically and empirically studying, researching and recording observations of phenomena (Boyer, 2002). At times this may include sitting down with information on a topic from both knowledge systems and other times it may be as simple as learning something through a TK/LK scope and an SK academic background. In doing so I have aimed to avoid using TK/LK as a crutch to support SK or vise versa. Through the linkage of these knowledge systems, this research will contribute significantly to the research topic by incorporating these various knowledge systems (Gilligan et al., 2006b).

In her dissertation titled *The construction of Traditional Ecological Knowledge: Issues, implications and insight* (1999) L. Simpson clearly explains the importance of TK to those who possess it and, as mentioned earlier, cautions on considering TK anything but equal to all other knowledge systems. In the first chapter Simpson puts TK into perspective when she discusses how Europeans relied on TK in order to stay alive when they first arrived to North America but then disregarded it as the continent modernized. Eventually they attempted to wipe out Indigenous culture in the late 19^{th} early 20^{th} centuries. This made me realize how poorly respected Indigenous Knowledge, referring to TK in this thesis, has been and how glorified western SK has become. Simpson helps caution readers from placing one type of knowledge system ahead of the other and this has taught me how important TK is to First Nations and their culture (Simpson, 1999).

A Brief History of Churchill

Located on the shores of Northern Manitoba, Churchill is an area with a rich past. While geographically located in the Sub-arctic, Churchill experiences climate and social orientation more consistent with those of the high Arctic (Koolage, 1971). The earliest evidence of human activity in the area dates back to ~1500 B.C. in the form of tent rings and other artifacts used by the Pre-Dorset peoples. The Pre-Dorset disappeared and by 0 A.D. the Dorset had moved into the area, predominantly hunting sea mammals from the sea-ice and continued their presence until the Thule moved in from the Alaskan area who then passed their great whale hunting skills onto the historic Inuit (Boothroyd, 2000). The area was also within the bounds of the Cree and Dené Indigenous groups whose presence increased as a result of the construction of the first Hudson Bay trading post in Churchill in 1717 (Brandson, 1981; Four Directions Consulting Group, 1995).

Once the fort was in place, the fur trade increased in the area and in 1730 due to increasingly less peaceful relations between the Hudson Bay Company and eastern fur traders, the decision was made to construct a stone fort in the area. The Prince of Wales Fort was established and lasted until the French destroyed it in 1782. The post was rebuilt and eventually the fort was too. A reconstructed version of the fort is under the auspices of Parks Canada and is open for tourism (Boothroyd, 2000). The Inuit, Cree, Dené and Métis hunted, fished, trapped and traded in the area alongside Eurocanadians and then in 1930, the Hudson Bay Railway reached the confluence of the Churchill River and

Hudson Bay (Boothroyd, 2000; Four Directions Consulting Group, 1995; Koolage, 1971).

The Hudson Bay Railway (HBR) was constructed to service the Port of Churchill, Canada's only prairie port set in place to export grain to international markets (Boothroyd, 2000). Non-indigenous pioneers began arriving in Churchill pre-dominantly working for the port or the HBR or living in a mixed-economy working for wage labor and harvesting natural resources (Boothroyd, 2000; Koolage, 1971). Adding to significant impact on the landscape, during World War II, the face of Churchill once again changed. Two thousand American troops arrived in Churchill in 1942 and established a military camp, Fort Churchill, east of the town site, it was later taken over by the Canadian Government in 1944 (Boothroyd, 2000). Fort Churchill became a base of operations for the Royal Canadian Navy and the Royal Canadian Air Force until the military pulled out in 1964. During the '50s and '60s Churchill began to boom and more high-tech programs were introduced to the area such as the Churchill Research Range who specialized in rocket science (Boothroyd, 2000). In addition to rail service in the community, Churchill, like much of the North, also experienced the introduction of public air service which increased throughout the twentieth century, particularly during the airline boom after World War II.

Following World War II several groups were relocated to Churchill by the federal government. The Dené were relocated to the area from Duck Lake and experienced difficulties adapting to western culture under the paternalistic federal departments (Brandson, 1981; Koolage, 1971). In 1972 many of the Dené in Churchill relocated to Tadoule Lake in Manitoba's northern interior, an environment better suited to their way of life (Boothroyd, 2000; Brandson, 1981). In the 1950s many Inuit also were relocated to the Churchill area and have slowly left the area which in 2001 exhibited an Inuit population of 35 (Koolage, 1971; Statistics Canada, 2007a). Presently the port is still open in Churchill, the train still makes several trips a week to and from the community and several daily flights to Churchill are available. Churchill is now quite the tourist destination offering something for the naturalist, bird watcher, historic sight seer, whale watcher, polar bear observer or aurora borealis enthusiast. The town offers several hotels, bed and breakfasts, restaurants, lounges and bars, and other local and tourist amenities (Town of Churchill, n.d.).

Traditional Harvesting Activities and Indigenous Groups in the Churchill Region

There is a deep and rich history of Indigenous resource use in the Churchill region prior to the construction of the port in 1930. The Cree, Dené and Inuit Indigenous groups have been using the Churchill region for harvesting activities longer than Europeans have been present in the area. The Churchill area is referred to as the northern extent of prehistoric Cree territory and the southern extent of the Dené territory. By the end of the 18^{th} century the Dené began to have a presence in the Churchill River region, co-occupying the area with the Cree. In this area the Cree and Dené would hunt for caribou, geese, they would fish for both freshwater and marine species and trap fur bearing animals. However, the Dené found that hunting and fishing in the area did not provide enough food to meet their needs. The Cree found that the area was good for fur trapping but lacked the big mammals to provide sufficient food supplies. As a result, both groups began to move back into their respective regions by the mid 19th century (Four Directions Consulting Group, 1995).

The Inuit have also had a significant presence in the Churchill area prior to the construction of the port in 1930 and still use the region today. The Inuit, along with their direct ancestors the Thule and the Thule's predecessors the Pre-Dorset and Dorset have been utilizing the land, water and ice of northeastern Manitoba since circa 1500 B.C. The area surrounding Churchill became a focal point for the Inuit when the first trading post opened in 1717 (Riewe, 1989). According to the *Nunavut Atlas* (Riewe, 1992) the Inuit of the Kivalliq region, chiefly from the community of Arviat (Eskimo Point), Nunavut, have conducted several harvesting activities along the shores of Northern Manitoba. These activities include the hunting of polar bear, seals, arctic fox, beluga whale, migratory birds and caribou. Riewe also categorizes the intensity of usage of the northern Manitoba area as medium intensity on shore and near shore and high intensity on the water and ice of Hudson Bay (1992).

According to Koolage (1971), the Inuit began relocating to Churchill in 1950 and came from the Kivalliq region of present-day Nunavut. Two major factors that brought them to Churchill are the depression of fur prices during the early '50s along with resulting trading post closures throughout the North and new policy from the federal departments responsible for Indigenous groups that sought to bring Indigenous peoples to settlements in hopes of integrating them into the dominant society (Koolage, 1971). When Inuit first arrived in Churchill they were under the paternalistic care of the Department of Northern Affairs and Northern Resources and were setup in single family dwellings at Akudlik, which means "the place in-between', representative of their physical location and their cultural location between two societies (Koolage, 1971). In return for their nominal rent, Inuit were expected to work for the government, many within manual labor positions (Koolage, 1971). According to anthropologist Koolage who studied in Churchill during the 1960s, several Inuit embraced western culture and could be witnessed sporting "'Beatle' style haircuts, miniskirts, and doing the latest dances to music played by an amplified Eskimo band—The Harpoons—" (Koolage, 1971, p. 53). In 1971 Koolage reported 100 Inuit living in Churchill. Today that number has declined significantly. The 2001 Statistics Canada census information indicates that there were 35 Inuit in Churchill in 2001 (2007a).

Environmental Change, Harvesting Activities and Off-road Travel

Environmental change can and does have significant implications for travelling on the land in northern regions. Nickels et al. (2006) indicates that in the Inuvialuit Settlement Region, Nunavut, Nunavik (Northern Quebec) and Nunatsiavut (Labrador) are all experiencing more difficult and less predictable travel conditions as result of climate change. Nickels et al. go on to indicate that hunting and travelling in the North are becoming increasingly riskier and more difficult, resulting in a decreased frequency of these activities (2006). In Nunavik, this has led to many residents becoming less active on the land (Nickels et al., 2006). I have set up this research to study the implications of environmental change on off-road travel in Churchill.

Hassol (2004) presents several key findings that will change the face of the North as a result of climate change and several of these relate to off-road transportation in the North. For example Hassol predicts shifts in vegetation zones (2004). If the treeline shifts north and forests replace tundra this will change the way people travel on the land. Insect outbreaks and forest fires can increase in frequency and severity as a result of shifting vegetation zones and this can also affect the way people travel on the land both psychologically and physically (Hassol, 2004). Forest fire burned areas may no longer sustain the resources that people once traveled to a particular destination to harvest and insect outbreaks may result in people's decision to no longer travel on the land as often.

There are several other key findings in Hassol (2004) that can have similar implications on the way people travel on the land including changes in wildlife diversity, range and distribution, which turns out to be very important to harvesters and is discussed further in section 5.4. Or increased exposure to storms off of large bodies of water (such as the Hudson Bay) may alter people's travel patterns. Sea-ice, which is traditionally important and essential to northern Indigenous groups, is also undergoing rapid change (Ford et al., 2007; Hassol, 2004; McDonald et al., 1997). Sea-ice has been likened to highways in the south as they are important to local travel, providing access to country foods as a highway provides access to a grocery store (Laidler et al., 2006). Reduced sea-ice will have direct implications for those who travel on the ice either by snowmobile, all-terrain vehicle, or dogsled. Thawing permafrost can create dangerously soft and boggy landscapes to travel over and even cause the creation of sink holes in particular areas as a result of thermokarst activity (Hassol, 2004).

Other predicted climate change trends for the Arctic mentioned in *Impacts of a warming Arctic: Arctic climate impact assessment* (Hassol, 2004) that will have implications for the way people travel on the land include the following: Rising temperatures, increasing precipitation, rising river flows, thawing permafrost, declining snow cover, diminishing lake and river ice, rising sea level, and changes in ocean salinity (Hassol, 2004). Nickels et al. indicate that decreased snow has a serious impact on one's ability to travel by snowmobile in the Inuvialuit Settlement Region, Nunavut, Nunavik and Nunatsiavut (2006). Hassol (2004) helps the reader understand how certain earth processes occur and how they will change northern landscapes. One can learn something new every time they open this book and can find new ways to apply the predictions to changes in off-road transportation in Churchill.

While Hassol (2004) does an excellent job of summarizing climate change trends and implications there are certain chapters in Symon et al. (2005) that highlight what these changes will mean for Northern people. A changing Arctic climate and landscape raises serious issues of access and safety among other things. There are numerous examples of why climate change will have serious implications on Northerner's, one such can be found in the following statement: "For the Qikiktagrugmiut, the weather determines if daily activities can be carried out safely and productively (for instance water and ice travel and being able to dry meat and fish successfully)." (Huntington et al., 2005, p. 73). If the weather changes or becomes more unpredictable as many scientists are indicating (Hassol, 2004; Huntington, et al., 2005; Jolly et al., 2002; Lafortune et al., 2004; Laidler et al., 2006; Tremblay et al., 2006) then this brings into question Northerners ability to carry out their traditional daily activities.

Another example of the importance of weather in Northern communities is highlighted in the following passage from *We can't predict the weather like we used to: Inuvialuit observations of climate change, Sachs Harbour, Western Canadian Arctic* by Jolly et al. (2002):

> Understanding, interpreting and predicting the weather and knowing about the weather is an integral part of community life [in the North]. People watch the weather, because the weather tells when it's a good time to go out on the land, leave for a camp or plan a hunting trip. The weather dictates if a plane will come that day, bringing mail and supplies. It influences when the geese will arrive, when the sea ice will begin to break, if the fish will bite, or a storm will come. (Jolly et al., 2002, p. 95)

Although the authors are referring to the Inuvialuit community of Sachs Harbour, NWT, I believe that this also applies to the people of Churchill, especially those that rely on accessing resources on the land. All the variables affected by weather mentioned in the above passage relates to people in Churchill. This further highlights the importance of conducting a study such as this one.

G. Laidler conducted a project in Cape Dorset, NU, that dealt with new exposures to risk as a result of changing environmental conditions in the sea-ice environment (Laidler et al., 2006). Laidler notes that locals from Cape Dorset have observed and reported experiencing in their local sea-ice conditions and climate, "different than 'expected conditions' have been noted mainly in the last few years" (2006, p. 167). Laidler (2006) indicates five significant changes that are occurring to the sea-ice that seriously affects locals' ability to travel and participate in hunting activities in Cape Dorset: 1) The floe edge is closer to town. 2) The ice is thinner. 3) The freeze-up happens later and takes longer. 4) The break-up happens sooner and faster. 5) The weather is generally warmer and the weather is less predictable.

Laidler also highlights what implications these changes have to local Inuit hunters (2006): While a closer floe edge means less travel to the floe edge it also leads to deteriorated travel routes and resulting earlier ice deterioration in the spring can reduce ability to access lakes for fishing, traditional geese hunting grounds and cabins. Thinner sea-ice leads to more hazardous travel and ice that is less resistant to tidal processes, In addition, thinner ice is further susceptible to ablation following snowfall events. A later freeze-up and earlier break-up result in a smaller timeframe to travel on the ice and contributes to thinner ice, hunting and fishing grounds become less accessible and travel routes become less reliable. Finally, less predictable weather leads the undermining of traditional methods for reading the ice, determining hazardous conditions and forecasting the weather.

Tremblay et al. conducted similar work in Nunavik (2006). Tremblay et al. used the combination of Traditional and Scientific Knowledge to help understand how climate change is affecting access to resources and use of trail systems (2006). Interviews were conducted with elders and community experts on qualitative indicators they use to determine when the ice is safe. Then this knowledge was presented alongside instrumentally collected data. This combined dataset was used to test the relationship between meteorological station observations and the knowledge from this research. The research team is currently working on determining more feasible ways of reviewing quantitative and qualitative data together to determine more feasible ways for local monitoring to gather this data (Tremblay et al., 2006). In conclusion, Tremblay et al. state that "through the use of both qualitative and quantitative data, and the involvement of Local Knowledge and expertise, the most appropriate and relevant indicators for monitoring activities can be determined" (2006, p. 136).

Similar research on the effects of climate change on the snowmobiling season is being conducted by McBoyle et al. (in press). This team of researchers used climate change prediction models to determine the future of recreational snowmobiling in southern Canada, roughly from Saskatoon, SK, to Gander, NF. They determined that snowmobiling is extremely vulnerable to climate change. Under their warmest climate scenario prediction, they determined that snowmobiling would be eliminated from their study area by the 2050s. Using the 1961-1990 data as a baseline, they used 2 different climate change modeling scenarios (a least change scenario and a more change scenario) to determine the change in season length (based on number of days per year with 15 cm of snow on ground or more) during the 2020s and the 2050s.

McBoyle et al.'s results show that under least change scenario in the 2020s Saskatoon, SK could experience the biggest loss at -90% and Ste Agathe, QC could experience the smallest loss at -11% (in press). Under the more change scenario during the 2020s it was determined that Saskatoon, SK could experience the biggest loss at -89% and Ste Agathe, QC and Sydney, NS could experience the smallest loss at -39%. During the 2050s, the least change scenario indicated the largest potential loss at Saskatoon, SK at -90% and the smallest at Ste Agathe, QC at -19%. The more change scenario indicates that during the 2050s, both Saskatoon and Regina, SK face completely losing their snowmobile season and that the least amount of change projected is -87% at Kenora, ON

(McBoyle et al., in press). McBoyle et al. have represented the recreational snowmobiling industry's vulnerability to climate change (in press).

The Connection between Health and Harvesting

In the North harvesting is critically linked to both the physical and mental health of Northern Indigenous people. As a result any negative changes to harvesting activities will have a negative impact on physical health, mental health or both. According to Hassol (2004) and Nutall et al. (2005), warming puts both hunting culture and food security into jeopardy as a result of changing abundance and distribution of harvested species. Stairs (1992) connects mental health to connections with the land, connections that may be severed or seriously altered as a result of environmental changes. Several other researchers have reported on this importance and tied into physical and mental health as well.

Nutall et al. (2005) discuss the importance of harvesting activities on the physical health of Northern peoples. There is an obvious dietary importance of harvesting activities. Traditional (or country) food is defined by Myers et al. as "foods that are available from local natural resources and which are culturally accepted" (2005, p. 24). In most cases traditional country foods are far superior nutritionally to the alternative options imported into northern communities. For thousands of years Indigenous peoples of the North have met their balanced diet requirements from their country food. Meat from fish, mammals and birds along with berries and other edible plants have been sufficient to sustain Northern people's diets. If access to these food resources becomes further limited or restricted then Northern people must rely on the imported food options, which has negative consequences on the economic and physical health of Northern residents (Nutall et al., 2005). A change to a more Western diet has built in increased risks of diabetes, obesity and heart diseases (Hassol, 2004).

Restricted and limited access to food resources and a disintegration of the hunting culture can be connected to decreased mental health including high rates of suicide. Kral et al. (2000) indicate that suicide is often connected with a loss of culture and self-identity. Stairs (1992) connects hunting as a crucial part of the *inummarik* which is the concept of "a most genuine person" (p. 117) a critical part of an Inuit feeling positive about their self-image and self-worth thus resulting in happiness and fulfilling feelings about ones life. In order to become *inummarik* one must undertake a lifelong process of developing positive interactions with people, animals, community and environment through attitude and skill (Stairs, 1992). This is consistent with other Northern Indigenous groups as highlighted by Myers et al. who indicates that "Northern Aboriginal identity is partly defined in terms of living off the land and producing food from lands and waters" (2005, p. 24). There is also a strong connection between cultural values and being able to access and consume country foods (Myers et al., 2005). In addition, much cultural importance is placed on food sharing practices, whereby individuals share harvested country food with the community (Myers et al., 2005).

To the Inuit these aspects are not separated but combined as one concept, a concept that would be incomplete if there were missing interactions with people, community, environment or animals (Stairs, 1992). Harvesting activities play an important role in developing these interactions, bringing Inuit closer to their environment and the animals, and the resulting social food sharing network develops the interactions between people and community (Stairs, 1992). Thus *Inummariit* (plural for *inummarik*) "hunt and distribute food not only to eat, but to structure their society, and ultimately to build a cognitive model of the world by which they are defined" (Stairs, 1992, p. 118). These interactions build towards their sense of self (self-image, self-identity and self-fulfillment) and these senses come from a set of actions, largely including harvesting activities (Stairs, 1992). So limits and restrictions in harvesting activities result in a deterioration of the *Inummariit* concept. Stairs highlights this in the following: "without the cycling lived and symbolized by hunting, an Inuk ceases to be Inuk. Inuit both may and must continue to "hunt" to maintain identity" (1992, p. 125). And according to Stairs, 1992, Kral et al., 2000, Nutall et al., 2005 and Hassol 2004, a loss of identity leads to diminished mental health and increased occurrences of suicide in Northern Indigenous people.

The above mentioned literature is a summary of the key literature that applies to this research. The first theme, knowledge systems, helps one understand the definitions and differences between the three types of knowledge systems mentioned in this research and raises the issue of whether or not we should define/categorize these knowledge systems and explains that neither is superior to another. Then literature relating to the traditional harvesting activities (hunting, trapping and fishing) and the different ethnic groups (Inuit, Cree, Métis, Dené and non-indigenous) of the Churchill area was summarized. Following this, literature relating to the important relationship between environmental changes and harvesting activities was reviewed. Finally, literature was presented that explains the important connection between health and harvesting activities in Northern communities was presented. This is the body of literature that has informed my thinking and thought process throughout this research.

Chapter 4 Results and Discussion

This chapter documents the observed changes of both harvesters and scientific data in Churchill, Manitoba relating to environmental change and off-road transportation. The harvesters' knowledge is represented in several topics based on broad themes surrounding environmental change. This chapter also uses many excerpts or examples from interviews to highlight and demonstrate the changes presented. Modeled after Riedlinger 2001, this technique helps present the harvester's knowledge as accurately as possible. The discussions in this chapter are represented in several topics, each topic relating to a type of environmental change that directly or in-directly affects the way harvesters travel on the land.

In many cases throughout this chapter Traditional/Local Knowledge is presented alongside with Scientific Knowledge on the topic. The Scientific Knowledge comes from a variety of sources including other research publications and Environment Canada (EC) weather observations from Churchill which the researcher analyzed for trends (2004b; 2007b; 2007c). These two knowledge sets are not presented in order to validate or verify one another. Rather they are presented and occasionally compared in order to present a more holistic view on the subject. Neither of the knowledge sets is more or less correct than the other, even if they appear to contradict one another.

Before moving on to the key discussion of this chapter it is important to make a few comments. First, the following observations and examples that are the basis for discussion in this chapter were learned from the community through several methods discussed in detail in the methods chapter of this thesis. Second, the discussion in this chapter is also a reflection of the researcher's interaction with the entire community.

Sixty-seven days were spent in Churchill and the resulting general conversation and participant observation with community members helped me better understand the community and its outlying territory. This has better enabled me to understand and relate to the interview topics and interviewee's responses and as a result has better enabled me to put together the following discussion. Third, the observations and discussions in this chapter are those of the community members. If there are any errors in this chapter they will be the responsibility of my interpretation and understanding of the knowledge shared by study participants and community members.

Finally, in terms of individual knowledge and expertise of study participants, interviewees who have been in Churchill longer speak with more confidence about the following changes because they have a longer data set in their mind built by their decades of experience in the community. That being said, interviewees who have between one and two decades of experience in the community also report the same observations but occasionally speak about it with less confidence adding statements such as "I can't say for sure but it seems like…" or "Although I haven't been around as long as other guys I *have* noticed…". Also, when asked a question that the interviewee feels is out of their area of expertise many would answer with phrases such as "I haven't been around long enough to say" or "I don't really travel in that area".

Changes Related to General Weather Conditions

Changes relating to general weather conditions, such as temperature, winds, weather extremes, and weather predictability are important to harvesters in Churchill. They are also some of the most common changes noticed by interviewees in this project.

Often the interview would start with a discussion of these themes and then move forward to more specific observations. These variables lay the groundwork for many changes observed by locals and discussed later in this chapter. Nearly every observation recorded during this project can be traced back to one of the above mentioned topics. For example, temperature is part of the equation for nearly every observation discussed in this chapter. For example, temperature influences whether or not precipitation is snow or rain and temperature dictates whether freshly fallen snow will melt or accumulate. These variables provide an excellent starting point for presenting the changes observed by harvesters in Churchill.

Temperature

According to Hassol, temperatures in the Arctic have been rising in recent years and are projected to increase (2004). This is consistent with the Scientific and Traditional/Local observations of temperature trends in Churchill which both indicate warming temperatures in recent decades. In 1998 Skinner et al. indicated that the temperature at Churchill and over the nearby sea-ice had warmed by 0.3-0.5°C from 1950 to 1990. Temperature trends in Churchill are also presented more recently in the work of Gagnon et al. (2005) who indicate that the mean annual temperature in Churchill has significantly increased at a rate of 0.5°C per decade from 1971-2001. Winter temperatures indicate a warming trend but it is not a statistically significant trend, the spring temperatures trend indicates a near-zero trend which is not significant, the summer temperatures trend indicates significant warming and the trend for autumn temperatures also indicates a warming but the trend is not significant (see Figure 3 for a breakdown of trends by season) (Gagnon et al. (2005).

It is important to note that Gagnon et al. (2005) do not incorporate 2002-present within their data set, a time which included two of Canada's hottest winters on record. The winter of 2006/2007 is tied with the winter of 1986/1987 for second warmest winter in Canada with Churchill experiencing temperatures approximately 3.5°C above normal. The winter of 2005/2006 was the warmest Canadian winter on record at 3.9°C above normal (Environment Canada, 2007a). While it was unavailable at the time of publication, it should be noted that including the past 5 years within their dataset would have affected the magnitude of the trends established.

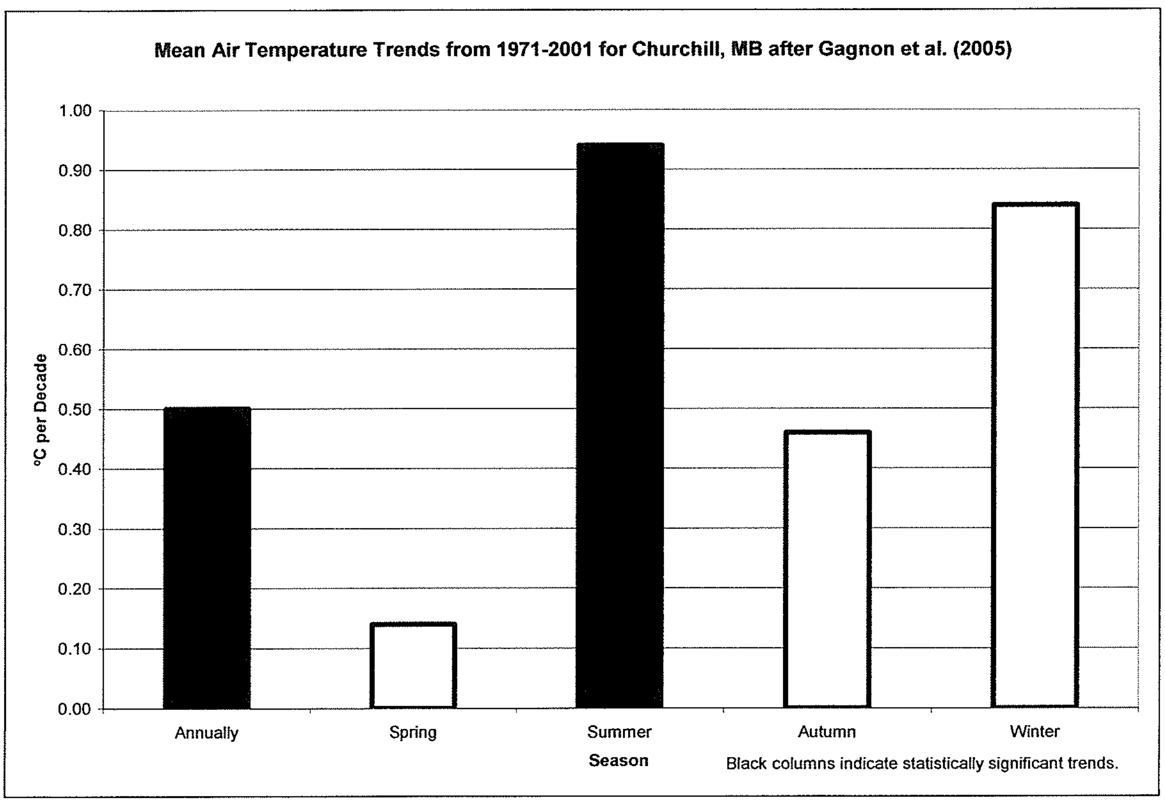

Figure 3: Mean air temperature trends in Churchill, 1971-2001. Created with data presented in Gagnon et al. (2005).

In summary, statistically significant warming trends in Churchill exists annually in the order of 0.5°C per decade, in March by 1.5°C per decade, in June by 1.0°C per decade, in July by 0.86°C per decade, in August by 0.75°C per decade and in September by 0.84°C per decade (see Figure 4 for a breakdown of monthly trends) (Gagnon et al. 2005).

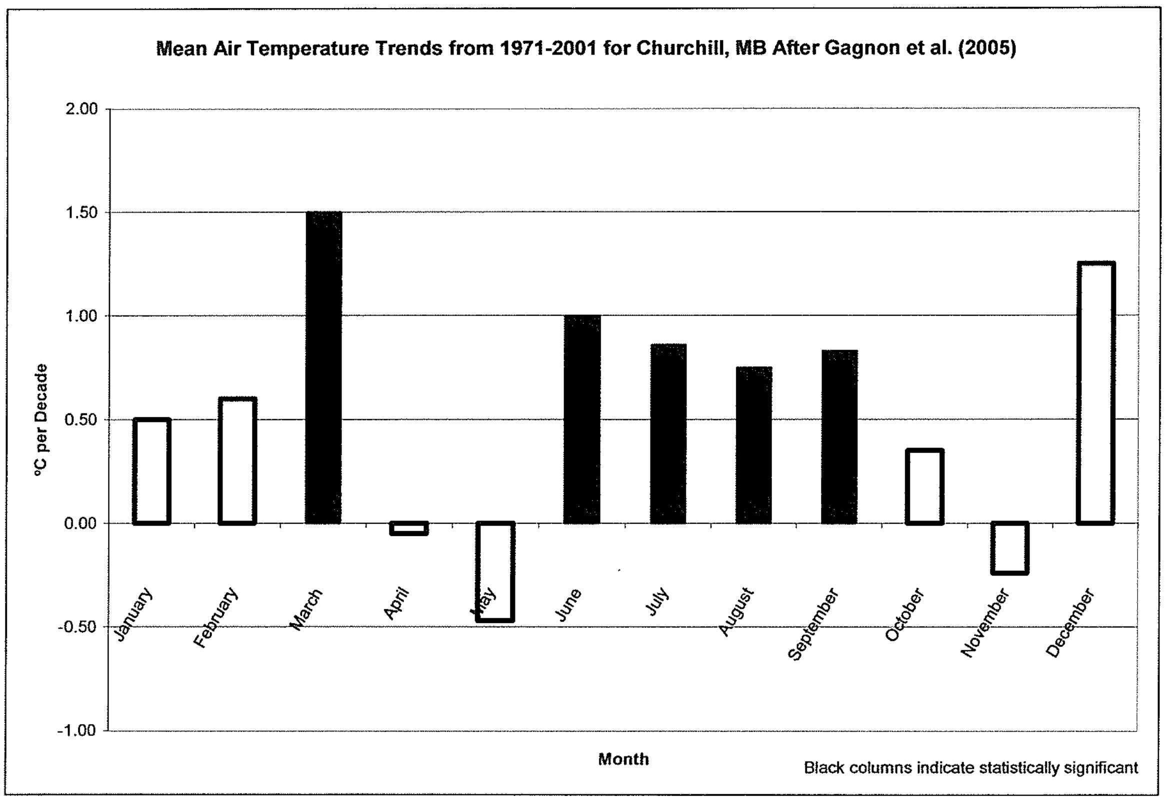

Figure 4: Monthly mean air temperature trends for Churchill from 1971-2001. Created with data presented in Gagnon et al. (2005).

Study participants across the board reported observations related to increased temperature, consistent with quantitative analyses of Gagnon et al. (2005) and Skinner et al. (1998). In general, local harvesters have reported that it appears to be getting continually warmer in Churchill.

> It used to be you could count on about six weeks of -50°F a year [in the 1970s]. Now you would be lucky to see two weeks of -40°F a year. – D. Hunter, 2006.
>
> We are having milder winters. 2005-2006 was a really mild winter. – G. Lundie, 2006.
>
> It's much warmer in general, we are having later falls and earlier springs. But every year can be different, from one extreme to another. – P. Fitzpatrick, 2006.
>
> It used to be too cold to Ski-Doo most of December to February, but now we're getting rain in February. – D. Hunter, 2006.
>
> It's getting gradually warmer, but it can be different from winter to winter. – R. Bougie, 2006.
>
> [Lately] the winters have been milder then normal. – D. Lundie, 2006.

These observations in temperature demonstrate a warming trend in Churchill, one that is especially noticeable in the winter months. As indicated earlier, Gagnon et al. (2005) also indicates a warming trend in winter of 0.8°C per decade from 1971-2001 and EC reports that the winter of 2006/2007 was approximately 3.5°C above normal in Churchill (2007a). Temperature is an important variable that plays a key role in many changes discussed later in this chapter such as the snowmobiling and boating seasons, the timing of the freeze-up and break-up of ice, ice thickness, changes in sea-ice dynamics, and changes in hazards associated with travelling on the land.

Winds

A lack of good strong winds, especially north winds, has caused some problems for Churchill harvesters who travel inland southwest of Churchill. P. Fitzpatrick, a local hunter and trapper, discusses how a lack of strong and consistent north winds changed his way of travel in the winter of 2005-2006 near his Condie Lake trapline approximately 200 km southwest of Churchill.

> You usually get hard pack drifts but this year it didn't start [to drift] until around February on South Knife Lake. Normally you have drifts all winter. This is due to a lack of north winds. When you have a lack of strong and consistent north winds you don't get drifts. Usually you can snowmobile over the willows as the snow drifts hard around and on them, but this year it was more snowmobiling in the soft snow between them. On the flip side, softer snow makes it easier to travel on the barren lands. It also makes it easier to track wolves on the barren lands. Softer snow on ice can also make the ice thinner by insulating it from the cold air temperatures, leading to safety issues when travelling on ice. – P. Fitzpatrick, 2006.

As seen in this passage, winds play a key role in determining snowmobiling conditions by the creation and placement of snowdrifts. This is consistent with reports from Nunatsiavut and Nunavut hunters who indicate that softer snow conditions is causing snowmobiles to sink into the snow, leaving hunters stuck on the land more frequently (Nickels et al., 2006). Softer snow drifts will also insulate the ice restraining its ability to thicken (Woo et al., 2007). Wind is also important as it influences surface temperature and when the freeze-up and the break-up occur. While it is possible to compare qualitative observations of wind patterns with quantitative data, there is no Environment Canada archive data available for or near the South Knife Lake area.

Weather extremes

Weather extremes also appear to be changing although in which direction it is hard to tell. According to local harvesters, phenomena such as white outs appear to be decreasing whereas occurrences of extreme weather in the spring appear to be increasing.

> Back then [1970's] we would get whiteouts for 6-7 days at a time, the whole town would shut down. Now you're lucky to see a whiteout a year. – D. Hunter, 2006.
>
> From 30 years ago to today, there used to be more whiteouts back then. – Anoymous2, 2007.
>
> We still get the extremes like blizzards and whiteouts but the frequency in these extremes is declining. But extremes in the spring are becoming more drastic, whereas before you wouldn't get the extremes in the spring as much. – D. Lundie, 2006.
>
> In the spring of 2004 or 2005, a snow storm came in and you could snowmobile into June that year. – R. Bougie, 2006.

According to EC hourly weather observations from Churchill (2007c), the frequency of visibility less than 1 km/h and temperature below 0°C is decreasing, consistent with the above observations on whiteouts, or low visibility during the winter. This was determined by counting the number of hours per year from 1970 to 2006 that visibility was observed to be less than 1 km/h and temperature was less than 0°C (see Figure 5). When applying a linear least squares fit trendline to the data a loss of 8.312 hours per decade is indicated. The graph in Figure 5 shows significant decreases in the 1990s which spikes from 2003 to 2005 then drops significantly in 2006 with less than 100 hours per year in 1986, 1994, 1998, 2000 and 2006.

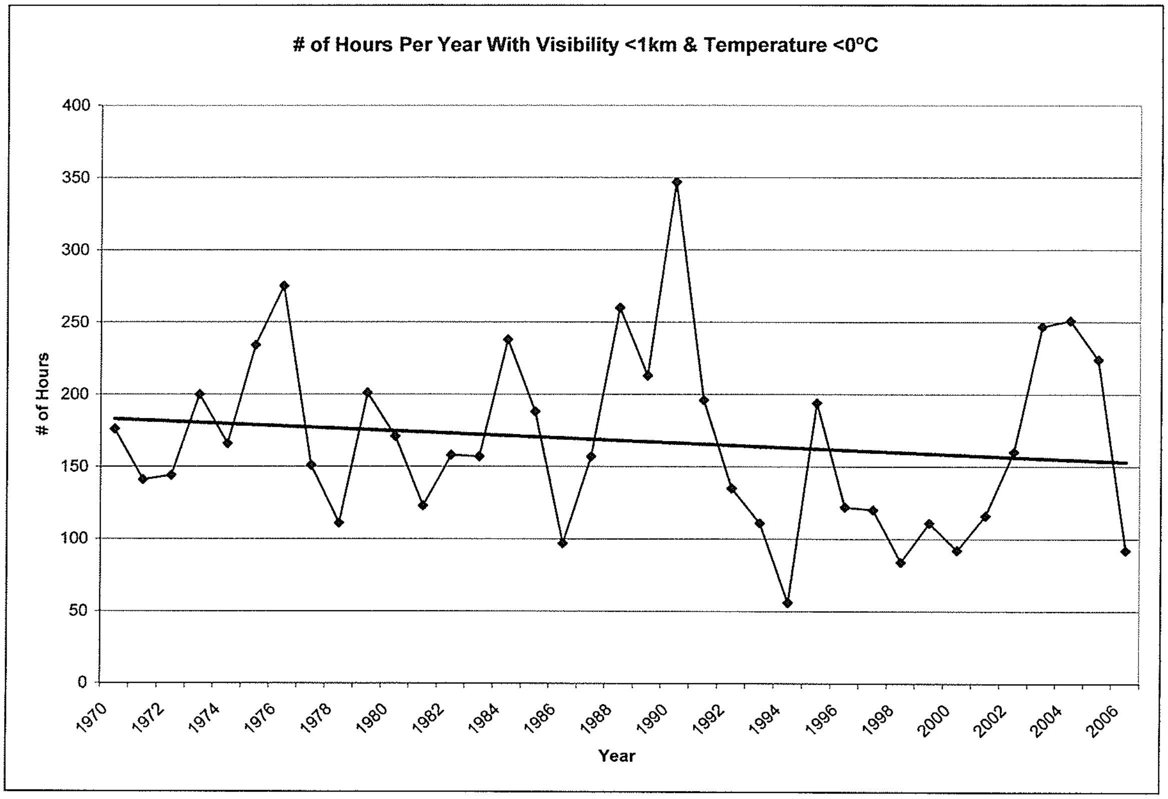

Figure 5: Number of hours per year with visibility less than 1 km and temperature below 0°C from 1970-2006. Based on EC hourly weather observations from Churchill (2007c). Missing data was ignored.

Trends in frequency and average duration of blizzards were also derived from EC hourly weather observations from Churchill (2007c). Environment Canada data indicates a near zero increasing trend for both frequency and duration from 1970-71 to 2005-06. When a linear least squares fit trendline is applied to the data, the trend for blizzard frequency is an increase of 0.176 blizzards per decade and the trend for average duration is an increase of 0.279 hours per decade, both near zero trends (see Figure 6).

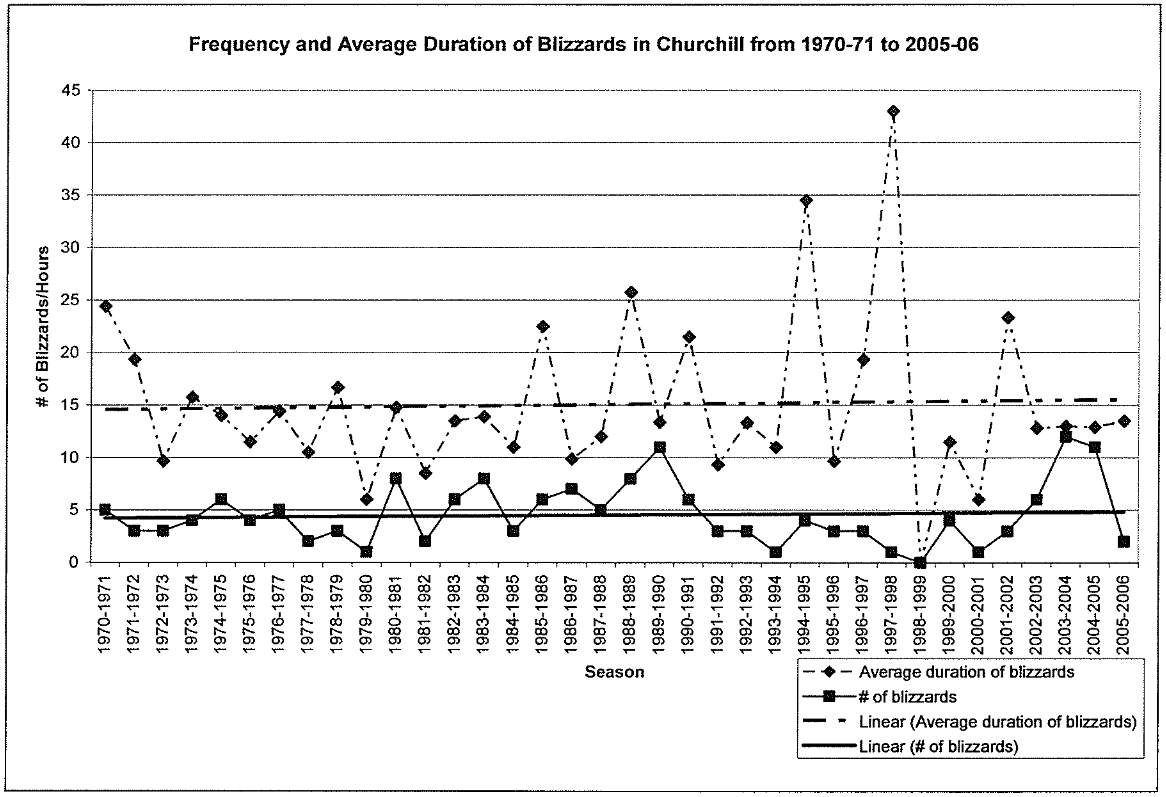

Figure 6: Frequency of blizzards and average duration of blizzards from 1970-1971 to 2005-2006. Based on data from Environment Canada (2007c). Missing data was ignored.

However, it should be noted that from the 1991-1992 season to the 2000-2001 season, blizzard frequency was considerably low at 4 or fewer blizzards per season including 5 occurrences of 3 blizzards per season, 3 occurrences of 2 blizzards per season and the one and only occurrence of 0 blizzards per season during the data set. Compared to the frequency of blizzards from the 1970-1971 to the 1990-1991 seasons, which is 5.047 blizzards per year, we see why qualitatively fewer blizzards have been observed in recent years.

When observing the plots of average blizzard duration in Figure 6 we can see why qualitatively local harvesters are reporting a decrease in blizzard duration. Figure 6 indicates that average duration of blizzards in 2002-2003 to 2005-2006 below 15 hours.

When compared to the approximately 2 decades previous when the average duration of blizzards often reached heights of above 20 hours, including 6 occurrences above 20 hours, 3 occurrences above 25 hours, 2 occurrences above 30 hours and 1 occurrence above 40 hours, we see a significantly higher average duration than the last four years of the data set, years which are fresh in the mind of local harvesters.

In comparing Traditional/Local Knowledge and Scientific Knowledge observations of blizzards and blizzard characteristics it is important to consider the following. Environment Canada defines a blizzard as 6 or more continuous hours with winds exceeding 40 km/h, temperature below 0°C and visibility below 1 km (D. Marciski, personal communication, March 15, 2007). While EC has a strict definition of a blizzard, local harvesters do not necessarily use the same variables to determine whether or not they are experiencing a blizzard. If one variable is slightly off, EC will not consider the occurrence a blizzard. However, to a local harvester it doesn't matter if visibility is 0.9 km or 1.3 km, to them they are still experiencing a very difficult and dangerous situation for travelling on the land. But to EC the difference is pivotal in declaring a blizzard. The same holds true for minor differences in wind speed and duration. Table 3 highlights potential situations that present difficulties for harvesters travelling on the land and determines whether or not the situation would technically be considered a blizzard by EC's definition. Bolded numbers represent the variable which does not meet EC's definition of a blizzard and thus why the occurrence would not be considered a blizzard by EC.

Table 3: Examples of blizzard conditions

Wind speed in km/h	Temperature in °C	Visibility in km	Duration in hours	Does it meet the EC definition of a blizzard?
45 to 60	-15 to -35	0.2 to 0.8	8	Yes
35 to 38	-35 to -42	0.5 to 0.7	18	No
75 to 85	-33 to -39	0.1 to 0.3	**5**	No
43 to 49	**0.4 to -1.0**	0.3 to 0.9	7	No
42 to 53	-25 to -32	**0.4 to 1.3**	12	No

Extreme weather occurrences play a very important role in the lives of harvesters in the North. A decrease in winter low visibility situations can be perceived as a good thing. For example, in the book *Churchill on Hudson Bay*, Churchill trapper Angus MacIver recounts being trapped in a snowdrift during a blizzard in the 1930s. He nearly met his end that day. He was travelling out on the barren land and when the blizzard moved in and visibility dropped to nothing, he had no choice but to lie in his sleeping bag covered by a tarp and wait out the storm for twenty-two hours (MacIver et al., 2006). This is without a doubt a hazard associated with travelling on the land in the winter months. Thus a decrease in the frequency of winter low visibility situations would presumably increase safety and decrease hazards while travelling on the land.

Weather predictability

One aspect of travelling on the land that is very important to staying safe and ultimately making it home has to do with being able to predict the weather. Hudson Bay Indigenous people have traditionally used certain environmental indicators to interpret the weather and forecast weather conditions, both immediately and seasonally. However, as a result of environmental changes, certain indicators which have been used for generations no longer matched existing weather (McDonald et al., 1997). With all the changes that are occurring, harvesters are having a tougher time with weather predictability. This is a problem that affects many aspects of travelling on the land.

> The weather nowadays is unpredictable. You can check the five day forecast but that doesn't mean that's the weather you're going to get. – G. Lundie, 2006.
>
> When you're travelling inland, crossing lakes and rivers is less predictable. – B. McEwan, 2006.
>
> When the weather isn't the same as it used to be, it's less predictable. C. Daudet, 2006.

This is an important issue because being able to predict the weather means being able to predict whether or not travelling conditions will be safe. Nickels et al. (2006) indicates that increasingly unpredictable weather conditions and travel conditions make it very difficult to prepare for and plan for travel and hunting trips as it makes travel much more difficult. Nickels et al. also indicates that increasingly unpredictable weather systems throughout the Canadian Arctic have made travel conditions much more dangerous (2006). As a result, hunting and travel become riskier activities and consequently less frequent in Northern communities (Nickels et al., 2006).

When discussing how to include scientific data on this aspect into this thesis, meteorologist Jay Anderson recommended looking at the frequency of three unpredictable weather phenomena throughout the EC Churchill hourly observations data set (J. Anderson, personal communication, March 29, 2007). This was done using the following 3 unpredictable weather phenomena; winds of 70 km/h or greater (Figure 7), thunderstorms (Figure 8) and the occurrence of rain and freezing rain from December 1 to March 31 (Figure 9). The results of this analysis indicate increasing trends for 2 of these phenomena. Analyzing the number of hours with winds of 70 km/h or greater per year indicates an increasing trend of 2.53 hours per decade. Number of hours of thunderstorms per year indicates an increasing trend of 2.096 hours per decade. Number or hours of rain or freezing rain between December 1 and March 31 per winter season indicates a near zero trend of 0.277 hours per decade including a large spike in 2004-2005. With increasing unpredictable weather phenomenon such as winds of 70 km/h or greater and increasing thunderstorms we can see that predicting the weather is more difficult then in previous decades.

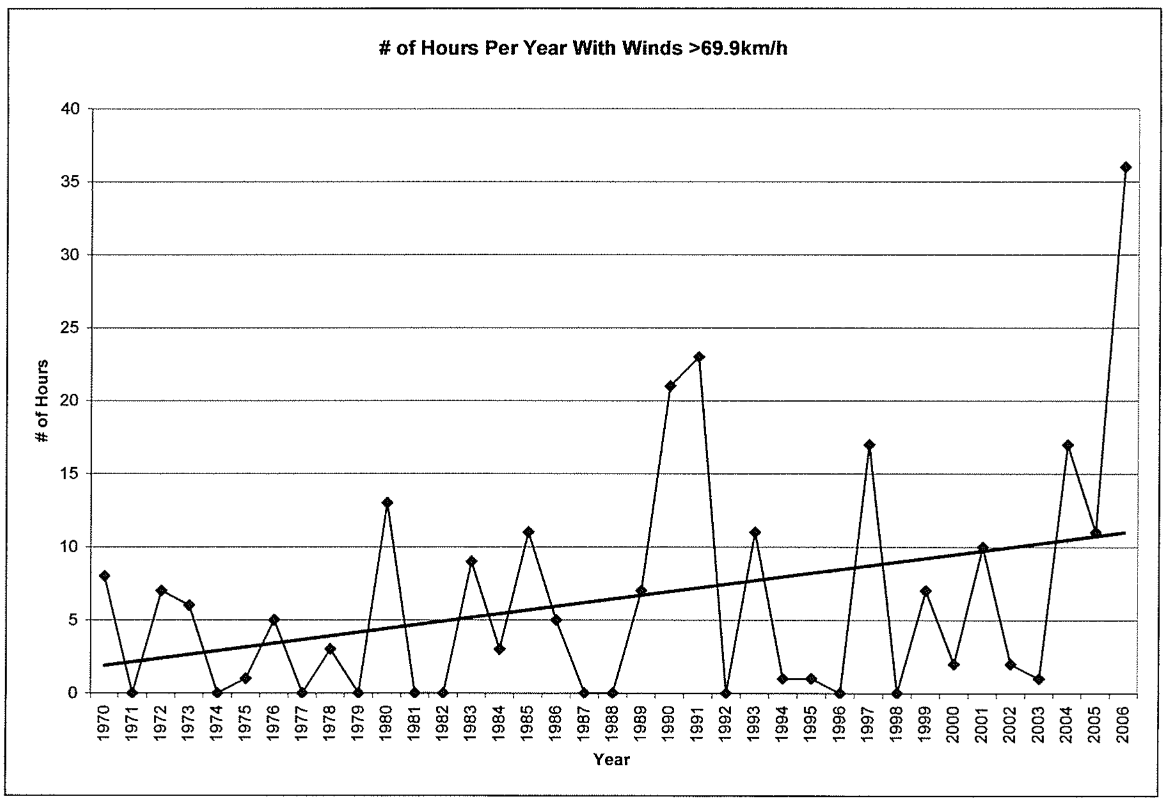

Figure 7: Frequency of winds of 70 km/h or greater form 1970-2006. Based on EC hourly observations from Churchill (2007c). Missing data was ignored.

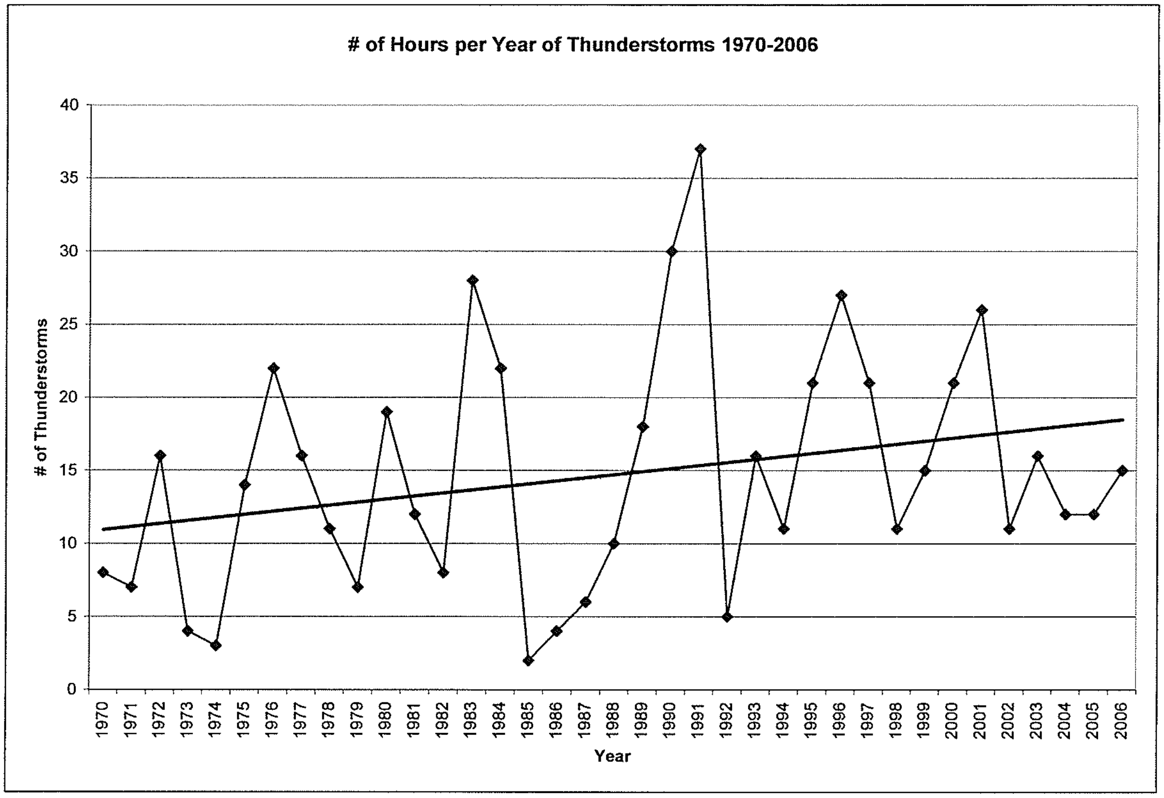

Figure 8: Frequency of thunderstorms from 1970-2006. Based on EC hourly observations from Churchill (2007c). Missing data was ignored.

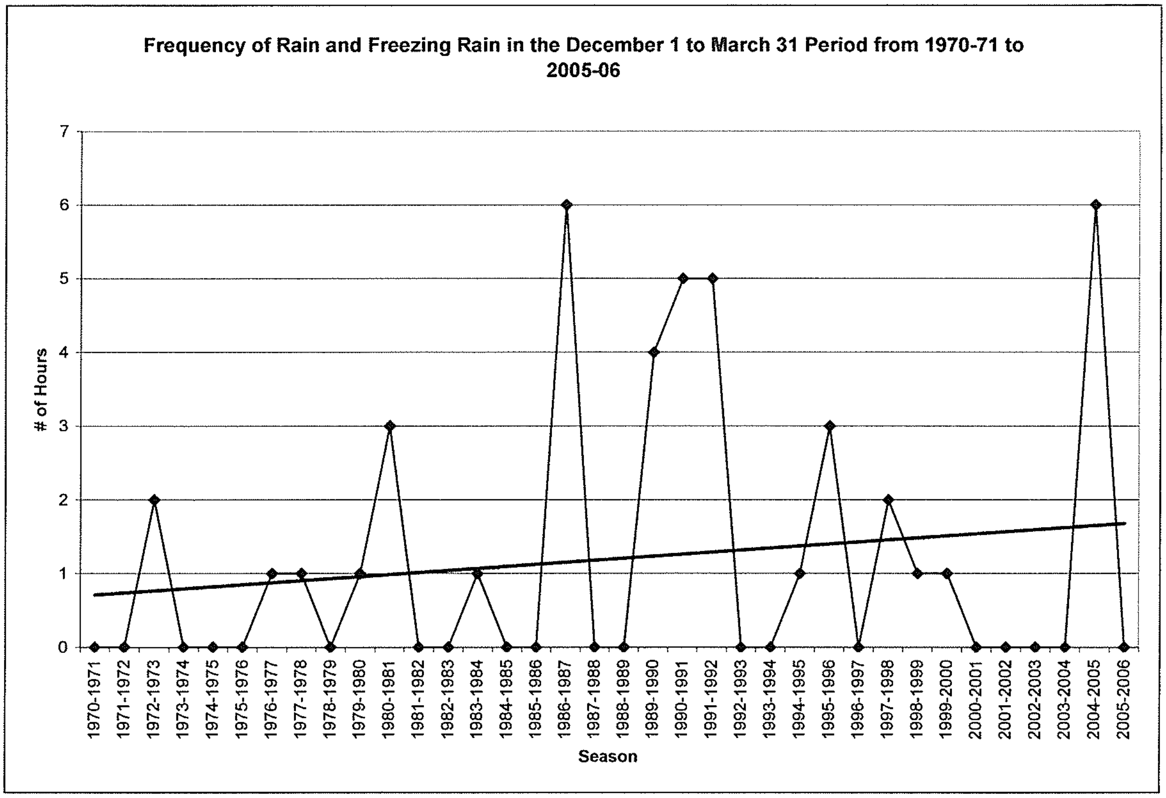

Figure 9: Frequency of rain and freezing rain between December 1 to March 31 from 1970-71 to 2005-06. Based on EC hourly observations from Churchill (2007c). Missing data was ignored.

The unpredictability mentioned in the interviews stretches into many aspects of travelling on the land. It affects one's ability to read the freeze-up and the break-up and thus determine when it is and is not safe to travel during these seasons. Many interviewees report that the end of snowmobiling and boating seasons can happen all at once rather then gradually over a span of several days or weeks. Nickels et al. (2006) indicates that Canadian Inuit hunters are now recognizing that an earlier spring snow melt triggers shorter snowmobile seasons and that hunters must return to their community before the snow has melted or they risk not being able to safely travel home by snowmobile and getting stranded. This is also the case in Churchill.

> It used to be you could tell when the end of the Ski-Doo season was coming, you could tell about one week before. But now, because of the fast melt, you can't tell from one day to the next, it can ruin your plans and get you and your machine stranded on the other side of the river. – D. Hunter, 2006.

Several study participants shared anecdotes of *just* making it home on the tail end of a season as a result of increasingly unpredictable weather. G. Lundie tells a story of returning from a fall hunting trip up the Churchill River in 2004. The day he left for home the weather turned for the worse and then the morning after he returned he awoke to approximately 10 cm of ice on the Churchill River. The end of the boating season came overnight with little warning and/or transition period. If this had happened while he was up river he would have likely had to be taken out by helicopter and forced to leave his boat in the ice all winter, an expensive piece of equipment essential to most harvester's activities (Lundie, 2006).

D. Hunter has a similar story he shared during his interview relating to the tail end of the snowmobile season during the spring of 2006. D. Hunter and a friend were harvesting wood at Goose Creek by snowmobile on a Saturday. They returned on Sunday to cut more wood but he states:

> Wrong! End of Ski-Dooing. Too much water, the snow was melting because of the rain on Saturday night" – D. Hunter, 2006.

As a result they could not use their snowmobiles and they could not harvest any more wood. An unexpected rain from the night before caused this to happen.

Changes Related to Snow and Ice Conditions

Churchill has traditionally had a very long winter season. According to the EC climate normals for Churchill from 1971-2000, Churchill experienced an average of 224.2 days per year of minimum temperature equal to or below -2°C (2004a). As a result, harvesters in the area conduct hunting, trapping and fishing activities throughout the winter months. Snowmobiling is one of the most common modes of off-road transportation in the winter months. People in town use their snowmobiles in the same way that many people in the south use their cars. Thus, any changes to the snow and ice are changes to how you can travel with a snowmobile. Crossing creeks, rivers, lakes and travel on the sea-ice is dictated by freeze-up and break-up timing as well as ice thickness. And travel over land is strongly influenced by snow cover and consistency. Any changes to snow and ice conditions have serious ramifications on travel in the winter. Nickels et al. (2006) indicates that decreased snow cover, earlier snowmelt, thinning ice conditions, earlier break-up and later freeze-up combined with increasingly unpredictable weather results in a decreased ability to predict if it is safe for travel by snowmobile.

Changes in snow cover and consistency

Snowmobiling is one of the most common modes of off-road transportation in the North (Nickels et al., 2006). You need snow to steer your machine, lubricate the moving parts of the track and suspension, and for those with certain liquid cooled machines snow is required to maintain proper engine temperatures. Hassol (2004) indicates a decline in Arctic snow cover extent of about 10% in the last three decades and a projected additional decline of 10-20% by the 2070s, with the greatest declines in snow cover in the spring. Nickels et al. (2006) reports that decreased snow cover and earlier snowmelt in the spring has led to shorter and more difficult snowmobile seasons in the Canadian Arctic, thus making snowmobiles less useful. Study participants across the board are reporting decreases in snow cover on the ground in recent years:

> It used to be you had good snow cover [for snowmobiling] on Halloween. But now the weather is good for kids out trick or treating for candy. – D. Hunter, 2006.
>
> There's less snow then there was a long time ago. There's more bare ground because we get less snow and the little bit of snow on the bare ground thaws out faster. – Anonymous1, 2006.
>
> It seems to me there was more snow in the years when I first came here [1989]. – R. Bougie, 2006.
>
> Before we used to get snow before Halloween, but lately we haven't had much by Halloween. – Anonymous2, 2007.
>
> There's not as much snow cover, snow isn't as abundant as it used to be. There used to be enough to snowmobile on Halloween, now that's unheard of. – D. Lundie, 2006.
>
> Last year there was hardly any snow. There used to be a lot more snow. – C. Daudet, 2006.
>
> There was plenty of snow, about 1 foot everywhere when I was a kid [1970s]. I guess probably in the past sixteen years there is less snow cover. And I know that the snowmobiling season has changed as a result. The snow starts to fall around the end of October, just snow falling not snow cover, whereas before there was snow on the ground earlier in October. And mild winters like last [2005-2006] means the snow is gone by May. – G. Lundie, 2006.

However, from a quantitative standpoint, the amount of snow on the ground is experiencing an increasing trend, inconsistent with local observations. Using daily observations for snow on ground in Churchill from the EC *Canadian Daily Climate Data*

Temperature and Precipitation: Western Canada (2004b) CD-Rom for data up until September, 2003 and using the EC daily observations from Churchill website (2007b) for October, 2003 to December, 2006, snow on ground trends were analyzed from 1955 to 2006 using averages for the months of October to May. Annual averages were established using the monthly averages. After plotting the annual averages and applying a linear least squares fit trend line we see that the annual average snow on ground is experiencing an increasing trend of 1.366 cm per decade (see Figure 10).

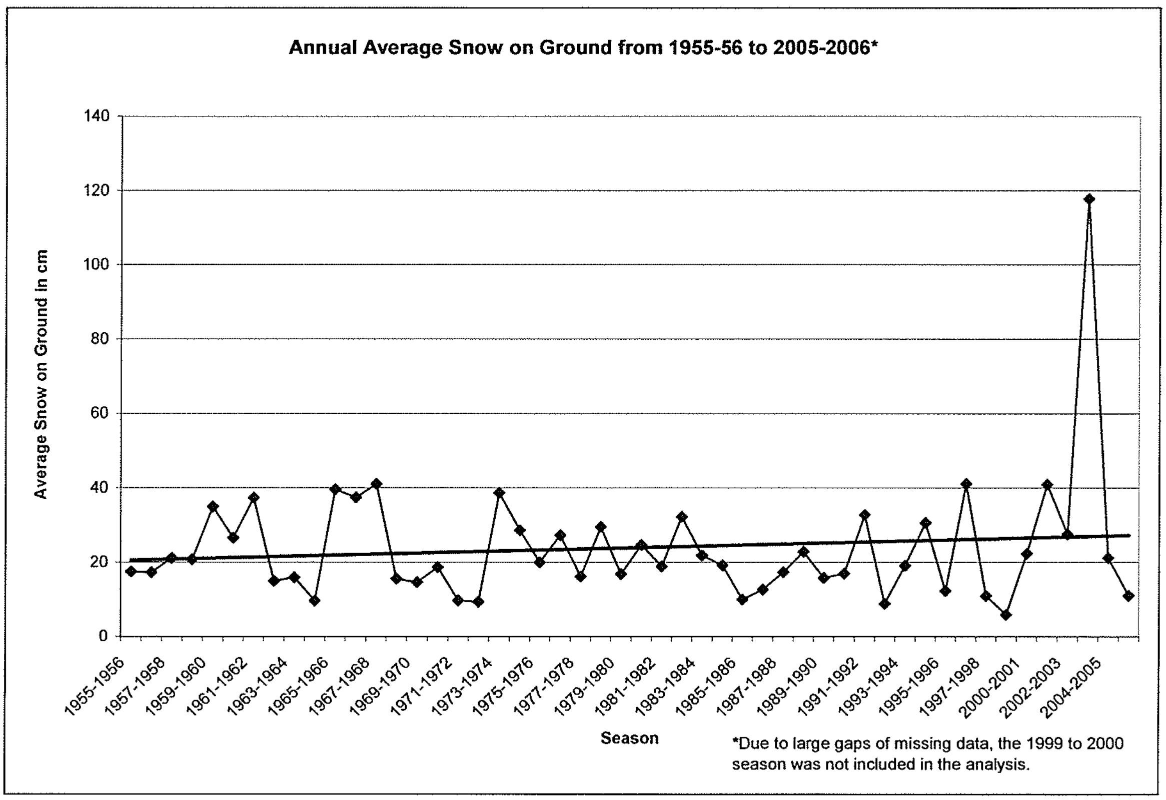

Figure 10: Annual average snow on ground from the winter of 1955-56 to the winter of 2005-06. Based on daily observations from Churchill (EC 2004b, 2007b). Missing data was interpolated with the exception of January 2000 to April 2000 due to large gaps of missing data. As a result the winter of 1999-2000 was not included in the analysis.

When comparing the Traditional/Local and Scientific observations it is important to consider this. While it is the best data available for the area, the snow on ground observations from EC are quite limited. In order to determine depth of snow on ground, EC measures the snow depth of several points representative of the immediate area and averages these points (EC, 2004b). While this gives us great data temporally it is not very good data spatially. If a hunter/trapper is deciding whether or not to travel by snowmobile, he/she will evaluate snow cover and depth over the entire landscape to be travelled. He/she will not sample several points representative of the immediate area, average them and then determine whether or not to travel by snowmobile. The same concept applies to monitoring snow cover change over the past few decades. A harvester will use several reference points in determining whether or not snow cover is changing from more then one immediate location. A harvester travels inland, on the sea, on lakes, rivers, creeks and in the bush. Snow cover will differ in each of these areas. Thus, a harvester's qualitative observation on snow cover change is much more useful in understanding snow cover change as it applies to snowmobiling then the EC data used to quantitatively measure the trend.

We also must consider the following. Due to its proximity to a large body of water, Churchill experiences lake-effect or lake-enhanced snows. This type of snowstorm, most numerous from November to January, occurs on the downwind side of large bodies of water and brings heavy snowfall in a highly localized area extending from a few to up to 100 km (Ahrens, 2008). In Churchill the EC observation station is located within 3 kilometers of the Hudson Bay coast (EC, 2007b), thus making it a likely locale for experiencing lake-effect snows. Whereas the areas where harvesters travel are not always within the lake-effect snows range. In conclusion, a harvester observes a broader area, including areas outside of the lake-effect snow zone, and directly applies these observations to his/her travelling experiences. Whereas EC observations are subject to lake-effect snow and merely sample one immediate area.

Interviewees indicated how changes in snow cover and consistency have negative implications for the act of snowmobiling, machine maintenance and safety issues when riding.

> Some years you can sled 100 km/h, some years 25 km/h, it depends on the snow conditions. It's variable from year to year. – R. Bougie, 2006.
>
> The snow is a lot harder now and there's less of it, which means it's a rougher ride and it's harder on the equipment. – G. Lundie, 2006.
>
> With less snow, your machine takes a beating. There are more rocks exposed on the trails that used to be covered in snow. – D. Lundie, 2006.
>
> In the years with less snow more rocks and palsas are exposed. – R. Bougie, 2006.
>
> Guys' sleds and qamutiks are breaking down when travelling inland. – B. McEwan, 2006.
>
> Less snow and warmer weather means igloo snow is harder to find, it's harder to build an emergency shelter. It used to be wherever you broke down the snow was good enough. – D. Lundie, 2006.

The rough terrain has negative impacts on the equipment used in winter travel, such as the snowmobile's suspension and qamutiks (sleighs used to haul equipment behind snowmobiles (Riewe, 1991)). In fact, some harvesters have had welders reinforce the main cross members of their snowmobile's suspension. They have also learned which parts are most likely to break and ensure they carry spares in case of an emergency. P. Fitzpatrick, a trapper who travels several hundred kilometers by snowmobile inland to his trapline throughout the winter had the main components of his snowmobile's rear suspension reinforced by welding solid metal plates along the components. This increases the strength of the components and reduces the chance of suspension failure on the trail. Most harvesters also install reinforced tow hitches to their machines because of the uneven terrain and because the weight of the qamutik and supplies place an extreme strain on the rear of the snowmobile. Losing your tow hitch would result in difficulties in towing your qamutik and transporting essential supplies (Fitzpatrick, 2006).

Breakage of qamutiks is also a serious threat when travelling inland. The qamutik is an Inuit invention adaptable to varying terrain. The modern qamutik is a wooden sleigh that resembles a pallet on skis. Some have boxes for gear tied to the main body. They are built by tying each wooden component together with a thin strong rope, except for the tow bar which is often bolted on. One puts their gear and harvest on a qamutik and pulls it behind their snow machine. Traditionally it would be towed behind a dog team but today is most commonly pulled by snowmobiles (Riewe, 1991). The reason for tying the components together rather then bolting or nailing is because it gives a little flex and give when travelling over rough and uneven terrain (Lundie, 2006).

With rougher terrain caused by less snow, different snow consistency and more exposed rocks and palsas, qamutiks are more susceptible to breakage on the trail. A broken qamutik can mean you have to leave the majority of your supplies, including food and gasoline, behind (Fitzpatrick, 2006). This is consistent with Inuit observations presented in Nickels et al. (2006) that indicate that less snow leads to damage to snowmobiles and other equipment associated with this type of travel, i.e. qamutiks. In this section the direct affects of changes in snow cover on travel have been discussed. Indirect changes of snow cover on travel are discussed throughout this chapter.

Diminishing lake, river and sea-ice thickness

Another change in the environment that is impacting the way harvesters travel on the land is the thickness of both freshwater ice and sea-ice. This section discusses ice thickness and the changes that have been observed by interviewees while the next section in this chapter discusses changes in the freeze-up and break-up of the ice and what implications this has on harvesters' travel. The *Impacts of a warming Arctic: Arctic Climate Impact Assessment* indicates that significant reductions in ice thickness are occurring across the Arctic in both freshwater and marine environments (Hassol, 2004). No quantitative data is currently available on changes in sea-ice and freshwater ice thickness for the Churchill area.

Complimentary to Hassol (2004), study participants have shared several observations on changes in ice thickness during this project. Thinner ice leads to increased danger associated with travel over frozen rivers, lakes and the Hudson Bay. According to these observations the trend is that the ice is significantly thinner than before. This is highlighted in the following:

> Ice thickness is a little more than half compared to normal on freshwater. – P. Fitzpatrick, 2006.

> As for ice, in '04-'05 there was about 6-7 feet. In '05-'06 there was about 3 feet. – R. Bougie, 2006.

> In spring, track machines and sleds travel up the coast. This season is decreasing too. The trail is worn out because there's less snow and the ice is thinner, as a result it goes away sooner. – D. Lundie, 2006.
>
> Fishing is more dangerous in the freeze-up/break-up seasons. For ice fishing the ice is not as thick, but still thick enough. – D. Lundie, 2006.
>
> The ice is thinner, like about 3 feet max where usually its five to six feet. – C. Daudet, 2006.

Local harvester's observations of thinner ice conditions are consistent with Hassol (2004) who states that ice thickness in the Arctic has been decreasing in recent years and that this trend is expected to continue. In fact, other observations made by study participants help put some of the pieces together in understanding decreased ice thickness. According to Ledley (1991) the thickness of ice is influenced by snow cover. Study participants have been observing decreasing snow cover in recent years. Snow influences ice thickness because snow has a higher albedo than ice. This means snow reflects more solar radiation back into space than ice. This results in a cooling effect on climate. Conditions that favor ice growth are inhibited without the cooling effect on the climate provided by snow's high albedo (Ledley, 1991). However, snow can also insulate ice from the cool climate limiting ice growth but protecting it from an earlier melt (Woo et al., 2007).

> The snow melts fast cause there's less snow on the barren lands and coast. This means there is less snow on the near shore sea-ice protecting it from melting and the shore ice [from] thawing earlier in the season. Not much snow on the ice means the ice melts faster. – Anonymous1, 2006.

Combined factors such as a lack of strong and consistent winds, warmer temperatures, and changes in snow cover and consistency appear to be causing decreasing freshwater and marine ice in the Churchill region. This trend is observed by local harvesters and causes increased danger associated with travelling on the land.

Changes in the timing of freeze-up and break-up of freshwater and sea-ice

Changes in the timing of freeze-up and break-up of freshwater ice and sea-ice in and around Churchill are having significant impacts on the harvesters of the area. Hassol (2004) indicates that later freeze-up and earlier break-up is one of the trends of a warming Arctic. This combination of a later freeze-up and earlier breakup results in a 1-3 week reduction of the ice season in certain areas of the Arctic (Hassol, 2004). This is demonstrated in the work of Stirling et al. (2006) who indicate that sea-ice breakup in Western Hudson Bay is taking place approximately 7-8 days earlier per decade, based on data from 1979–2004. Gagnon et al. indicate the breakup trend in Western Hudson Bay to be more than 0.8 days per year (2005). Stirling et al. (2006) and Gagnon et al. (2005) indicate that the Western Hudson Bay sea-ice is experiencing breakup approximately 3 weeks earlier than it did 30 years prior. Gagnon et al. also points out that trends suggest a later freeze-up over most of Hudson Bay, with the exception of an area near the west cost of James Bay (2005).

Study participants shared observations and experiences about the timing of the freeze-up and break-up in and around the Churchill area:

> The freeze-up takes longer and break up is sooner in both marine and freshwater. – D. Lundie, 2006.

> It was a late freeze-up this year and early thaw. – C. Daudet, 2006.
>
> Usually we get freezing ice by beginning of October and this year was late and it didn't start until the end of November, this has been happening for a few years. – Anonymous2, 2007.

Changes in the timing of freeze-up and break-up are very important to harvesters in Churchill because it affects several different aspects of travel on the land. First and foremost it influences hazards and safety associated with travelling on the land. Being able to know and understand the ice during the freeze-up and break-up seasons is crucial to safe travel over the ice. Several participants reported how predictability of the ice during these seasons is changing.

> The freeze-up and break-up are unpredictable now, it was more predictable when it was colder. – G. Lundie, 2006.
>
> Crossing creeks and rivers is less predictable depending on the kind of year, you get slushier creeks and rivers, it depends on the year. – B. McEwan, 2006.
>
> During the freeze-up you can't be sure how thick the ice is. In spring everything is softer and thus more dangerous. Fishing is more dangerous in the freeze/thaw seasons. – D. Lundie, 2006.

Unpredictability of ice conditions is not the only change making travel during the freeze-up/break-up seasons more dangerous. The freeze-up and break-up are also happening much faster then in previous years. Interviewees report that this is increasing dangers related to travel by boat and snowmobile during the tail ends of the season. For an example of how dangers associated with boat travel are occurring see G. Lundie's story in the 'Weather predictability' section of this chapter about hunting up the Churchill

River by boat when the Churchill River went from open water to approximately 10 cm of ice overnight. With snowmobiles, the danger lies in breaking through the ice and encountering river and lake crossings along the trail that have become open water sooner than expected in the late season or have not yet frozen during the early season. An example of this situation is seen in the following observation:

> Last spring was the first I've seen water on Matonabee Creek (80 mi. inland). We had to pull the other Ski-Doo's over about two feet of water at the creek. – P. Fitzpatrick, 2006.

Figure 11: Open water on Matonabee Creek April 14, 2005. This type of unexpected hazard is associated with earlier and warmer springs and an earlier break-up of ice (Image credit: P. Fitzpatrick).

Due to earlier open water than expected on Matonabee Creek on April 14, 2005, P. Fitzpatrick and his friends encountered a situation on their way home from his trapline, forcing them to cross open water with their equipment and take serious risks (see Figure 11). In order to cross Matonabee Creek, a requirement for returning to Churchill, they were forced to risk damaging their equipment which would have left them stranded, losing equipment all together, being exposed to hypothermia as a result of getting wet and even drowning. In order to cross the creek, P. Fitzpatrick used every piece of fabric he had in his luggage, mittens, socks, t-shirts, etc., to plug the vent holes on the cowling (hood) of his snowmobile and crossed the creek with enough speed to prevent the machine from sinking into the water. By minimizing how much water entered the engine compartment he had a better chance of crossing the open water without damaging his engine (see Figure 12). To be safe the group tied a long rope to P. Fitzpatrick's snowmobile, in order to recover it had it lost its momentum and sunk. P. Fitzpatrick successfully crossed the creek and the group began pulling the remaining equipment (snowmobiles, sleighs and gear) across the creek (see Figures 13 and 14). When pulling the remaining snowmobiles across the engines were shut off to minimize the chance of water getting into the engine and causing damage. What could have been an expensive and harmful event luckily worked out well for P. Fitzpatrick and his friends.

Figure 12: Plugged cowling to minimize water entering the engine compartment. In order to successfully cross the open water by snowmobile, P. Fitzpatrick plugged the cowling of his snowmobile with whatever materials he could find in his gear. Thankfully this worked and the group continued to haul remaining equipment and supplies across the water (see figures below) (Image credit: P. Fitzpatrick).

Figure 13: Hauling equipment across the creek. The group floats a sleigh with gasoline containers across the creek (Image credit: P. Fitzpatrick).

Figure 14: Hauling snowmobiles across the creek. With the engine shut off, the group pulls the last snowmobile across the creek. Once successfully crossed, the snowmobiles ran properly (Image credit: P. Fitzpatrick).

Changes in the timing of freeze-up and break-up are also having implications on the duration of the snowmobile season and the boating season. A later freeze-up and earlier break-up has two significant implications on these seasons. The first is that the boating season is extended, both in the fall and spring time. The second is that the snowmobiling season is reduced, which either prevents harvesters from crossing the river to access traditional hunting grounds or makes accessing these areas much more dangerous. These aspects are looked at further in the 'Changes in travel seasons' section of this chapter.

The changes in the timing of the freeze-up and break-up are directly affecting the way harvesters travel on the land and also directly affecting the distribution of popularly hunted animals such as moose and caribou. This is highlighted in the knowledge and observations of local hunting guide B. McEwan:

> This year the moose around Button Bay and North River came out late in the fall/winter of 2005. This is due to less snow and later freeze-up. Plus the ice was rougher at North River (like the Deer [River] and others). The rough ice is hard on their hooves. The snow usually covers up the rough ice plus the later freeze-up means they couldn't travel over water. – B. McEwan, 2006.
>
> As for caribou [Beverly and Qamanirjuaq herd], this year the Seal River froze late and the caribou went further inland to cross the river. As a result they were further away from town all winter. – B. McEwan, 2006.

These changes have implications for hunters who rely on these populations of animals for harvesting purposes. As a result of these changes, animals can be more difficult to locate.

As you can see from the scientific literature and knowledge and observations of local harvesters in the area, the freeze-up and break-up has been changing in recent decades. Later freeze-ups and earlier break-ups have been observed. This is increasing the duration of the boating season and shortening the duration of the snowmobile season. It is also increasing risks and hazards associated with travel by snowmobile over both freshwater and sea-ice due to thinner and less predictable ice thickness during the freeze-up/break-up season.

Changes in Harvest Success and in Populations and Locations of Harvested Species

Changes in harvest success and populations/locations of harvested species are important to harvesters. It affects how they travel on the land by influencing where and when they go to harvest. This section is separated into categories based on type of harvesting and includes hunting and fishing. Then each category is separated into sub-categories based on type of species harvested for hunting and by freshwater or saltwater fish for fishing.

Changes to harvest success of mammals and birds

There have been several changes to the harvest success of mammals and birds. Mammals and birds harvested in the Churchill area include caribou, moose, geese, ducks and ptarmigan. All harvesters interviewed in this research indicated changes in harvest success are occurring in regards to caribou, moose and geese. Overall, the harvest success of caribou and moose is increasing and the harvest success of geese, more specifically during the spring, is declining.

Changes related to moose hunting

In this project all hunters interviewed indicated that moose (*Alces alces*) populations are increasing in the Churchill area. They also report that moose are located closer to town then they have been in the past. This has positive implications for hunting moose because there are more of them and they are closer to town. Moose harvest success is increasing in the Churchill area.

As for moose, there are more here then they have 250 mi. south (around Norway House). Why? Because fires in '86 scared the moose north and they found their perfect environment and never went back. It has also been warming up and the snow is thinner so it's easier for them to eat. – D. Hunter, 2006.

There are more moose now, there is a larger population then before. Possibly forest fires in the south pushes things north. – G. Lundie, 2006.

I've noticed lots of moose, more each year. It's got a lot to do with a warmer climate and what moose eat. They browse and there's more willows caused by changes in the growing season due to a warmer climate. In general, they are moving north because of the warmer temperatures year round. – P. Fitzpatrick, 2006.

North River is packed with moose, crazy numbers. – B. McEwan, 2006.

Years ago you had to look for moose, now you don't have to, they are down around Goose Creek. I used to hunt them at North River but now they are so close to town, I don't have to go as far. Around CR30 and Warkworth Lake the moose are thick. – R. Bougie, 2006.

In '05 I got my moose at the culverts [at Goose Creek], in '04 4km north of CR30, and in '03 10km south of CR30. Whereas in '94, '95 and '96 the moose were around Deer River [significantly further from town], you wouldn't get moose all the time. – R. Bougie, 2006.

Moose are more abundant, it used be a challenge to find a moose but now you can find them in herds of ten. Wolves are more evident as well, there is a connection to the moose and caribou. – D. Lundie, 2006.

Figure 15: Hunted moose. This moose was harvested by local hunter G. Lundie (right) with friend A. Mackenzie (left) in September of 2003 at Warkworth Creek (Image credit G. Lundie).

The Traditional and Local Knowledge of changes in moose abundance and distribution is mirrored by other Traditional and Local Knowledge from around the Canadian North. In *Voices from the Bay: Traditional Ecological Knowledge of Inuit and Cree in the Hudson Bay bioregion* McDonald et al. (1997) indicates that residents of the southeastern James Bay report a loss and disturbance to moose habitat in their region and as a result, the moose are moving north toward the communities of Kuujjuaraapik/Whapmagoostui, Nunavik. In *The changing Arctic: Indigenous perspectives*, Huntington et al. (2005) indicates that several species are on the move north including moose, certain birds never before seen, new types of insects and parasites and diseases that are problematic for spruce and pine. Furgal et al. (2002) use a quote by a hunter from Nain, Labrador to summarize the increased presence of moose in the Nain area:

> "We see moose now, and never did before. We see them more and more each year. We've seen them up as far as the bay north of here. Nain man, aged 43 (p. 283)

According to Hassol (2004), climate change is expected to lead to a shifting range and abundance of animal species such as moose. Hassol also indicates that this is projected to be a northward shift (2004). Building on the Scientific Knowledge regarding moose moving North, Nutall et al. (2005) indicate that moose are indeed expanding in range into more northerly environments. Weller et al. (2005) report that "as the boreal forest and associated shrub communities expand northward at the expense of tundra, changes in habitats, migration routes, ranges and distribution and density of a number of wildlife species, particularly caribou and moose, are projected" (p. 1017). Klein et al. (2005) indicates that invasive species such as moose, located in biomes such as the boreal forest found adjacent to the Arctic and Subarctic, have expanded into parts of the North American Arctic. Klein et al. also indicates the trend of moose populations in detail for the Alaskan Arctic, represented in Table 4 (2005).

Table 4: Alaskan moose populations

Region	Estimated population	Trend	Number harvested per year	Threats
North Slope	750	Up	30	Disease
Selawik/Kobuk/Noatak	10,000	Stable	400	No immediate threats
Seward Peninsula	5,000	Stable	350	No immediate threats
Yukon/Kuskokwim	3,000	Up	200	Illegal harvest
Northern Bristol Bay	3,500	Up	600	No immediate threats
Alaska Peninsula	5,000	Stable	300	No immediate threats

*Reproduced from data presented in Klein et al. (2005).

As Table 4 demonstrates, half of the Alaskan region's moose are experiencing an increasing trend while the other half remains stable. We also see in Table 4 that threats to these populations are low and the number harvested per year appears to be of a sustainable nature. Complementary to the Traditional/Local Knowledge from Churchill, the Scientific observations also indicate a northward shift in range and abundance of moose.

As seen in the knowledge and observations of local harvesters, moose are increasing in population and are found closer to Churchill than in previous years. While an increased population in moose increases harvest success so does their proximity to town, as hunting effort is reduced along with distance required to access moose hunting areas. Their change in distribution/location also directly affects the way harvesters travel when on the land. The mode of transportation required to hunt moose is no longer a boat or snowmobile. Now moose are in walking, canoeing, track machine and all-terrain vehicle distance of town. This is highlighted in the following:

> Before, moose hunting in September in areas like North River took a boat. Now with the moose so close to town you can walk, ATV or use a track machine. – R. Bougie, 2006.

> When hunting moose [in winter] at North River you'd have to use a sled. But now you only have to go to Goose Creek, you can take a canoe in the fall. – D. Lundie, 2006.

With more moose being found closer to town, moose hunting is easier then it has been in the past. It also requires less equipment and overhead then before. Now you can hunt moose by walking, which is free. Or you can hunt moose with a canoe, which can be purchased for relatively cheap with very little maintenance. This means you no longer require a snowmobile or motor boat, which are considerably more expensive and require significant maintenance.

Changes related to caribou hunting

Before discussing changes in caribou in and around Churchill it is essential to review the background of caribou in the Churchill area. According to Campbell (1995) there are three separate herds of caribou whose range overlaps with each others in the Churchill area. The Penn Island caribou herd, a woodland caribou (*Rangifer tarandus caribou*) herd, is located in a more southerly range than the rest but overlaps slightly in the southerly region of the Cape Churchill area. This herd conducts its rut away from the other herds and thus is isolated from the other herds. The Kaminuriak (also known as the Beverly Qamanirjuaq) is a barren ground caribou (*Rangifer tarandus groenlandicus*) herd and its range is located more northerly then the other herds present in the Churchill area. This herd is isolated from the rest during the fall rut and spring calving periods but often migrates into the Churchill area during the winter. Finally, we have the Cape Churchill caribou herd, of which there is no definitive taxonomic status. Their range is bordered by the Hudson Bay to the north and to the east, by the Nelson River to the south and by the Hudson Bay Railway to the west (see Figure 16) (Campbell, 1995). The town of Churchill is located within the Cape Churchill herd's range. The Cape Churchill and the Beverly Qamanirjuaq herds were the two discussed by harvesters in the project interviews.

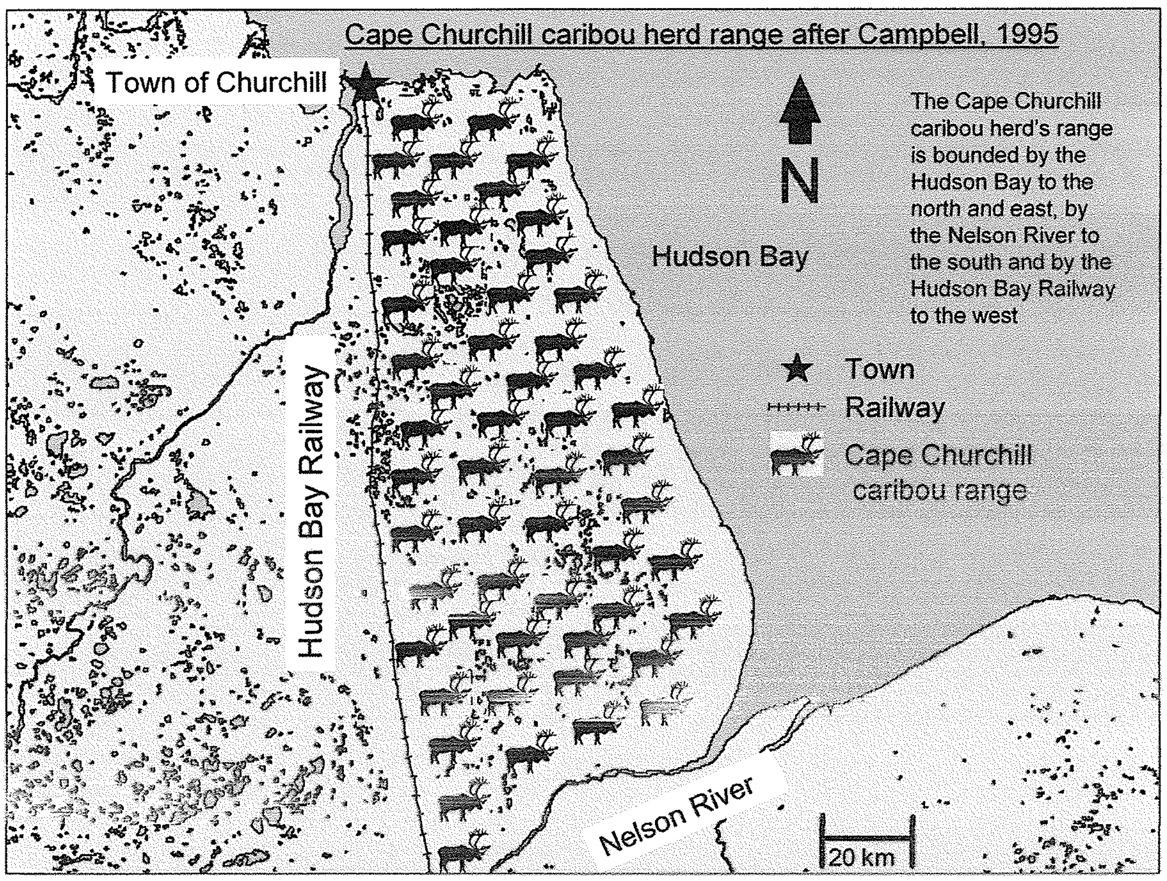

Figure 16: Cape Churchill caribou herd range. This image demonstrates the range of the Cape Churchill caribou herd (after Campbell, 1995). Derived from Manitoba Land Initiatives 1:500,000 Manitoba base map. © 2001, Her Majesty the Queen in Right of Manitoba. All rights reserved. Used with permission, permission granted August 15, 2007.

Much like moose, caribou are also being found closer to town. In fact, interviewees report that in recent years caribou have been coming right into town and into nearby cottage sub-division Goose Creek (see Figure 17). However, unlike moose, interviewees did not report an increase in the population of caribou, just their proximity to town. The following excerpts demonstrate that in recent years, caribou (Cape Churchill herd) are being observed closer to town:

> You used to have to go about 65 mi. east to get a caribou... now the caribou are coming to town, it's easier to find them. You can find them in a 10 mi. radius of town. – D. Hunter, 2006.
>
> ...there was even caribou out at Goose Creek. – G. Lundie, 2006.

Figure 17: Caribou at Goose Creek. This photo, taken by G. Lundie, was taken on Goose Creek road when a herd of caribou moved through the cottage subdivision.

According to interviewees, it is relatively easy to hunt caribou from the Cape Churchill herd. I went on several trips to the Churchill Wildlife Management Area (WMA) and a five day trip to Wapusk National Park (WNP) by all-terrain vehicle, four-wheel drive pickup truck, tundra buggy and helicopter during the summer of 2006. Nearly every visit to the WMA yielded multiple caribou sightings. And each day spent in WNP yielded at least one caribou sighting. I also went on a caribou hunt by all-terrain vehicle in the WMA in August, 2006. Multiple caribou were spotted that day and several hunters completed a successful harvest (see Figure 18).

Figure 18: Hunted caribou. Project mentor G. Lundie (centre) skinning a caribou on August 26, 2006 east of Churchill near Knight's Hill in the Churchill Wildlife Management Area (Image credit: J. Gilligan).

Several observations on the Beverly Qamanirjuaq herd were also presented during interviews with Churchill harvesters. According to the knowledge of interviewees, the location of Beverly Qamanirjuaq caribou is less predictable then that of Cape Churchill caribou and more sporadic. This is demonstrated in the following:

> As for caribou [Beverly Qamanirjuaq herd], this year the Seal River froze late and the caribou went further inland to cross the river. As a result they were further away from town all winter. – B. McEwan, 2006.
>
> In all the years I've traveled up and down the coast to Arviat I've never seen caribou along the coast. Last year I saw five to six thousand caribou on the coast, starting at Caribou River and going up to Nunalla. – C. Daudet, 2006.

To summarize, the Cape Churchill caribou herd is located closer to town then it has been in the past. G. Lundie indicates that "when the military pulled out the caribou moved back into the area" (Lundie, 2006). Whereas the Beverly Qamanirjuaq herd is less predictable in its location. Harvesting of Cape Churchill caribou is successful right now. The fact that many hunters access Cape Churchill herd hunting grounds by all-terrain vehicle means that travel to this area is less likely to experience significant changes then harvesting areas accessed by snowmobile during the spring and fall. However, further studies should be done to determine the implication of potential thawing permafrost in the area on all-terrain vehicle travel.

Changes related to goose hunting

One traditional activity that is impacted by an earlier ice break-up is the spring goose hunt. According to interviewees, changes in the Churchill River's dynamics during spring, including snow cover, ice thickness and timing of break-up are increasing the dangers of crossing the river by snowmobile. Also, interviewees report that once on the other side there is often no snow in the spring to travel by snowmobile. Some suggest that it is still an option if travelling by all-terrain vehicle but study participants indicate that it is far easier by snowmobile. Some interviewees report that although it is more dangerous then in the past, that danger is related to experience and proper knowledge can get you successfully across the river despite new hazards. The situation surrounding the spring goose hunt is highlighted in the following knowledge shared by study participants:

> The snow is melting sooner some years, shortening the Ski-Doo season. We used to go goose hunting by sled [across the river] every year but now it's rare. The river is not safe for sleds to cross there due to a lack of snow, but an ATV is still capable because the ground, ponds and lakes are still frozen but there is no snow cover on them to snowmobile. – P. Fitzpatrick, 2006.

> This year's spring goose hunt success went down because it wasn't safe to cross the river [Churchill River]. – B. McEwan, 2006.

> The river [Churchill River] was unsafe to cross when the spring goose season started. – R. Bougie, 2006.

> Goose hunting across the river [Churchill River] in spring is more dangerous. I still cross the river but if you're not experienced its very dangerous. – D. Lundie, 2006.

> It used to be I would goose hunt at Seal River [across the Churchill River] by snowmobile on May long, one year I went June 2^{nd}. In the last few years the first week of May was pushing it. It's more dangerous in the first

> week of May but that used to be prime time to sled. Although danger is relative to experience. – C. Daudet, 2006.

The spring goose hunt is an important activity to Churchill harvesters. Although there are geese on the east side of the Churchill River, the best hunting opportunities and several developed camps are on the west side. Several interviewees also indicate that spring geese are better for consumption then geese hunted during the fall. Based on the experiences of study participants, the harvest success of the spring goose hunt has been declining in recent years as a result of increased danger in crossing the Churchill River by snowmobile in the spring.

Changes to harvest success of fish

There have been several changes reported by certain study participants relating to fishing success. This applies both to the inland freshwater fish harvest and to the estuary and marine fish harvest. Changes in the freshwater harvest are associated with changes to the Churchill River by Manitoba Hydro (Boothroyd, 2000). As for saltwater fishing, study participants are recording decreased harvest success related to char fishing which can be associated to climate change.

Changes related to fishing freshwater species

As mentioned previously, changes to the Churchill River by Manitoba Hydro has resulted in less successful harvests of freshwater fish on the Churchill River (Boothroyd, 2000). In 1976 Manitoba Hydro began diverting water from the Churchill River into the

Nelson River via the Rat-Burntwood Rivers. This was done in order to increase production of the hydro-electric dams along the Nelson River. This resulted in significantly lower water levels in the Churchill River. This seriously impacted the ecology of the river including major changes to freshwater fish populations (Edye-Rowntree et al., 2006). Fish traditionally harvested in freshwater include pike, suckers, cisco, whitefish, grayling, sturgeon and pickerel (McRae et al., 1997)

These ecological changes to the river significantly reduced the harvest success of freshwater fishing in the Churchill River along with local harvester's ability to access cabins, camps and harvesting grounds, which is further discussed later in this chapter (Boothroyd, 2000). In Boothroyd (2000) Churchill residents are quoted discussing their knowledge and experiences of the Churchill River diversion:

> "…I don't know what Hydro was thinking when they took the water… all they was thinking was getting their power – what about the people that was using that river?..." Barbara Gordon, Churchill resident (Boothroyd, 2000, 48)

> "…I phoned Hydro and I said you just can't do that to people – you can't just take the water away and kill 300 miles of fish…" Ed Bazlik, Churchill resident (Boothroyd, 2000, 47)

> "…quite a few people had a boat and motor back then but not anymore… you don't see Aboriginals going up there no more because the water's not there – the only people that go up are people with airboats now…" Morris Spence, Churchill resident (Boothroyd, 2000, 51)

Churchill harvesters in this project also indicate that the harvest success of fishing freshwater fish on the Churchill River significantly decreased as a result of the Churchill River diversion:

> I am fishing less freshwater and more salt water because of Hydro diverting the water from the Churchill River. – D. Hunter, 2006.
>
> Fishing success has gone down big time. In the Churchill River we used to catch grayling, brookies, big jacks, whitefish, suckers and mariahs. Now you catch small jacks, the odd brooky, and a half a dozen pickerel a year if you're lucky. – D. Hunter, 2006.
>
> When I was a kid fishing at Goose Creek I could catch grayling, trout, whitefish and now it seems that there is nothing but pike. The shortage of water destroyed the habitat of certain species of fish. – G. Lundie, 2006.

In response to the negative implications of the Churchill River diversion Manitoba Hydro constructed a rock-fill weir approximately 10 km south of the town site. The goal of this project was to bring up the water levels of the Churchill River south of the weir (Edye-Rowntree et al., 2006). However, several harvesters interviewed during this project indicate that the construction of the weir had further negative implications on the use of the river:

> In the Churchill River there's a big difference in size, amount and species of fish following the weir construction. Before the weir we were able to get whitefish, grayling, brown trout and pike. Now you can't get grayling, there might be some in the rocks but no one catches them. When I first got here you would see hundreds of pike hanging out by the culverts, some 15-16 pounders. Now pikes are about 2-4 lbs. You can catch the odd brown trout now but no whitefish. – R. Bougie, 2006.
>
> Since the diversion you can't get up river with an outboard motor unless there's a lot of rain down south like last year. And that weir is a piece of ...[garbage]... that doesn't even work. - Anonymous1, 2006.

Changes related to fishing in the marine environment

Fishing in saltwater by net in the tidal areas for species such as Arctic charr (*Salvelinus alpinus)*, broad whitefish, Arctic cisco and trout, is a traditional harvesting activity in Churchill. While Arctic charr are less common in Manitoba then in Nunavut or Quebec (Nunavik), there still exists a small harvest which Churchill residents consider a welcome treat (McRae et al., 1997). Saltwater fishing with nets has traditionally been done in the Churchill area along the shore of Hudson Bay between the town site and Fort Churchill, at the Flats, and at other locations across the Churchill River including Button bay (Koolage, 1971). Harvested char are consumed and sold locally by harvesters. Saltwater fishing is primarily done with gill nets set in the tidal zone along the Hudson Bay coast (Stewart et al., 2005).

The Traditional/Local Knowledge of harvesters interviewed in this research corresponds well with scientific predictions of the implications of climate change on Arctic charr. Study participants indicate that the Arctic charr harvest has been declining.

> Setting nets off-shore, you would be able to catch good numbers of charr, but now you catch less charr, the odd cisco and lots of seaweed. – G. Lundie, 2006.
>
> Fifteen years ago we could get 20, 30, 40 charr in one tide, now you're lucky to get one or two, even trout are down a bit. – D. Lundie, 2006.

Arctic charr are one of the most sought after fish in the Western Hudson Bay region. This is because it has traditionally been available at predictable times and predictable locations. In addition, they are easy to catch with the use of gill nets. Arctic charr are common along the shores of Quebec (Nunavik) and Nunavut, while they are less common along the shores of Manitoba and Ontario (Stewart et al., 2005). Arctic charr are diadromous fish, i.e. fish that spend part of their life in marine environments and move to freshwater environments to spawn, or vise versa. More specifically, Arctic charr are anadromous which means they spawn, rear and overwinter in freshwater and move into marine environments to feed. Most anadromous species in the Arctic, including Arctic charr, are facultatively anadromous. This means that they do not necessarily move into marine environments just because it is accessible (Wrona et al., 2005). In Hudson Bay, Arctic charr migrate to the marine environments sometime between mid-June and mid-July, feed in Hudson Bay and James Bay and return to the freshwater environments sometime between mid-August and mid-September (Stewart et al., 2005).

One reason why there are less Arctic charr in Manitoba and Ontario compared to Nunavut and Quebec (Nunavik) is that anadromous behaviour declines in frequency or stops all together towards the southern distribution of the species (Wrona et al., 2005). It is predicted that climate change will very likely increase productivity in Arctic lakes. As a result, facultatively anadromous species may potentially demonstrate progressively less anadromous behavior, opting to stay in the now more productive freshwater environments if it becomes more beneficial to remain there for feeding (Wrona et al., 2005). However, Wrona et al. (2005) also warn that higher productivity in estuaries may counter this.

One threat climate change poses to Arctic charr involves alterations in Arctic environments which can lead to reductions in the species preferred habitats and ultimately extirpation (Wrona et al., 2005). In addition, anadromous species from lower latitudes could possibly expand north as a result of climate change with negative impacts on currently present anadromous species such as Arctic charr (Wrona et al., 2005). Stewart et al. (2005) warn that because their distributions infrequently overlap, lower latitude anadromous species such as pike and brook trout could move north and reduce or eliminate Arctic charr populations along the Hudson Bay coast. Either or both of these implications of climate change on Arctic charr could be responsible for declining numbers in the southwestern region of Hudson Bay.

Saltwater fishing is not limited to net fishing in the tidal zones. There also exists fishing by rod and line for cod and capelin. Fishing for cod is commonly done in deep water areas with a rocky bottom. According to study participant R. Bougie, the best place to do this is just off Eskimo Point. Very little knowledge regarding harvest success of cod fishing was shared during the 2006 field season. Some study participants discussed the success of cod harvests during participant observation activities but to a limited extent. Based on these short conversations and local observations, the harvest of cod appears to be quite consistent and is best defined as 'hit and miss'. One interviewee reported on the success of cod harvesting during an interview:

> With cod, some guys catch a couple and some a dozen. – D. Lundie, 2006.

Capelin is another saltwater species occasionally harvested by Churchill residents. According to study participants G. Lundie and B. McEwan, this is done by dragging a large hook attached to a line through the water which most commonly hooks into the sides of the fish passing by in dense schools. Capelins are consumed very similarly to sardines as they are also smaller fish, which filleting would be a wasteful endeavor. No observations were recorded on the harvest success of capelin fishing.

Changes in Access to Cabins, Camps and Harvesting Locations

Environmental changes are affecting how and when people access their cabins, camps and harvesting locations. One of the biggest impacts is on the access of cabins (used for hunting, trapping and fishing) along the Churchill River caused by changes to the river by Manitoba Hydro, as mentioned earlier. The Churchill River is the main river in the area and provides access to all the inland tributaries and associated harvesting areas. Access to cabins and traditional harvesting areas inland via the Churchill River is limited during the open water season.

> There used to be about twenty cabins on the Churchill River, now there's about 4 cabins. You can't get to them because of the low water, unless you got the cash for a jet or air boat. Plus there's less reason to go there, there's less fish. – D. Hunter, 2006.

As a result of the changes to the Churchill River by Manitoba Hydro it is more expensive to access harvesting areas inland. In addition, further changes to the Churchill River by Manitoba Hydro have limited access with the use of all-terrain vehicles along the river.

> Before the weir you could travel along the river with an ATV, you'd keep to the east side and go to Deer River. Now the water is too high. The trees

> on the bank are too thick. You can get about 12km from CR30 by ATV and that's about it. I used to moose hunt by ATV 'cause you could travel the shore. I don't hunt moose at Deer River anymore because I can't get there with an ATV. – R. Bougie, 2006.

Because of these changes, less people are travelling to these areas and practicing harvesting and recreational activities along the Churchill River (Edye-Rowntree et al., 2006).

Another way environmental changes are impacting access to harvesting locations is discussed in detail earlier in this chapter in regards to the spring goose hunt. Reduced snow cover and changing dynamics in the Churchill River during the spring has increased the danger associated with crossing the river to the traditional hunting grounds on the west side of the river. This is also the case during the fall/early winter. Changes in the freeze-up of the Churchill River also lead to reduced access to cabins, camps and harvesting areas on the west side of the Churchill River in the early snowmobile season. Harvesting activities on the west side of the river during this time of year includes moose hunting and trapping. With increased danger associated with crossing the river during this period, the timeframe in which these activities can be done is being reduced. Changes in the environment such as snow cover and ice thickness are reducing access to cabins, camps and harvesting grounds.

Changes in Travel Seasons

All of the environmental changes looked at in this chapter have implications on off-road travel. So far this chapter has made short references to how observed changes are altering travel by certain off-road vehicles. This section will take a more in-depth look at how the changes observed by study participants is currently altering the travel season of boats, snowmobiles and all-terrain vehicles. These are the three most commonly used vehicles when travelling on the land (Nickels et al., 2006) and an in-depth look at how each respective season is changing is essential to the proper understanding of the implications of environmental changes on off-road travel.

The boating season

As a result of diminishing lake, river and sea-ice, as discussed previously, the open water season is increasing in duration by several weeks, depending on annual conditions. As mentioned earlier in this chapter, both Stirling et al. (2006) and Gagnon et al. (2005) indicate that sea-ice breakup is occurring approximately 3 weeks earlier than it did 30 years ago. In addition, Gagnon et al. also indicate that there is a trend towards later freeze-up (2006). A longer open water season results in a larger window of time for harvesters to use their boats. The boating season is getting longer in Churchill.

> The [boating] season's getting longer. It used to be July to mid-September, now boats are in the water in early June and you can boat until early October. – D. Hunter, 2006.
>
> Now you can get out boating at the beginning of June whereas before you would get out toward the end of June. – G. Lundie, 2006.

This is also the case in Nunavik where residents have indicated that a longer open water season, as a result of later freeze-up and earlier break-up, has made the boating season longer "a positive for those that have boats and enjoy hunting during the open water season" (Nickels et al., 2006, p. 73). As a result, harvesters have more time to spend at their cabins, camps and harvesting grounds which are accessible by boat in the open water season.

Study participant D. Hunter sees a positive side to this. He enjoys fishing at his cabin at Seahorse Gully on Button Bay, west of the town site. A longer open water season results in more weekends that he is able to travel to his cabin and fish. Hunter recognizes that harvesting by boat is his preference and that those who prefer to harvest by snowmobile see a negative aspect of a longer open water season. There is a relationship between the changes in the snowmobile season and the changes in the boating season. If one of these seasons is extending in length then the other one will become shorter. This is highlighted in the following:

> The Ski-Doo travel season is shorter but this increases the boating season.
> – D. Lundie, 2006.
>
> If you were living on the land you will be boating more and snowmobiling less. – P. Fitzpatrick, 2006.

Based on the interviews of this research, the trend in Churchill is that the boating season is getting longer. This means harvesters have a longer time frame to travel to cabins, camps and traditional harvesting grounds accessible by boat. As a result, one has a longer period of time to participate in open water season harvesting activities such as hunting and fishing. However, Nickels et al. (2006) indicates that increasingly unpredictable weather conditions are making it more dangerous to travel by boat, an aspect not yet reported by local Churchill residents.

The snowmobile season

As mentioned in the previous section, the snowmobile season in Churchill has been shortening in recent years. Reduced snow cover, diminishing lake-, river- and sea-ice and changes in the timing of freeze-up and break-up are changes observed by local harvesters that combine to significantly shorten the snowmobile season by several weeks, depending on annual conditions. However, study participants also indicate that warmer temperature in the December to February period enables more days to snowmobile, whereas previously much of this timeframe was too cold to do so. Inuit observations presented in Nickels et al. (2006) also report shorter snowmobile seasons as a result of decreased snow cover, more rapid spring snow melts, earlier break-up and later freeze-up. Every harvester interviewed in Churchill during this study indicated a shortened snowmobile season.

> I used to travel by sled from around November 15th to about June 20th in the '70s. Now you can sled from around November 15th to April (mid to end). You used to be able to hunt geese by sled in May, now you can't. You used to be able to sled on the Churchill River until June but not anymore, it melts too fast. – D. Hunter, 2006.
>
> There used to be plenty of snow, over one foot everywhere, when I was a kid. I guess probably in the past sixteen years there is less snow cover. And I know that the snowmobiling season has changed. The snowmobile season is shorter. In the springtime, if there's less snow from winter there is more water because more ice is exposed to the sun, this shortens the

season too. – G. Lundie, 2006.

There's less snow from a long time ago. Years back I never seen no snow until just about the end of November. This was a long time ago, it only happened that one time back then. The snow melts fast cause there's less snow on the barren lands and coast. This means there is less snow on the near shore sea-ice protecting it from melting and the shore ice thawing earlier in the season. Not much snow on the ice means the ice melts faster. – Anonymous1, 2006.

If you were living on the land you will be boating more and snowmobiling less. – P. Fitzpatrick, 2006.

You used to be able to sled from October 31 on. At about mid-November the good conditions snowmobile season usually starts. – B. McEwan, 2006.

April is usually a good time to sled but we were ripped off this year. – R. Bougie, 2006.

The snowmobile season is shorter on both sides [fall and spring]… you used to be able to sled on Halloween, now that's unheard of. – D. Lundie, 2006.

It used to be I would goose hunt at Seal River by snowmobile on May long, one year I went June 2nd. In the last few years the first week of May was pushing it. It's more dangerous in the first week of May but that used to be prime time to sled. – C. Daudet, 2006.

Churchill harvesters' local observations of a decreased snowmobile season are consistent with quantitative trends. Using EC daily observations from Churchill (2004b; 2007b), a trend for the length of the snowmobile season from 1955-56 to 2005-06 was established. This was done following a model established by McBoyle et al. (in press) that counted how many days per year there was 15 cm of snow on the ground or more, considered the minimum snow depth suitable for operating a snowmobile trail for their study. While McBoyle et al. based their work on snowmobiling for recreation, Churchill harvesters use their snowmobiles for sustenance and as a result are more inclined to snowmobile when the conditions are less than ideal. The model used to quantitatively measure the trend of the snowmobile season is based on ideal conditions. While it is not as applicable to subsistence snowmobiling as it is recreational snowmobiling, it is one established way to measure such trends quantitatively and is still representative of the snowmobile season in Churchill.

The number of days per year with 15 cm of snow or more was determined for the seasons 1955-56 to 2005-06, with the exception of the 1999-2000 season due to large gaps of missing data. Other missing data was interpolated based on the daily weather observations and the available depth of snow on ground data from adjacent days (EC, 2007b). These numbers were plotted on a graph and a linear least squares fit trendline was applied to the graph to determine the trend. The trend was negative and indicated a loss of 4.944 days per decade with 15 cm or more of snow on the ground (see Figure 19). The negative trend indicated by this quantitative analysis is consistent with the qualitative trend observed by local harvesters.

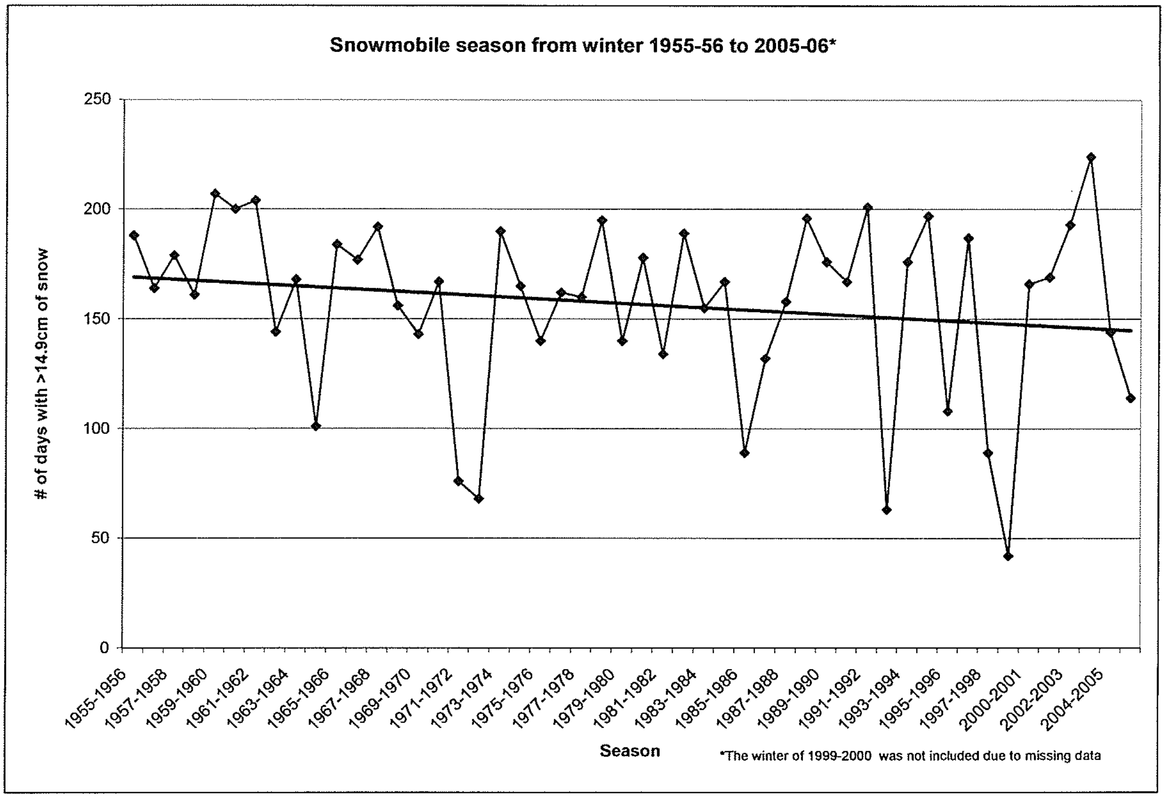

Figure 19: Trends in snowmobile season length. The snowmobile season, based on days per year with 15 cm of snow on ground or more, was plotted from 1955-56 to 2005-2006 based on daily observations from Churchill (EC 2004b, 2007b). Missing data was interpolated with the exception of January 2000 to April 2000 due to large gaps of missing data. As a result the winter of 1999-2000 was not included in the analysis.

Given that snowmobiling is one of the most common modes of transportation when harvesting, a reduced season is quite significant to harvesters in Churchill (Gilligan, 2006).

> I hunt less because it's too warm, you can't use your Ski-Doo. – D. Hunter, 2006.

Also, as mentioned earlier in this chapter, many hunters are unable to reach their traditional goose harvesting areas on the west side of the Churchill River because the ice is breaking up earlier in the spring. The harvest of geese in this area has been done by Indigenous harvesters for at least centuries (Brandson, 1981), and now this traditional hunt is at risk due to an earlier break-up. A shorter snowmobile season is having negative implications for harvesters who require snowmobile travel to reach their harvesting grounds.

Many trappers also rely on snowmobiles to set and check their traps as well as access the general area where the trapline is located. As a result this group is experiencing difficulties associated with changes in the environment. As discussed previously, P. Fitzpatrick encountered problems with open water on Matonabee Creek when returning home from his trapline. P. Fitzpatrick also indicated that the later and warmer falls have caused extremely slushy conditions when attempting to travel to his trapline during the early season. As a result, trips that would normally have taken approximately 8-12 hours were taking nearly 24 hours during the early portion of the 2006-2007 trapping season. Increased slush conditions caused many problems for trappers in the Condie Lake area (Fitzpatrick, 2006).

As a result of changes to the environment such as reduced snow cover, diminishing lake, river and sea-ice and changes in the timing of both freeze-up and break-up, the snowmobile season in Churchill is shorter in length then it has been traditionally (Gilligan, in press). This has negative implications on harvesting activities, such as trapping, that rely on snowmobile travel for access to certain areas. As mentioned earlier, shortened snowmobile seasons are altering the traditional spring goose hunt that takes place on the west side of the Churchill River and reduces harvest success during this period. However, a shorter snowmobile season leads to a longer open water season and a longer boating season. This shift in seasons is seen positively by some who prefer open water harvesting activities such as fishing to winter harvesting activities such as trapping.

The all-terrain vehicle season

All-terrain vehicles are a unique type of transportation. Many Churchill residents indicate that when equipped properly, these machines can be used year round. They are rugged capable machines used in many harvesting activities in Churchill. These machines are the primary mode of transportation for accessing many of the caribou hunting grounds east of Churchill during the months without snow cover. Due to the versatility and exceptional capability of these vehicles, study participants indicate that there has been little to no change in the season length of all-terrain vehicle transportation.

> As for ATV's, you can go year round. I drive my ATV from March to December. I use my ATV as a southerner would their vehicle. – D. Lundie, 2006.
>
> As for ATVs, the season hasn't changed much. The season length is about the same but it's now more dangerous because of [polar] bears arriving earlier. – G. Lundie, 2006.

As indicated above, changes in the level of danger associated with travelling by ATV are occurring. With increasing reductions in sea-ice and an earlier spring break-up, polar bears are returning to land earlier in the season and hungrier then normal (Hassol, 2004). G. Lundie explains that if your ATV breaks down or while one is field dressing game, there is an increased chance of having a human-bear encounter (2006). This is consistent with Stirling et al. who indicate that earlier break-up leads to more human-polar bear encounters (2006).

Although many interviewees indicated that most ATV's are capable enough to handle the bulk of environmental changes, G. Lundie pointed out one environmental change that will impact the use of ATV's; increased precipitation. Hassol (2004) indicates that the Arctic is expected to receive increased precipitation in the form of rain in the coming century. G. Lundie explains exactly how this will impact ATV users: From his experiences travelling by ATV on the tundra he observed that during dry conditions floating fens will sit solidly on firm ground but during wet conditions they will rise up and sit around the water level. The National Wetlands Working Group (1997) further discusses the dynamics of floating fens. This makes this type of terrain very unstable and increases the likelihood of getting stuck, break downs and serious harm. In extreme situations, one can break through a floating fen, sink and drown. Nickels et al. (2006) indicates that residents of Ulukhaktok are also reporting increased situations where ATV's get stuck because of softer and more unstable trail conditions (often caused by increased precipitation and thawing permafrost) which results in more ATV riders requiring rescue.

Many local residents of Churchill are confident that when equipped properly ATV's are capable enough for use in all seasons. In fact, if further reductions in snow cover occur, a shift in the balance of the use of snowmobiles to ATV's in the winter may occur. As demonstrated in the following observation by P. Fitzpatrick, ATV's make a reasonable substitute for snowmobiles when the ground is frozen with little to no snow present:

> The snow is melting sooner some years, shortening the Ski-Doo season. We used to go goose hunting by sled every year but now it's rare. The river is not safe for sleds to cross there due to a lack of snow, but [once on the other side] an ATV is still capable because the ground, ponds and lakes are still frozen but there is no snow cover on them to snowmobile. – P. Fitzpatrick, 2006.

Unfortunately, switching to the use of an ATV does not solve the problem of crossing the river during dangerous ice conditions, as described in the spring goose hunt problem earlier in this chapter.

When discussing changes in the ATV travel season with harvesters in Churchill it became apparent that the capability of these machines make them a viable option for off-road transportation in all seasons. However, like snowmobiles their use is still limited by changing ice conditions. Although there is little changes observed for travel during the ATV season certain vulnerabilities to their use have been highlighted by local harvesters. An increasing presence of bears increases the danger associated with travelling on the tundra by ATV. As well, increased precipitation can lead to more floating fens on the tundra which presents more opportunity for machines to get stuck as well as the danger of breaking through the fen and potentially drowning. Perhaps with further reductions in snow cover there will be more harvesters travelling by ATV in the winter than by snowmobile.

Changes in Hazards and Safety When Travelling on the Land

This thesis has looked at how observed environmental changes in Churchill is impacting the way harvesters travel on the land. Throughout this thesis changes associated with safety, risks and hazards have been discussed. This section will briefly review these changes. This section discusses key concerns raised by study participants relating to safety and hazards associated with off-road travel and associates them to environmental changes believed responsible. Table 5 summarizes these issues and links them to the environmental changes associated with them.

Table 5: Safety and hazards

Changes in safety and hazards	**Environmental changes potentially responsible**
Increased chances of breaking through ice	Changes in: Temperature, diminishing ice, weather predictability, winds and timing of freeze-up and break-up, ability to predict ice conditions.
Increased likelihood of crossing open water	Changes in: Temperature, timing of freeze-up and break-up and weather conditions.
Increased chance of snowmobile breakdowns	Changes in: Snow cover and winds.
Increased chance of breaking qamutiks	Changes in: Temperature and snow cover.
Decreased ability to construct emergency shelters (i.e. igloos)	Changes in: Temperature, wind and snow cover.
Increased chance of winter rain rapidly changing conditions by degrading snow pack (i.e. snowmobile trails)	Changes in: Temperature, weather predictability, weather extremes and increased precipitation.
Increased chance of getting stuck in or breaking through floating fens	Changes in: Temperature, permafrost, and increased precipitation.
Increased chance of human bear encounters	Changes in: Temperature, diminishing ice, snow cover and an increased presence of bears.
Decreased chance of getting lost in a whiteout	Changes in: Weather extremes.

A very important issue revolving around safety and off-road transportation shared by study participants is the increased chance of breaking through ice. Breaking through ice can lead to damage to equipment, loss of equipment, exposure to frostbite and hypothermia as a result of getting wet and even loss of life as result of drowning or hypothermia. The increased chance of breaking through ice is associated with changes in; temperature, diminishing ice thickness, less predictable weather and ice conditions, changes in wind direction and strength and changes in the freeze-up and break-up of ice on rivers, lakes, creeks and Hudson Bay.

Recent environmental changes area also increasing the chance of being forced to cross open water on rivers and creeks during the early and late snowmobile season. As a result of warmer temperatures and changes in the ice freeze-up and break-up timing, the likelihood of encountering open water at a creek or river, which one would be forced to cross if they were heading home has increased. Earlier in this chapter P. Fitzpatrick shared his story of encountering such a situation. Luckily he and his group were able to cross the creek without damage or injury. However, the situation could have had serious implications to human health and equipment.

Another issue that was shared by local harvesters during this research was the increased chance of mechanical failure of snowmobiles. As a result of decreased snow cover and changing wind patterns (which contribute to the creation of snow drifts), snowmobilers are being forced to travel over rougher terrain. This rougher terrain is harder on several components of the snowmobile. Rear suspension parts including cross-members, sliders, springs and shocks are experiencing higher rates of degradation in the rougher terrain. Front end parts such as skis, suspension, and carbides/wear bars are also at higher risk of failure as a result of rougher terrain caused by decreased snow cover. Mechanical failure leaves snowmobilers at a higher risk of being stranded on the land or being forced to end harvesting activities sooner than intended. In addition, it adds economic pressure as a result of increased repairs and maintenance.

In addition to increased chances of mechanical failure to snowmobiles, decreasing snow cover is also increasing the chance of breakage of qamutiks. Qamutiks are sleighs used to haul equipment behind snowmobiles (Riewe, 1991) and if one should break beyond repair, a snowmobiler would not be able to haul the equipment required, including fuel, for the activity. Also, if this should occur while a great distance from town and the snowmobiler is forced to abandon the qamutik, there is a chance he/she would not be able to carry the proper amount of fuel required to return home.

Changes in temperature, wind patterns, snow cover and snow consistency also lead to another issue, the ability to construct an emergency shelter, i.e. an igloo. While travelling on the land, if one experiences a mechanical failure or weather conditions which are not safe to travel in, one would often rely on the ability to construct an igloo. However, the changes listed above are now making the snow required to construct such an emergency shelter hard to find.

As discussed previously, local snowmobilers are observing increased rain occurrences during times of the year when they have not occurred previously, such as in the middle of winter and earlier in the spring. Due to decreased snow cover in the area, an occurrence of rain has the potential to completely degrade the snow pack on trails required to travel by snowmobile. If this occurs when you are away from town, then it limits your ability to get home. This can result in damage to equipment, being forced to leave equipment behind and possibly having to walk home, which could be up to several hundred kilometers.

Another safety/hazard issue raised by a study participant during this research is the increased chance of breaking through a floating fen. Increased precipitation and wetter conditions in general causes floating fens to rise up off the firm ground. When this occurs, it creates an increased chance of breaking through and sinking into them. This can lead to increased chance of getting all-terrain vehicles stuck, loss or damage to equipment, serious injury and potentially death by drowning when travelling by all-terrain vehicle.

Diminishing sea-ice is having serious impacts on polar bears, forcing them to spend more time on land and causing them to be hungrier than normal (Hassol, 2004). Three study participants indicated increased polar bear presence in the Churchill area. As a result of earlier break-up and later freeze-up of Hudson Bay, the likelihood of having a polar bear encounter is on the rise. Stirling et al. (2006) indicates a statistically significant relationship between the date of sea-ice break-up in Hudson Bay and the amount of problem bears handled by Churchill Conservation Officers, "i.e., the earlier the ice breaks up, the more problem bears there are , and conversely" (p. 266).

Stirling et al. also indicates that the Western Hudson Bay polar bear population is expected to decline and that this decline will continue, and potentially increase, the frequency of polar bear and human problem encounters as a result of bears seeking substitute food sources (2006). This makes it especially dangerous when travelling by all-terrain vehicle during the summer and field dressing game when hunting. This is an important issue because polar bears can be quite aggressive to humans and can easily cause injury or death.

While there are plenty negative impacts of environmental change on safety and hazards associated with off-road travel in Churchill, one positive aspect was discovered in this research. Frequency of whiteouts in the Churchill area has been declining. This means that there is less of a chance of getting stranded or losing your way home while travelling on the land, although mechanical failure and human error such as running out of fuel still exist. Being caught in a whiteout limits your navigational skills and quite often requires you to take shelter from the snow. As a result of declining whiteouts, there is a decreased chance of having to face this type of situation.

Chapter 5: Conclusion

The purpose of this research is to determine how environmental change, including climate change, is altering the way hunters, trappers and fishers travel by boat, snowmobile and all-terrain vehicle in Churchill, Manitoba. This thesis has done so by linking TK and LK from local harvesters in Churchill with SK from a variety of sources including literature and the work of natural scientists working in similar fields. The objectives of this research were three fold. The first was to connect with local harvesters to determine the focus of the study. This objective was met through a series of preliminary research/relationship building field trips and with the help of project mentor, G. Lundie. The second objective was to document local harvester's observations of changes to the environment and how they have affected off-road travel. The third objective was to link the Traditional/Local Knowledge with Scientific Knowledge on the topic and present a holistic understanding of the effects of environmental change on off-road travel. These objectives were completed successfully as demonstrated in this thesis.

The methods used in this research combined to provide an effective way of collecting data on the research topic. The method which set this research in motion is the mentor-apprentice relationship (Ellerby, 1999; Gallagher, 2002). G. Lundie assumed the position of project mentor and helped guide the research in a meaningful way to the community and introduced the researcher to the local harvesters who joined the project without hesitation. Study participants were recruited via the snowball sampling method (Babbie, 1998; Coleman, 1958; Erickson, 1979; Flick, 2006; Heckathorn, 1997; Jorgensen, 1989) where the study participants recommended potential study participants for recruitment. The next method which helped build my capacity to study this topic in the community is the participant observation method (Babbie, 1998; Corbetta, 2003; Frankfort-Nachmias, 1996; Jorgensen, 1989; Sanday, 1979; Stocking, 1974). This method enabled me to further build meaningful relationships with study participants as well as to learn about the research topic by observing and participating in various activities. Data collection was done through both the participant observation method and the semi-directive interview method (Edgerton et al., 1974; Huntington, 1998; Nakashima, 1988). The semi-directive interview method enabled me to conduct interviews that followed certain research topics (see Appendix A) but also enabled the interviewee to guide the interview in a way that best reflected their knowledge base and what they felt was important and relevant to the research topic. Finally, reflexivity (Babcock, 1980; Briggs, 1986; Creswell, 2003; Giddens, 1976) enabled me to understand and acknowledge how my personal biography shaped the research and its results.

The results of this research, presented in depth in Chapter 4, demonstrates the affects of environmental change, including climate change, on off-road transportation in the Churchill area. Key themes used to present this information include changes in the general weather conditions, changes related to snow and ice conditions, changes in harvest success, changes in access to cabins, changes in the travel seasons of snowmobiles, boats and all-terrain vehicles and finally, changes in hazards and safety associated with off-road travel. In discussing changes to general weather conditions, some highlights include a general warming in the temperature, observations of changes in wind patterns, changes in the frequency and magnitude of weather extremes and decreased weather predictability.

As for changes related to snow and ice conditions, several important issues were raised. Changes in snow cover and consistency are making it more difficult to travel by snowmobile along with increased mechanical failures of machines due to travel over rougher terrain. In turn, this has the ability to place economic stress on harvesters due to increased repairs and maintenance. Due to the fact that snow is falling and accumulating later in the fall and thawing earlier in the spring, the snowmobile season is being decreased by several weeks, variable from year to year. Ice is diminishing in general as well, resulting in later freeze-up and earlier break-up of ice on lakes, rivers, creeks and the Hudson Bay. This contributes to the shorter snowmobile season and creates thinner ice and unpredictable ice conditions, making it more dangerous to travel on ice. However, a longer open water season leads to a longer boating season.

In addition to changes to the snow and ice conditions, local harvesters are experiencing changes in harvest success of certain species. Caribou are found closer to town and thus are easier to hunt. Moose are increasing in numbers and proximity to town, which increases the success of moose harvesting. However, an earlier break-up of the Churchill River is causing decreased harvest success in the traditional spring goose hunt on the west side of the Churchill River. Fish in the freshwater environment have decreased in numbers, size and diversity of species. This is attributed to the diversion of water from the Churchill River into the Nelson River. Finally, Arctic charr fishermen are reporting decreased success of charr fishing by net in the Hudson Bay.

As a result of changes in the physical environment, access to certain traditional harvesting areas is also being limited. Decreased water levels on the Churchill River have limited harvesters' ability to travel up the river during the open water season by boat to access cabins along with traditional hunting and fishing areas. Decreased snow cover and diminishing ice also leads to limited access of certain areas, such as the traditional spring goose hunting areas on the west side of the Churchill River. The same changes also cause restricted access to areas such as traplines in the early winter. In general, changes to the physical environment are changing when and where hunters, trappers and fishers travel.

Travelling seasons for boats, snowmobiles and all-terrain vehicles are also affected by environmental change. Boaters are experiencing a longer season by several weeks as a result of warmer temperatures and earlier break-up and later freeze-up of water. Snowmobilers are limited on both ends of the season as result of changes in the physical environment but the season is longer in the sense that it is no longer too cold to snowmobile during most of January and February. While all-terrain vehicles are generally well equipped to travel year round when properly outfitted, certain changes such as increased precipitation and an increased presence of polar bears are making travel by all-terrain vehicle more dangerous during the summer.

One of the most important sections of this thesis deals with changes in hazards and safety associated with off-road travel as result of environmental change. While these topics are discussed throughout the results section, one can not stress how important they are. Changes in the weather are changing the frequency and magnitude of weather extremes, moving from occurring pre-dominantly in the winter in the form of blizzards, extreme temperatures and whiteouts to occurring more during the spring in the form of warmer temperatures during the early spring which quickly degrade snow and ice conditions and freak blizzards such as those in spring of 2004. Changes in snow and ice throughout the winter are making it more dangerous to travel by snowmobile. Thin ice, unpredictable ice, less snow cover and changes in snow consistency are a few ways this is happening. Changes in temperature, precipitation and increased polar bear presence are making it more dangerous to travel by all-terrain vehicle during the summer.

In summary, there are certain impacts and opportunities for off-road transportation associated with environmental change. Impacts include a more dangerous snowmobile season that is shorter in length, new risks and hazards associated with travel by boat, snowmobile and all-terrain vehicle, loss of access to traditional harvesting areas and decreased success of certain types of harvesting activities including fishing and the spring goose hunt. Select opportunities of environmental change on the subject include a longer boating season, the opportunity to travel more by all-terrain vehicle in the winter, increased success of caribou and moose hunting and decreased effort and overhead required to hunt moose and caribou.

This research project worked with hunters, trappers and fishers to determine how environmental changes are altering the way they travel by boat, snowmobile and all-terrain vehicle. By combining the Traditional Knowledge and Local Knowledge with Scientific Knowledge on the subject, this research has presented these changes and the importance of these changes. It is important to have these changes and their implications documented as they have great impact on culture, tradition, recreation and several aspects of health including physical and mental health. While local harvesters have demonstrated great resilience in the face of these changes, many scientists indicate that within the next century these changes are expected to continue and change the face of the climate and landscape in the North and across the globe.

Appendix A: List of Topics for Semi-directive Interviews:

1. The study participant's personal history in Churchill
2. Harvesting activities the study participant participates in
    - Hunting
    - Fishing
    - Trapping
3. Changes in the environment the study participant has observed
    - Weather
    - Snow cover
    - Ice on rivers, lakes and creeks
    - Ice on Hudson Bay
    - Timing of freeze-up and break-up
    - Peat lands and permafrost
4. Changes the study participant has noticed travelling on the land by:
    - Snowmobile
    - Boat
    - All-terrain vehicle
5. Changes in safety and hazards the study participant has observed
6. Invite study participant to share any stories about travelling on the land they feel is relevant to this research

7. Changes the study participant has observed in the travelling season (i.e. start/end time) for:
    - Snowmobiles
    - Boats
    - All-terrain vehicles
8. Changes the study participant has noticed in the amount of ice present during the annual July 1st 'Bay Dip'
9. Changes the study participant has noticed in the amount of snow present at Halloween (October 31st)
10. Changes in the distribution and population size of harvested species
11. Changes in how often the study participant fishes
12. Changes in how often the study participant hunts
13. Changes in how often the study participant traps

Appendix B: Study Participants' Biographies

Personal biographies of study participants (arranged alphabetically by last name):

Rick Bougie: Rick came to Churchill in 1989 for work purposes. He fishes both saltwater and freshwater species. He hunts caribou, moose, geese ducks and seals. Rick was in partnership with Parker Fitzpatrick on a trapline in 2000 and 2001 when he trapped quite steadily. He has since sold his share in the trapline but still helps Parker out occasionally. He has worked for Calm Air, Parks Canada and as a private contractor. Rick has also been a Canadian Ranger since 1993.

Claude Daudet: Claude came to Churchill in 1981 as a butcher for the Hudson Bay Company (HBC). While in Churchill, Claude has also worked driving track machines hauling freight to the Kivalliq region of Nunavut. Claude has experience net fishing in the Churchill River estuary and hunts geese 'like mad'. He is a Canadian Ranger as well, worked for Parks Canada as a Park Officer and currently manages Gyrfalcon Arctic Expeditions where he has been providing snowmobile expeditions to tourists since 2004.

Parker Fitzpatrick: Parker came to Churchill as an employee of Manitoba Hydro, occasionally working in the community from 1989 until 1992 when he moved there permanently. He is an avid hunter, fisherman and operates his own trapline based out of Condie Lake, approximately 240KM southwest of Churchill. Parker was drawn to Churchill by the local hunting, fishing and trapping opportunities.

Dick Hunter: Dick has spent as much of his time on the land since he arrived in Churchill on July 1st, 1973. He hunts moose, geese, ptarmigan, ducks and caribou. Dick is also an avid fisherman who states that the excellent fishing opportunities of the Churchill River in the 1970s as the reason why he chose to stay. Currently Dick's favorite harvesting activity is net fishing for char at his cabin on Button Bay. Dick owns and operates his own hotel in Churchill, the 'Iceberg Inn'.

Dave Lundie: Dave was born in Churchill and attended kindergarten there but then moved away. However, he maintained regular visits to Churchill during this time and moved back in 1992. Dave is currently the Regional Coordinator of the University College of the North in Churchill. Dave is an avid harvester who hunts caribou, moose, geese, ducks and black bear. He regularly fishes both fresh- and saltwater environments and occasionally helps out on friends' trap lines.

Greg Lundie: Greg grew up in Churchill and has lived there his entire life, over 30 years. Greg has hunted and fished since he can remember. Greg hunts moose, geese, ducks, ptarmigan, and caribou. He fishes both fresh- and saltwater environments and also helps friends out on their trap lines on occasion. Greg is currently employed seasonally by Parks Canada as a Park Officer for Wapusk National Park. During the off season, Greg is also a tour guide for Sea North Tours, providing tourists with the chance to come face-to-face with a variety of Churchill's marine species, including beluga whales and polar bears.

Brendan McEwan: Brendan was born in Churchill in 1988, was raised there and went to school there. He has been active on the land since a young age, hunting, fishing and trapping with his parents and friends. Brendan hunts caribou, moose, geese, ducks and ptarmigan, fishes both fresh- and saltwater species and also started his own trapline based out of Warkworth Lake in 2006. Brendan has been employed as a hunting guide for Dymond Lake Lodge since he was fourteen and is also a tour guide for Sea North Tours.

*In addition to the above mentioned study participants, there are also 2 additional participants who wish to remain anonymous.

Appendix C: Field Season Dates:

April 10 – April 14, 2006: Preliminary research

June 20 – July 1, 2006: Preliminary research

July 20 – August 1, 2006: Data collection

August 13 – August 15, 2006: Data collection

August 29 – September 6, 2006: Data collection

January 29 – February 1, 2007: Data collection and data verification

February 15 – February 22, 2007: Data collection and data verification

Total: 67 days

Appendix D: Facts for Policy Makers

- Integrating 2 knowledge sets (i.e Traditional or Local and Scientific) is extremely useful for developing a holistic understanding of a situation or problem.
- Changes are occurring to harvesters' off-road travel which includes:
  - An increasingly longer boating season which leads to more usefulness of boats.
  - An increasingly shorter snowmobile season which leads to less usefulness of snowmobiles.
  - All-terrain vehicles are currently and are predicted to be used year round with certain limitations in deeper snow.
  - New risks and hazards are associated with travel by boat, snowmobile and all-terrain vehicle.
- A longer boating season has resulted in certain people focusing more on hunting and fishing activities during the open-water season.
- Changes to the beginning and the end of the snowmobile season are having negative implications for trappers who have to travel considerable distances to access their traplines.
- A shorter snowmobile has resulted in certain people hunting less due to the relative ease of hunting with snowmobiles.
- A shift to travelling by all-terrain vehicle in the winter as opposed to snowmobile may take place as a result of less snow and a shorter snowmobile season.
- Churchill's youth are less interested in participating in harvesting activities.

- There are more moose in the area. This is creating more opportunities for moose hunting. As a result, moose hunting is increasingly more successful. Effort and overhead required to participate in moose hunting is reduced.
- Caribou are being found closer to town then in the past. Certain harvesters attribute this to the end of military activity in the area.
- Snowmobile manufacturers should consider the effects of snowmobiling in large expanses of snowless areas (i.e. barren tundra or sea-ice with no snow cover) when designing cooling systems for liquid cooled snowmobiles.

Appendix E: Sample Consent Forms

The following are samples of the consent forms used during this research.

Informed Consent Document

Research Project Title: Environmental change and transportation in Churchill, MB

Researcher: Justin Gilligan
Telephone: ************
Email: *********************

Sponsor: ArcticNet (www.arcticnet-ulaval.ca)

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.

The purpose of this research is to study the implications of environmental change on transportation "out on the land" (i.e. travel off-road and off-rail over land, ice, snow and water). Traditional/Local Knowledge and Scientific Knowledge will be studied during this research. The study findings will be based upon the linkage of these types of knowledge. Participating in this study would mean agreeing to share knowledge on the topic either through agreeing to have the researcher learn from participating in your daily activities and/or through non-structured interviews. There is no risk outside of your everyday activities associated with this project. The information you share will be included in the findings of this project along with your name and possibly a picture of you but you will have the opportunity to review your input before findings are submitted for publication or presented to the public. If you wish to remain anonymous then no information on the source of the data you provide will be included other than 'Study participant from Chruchill, Mb." If you decide that your input has been misconstrued the researcher will work with you to make changes. Any reports or publications that result from this project will be provided to you free of charge. Also, the researcher will provide a small gift of appreciation for all study participants (approximately $20.00 in value).

Your signature on this form indicates that you have understood to your satisfaction the information regarding participation in the research project and agree to participate as a subject. In no way does this waive your legal rights nor release the researchers, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from the study at any time, and /or refrain from answering any questions you prefer to omit, without prejudice or consequence. Your continued participation should be as informed as your initial consent, so you should feel free to ask for clarification or new information throughout your participation.

Principal Researcher: Justin Gilligan, Telephone: ************
Supervisor: Dr. Jill Oakes, Telephone ************

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 has been given to you to keep for your records and reference.

____

Participant's Signature Date

Do you, the participant, wish to remain anonymous? Yes ☐ No ☐

____

Researcher and/or Delegate's Signature Date

Informed Approval Document

Research Project Title: Environmental change and transportation in Churchill, MB

Researcher: Justin Gilligan
Telephone: ************,
Email: ****************

Sponsor: ArcticNet (www.arcticnet-ulaval.ca)

I have been asked to review the notes and/or transcriptions recorded by the researcher during this project and provide feedback or comments for any revisions.

1) I have reviewed my transcribed and edited interview and have no further comments.

Participant's Name (Printed)	Participant's Signature	Date

OR

2) I've reviewed my transcribed and edited interview and have attached my comments.

Participant's Name (Printed)	Participant's Signature	Date

Researcher's Signature	Date

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