SPATIAL ANALYSIS OF COMMUNITY OBSERVATIONS OF ENVIRONMENTAL CHANGE IN NORTH WEST RIVER, LABRADOR

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By

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ABSTRACT

The Sivunivut Inuit Community Corporation (SICC) is funded by the Nunatsiavut Government to represent North West River (NWR) residents who are beneficiaries of the Labrador Inuit Land Claims Agreement. In 2010, they began work on a community driven, participatory research project that was aimed at addressing community concerns regarding the ongoing effects of climate change on local resource use. This resulted in the completion of forty-nine surveys by resident land use experts. These semi-directed surveys were completed in conjunction with a spatial component and were designed to collect traditional ecological knowledge related to the local effects of climate change. This thesis examines this knowledge using grounded theory and spatial analysis to identify and describe thematic patterns. The spatial extent of environmental change is described through the use of kernel density analysis (KDA) maps illustrating concentrations of environmental change. The regions identified denote commonly referenced areas that, in many cases, are highlighted in multiple survey categories. Through this analysis it is clear that local environmental change is influenced by many factors. Climate change is one such factor but other major drivers of environmental change include weather events, harvesting pressure, infrastructure development, accessibility, and habitat quality. In the face of ongoing environmental change, residents of NWR employ a number of adaptation strategies to maintain their strong connection to the land. This thesis examines aspects of these adaptation efforts in light of a number of technological, societal and political factors.

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As a reminder to not take ourselves too seriously in life, a favorite quote:

"I have a small idea of the degree of accuracy possible to man, and I feel these studies teem with error." —Robert Louis Stevenson

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LIST OF ABBREVIATIONS

ArcGIS	Arc Geographic Information Systems Software Suite
CBPR	Community Based Participatory Research
DLNR	Department of Lands and Natural Resources
ESRI	Environmental Systems Research Institute
GIS	Geographic Information Systems
HVGB	Happy Valley-Goose Bay
IDHL	Inuit Domestic Harvest Level
KDA	Kernel Density Analysis
LCO	Little Climatic Optimum
LI	Labrador Institute
LILCA	Labrador Inuit Land Claims Agreement
MBCP	Minimum Bounding Convex Polygon
MITACS	Mathematics of Information Technology and Complex Systems
NG	Nunatsiavut Government
NWR	North West River
SICC	Sivunivut Inuit Corporation
TEK	Traditional Ecological Knowledge
ULM	Upper Lake Melville

CHAPTER 1: INTRODUCTION

1.1 Overview

The climate of northern Canada has been warming for hundreds of years (Prowse, 2009a). It is the current pace of change that has made climate change an immediate concern. Over the last fifty years there has been a significant increase in temperature and precipitation and many models show this trend continuing with further increases in both temperature and precipitation into the future (Prowse and Furgal, 2009; Comiso et al., 2014; Way and Viau, 2015).

Environmental change, particularly evident in the cryosphere—snow, permafrost, sea/lake ice, and glaciers—has become evident in northern landscapes (Prowse, 2009b; Furgal, 2008; Eisner, 2009; Comiso et al., 2014). Climate-induced environmental change is a significant parameter in a northern reality that includes many different drivers of change. Industrial development, mining exploration, hydro-electric development and the effects of population growth are among the many effects that dramatically alter the natural systems that are typical for the area. More specifically, it has been suggested that the climate of the Lake Melville area in central Labrador will be subjected to an increase in both temperature and precipitation over the coming decades (Banfield and Jacobs, 1998; Durkalec et al., 2016).

Residents of North West River (NWR), a small community located in the vicinity of Lake Melville, have long relied on their natural surroundings for subsistence use as well as their overall well-being (Fitzhugh, 1972). Their relationship with the land and the natural resources found there has allowed them to succeed in what could be described as challenging circumstances. Environmental change has been a constant variable for residents of NWR. For Labrador Inuit, exposure to environmental change is nothing new, as has been documented in the archaeological record (Woollett, 2007). These northern people are accustomed to adapting to a changing environment. This adaptation is hampered by the heightened rate and levels of environmental change. In addition, the complications associated with the scope of contemporary social and cultural change have exacerbated this ongoing challenge.

Many residents of the community have had growing concerns with local environmental changes for some time. In 2008 the Labrador Highlands Research Group and the Labrador Institute (LI) held a climate change workshop in NWR, which was very well received (Bell et al., 2008). The conference undoubtedly had a significant role in shaping community discussion around the topic of climate change. The community recognized a new opportunity to share useful information amongst researchers and community members alike.

Subsequent discussions in NWR regarding the existing and potential negative effects of environmental change provided the impetus for the development of a traditional ecological knowledge (TEK) based survey to examine the topic in a systematic way. In this context TEK can be considered as the "cumulative, collective body of knowledge, experience, and values held by societies with a history of subsistence" (Ellis, 2005, p.66). This definition is discussed further in the following chapter. The TEK based survey was intended as an initial step in helping to determine the long-term ramifications of ongoing climate change for the residents in this area (Neilsen, 2012). One such potential negative effect was voiced through resident concerns that TEK is not being shared and passed along to new generations as has been done in the past. Verbal transmission of traditional knowledge is still used among primarily older generations but is not as common with younger generations due to societal factors (Neilsen, 2012). Youth are spending less time on the land than previous generations and there are fewer opportunities for the transmission of knowledge (Liebenberg et al., 2015). There is a palpable fear that much of the distinct culture in the community is going to be lost.

1.2 Research Context: "Traditional Knowledge: A Blueprint for Change"

This thesis is one result of a joint research project conducted by Sivunivut, a local Inuit Community Corporation (SICC) representing Inuit in both NWR and Sheshatshiu with the Labrador Institute of Memorial University located in Happy Valley-Goose Bay (HVGB). "Traditional Knowledge: A Blueprint for Change" (the Project) was funded by Health Canada and Mathematics of Information Technology and Complex Systems (MITACS). The project objective was to conduct research to inform community members regarding the potential for climate related impacts on Inuit living in the community of NWR, and to offer baseline information with regard to local environmental characteristics through the collection of Inuit TEK centered on "threats to fresh water, sea ice, sensitive habitats and species" (Neilsen, 2012).

SICC approached the LI for assistance with their application for funding under Health Canada's Climate Change and Health Adaptation Program. Dr. Keith Chaulk conceived the working idea for a project around TEK collection in conversation with the Chair of the SICC, Ed Tuttauk (personal communication, January 27, 2014). Dr. Chaulk was the Director of the LI at that time. He has a strong background in science with a PhD in Cognitive Behavioral Ecology from Memorial University of Newfoundland. Dr. Chaulk is also an Inuit beneficiary of the Labrador Inuit Land Claim Agreement (LILCA) and was born and raised in NWR. Dr. Chaulk was also a participant in the 2008 climate change workshop in NWR and closed his presentation with the following question:

"If Labrador is changing, and if global warming speeds these changes up, what will it mean for our renewable resources like the plants and animals... what will these changes mean for the way we live, what will it mean for our economy, our infrastructure and our future in general?" (Bell et al., 2008).

Dr. Chaulk is a native of Labrador and maintains active participation in traditional harvesting activities. His concerns are founded upon a personal familiarity with the Labrador Inuit lifestyle. In addition to his cultural ties to NWR much of his considerable experience was obtained while he was employed as the Chief of Staff for the Nunatsiavut Government (NG), in the Department of Lands and Natural Resources (DLNR). He is familiar with the human dimensions of natural resource management and has experience with other TEK projects conducted in Labrador.

Ed Tuttauk was the elected member who represented the Inuit of NWR in the Nunatsiavut Assembly. Mr. Tuttauk took the lead on the project when he approached LI for assistance in developing the proposal submission to Health Canada for the funding to carry out the project (personal communication, January 27, 2014). Mr. Tuttauk has also served on the Town Council for NWR, the NWR Inuktitut Language Committee and the OKâlaKatiget Society (a regional Indigenous radio service for the North Coast and Lake

Melville). He is also a beneficiary of the LILCA and is an active participant in traditional harvesting activities.

The original proposal submitted by SICC (Phase I) was designed for one year with an outlook of securing additional funding in subsequent years if those involved deemed it worthwhile. It was designed to include various partners including Memorial University, the NG, the LI and SICC. Partners brought their own resources and experience to the project. The NG offered its support through the provision of Geographic Information Systems (GIS) services through the DLNR. I was employed in this role at the time and was engaged by Dr. Scott Neilsen (former Operations, Facilities and Logistics Coordinator for LI) to help design the spatial component of the project for the first phase. I had garnered experience in the collection of TEK through previous GIS work in Labrador and thought I would be able to provide some useful advice. It was this early involvement and subsequent discussions with members of SICC and the LI that encouraged me to utilize the data for this thesis. During this phase of the project Dr. Neilsen was tasked with the day-to-day management of project components (personal communication, 2014). This work was not done in isolation as a project team was formed to provide ongoing advice and direction (Table 1). The project team consisted of community members, staff members of the LI and the SICC. The project team was involved in much of the planning to ensure that best practices were followed and cultural sensitivities were taken into consideration. The development of the survey questions and surveyor prompts were completed with guidance from the team. All of the members of the team were residents of the Upper Lake Melville area and brought a wealth of knowledge and experience to the project.

Table 1.1: Project Team Members in 2010

Project Team Member	Affiliation	Role
Mr. Ed Tuttauk	Sivunivut	Project Manager
Dr. Keith Chaulk	Labrador Institute	Expert Advisor
Ms. Jennifer Butler	Labrador Institute	Proposal Development
Dr. Scott Neilsen	Labrador Institute	Project Coordinator
Mr. Jamie Jackman	Labrador Institute	Community Researcher
Ms. Rebecca Watts	Sivunivut	Summer Student Researcher
Mr. Herman Andersen	Community Member	Interviews/data management
Mr. Billy Evans	Community Member	Interviews/data management
Dr. Martha MacDonald	Labrador Institute	Interviews/Technical support
Mr. Bryn Wood	Nunatsiavut Government	GIS support

The climate of Lake Melville has changed over time (Labrador Highlands Research Group, 2009). Growing community concerns regarding climate change and the potential long-term effects on livelihoods and cultural traditions were evident to the SICC. As the body responsible for advancing the interests of the NG beneficiaries of NWR, the SICC identified a need for data collection to support decision making with regard to ongoing and cumulative environmental change in and around Lake Melville. Members of the SICC were hopeful that the ability to adapt to significant environmental changes could be improved through research, analysis and preparation.

The project was focused on documenting "specific ecological knowledge of NG Beneficiaries living in NWR, Labrador (Stage I and II); and to begin to monitor, record and document specific environmental characteristics at significant locations in the region (Stage III)" (Neilsen, 2012). The SICC also requested that the LI provide training to community members with regard to methods for collecting TEK on current and historic Inuit land use through the use of personal surveys. Employing these methods, the surveys would provide for a robust collection of TEK from subsequent transcripts and digitized geographic data, ensuring a great deal of utility for final analysis (Sivunivut Inuit Community Corporation Inc., 2010).

The project was aimed at providing the ability for the SICC partnership to develop adaptive strategies for the community and develop detailed maps of cultural activity. The original design of the project was created first and foremost to empower the community. The project included questions designed to obtain TEK regarding a number of areas of interest including potable water, commonly harvested species (seals, salmonids, game birds), ice conditions and sensitive animal habitats. All of the collected information has been included in a GIS and is housed with the LI for future use. The data are available for use with other projects whenever the SICC feels it is appropriate. This could include local use within an external research setting. This thesis is based on a mixed methods analysis of this body of work.

1.3 Significance of Research

The Arctic climate is already changing at an increasing rate; this suggests that adaptation “should become a central feature of climate change policy” (Ford et al., 2010, p.180). The inevitability of further environmental change requires ongoing adaptation of northern peoples to reduce their vulnerability to changing circumstances (Laidler et al., 2009; Wenzel, 2009; Berman et al., 2017). The identification and enumeration of the threats associated with environmental change outlined in this thesis is a positive step that can aid in further development of research, education and social programs that may be utilized to assist the residents of NWR in preparing for and adapting to further environmental change.

In the course of determining effective public policy with regard to climate change, it is helpful to examine the vulnerability of communities. The use of local perspectives can help provide a clear view of some of the links between environmental change and adaptation through changing policy. In this thesis I have examined environmental change as observed by NWR community members. I have gained insight as to how this knowledge may be used for community planning, informing policy and potential opportunities for mitigation of risk and enhancement of personal safety. It is also clear that residents of NWR continue to adapt to changing circumstances through various means.

There were a number of threats to residents of NWR evident from the research. Ongoing concerns regarding existing supplies of potable natural spring water ensured that this topic was included in the survey. It is a concern that has been documented in other northern research (Goldhar et al., 2014; Harper et al., 2015). Some residents were concerned that these sites could be at risk due to their low elevation combined with rising sea levels and a change in seasonal run-off patterns. Contamination of potable water sources or a loss of usable locations has the potential to negatively impact local users (Harper et al., 2015).

Research has shown that Inuit confidence in the state of their physical environment and ongoing access to natural resources is of great relevance to Inuit culture and well-being (Furgal et al., 2002; Tremblay et al., 2006; MacDonald et al., 2013). A changing environment has significant impacts on Inuit access to natural resources as well as the resources themselves (IPCC, 2014). Inuit access to their natural environment has become compromised through environmental change as well as through a related change in the perception of risk (Ford et al., 2008). Inuit continue to adapt to their changing circumstances.

The availability of safe travel routes over frozen waterways is very important to Inuit across the north (Aporta, 2009; Laidler et al., 2011; Riedlsperger, 2014). Travel routes for traditional resource harvesting and poor conditions can have major implications on Inuit access to country food. These routes are dependent on snow depth and dependable ice conditions, which are becoming less reliable (Ford et al., 2008; Prowse and Furgal, 2009; Adger et al., 2011). Travel routes are increasingly being adjusted to meet these changing conditions (Berkes et al., 2001; Laidler, 2006; Eisner et al., 2008). Ongoing changes to local travel routes emerged as a theme from this survey.

Generations of residents of NWR have traveled around Lake Melville using long-standing trails and their knowledge of safe routes and areas to avoid has been handed down reliably over time. This transmission of localized information is similar to other areas throughout the Arctic where Inuit demonstrate knowledge sharing (Aporta, 2009; Laidler, 2006; Karpala, 2010). With a changing environment the accuracy of this long experience can be called into question. The development of uncertainty impacts how residents interact with their environment. This can include physical changes through exposure to new hazards; however, there are also implications for mental and emotional health that can be attributed to a lost or modified sense of place (Adger et al., 2011; Cunsolo Willox et al., 2012; MacDonald et al., 2013; Cunsolo Willox et al., 2013a).

Many community members define themselves through their relationship with the physical environment. Ongoing changes in their environment are a threat to both their livelihood and cultural identity (Adger et al., 2011; Downing and Cuerrier, 2011; Riedlsperger et al., 2017).

Variations in climate affect more than ice patterns and impacts are undoubtedly made on the habitat of species that are important to the cultural identity of residents. Biodiversity has been impacted as species adapt by altering their current ranges. For example, Chaulk et al. (2004) suggest that the "amelioration of conditions in Labrador" may be responsible for the recent range expansion of the Black-headed Gull (*Larus ridibundus* L.) Similarly, Chubbs and Phillips (2010) list climate change as a potential contributing factor to the recent range expansion of the Ruffed Grouse (*Bonasa umbellus)*. Local residents have definite opinions on these fluctuations and what they may mean with regard to longer or shorter seasons for migration, the introduction of new species and the eventual loss of some populations of particularly sensitive species (Furgal 2008). In time we can expect major changes to renewable resource sectors such as hunting, trapping, forestry and fisheries. This will have an impact on subsistence food collection patterns. Subsistence foods may not be available at accustomed times due to changing local conditions or variation in species migration patterns, and overall food quality may be impacted as species are found farther from their climate norms (Furgal 2008; Prowse and Furgal, 2009; IPCC, 2014: Pearce et al., 2015). These circumstances are affected by climate change as well as a host of environmental and socio-economic changes. There has also been an ever-increasing opportunity for people in the north to participate in a wage economy, which in turn has a dramatic influence on traditional subsistence lifestyles (Ford et al., 2010; Organ et al., 2014).

The application of Inuit knowledge is valuable to climate change research in that it provides a local, on-the-ground perspective regarding potential impacts. “The ecological and environmental expertise found in Inuit communities can highlight parameters rarely measured by scientists and help make sense of scientific findings by placing them in a local context” (Reidlinger, 2001, p. 91). The collection and application of this knowledge in the context of climate change is a fairly new activity (Huntington et al., 2011). It has been carried out across the Arctic at various scales in different areas. The use of local perspectives can help provide a clear view of some of the links between climate change and adaptation through policy changes (Berkes et al., 2001). For example, the increase in co-management bodies across the north incorporating local knowledge in resource management has helped focus wildlife management on at-risk populations (Ford et al., 2010). Examples of adaptation through policy in a NWR context were evident in the results of this thesis and will be discussed in chapter six.

The dataset produced through the project was community driven and not created with a specific analysis in mind. As a collection of information, the dataset is well suited to detailed qualitative analysis using grounded theory. Charmaz (2006, P.4) describes grounded theory as a method for “collecting and analyzing qualitative data to construct theories ‘grounded’ in the data themselves.” The goal is to develop ideas and interpret the data based on categories derived from the coding process (Charmaz, 2006). In this case the process involved taking an existing dataset and coding it with simple, analytic categories that could be used to classify sections of collected transcripts. This method can be especially useful when attempting to visualize patterns from an already existing dataset in a GIS. Steinberg and Steinberg (2005, p. 80) noted that the "visual patterns that are often visible in spatial data can provide a powerful indicator when exploring emergent themes drawn from existing data to develop theory."

It is also important to note that the project differs from many similar research projects endeavoring to utilize Inuit knowledge regarding land use in that it was community conceived and executed, ensuring that it is inherently relevant to the Inuit residents of NWR (Jackman et al., 2013). In this way, the common difficulties associated with earning trust and eliciting cooperation with residents were greatly simplified. The researchers who dealt directly with respondents were trusted community members. Community members were helpful in defining the subject matter for the survey, which in turn helped to put those surveyed at ease with the data collection process. Other benefits of the research include the documentation and preservation of existing TEK as well as increased awareness of the importance of TEK. The process up to the point of the analysis conducted through this thesis was community-based. The analysis conducted through this thesis is based on my thematic coding of the data and is the starting point at which a perspective from outside the community is introduced.

As an Indigenous person living in Labrador, my perspective is influenced by my experience from having lived in NWR and from relationships with family and friends who are part of the community. I have frequented some of the areas discussed during the survey for my own harvesting use and having grown up in the nearby community of Happy Valley-Goose Bay, I can relate to much of the information regarding Lake Melville. Throughout my working career I have also been employed by Indigenous governments and organizations such as the Nunatsiavut Government and the NunatuKavut Community Council, and I am currently employed with the Torngat Wildlife, Plants, and Fisheries Secretariat. Through this work experience I have gained familiarity with many Indigenous issues as seen through a natural resource management lens. Traditional knowledge has been a frequently referenced tool in much of this work. There is great value in the knowledge shared by resource users. Making this knowledge available as a practical resource for others, either in the community or for external academic or other interests is important. I am pleased to take part in helping knowledge holders to share aspects of Labrador's regional and Indigenous cultures in a way that is relatable to western academic ways of learning. Ultimately the research and analysis provided in this thesis is meant to add value to an existing data set by providing community members with new insights regarding the potential utility of their own knowledge.

1.4 Research Objectives and Rationale

One of the primary purposes of the SICC's project was to try to better understand the existing ice conditions in and around Lake Melville, along with local adaptations to ongoing climate changes. In addition, the project also examined existing and potential sources of potable water and identified harvest locations and associated sensitive habitats that might be vulnerable to climate change. As well, a section of the survey regarding Scaup (*Aythya marila*) was proposed as a means of determining whether there has been an increase in the prevalence of this species. Interest in this species has developed due to its significant decline in core breeding areas in North America (Ross et al., 2015; Afton and Anderson, 2001). An increase in scaup populations in Lake Melville had been noted on more than one occasion in anecdotal communications and the addition of this subject to the survey process was seen as an opportunity to substantiate the accuracy of these claims (Neilsen, personal communication, 2012). These topics were investigated in light of ongoing concerns regarding climate change. When the grounded theory analysis of the surveys for this thesis were conducted, it became clear that the survey respondents had not limited their discussion to climate change. In fact, for many areas of discussion the primary drivers for change were unrelated to climate change. A number of drivers of change in Lake Melville were discussed during the survey process. These various catalysts for change have come to light through the qualitative analysis and review process and are examined further in this thesis. The survey responses and associated geographic data relating to these themes have been examined and a structured discussion is focused on the following research questions:

1. What are the major drivers of change affecting the traditional harvesting activities of residents of NWR, Labrador?
2. What geographical areas have been most impacted by the identified drivers of change?
3. Why have these areas been impacted to the degree that they have been?
4. How have the residents of NWR adapted to maintain their close connection to their environment in the face of these changes?

1.5 Thesis Outline

This thesis has been divided into seven chapters. Chapter One provides the context for the "Traditional Knowledge: A Blueprint for Change" project conducted in NWR and delves into the significance of this research. It includes a description of the research objectives of the thesis as different from those of the original project.

Chapter Two includes a literature review describing relevant aspects of community-based environmental change, Inuit knowledge and Inuit observations of environmental change, and community vulnerability and adaptation to environmental change research in Indigenous communities. The chapter also outlines where this thesis falls in relation to these topic areas.

Chapter Three provides a description of Lake Melville and the community of NWR. This includes details regarding recent history, local geography, and economic and demographic information. This chapter has been included to provide the reader with a solid foundation that will aid in the understanding of the research results. Additional background information with regard to settlement, economy, climate and physical geography is also presented in chapter three. Contemporary community context and the recent settlement of the LILCA are discussed at length. This information is also essential for interpretation of research results.

Chapter Four describes the methods used for the project. As this work provides an example of a mixed methods approach, the chapter includes discussion regarding aspects of both qualitative and quantitative research. An outline of the survey process is provided and the basis for using grounded theory for subsequent qualitative analysis is explained. A detailed description of the GIS approach to analyzing the spatial data analysis of the NWR TEK geodatabase is also provided.

Chapter Five provides an overview of the results of the analysis along with a number of relevant examples that are illustrative of the recurring themes identified during the qualitative review. Specific examples of change provided and described by local experts are outlined to illustrate the emergence of key themes regarding local perceptions of the environment. These examples are related to the discussion around each of the topics covered in the survey document. These topics include ice, seals, birds, fish and potable water. The chapter also includes results pertaining to resident perceptions and adaptations to changes in their environment.

Chapter Six provides discussion around the topics of environmental change, local weather events, climate change, animal habitat, harvesting and future drivers of change. These are discussed in light of the results presented in Chapter Five and I include relevant information from the survey transcripts as a source to emphasize discussion points. This chapter concludes with a summary of limitations of the research.

Chapter Seven is the final chapter and contains concluding remarks and final thoughts about the potential utility of this research. I discuss how these findings may be used for community planning, to inform policy or to identify potential opportunities for the mitigation of risk and the enhancement of personal safety for residents of NWR who continue to pursue traditional subsistence activities.

CHAPTER 2: Literature Review

This chapter provides a review of relevant literature with regard to the use of community-based participatory environmental change in conducting research in the Arctic. This is followed by a conceptual overview of Traditional Ecological Knowledge (TEK) and how it relates to observations of environmental change in a northern context. This leads into a discussion of literature related to examples of approaches regarding vulnerability and adaptation to environmental change as it relates to northern Indigenous communities. There is a definite overlap in these subject areas with Community Based Participatory Research (CBPR) projects often including TEK and discussions of vulnerability and adaptation including both TEK and aspects of CBPR. In the remainder of this chapter, however, I have focused on each broad category individually, with a section at the end detailing where this study is situated.

2.1 Community-Based Participatory Environmental Change Research in the Arctic

Many northern communities have observed changes on a local scale with regard to the extent and timing of ice production, the health, abundance and timing of flora and fauna and the extent of permafrost. These observations are a few among many local observations that are unique to northern residents (Riedlinger and Berkes, 2001; Cunsolo Willox et al., 2013a; Goldhar et al., 2014; Pearce et al., 2014). Recent decades have seen growth in the involvement of local Indigenous populations in northern ecological research (Ford, 2000; Berkes et al., 2001; Reidlinger and Berkes, 2001; Tondu et al., 2014; Ford et al., 2016; Gordon, 2017). The ways in which community engagement is being approached are changing; there has been a movement toward increasing community involvement in northern research (Tremblay et al., 2006; Pearce et al., 2009; Ford et al., 2012; Ford et al., 2016; Wright et al., 2018). Ford et al. (2012) point out that this increased involvement is university-led in most cases and that there is a need for further partnerships that meaningfully engage local people.

Community-based monitoring has recently become a more commonly utilized tool in research and 'citizen science' has been adopted to describe a movement toward the inclusion of community members in organized data collection (Pulsifer et al., 2014). Castleden et al. (2012, p. 162) define CBPR as "a process by which decision-making power and ownership is shared between the researcher and the community involved; bi-directional research capacity and co-learning are promoted; and new knowledge is co-created and disseminated in a manner that is mutually beneficial." Indigenous peoples in Canada are encouraging this trend and there have been many examples of community-based participatory research (CBPR) in northern Canada (Furgal et al., 2002; Pearce et al., 2009; Peace and Myers, 2012, Chaulk et al., 2013; Ford et al., 2016). CBPR is flexible and can be adapted readily to the myriad of social, economic and environmental changes that are currently shaping the northern context (Markey et al., 2010; Ford et al., 2016; Hirsch, 2016).

The trend toward community inclusion is also linked to legislated responsibilities. For example, the collection and use of TEK for decision-making in Nunavut and Northwest Territories has become a legislated requirement (Krupnik and Jolly, 2002; Gordon, 2017). Researchers and policy developers are awakening to the fact that the potential for local acceptance of policy recommendations is significantly greater when the communities who are impacted are directly involved in the research that informs the decision-making process (Pearce et al., 2009; Ford et al., 2010; Huntington et al., 2011; Ford et al., 2016). A number of organizations and government bodies such as the (former) National Aboriginal Health Organization, the Canadian Institute for Health Research and Inuit Tapiriit Kanatami, among others, have developed policies regarding their preference for increased use of CBPR as the model for working with Inuit communities (Pearce et al., 2009; Koster et al., 2012). Such policies are important because despite the increase in local involvement, the form and depth of involvement remains limited and inconsistent without resulting in real empowerment for northern communities (Ellis, 2005; Gearhard and Shirley, 2007; Brunet et al., 2014). Many northern communities have observed change on a local scale with regard to the extent and timing of ice production, the health, abundance and timing of flora and fauna and the extent of permafrost among many other local observations that are unique to the residents (Riedlinger and Berkes, 2001; Cunsolo Willox et al., 2013a; Goldhar et al., 2014; Pearce et al., 2014).

Ford (2012a, p. 1) states that the Arctic "has become a hotspot for climate change research due to amplification of impacts, presence of vulnerable populations and emergence of the region as an early warning opportunity." Ford suggests that with the concentration of research effort in one area there is the potential for a duplication of effort in northern research. The early involvement of northern communities can help to ensure that research is focused on subjects that are timely and relevant to the people most affected (Peace and Myers, 2012; Ford and Pearce, 2012). Pearce et al. (2009) organize Arctic research into a number of related categories including global climate modelling, Indigenous observations of environmental change, community sustainability analyses, social-ecological resilience and community vulnerability. They point out that research focused on many of these areas "necessitates input from local people" (Pearce et al., 2009). The growth of CBPR has added significantly to our understanding of environmental change in the north (Furgal et al., 2002; Huntington et al., 2011; Ford and Pearce, 2012; Peace and Myers, 2012; Cunsolo Willox et al.; 2012; Tondu, 2014; Riedlsperger et al., 2017).

The use of CBPR in the north has provided opportunities for researchers to vary their approaches to northern environmental change research. Various levels of community involvement have been used and range across a spectrum from simple consultation to fully-fledged community driven research (Pearce et al., 2009; Koster et al., 2012). Koster et al. (2012, p. 208) suggests further that research "should be conducted by Indigenous communities as Indigenous peoples have successfully been conducting their own research since time immemorial." Northern research utilizing varied means of community consultation has included surveys, workshops, focus groups and interviews working with local residents to explore the complex relationships between these residents and their environment (Pearce et al., 2009). Participatory approaches can be further developed through the utilization of TEK, the use of which is becoming increasingly common in northern research (Riedlinger and Berkes, 2001). The inclusion of TEK promotes community involvement in research and offers an opportunity for researchers to work with communities to promote mutually beneficial outcomes (Castleden et al., 2012).

2.2 TEK and Inuit Observations of Environmental Change

A consistent definition for TEK is elusive due to the variety of settings in which it is used (International Council for Science, 2002; Ford, 2000; Laidler, 2006; Arctic Council, 2015). Further complicating matters is the use of alternate wording to describe the same or similar concepts such as Aboriginal Knowledge, Indigenous Knowledge or local knowledge. The Government of Nunavut has opted for the use of Inuit Qaujimajatuqangit (IQ), which "embraces all aspects of traditional Inuit culture, including values, world-view, language, social organization, knowledge, life skills, perceptions and expectations" (Government of Nunavut, 1999). Berkes (2009) defines TEK as "a cumulative body of knowledge, practice and belief, evolving by adaptive processes and handed down through generations by cultural transmission." This thesis accepts a broad definition of TEK as "a cumulative, collective body of knowledge, experience, and values held by societies with a history of subsistence" (Ellis, 2005). Bennett and Lantz (2014) go a step further by categorizing this knowledge as pertaining to travel and navigation, vegetation, weather, wildlife and hunting, fishing and trapping. These topics represent a concise subset of IQ that accurately describes the majority of the dataset investigated in this thesis.

TEK has been incorporated more frequently in northern research regarding land and resource management over recent decades (Berkes, 1999; Wenzel, 1999; Furgal et al., 2002; Nadasdy, 2005; Ellis, 2005; Laidler, 2006; Tremblay et al., 2006; Tester and Irniq; 2008; Dale and Armitage, 2011; Riedlsperger, 2014). The nature of the relationship between TEK and Western Science has evolved over time. The change is in no small part due to the use of TEK being mandated by Indigenous, federal and territorial government bodies under various land claims agreements (Gearhard and Shirley, 2007). The mandated requirement for inclusion has ensured that TEK has been incorporated into a number of varied areas of northern research (Kendrick and Manseau, 2008; Gangnam and Berteaux, 2009; Dale and Armitage, 2011). A description of commonly cited differences between TEK and western science is included below (Table 2.1). In particular the management consensus based character of TEK is more in line with CBPR.

Table 2.1: Differences Between TEK and Western Science (Tsuji and Ho, 2001).

CHARACTERISTIC	**TEK**	**WESTERN SCIENCE**
Position in Western Society	Subordinate	Dominant
Dominant mode of thinking	Intuitive, holistic	Analytical, reductionist
Reason for data collection	Subsistence Goals	Varied
Type of Data	Subjective, qualitative, diachronic	Objective, quantitative, synchronic
Data Collection	Slow, inclusive	Quick, selective
Data Storage	Oral	Written
Learning	Storytelling, hands on, experimental	Didactic, reading, experimental
Management	Consensus Based, self-regulated, decentralized	Centralized bureaucracy

Despite these differences there is much that is shared between these knowledge systems. Similarities between TEK and western science are obvious in that both knowledge systems are based on observation (Agrawal, 1995; Berkes, 1999) and in many cases TEK meets scientific criteria such as “replicability, rationality, rigour and universality” (Ellis, 2005).

The varied utility of TEK across the north is impressive and it has been used in tandem with western science across a number of disciplines. Gearhard and Shirley (2007) discuss the exchange of TEK between communities and researchers with regard to subjects as varied as astronomy, geology, glaciology and oceanography. Other examples of TEK use can be found in Arctic Char studies in the Northwest Territories (Knopp, 2010); climate change and health in Labrador and Nunavik (Furgal, 2002; Harper et al., 2012; Cunsolo Willox et al., 2013a) and sea ice studies spanning the Arctic (Laidler, 2006; Pearce, 2006; Bell et al., 2014). Local perspectives based on long experience regarding these varied issues have proven to be quite valuable.

There are numerous benefits of incorporating TEK in northern research, beginning with the simplification of complex logistics. Researchers can consult with local knowledge holders in order to improve planning with regard to trip routing. TEK in relation to the presence or absence of phenomena can also help to save researchers time and money. The associated reduction in time spent in the field makes the inclusion of TEK that much more attractive from a financial standpoint (Pearce et al., 2009; Bennett and Lantz, 2014). There is also the consideration that local residents view environmental change in a different context than can be easily attained by academics who are external to the locale. This can provide researchers with potential research questions that may not have been obvious to an external perspective (Berkes, 2009; Bennett and Lantz, 2014). These described incentives for the inclusion of TEK have led researchers to pursue relationships with community members at an increased rate. The movement toward increased use of TEK has helped further the development of long-term research relationships in the north (Laidler et al., 2009; Ford et al., 2010). It is now common to see TEK and western scientific knowledge used together in resource and land use research. However, the relationship is still commonly weighted toward western scientific knowledge (Nadasdy, 2005; Inuit Tapiriit Kanatami, 2018). Typically, in the past TEK was viewed as a tool to inform western science (International Council for Science, 2002). Due to its holistic approach TEK may be used as a complement to western science and Berkes (2000, p. 1259) suggests that TEK "can be viewed as a library of information on how to cope with dynamic change in complex systems." Dale et al. (2011, p. 448) warn that "conventional management can prove resistant to change when certain types of knowledge are undermined."

Riedlinger and Berkes (2001) identify five main convergence areas for TEK and western science through which these two knowledge systems can be linked. These include local-scale expertise, climate history, research hypotheses, community adaptation and community-based monitoring. Local expertise can provide scientists with access to ground truthing for validation of their work as well as providing a local perspective regarding the real-world implications of their work. TEK also extends the historical record through the inclusion of detailed records that often pre-date existing formal records. As well, the observations made by local residents on a given subject are often further refined through their association with seasonality in addition to being spread over many years (Berkes, 1999; Riedlinger and Berkes et al., 2001; Gagnon and Berteaux, 2009; Finnis et al., 2015). Vinyeta and Lynn (2013, p. 9) describe "TEK holders" as having "a fine-tuned sense of nature's temporality, diversity, and variability" that can be used to better understand local environmental conditions.

The inclusion of TEK represents collaboration that can influence the scope of inquiry and provide for increased involvement of communities in the research process (Riedlinger and Berkes et al., 2001; Gagnon and Berteaux, 2009). It was also noted that TEK observations could often lead to hypotheses that are more in line with community concerns. This could help to influence the direction of research (Riedlinger and Berkes, 2001; Gagnon and Berteaux, 2009; Bell et al., 2014).

Laidler (2009) suggests that policy initiatives for adaptation with regard to Canada's Inuit population are not going to be effective unless Inuit take ownership of them. She suggests that this will require a convergence of both western science and TEK. The use of TEK is one mechanism by which participatory problem solving can be approached. However, it has been argued that the involvement of communities through the use of TEK is more about legitimizing the decision-making process than providing for real participatory community-based involvement (Nadasdy, 2005).

Inuit in Canada seek to gain further influence in defining science and setting the research agenda in the north (Inuit Tapiriit Kanatami, 2018). The research policies developed by the NG have moved in a similar direction. The 2008 NG interim research guidelines (Appendix D) make specific mention of Inuit knowledge and require that researchers account for its role in their work if it is applicable. These guidelines were still in use when the survey for this project was conducted. Consideration of and remuneration for Inuit knowledge and the employment of local people where possible are now commonplace in northern research programs in Canada. The collection of TEK enables users to identify environmental changes that can aid communities in preparing for and mitigating the effects of these new challenges.

2.3 Vulnerability and Adaptation to Environmental Change in Indigenous Communities

Northern communities are typically remote and still heavily dependent on subsistence harvesting (Pearce et al., 2011; Cunsolo Willox et al., 2012; Harper et al., 2015; Riedlsperger et al., 2017). Issues such as food insecurity, inaccessibility of normal travel routes and disruption of cultural practices are all more pronounced across the north (Krupnik and Jolly, 2002; Ford et al., 2008; Pearce et al., 2011; Pearce et al., 2015). Given the consideration that the climate in the north is already changing at an increasing rate, Ford (2010, p. 180) suggests that adaptation "should become a central feature of climate change policy." Adaptation planning will benefit from community engagement to enable northern residents to share their knowledge and provide planners with local insight regarding complex problems (Pearce et al., 2011; Bell et al., 2014; Wolf et al., 2013; Riedlsperger et al., 2017).

Berkes and Jolly (2001) define adaptation using the biological roots of the word. Their definition identifies adaptation as a response to environmental variability that increases the probability of a population's survival. Smit and Wandel (2006, p. 282) define adaptation in the context of the human dimensions of climate change as referring "to a process, action or outcome in a system (household, community, group, sector, region, country) in order for the system to better cope with, manage or adjust to some changing condition, stress, hazard, risk or opportunity." The Intergovernmental Panel on Climate Change has defined adaptation as an "Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (Intergovernmental Panel on Climate Change, 2014). These are all similar descriptions of what is essentially the practical response of people to the changes they are confronted with.

Berkes and Jolly (2001) suggest two typical categories that adaptations fall into. Short-term adaptive responses are described as "coping mechanisms" and could be as simple as changing target species when hunting based on species health or environmental conditions. A coping mechanism such as this often occurs at the individual level. In contrast, long-term responses more likely come in the form of "adaptive strategies." These strategies are often planned and typically occur on a larger, community or government scale. These strategies are often associated with a change in cultural values (Berkes and Jolly, 2001). Wildlife co-management decision making processes are an example of one such strategy. For example, co-management decision making is being utilized in Nunatsiavut to work with species at risk and to determine Inuit domestic harvest levels. Coping mechanisms and adaptive strategies are utilized in managing environmental changes when they occur.

At the community level, the goal of alleviating the negative impacts of environmental change through adaptation is dependent on an understanding of how these communities are vulnerable (Adger, 2006; Smit and Wandel, 2006; Ford et al., 2010). The table below includes a summary of a subset of community-based adaptation and vulnerability related research pertaining to Inuit communities across the Inuit regions of Canada between 2006 and 2009 (Table 2.2). The table provides an idea of climate change related vulnerabilities and potential adaptive capacity. It is clear that these communities share similar vulnerabilities and sources for adaptive capacity (Ford et al., 2010). Many of the sources of adaptive capacity and the key determinants of vulnerability described in table 2.2 are also relevant to the community of NWR.

The vulnerability of a community to environmental change is dependent on the overall exposure to risk and the ability of the community to plan and adapt to changes as they occur (Ford and Smit, 2004; Goldhar et al., 2014; Pearce et al. 2014). Many case studies related to this topic have been conducted in the Arctic (Pearce et al., 2010; Ford et al., 2012; Goldhar et al., 2014).

Table 2.2: Summary of Findings from Community-based Research (Ford et al., 2010)

Communities involved	Key determinants of climate change vulnerability	Sources of adaptive capacity
Nunavut: Arctic Bay, Igloolik, Iqaluit	Erosion of land based skills Reduced resource use flexibility due to quotas Limited financial resources Community location	Social networks Traditional knowledge and culture Flexibility in resource use Technology Territorial policy (e.g. harvester support) Formal search and rescue
ISR: Ulukhaktok	Erosion of land based skills Limited financial resources (limited number of wage jobs, lack of qualifications, nepotism) High cost of hunting Time constraints due to employment obligations Substance abuse (health and well-being)	Social networks traditional knowledge and land skills Flexibility in resource use Financial capital Wellness
ISR: Ulukhaktok, Aklavik, Tuktayuktuk	Erosion of land based skills Institutional capacity already stretched Limited financial resources Community location High costs of hunting Population turn-over	Experience and traditional knowledge Wage income Technology
Nunatsiavut: Nain **Nunavik**: Kuujjuaq **ISR**: Inuvik, Tuktoyaktuk, Aklavik	Limited financial and technological resources Decrease in generation and sharing of land based knowledge Erosion of land based skills Existing health status Community location Lack of formal institutional support for adaptation	Social networks Communication networks and pathways for sharing/distribution of knowledge Traditional knowledge and land based skills Financial resources (among some individuals) Access to technology
Nunavik: Kangisualujjuaq	Limited financial resources Limited access to technological resources Limited social networks Erosion of land based skills and knowledge Limited pre-existing knowledge of region Approach to adaptation – perception and strategy	Financial resources Social networks Traditional knowledge and land based skills Knowledge of region/area (residence time in community) Access to technology (equipment) Perception of risk/hazard
Nunavik: Kuujjuaq, Kangiqsualujjuaq, Akulivik, Kuujjuarapik	Perception of risk Erosion of land based skills Experience/age	Traditional knowledge and land based skills Access to technology
Nunatsiavut: Hopedale	Traditional knowledge and skills Community location Changes to wildlife availability and accessibility Limited local employment & investment (natural resource development) Changing Governance systems Compromised sharing networks Increasing costs of living (remote, limited transportation)	Financial capital—personal mobility (connection to financial capital) Traditional knowledge Diversity of wildlife resources available Institutional support Local informal sharing norms, networks, principles of sustainability Wage income opportunities; out-migration for jobs Ability to make trade-offs in resources harvested

2.4 Convergence and Research Gaps

The work completed by the community of NWR is an excellent example of a convergence of CBPR, TEK and Vulnerability/Adaptation research. Due to the fact that it is both community designed and led, it exceeds the level of involvement found in much of the contemporary Inuit research conducted in the Arctic. This project began with the leadership of the SICC identifying an internal interest in the topic of community adaptation to climate change. SICC then contacted the LI with a request for assistance with developing a proposal for the research project. As a priority, SICC was intent on capturing knowledge for local empowerment and skill preservation and sharing. One concern held by many of the participants was that the transmission of TEK between generations was not occurring as it has in the past. A similar concern is reflected in the erosion of traditional skill sets in many northern areas (Ford et al., 2010; Pearce et al., 2015). Through the SICC, residents identified this as an important issue and suggested that recording this valuable information for future generations should be made a priority (Neilsen, personal communication).

A recent study of freshwater changes in Rigolet, Nunatsiavut concluded that there was a need to better understand the vulnerability of other coastal communities in Labrador (Goldhar et al., 2014) in light of ongoing climate change as well as the effects associated with ongoing hydroelectric development. This sentiment echoes conclusions drawn from a recent literature review completed in 2012 (Ford et al, 2012a. p 819.), which points out the need to pay “greater attention to regional centres and communities neglected by climate change research.” The work produced through the Labrador

Blueprint project adds to the understanding of these research gaps. A need to "develop a broader and more diverse geographic and sectoral knowledge base" regarding the human dimensions of climate change has been identified (Ford et al., 2012). Ford points out that there are Inuit located outside of the remote Arctic who represent a gap in the current knowledge base due to their less remote locations. The work completed in the area of NWR represents one such Inuit context. The community is less remote than many similar examples and vulnerable to many different exposures.

The adaptability of northern communities to environmental change has been demonstrated in the past (Ford and Smit, 2004; Woollett, 2007; Ford et al., 2010; Pearce et al., 2015). It is the current pace of change that may be overwhelming for some communities. Through the enumeration of community exposures and their adaptive capacities it is possible to determine the overall vulnerability of a community (Ford and Smit, 2004). As previously outlined, similar work has been conducted across the north in various case studies. SICC's project is a step toward enumerating the exposures and adaptive capacities of the residents of NWR.

CHAPTER 3: NWR and the Study Area

This chapter provides a detailed description of the study area (Figures 3.1 and 3.2) and includes background information regarding the physical environment, an overview of the historical and present climate and some historical community context. An overview of historical and contemporary economic development in NWR is also provided, as well as information pertaining to the regional lifestyle of NWR residents and their relationship with their environment. This provides a foundation for subsequent discussion regarding land use throughout the remainder of the thesis.

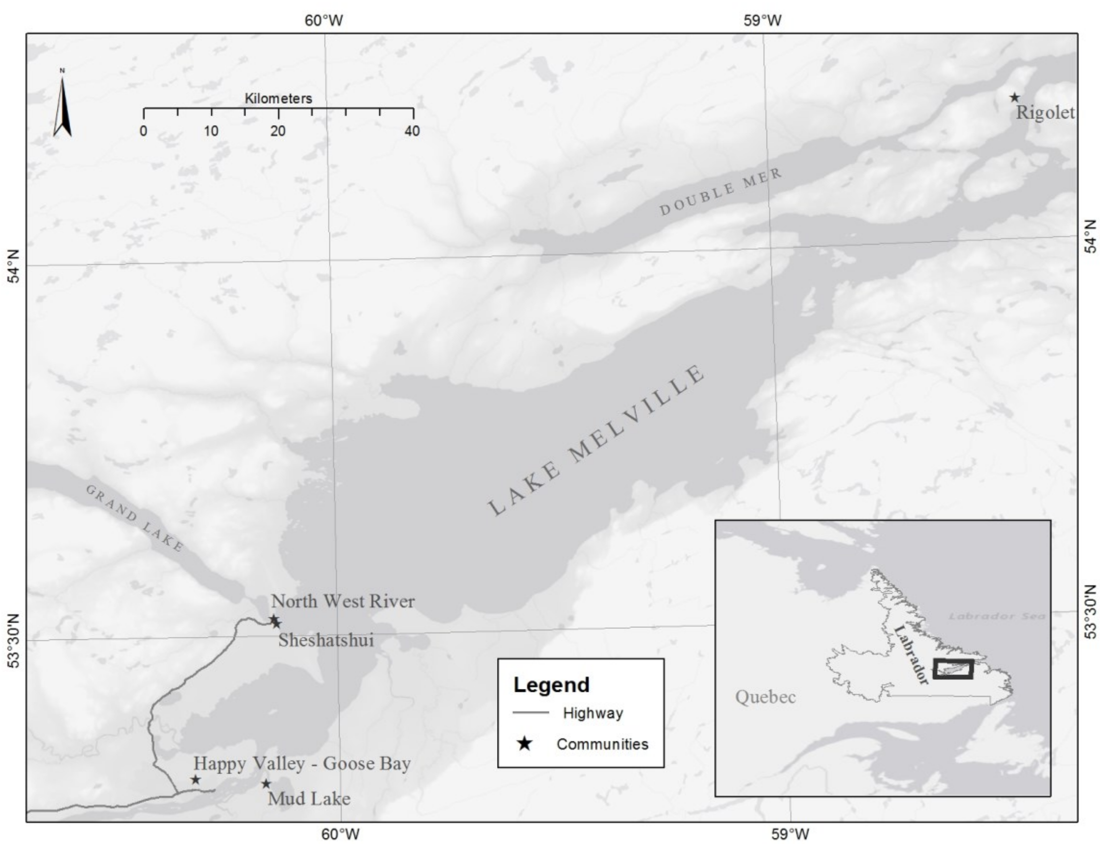


Figure 3.1: Lake Melville and North West River. Map produced by B. Wood

3.1 Study Area: The Lake Melville Region

Lake Melville has "distinctive regional ecological characteristics of climate, physiography, vegetation, soils, water and fauna" and by this definition has been described as a unique ecoregion (Notzl et al., 2013, p. 7). The Nature Conservancy of Canada has developed the most recent boundary delineation for this ecoregion illustrated in (Figure 3.2).

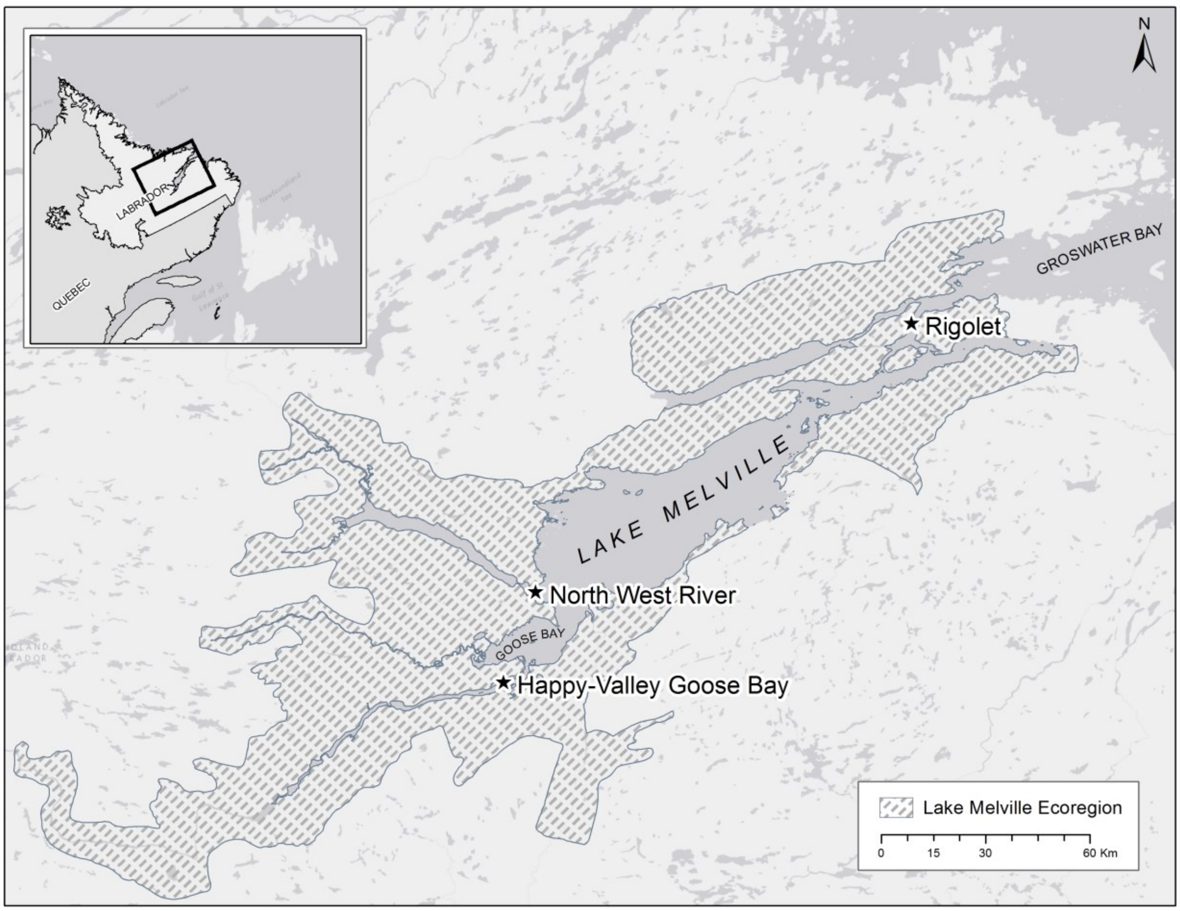


Figure 3.2: Lake Melville Ecoregion (Notzl et al., 2013). Map produced by B. Wood.

Hamilton Inlet is comprised of Goose Bay, Lake Melville and Groswater Bay and is a sub-Arctic fjord estuary that acts as an outlet for fresh water from four major rivers in the interior of Labrador (Zhaoshi et al., 2013). Two of Labrador's largest rivers, the Churchill (locally referred to as the Grand River) and Naskapi both drain into this region along with a number of smaller rivers and brooks. The south side of Lake Melville is bordered by the Mealy Mountains while the western end of Lake Melville narrows into the Terrington Basin. The coastal plain surrounding Lake Melville is dominated by alluvial soils (Meades, 1990; Notzl et al., 2013). The community of North West River is located on the western end of the lake at the confluence of Grand Lake and Lake Melville. The community of Rigolet is located at the north-eastern end of Lake Melville. It is at this point where Lake Melville meets Groswater Bay that the "Narrows" significantly restrict the flow. The Narrows is a 22 kilometre long restricted channel, approximately thirty metres deep and just under three kilometres wide. Lake Melville is roughly 170 kilometres long and up to thirty-five kilometres wide. The lake averages a depth of eighty-six metres and has a maximum depth of 256 metres. Flow rates at the Narrows are significant and can reach three to four metres per second (Zhaoshi et al., 2013; Schartup et al., 2015). The topography surrounding this area is primarily rugged, windswept heath lands, and the vegetation assembly is limited by short cool summers. These areas are commonly classified as coastal barrens (Lopoukhine et al., 1978).

3.2 Climate

Labrador's most recent deglaciation occurred approximately 10,000 to 8,000 years ago. Following this shift the climate reached a warm peak approximately 4,000 to 6,000 years ago. This is evidenced by the remnants of forested areas above Labrador's current tree line (Bell et al., 2008). Subsequent to this the "Little Climatic Optimum" (LCO) took place from roughly 700 to 1400 AD and brought a significant rise in temperature that persisted until the "Little Ice Age" that followed from approximately 1400 to 1800 AD. This period was roughly one to three degrees Celsius cooler than the preceding LCO (Vasseur et al., 2007). Way and Viau (2014) evaluated more contemporary Labrador air temperatures dating from the period of 1881-2011. These temperatures show an overall warming trend (Figure 3.3) despite the cooler temperatures from 1957 to the early 1990s. The last couple of decades have seen rapid warming which Way and Viau tie to natural and anthropogenic factors coupled with anomalies in the Arctic Oscillation and temperatures in the North Atlantic (2014).

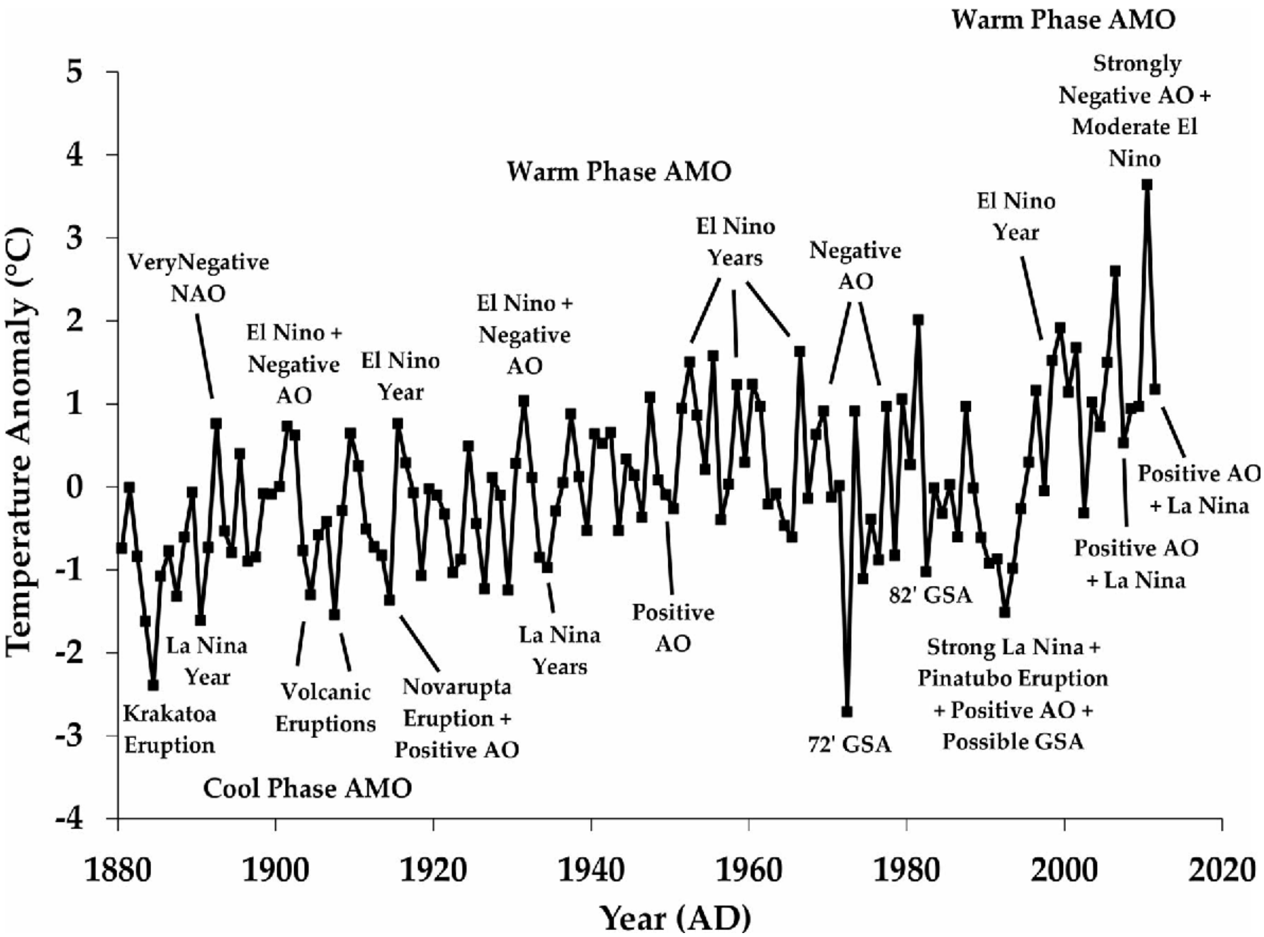


Figure 3.3: Labrador air temperatures annotated with natural contributors (Way and Viau, 2014)

Contemporary atypical weather events that result in very poor ice and snow conditions, such as those represented by the winter of 2010, may be a part of this warming trend (Way and Viau, 2014). According to regional climate models, similar events can be expected over the coming decades (Finnis, 2013, Way and Viau, 2014; Finnis and Bell, 2015). Typically, the current climate in the area in and around Lake Melville is northern boreal (Vasseur et al., 2007) and has the most favorable growing conditions found in Labrador (Meades, 1990). The July average temperature is approximately fourteen degrees Celsius while the January average is minus sixteen degrees Celsius. Precipitation ranges between 900 and 1000 mm annually (Notzl et al., 2013). The summers are warmer and winters are shorter due to topographically affected southwest winds that dominate in the region, counteracting some of the cooling effect of coastal north westerlies (Vasseur et al., 2007).

3.3 Flora & Fauna

A typical growing season in the Lake Melville ecoregion generally lasts between 120 and 140 days beginning from roughly June and lasting to September. The dominant vegetation assemblage in the region could be described as high boreal forest and includes species such as the Balsam Fir (*Abies balsamea*), Black Spruce (*Picea mariana*), White Birch (*Betula papyrifera*) and Trembling aspen (*Populus tremuoides*) (Notzl et al., 2013). Meades (1990) notes that this region "is often considered an outlier" and a number of bird species typical of more southern locations are found here at their northern limits. Other fauna common to a High Boreal Ecosystem such as Moose (*Alces alces*), Black Bear (*Ursus americanus americanus*), Labrador Wolf (*Canis lupus labradorius*), Marten (*Martes Americana atrata*), Red Fox (*Vulpes vulpes*), Porcupine (*Erethizon dorsatum*), Beaver (*Castor canadensis canadensis*) and Muskrat (*Ondrata zibethinus zibethicus*) are present (Meades, 1990). Some of the species commonly utilized by residents of the region for subsistence include Caribou (*Rangifer tarandus caribou*), Ptarmigan (*Lagopus lagopus*), various species of waterfowl including Canada Geese (*Branta Canadensis*), various species of seals and salmonids.

3.4 Community History

Currently there are five communities in Labrador that are found in close proximity to Lake Melville. These include Rigolet, Mud Lake, Happy Valley-Goose Bay, Sheshatshiu and North West River (Figure 3.1). The proximity of these communities to each other ensures that there is a measure of mutual influence felt amongst them. People often travel among these communities to avail of services and visit family members. HVGB is the youngest of these communities with its inception being linked to the construction of the Goose Air Base beginning in 1941 during the Second World War. The other communities all have a much longer recorded history in Labrador. Their histories are linked to traditional land use and various natural resource-based industries such as trapping, fishing and forestry related industry.

NWR is one of the oldest recorded communities in the Lake Melville area having been host to an established fur trading post since at least 1743. NWR and its residents are the focus of the remainder of this chapter.

3.5 Economic Development

The community of NWR has a long history in Labrador. There has been a settlement in this location for at least 250 years and archaeological evidence points to a much longer occupation amongst Indigenous Peoples dating back at least 3500 years (Fitzhugh, 1972). The beginnings of an economic history for NWR can be tied to the point at which a formally established French trading post was erected for trappers and fur traders in 1743. The English gained control of the area in subsequent decades and by

1836 the Hudson's Bay Company had established a trading post that now serves as the Labrador Heritage Museum. Smaller settlements were spread around Lake Melville. In 1857 there were an estimated 170 people within one day's travel of NWR but only fifteen residents living in the community (Rompkey, 2003). A section of a Labrador map produced by Moravian missionary Levin T. Reichel is included below (Figure 4). The map illustrates the decentralized nature of the early habitation of Lake Melville. Mulligan, as an example of one decentralized community, is listed with D. Campbell for a Campbell family who settled there in 1851. There is a Marceille Michelin located at Sebaskachu who married Hannah Mesher (a widow) already residing there (Baikie, 1991). Many other prominent Labrador names can be seen spread over the area (including Goudie, Davis, Blake and Flowers). These family names are still common in NWR and other communities in the Lake Melville region. The development of the fur trade had brought an influx of European settlers to the area, many of whom decided to take up permanent residence (Plaice, 1986).

The primarily subsistence lifestyle associated with the fur trade persisted into the twentieth century with change coming slowly in the early part of the century. For example, Dr. Harry Paddon established a cottage hospital, orphanage and school in NWR in 1914. This roughly corresponded with the height of the fur trade in the 1920s (Plaice 1986). The hospital became an important part of the economy of the community and was vital to coastal Labrador as well (Baikie, 1991).

The middle part of the century saw the establishment of a US Air Force base approximately thirty kilometres southwest of NWR in HVGB. The development of the base brought some of the first long-term wage employment opportunities in the area and an influx of workers from surrounding areas to settle near Goose Air Base (Plaice, 1986; Rompkey, 2003). The Hudson's Bay Company reported a dramatic drop in the number of trappers from around 90 before the construction began to less than seven the following year (Rompkey, 2003). NWR benefited from the influx of military development and many residents continue to travel daily to HVGB for employment on the base. The 1950s brought a considerable amount of mineral exploration to the area. A number of geologists working for Brinco were based in NWR (Rompkey, 2003).

Figure 3.4: Lake Melville section of "Aivektôk oder Eskimo Bay" by Reichel, Levin T (1872).

It was not uncommon for local residents to be employed as assistants in geological work. Discoveries such as a significant uranium deposit near Makkovik helped influence infrastructure development in the region. The road from Goose Bay to NWR was completed in 1980 with the installation of a bridge, the expense of which was justified through the anticipation of increased accessibility to these mineral resources (Rompkey, 2003). This was a significant improvement from the cable car system that had been employed to cross the river since the 1960s and further strengthened the ties between NWR and HVGB. It also had a major impact on the lifestyles of people with very few families owning cars prior to the bridge.

3.6 Demographics and Lifestyle

The community of NWR originally included both sides of the river but during the sixties the provincial government encouraged the settlement of the local Innu population on the south side of the river (currently the community of Sheshatshiu) and in 1971 the Innu portion was made a separate administrative unit (Plaice 1986). The 2016 population for the community of NWR was 547 with a self-identifying Indigenous population of 355. The population decreased by 1.1% from the 2011 census but gained roughly 10% compared to 2006 (Statistics Canada, 2007; Statistics Canada, 2013; Statistics Canada, 2017b). The majority of the Indigenous population is of Inuit descent with 290 of the 375 community residents self-identifying as Inuit (Statistics Canada, 2013). With this population in mind the Labrador Inuit Association negotiated section 17.3.4(c) of the Labrador Inuit Land Claims Agreement (LILCA) which provides for:

"the establishment of Inuit Community Corporations in the Upper Lake Melville area and other areas outside the Labrador Inuit Settlement Area to represent Inuit residents in those areas and provide for their participation in the Nunatsiavut Government;"

This ensures that those beneficiaries residing in the community of NWR are represented in the NG that was formed in 2005 through the ratification of the LILCA. The Nunatsiavut Region is shown below in relation to the other Inuit Regions of Canada (Inuit Nunangat), as is as the location of NWR in relation to the Nunatsiavut region (Figure 3.5).

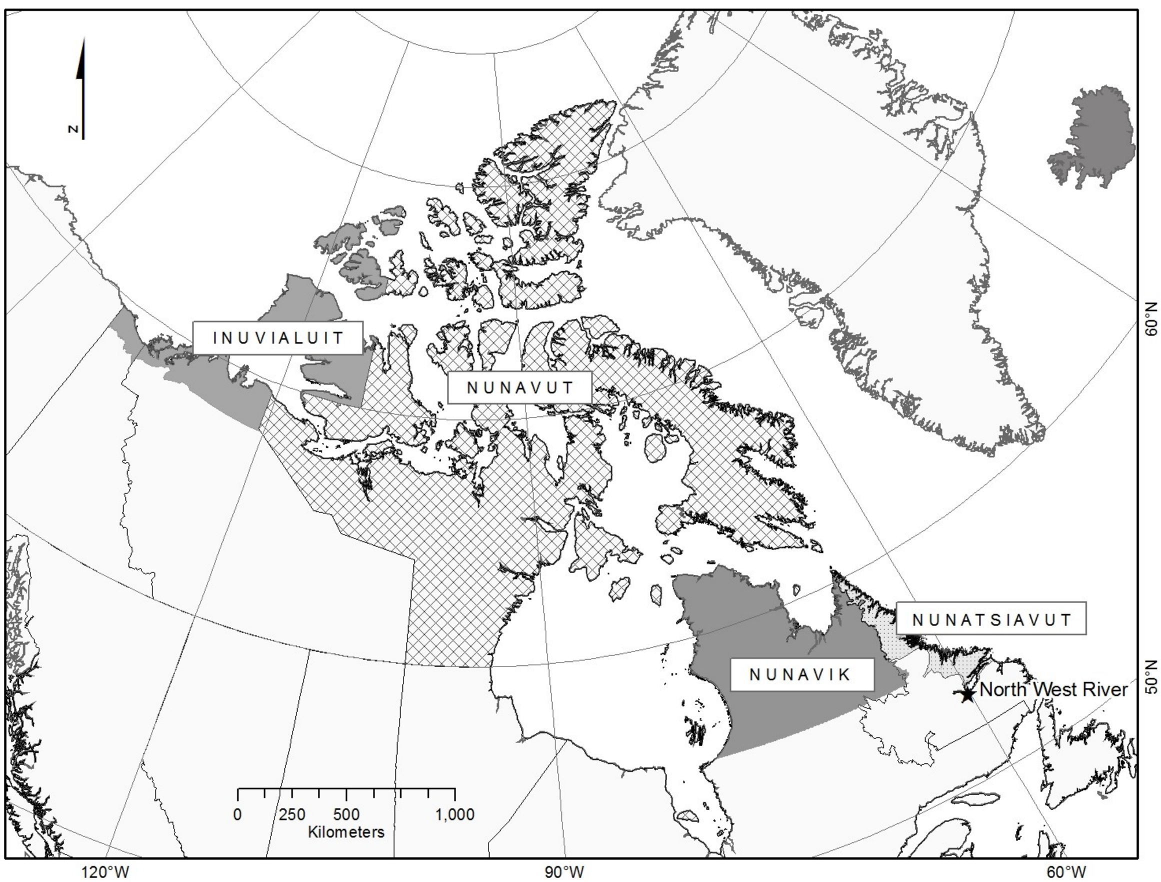


Figure 3.5: Inuit Nunangat (Inuit Regions of Canada) and NWR. Map produced by B. Wood.

Historically, settlers in the NWR area resided in locations appropriate to their harvesting patterns. These residents travelled inland during the winter months while participating in the fur industry and travelled out to the coast for salmon fishing in the spring and summer months. Baikie (1991) provides an example of this lifestyle:

"Thomas and Margaret Baikie lived at Snooks Cove, Grand Lake, Moulagn (Mulligan), and the Islands. Their life was spent salmon fishing "down the bay" at Snooks Cove and trapping "up the Bay" at the head of Grand Lake. However, part of the year was spent at the Islands where they had their vegetable gardens, and carried on hunting, trouting, sealing, and in the fall and spring, berry picking."

This pattern was necessary to disperse harvest pressure so that these settlers were able to make a living. By the 1930s, with increasing populations, trappers began encroaching on Indigenous trapping areas in order to avoid overlapping with each other. The decline of fur prices and the movement toward other occupations helped to assuage further conflict (Rompkey, 2003).

Today there is comparatively little trapping being done. The trapping that still occurs is primarily in the late fall and through the winter in keeping with provincial regulations and the season for each species. For the most part this activity is carried out as a way for individuals to supplement their income (Montague, 2013). In describing some current trapping practices, Montague (2013) states:

"These days with people hunting from their trucks along the road there's a lot of fur being taken in a small area but no one person is making a living at it…In our time it was all done on water routes so you were really spread out."

Salmon fishing is carried out primarily through the use of nets. The Federal Department of Fisheries and Oceans (DFO) halted the commercial fishery for salmon in Labrador in 1998. With the closure of the commercial fishery it was hoped that the stock would return to sustainable harvestable levels. Today, salmon fishing is carried out under a heavily regulated residential food fishery system. It is directed by DFO to aid in the management of the resource for all users in the area.

Ice conditions from late fall to late spring are of great importance to residents of NWR. Ice is important for travel and access to country foods. April and May are seal hunting months depending on the ice conditions (Montague, 2013). Later in May many residents take part in the spring migratory bird hunt that is regulated through the NG. Beneficiaries also participate to some extent in egging (harvesting eggs from wild nests). Many of these activities are geographically related to the location of cabin sites. Many of the cabins that have been constructed in Lake Melville can be found in proximity to old family homesteads. As an example, members of the Michelin family have occupied Sebaskachu ("Sabby") since before 1875 (see Figure 3.6). The picture below shows a cabin that belonged to Robert and Janet Michelin which has now been handed down to their daughter; collections of such cabin sites are now popular weekend retreats for many residents of NWR. Examples of similar conglomerations of cabin sites can be found at Mulligan, Northwest Islands and Bakeapple Island. These areas are among those mapped and discussed further within the results section. An estimated 763 cabin sites can be found in the Lake Melville area (Healthy Waters Labrador, 2012).

Figure 3.6: Janet Michelin and her cabin at Sabby (photo courtesy of Michael Barnes).

For many of the residents of NWR cabins act as home bases for activities such as sealing, ice fishing for trout or picking berries. Berry picking is a very common activity from August to October. It is not uncommon for residents to travel a long way out the bay to gather bakeapples on islands near Rigolet (Baikie, 1991).

Gardening is a common activity for many households. Fitzhugh (1999, p. 320) suggests that the practice is carried over from the examples set by Donald Smith, the Hudson's Bay Company factor from 1848 to 1868 who "transformed North West River Post into an experimental farm…to show Labradorians that with industry it was possible to live well in their country." Many residents still have gardens at their homes as well has their cabin sites. Baikie (1991) summarizes the lifestyle well:

"Trapping; salmon and cod fishing; sealing; trouting; caribou hunting; wood cutting; duck hunting; gardening; berry picking; and, partridge hunting was the way of life for the settlers of Esquimaux or Gros Water Bay for many decades."

In 2012, Natcher and Procter conducted an Inuit Domestic Harvest Level (IDHL) survey as part of an agreement between the NG and Memorial University. This survey included many of the activities listed above. Figure 3.7 shows harvest participation levels for the five Inuit communities found within the Nunatsiavut region and includes a column for the beneficiaries contacted in the Upper Lake Melville (ULM) area. This graph and the following table (Table 3.1) show the similarities between the communities with regard to harvesting. Food sharing is also considered through the inclusion of a recipient column for each community. This shows clearly that participation in the harvest of local foods and subsistence use is still important to the communities within Nunatsiavut and Upper Lake Melville.

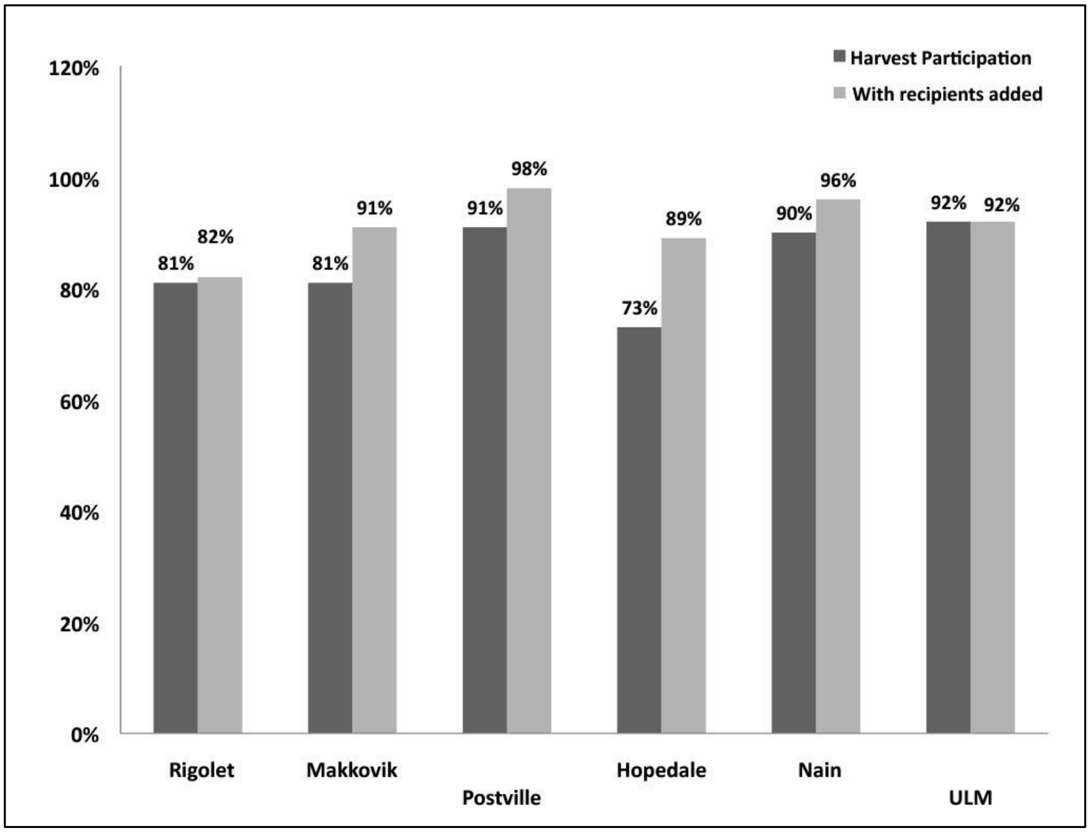


Figure 3.7: Harvest participation by community from Felt et al., (2007) Note: the "with recipients added" columns refer to individuals who benefit from harvesters but do not harvest themselves. This provides a "total households" number that is more illustrative of the benefits of harvesting as a whole (Natcher and Procter, 2012).

A partial list of a number of the "keystone species" that were identified for the IDHL is provided (Table 3.1). Natcher and Procter (2012) noted that during the consultation process a number of other important species were discussed including seal, partridge, rabbit, wild berries and various fish species. The species discussed within table 3.1 are very similar to those discussed in this thesis and highlight the importance of subsistence foods for Nunatsiavut beneficiaries. Natcher and Procter (2012) state that "Despite the incursion of many elements of modern life into coastal communities and households, subsistence harvesting continues to be a dynamic and flexible activity critically relevant, if not essential, for life in the Labrador context."

Table 3.1: Household Participation by Community and Species (Felt, 2007)

	Rigolet		Makkovik		Postville		Hopedale		Nain		ULM	
	N	%	N	%	N	%	N	%	N	%	N	%
Geese	33	45%	32	37%	32	57%	39	35%	85	40%	37	33%
Black Duck	37	50%	26	30%	27	48%	28	25%	61	29%	28	25%
Eider	33	45%	22	26%	26	46%	41	36%	62	30%	4	4%
Surf Scoter	28	38%	5	6%	14	25%	21	19%	5	2%	23	21%
Black Scoter	1	1%	17	20%	20	36%	10	9%	10	5%	9	8%
WW Scoter	0	0%	1	1%	5	9%	1	1%	11	5%	2	2%
Eider eggs	9	12%	32	37%	24	43%	58	51%	76	36%	1	1%
Tern eggs	24	32%	29	34%	5	9%	65	58%	73	35%	1	1%
Gull eggs	18	24%	1	1%	12	21%	4	4%	3	1%	1	1%
Guillemot eggs	1	1%	6	7%	0	0%	10	9%	37	18%	0	0%
Atlantic salmon	54	73%	56	67%	45	80%	31	27%	5	2%	99	88%
Arctic Char	21	28%	65	76%	40	71%	74	65%	160	76%	15	13%
Caribou	20	27%	37	43%	25	45%	33	29%	114	54%	66	59%

CHAPTER 4: Methodology

The data collection process included a structured survey complete with a system to enable the collection of geographic information through mapping. The analysis of these very different data formats required a mixed methods approach that utilized computer assisted text analysis software and computer software for GIS analysis. This chapter outlines the process for each system and provides a description of how these varied approaches are combined to highlight major themes that are grounded in the survey data. An overview of the project design and execution is provided, with detailed descriptions of methods including key informant surveys, GIS, sociospatial grounded theory and spatial analysis.

4.1 Overview of Project Design and Execution

SICC's project, "Traditional Knowledge: A Blueprint for Change," was developed as a multi-year research program that would inform researchers about the environmental effects associated with climate change and subsequent impacts on Inuit living in the community of NWR, Labrador (Jackman et al., 2013). During phase one of the project the goal was to collect baseline data on local ecological parameters that are important to the community of NWR and local land use practices. This led to the development of a detailed set of structured survey questions (Appendix A) that included the discussion of topics such as the location of late and early freeze-up and break-up areas, ice pressure crack locations, areas of reliable ice, small game use, nesting areas, sensitive wildlife habitat and sources of potable (primarily spring) water.

Partnership opportunities with the NG evolved during the first phase of the project with the provision of in-kind GIS services. As the GIS Specialist for the NG, I had the opportunity to provide advice on the way the spatial dataset should be collected and managed. The SICC spearheaded the collection of data throughout the project, working in partnership with the LI. The first phase of the project produced a total of forty-nine semi-structured detailed surveys and associated spatially referenced data provided by residents of NWR who were also beneficiaries of the LILCA.

Plans were made for an ongoing partnership with the LI to aid in the training of community members to complete the data collection process following the methods for Indigenous use and occupancy map surveys outlined by Tobias (2009). This partnership was meant to "successfully conduct community driven research that bridges traditional and academic knowledge with positive implications for planning and policy development" (Neilsen, 2012).

The collection of TEK by trained community researchers began with a snowballing approach to scheduling survey participants. Due to some refusals, not all those contacted were surveyed but most of those contacted were helpful in suggesting other contacts. Community researchers conducted a detailed mapping component during the survey process. This led to the storage, maintenance and use of TEK in GIS that in turn would allow for the study of the information in a systematic way to determine the implications of climate change in the area. In particular SICC planned to determine how people, wildlife and habitats would be impacted with a view as to how these impacts might be mitigated. The long-term goal remains the development of a climate change adaptation plan for the community of NWR (Neilsen, 2012).

The SICC worked collaboratively with the LI to create a GIS to house the collected data. The intent was to allow for the simplification of data access for researchers interested in making use of the data beyond the life of the project. As the project progressed, detailed surveys (phase two) were conducted with a subset of the original survey participants contacted to provide narratives of their experience in relation to practicing traditional cultural activities. Community meetings were conducted to obtain additional input from community members before finalizing research findings. The community meetings became a “focus group” exercise to ensure quality control, thereby minimizing potential misinterpretations of the data by anyone involved in the project.

The research conducted by SICC for the project was designed with the aim of collecting TEK regarding specific natural resources that were of particular interest to NWR residents. These topics included animal birthing locations, reliable and dangerous ice locations, resource procurement locations and potable water sources. In order to accomplish this goal a number of specific tasks had to be completed. The project had to meet the research approval requirements of the NG Research Advisory Committee. To help make this possible an advisory board was created for the project. Once the research permitting process was completed and the advisory board had the opportunity to provide input and advice, a survey handbook was developed by the committee members. At this point the community researchers were brought on staff and training was provided in survey and mapping techniques. SICC ensured that community researchers were the primary investigators and data collectors. The LI was available to provide external advice on the project and participated in community and advisory board meetings to provide support to the community researchers when required. With the handbook as a reference point, a few test surveys were conducted to organize the process and add efficiencies through a review of the initial outcomes. Survey areas that presented potential confusion were reworked to simplify the process.

4.2 Key Informant Surveys

In order to acquire relevant data regarding questions of interest to the community it was decided that the surveys conducted would be limited to those individuals who were regarded as experts on the land. These experts were individuals identified by the community who were either currently or historically very active resource users. This involved asking community members to provide direction as to who were the most knowledgeable community members with regard to land use practice. Each of the names provided was added to a list of potential survey candidates. Those names that were mentioned more frequently were given priority for scheduling and inclusion in the survey process. In many cases this led to Elders being highlighted for survey inclusion by the community. The surveys were conducted using a set of semi-structured questions that are included in Appendix A. The survey sessions were completed in person and at least two people involved in the survey process were present to conduct each survey. It was decided at the outset that the surveys would be conducted in English, as just under two percent of the entire population of NWR speak Inuktitut as their mother tongue (Statistics Canada, 2013).

The respondents who were surveyed ranged from between twenty-six and eighty-five years of age, with an average age of fifty-seven years. It is worth noting that only two female respondents were selected to participate in the survey process. Division of labour in the community over time has seen much of the domestic work left to women while men were more likely to travel for hunting, fishing and trapping (Kindl, 1999). Kindl (1999) notes, however, that there was significant overlap in these roles. This may in part explain there being a higher number of male respondents identified for the survey process.

The surveys required one researcher to record geographical data based on informant responses using a series of NTS map sheets at a scale of 1:250,000. The coding methods were derived from map biography methods outlined by Tobias (2009). The codes used on these maps (Appendix B) were predetermined during the development of the survey and required minimal ongoing refinement as the project progressed.

Once all of the participant surveys were completed, the mapped locations were digitized manually using the editing features in Google Earth. This work was completed by the original surveyors. Having the georeferencing work completed by local residents was extremely helpful as it was based on a familiarity with the subject areas and geographic locations. The resulting files were imported into the Environmental Systems Research Institute's Arc Geographic Information Systems Software Suite (ESRI: ArcGIS Version 10) geodatabase for subsequent analysis. The survey sessions were also recorded and the audio records were later transcribed. These transcriptions were imported into qualitative data analysis software (MaxQDA Version 10).

The community researchers began each session with a review of the survey questions with each participant. They described the methods used and provided a consent form to review and sign (Appendix C). Participants were given an opportunity to ask questions and voice any concerns. They were also given the opportunity to choose to opt out of participation in the survey altogether. A completed consent form signed by both the participant and the community researcher was required before each survey could proceed.

During the survey process participants were asked a series of pre-determined questions by the community researchers. These questions were designed to obtain specific geographic data associated with personal land use in the following broad research categories: ice conditions, sensitive wildlife habitat and potable water sources. One researcher was primarily responsible for conducting the oral portion of the survey while the other facilitated the data capture on topographic maps. The survey area could be viewed through the use of three Newfoundland and Labrador 1:250 scale NTS map sheets (13G, 13F and 13J: Natural Resources Canada). The locations provided during the surveys were tagged with a sequential alphanumeric code (e.g. ET006). The letters in the mapping code (Appendix B) indicate the type of land use, while the number(s) indicates the order in which each feature was recorded during the survey. To minimize possible confusion each survey was conducted with a new set of maps.

The audio record of each survey was collected for subsequent transcription to allow for the qualitative analysis of each participant's responses. Each record includes the date and time, along with the name of the participant. It was also important that the geographic areas identified by participants could be identified in the recording. To this end the surveyor repeated the coding aloud for the recording. This allowed for the development of a link between follow-up questions and the matching geographic location. Individual experiences described in the surveys were then easily linked to a geographic database (geodatabase). As this was a structured survey rather than a detailed interview process, each participant was asked every question. If the respondent did not provide an answer for a particular question the surveyor was required to carry on to the next question in the survey. The community researchers who conducted the surveys were responsible for keeping the respondent on topic while endeavoring to keep the survey process to a total of less than two hours. The collected survey results were compiled into a number of common formats used for digital information. The transfer from paper maps to digital versions was handled in a user-friendly manner utilizing Google Earth. Survey transcription was completed by two different professional services. These services were not local and extra time was required for follow up. Data loss was minimized through careful review and by transcribing missing sections where the sound quality was poor. A review and correction process for errors associated with misinterpretations of local vernacular was also completed after the primary transcription work was received.

4.3 Geographic Information Systems

Data collection took place over the fall and early winter of 2010, and included a spatial component. The community and LI researchers met with selected candidates in their own homes in North West River to record each individual's knowledge of the targeted resources on maps of the local region and through the use of digital audio recordings. The surveys were led by SICC researchers with staff of the LI providing assistance as required. The digitizing process was conducted by the interviewers using Google Earth. This process ensured that those most familiar with the data were associated with georeferencing it. Once this process was completed the data were converted to ArcGIS Shapefile format using ET GeoWizards software (version 10.1), a third party set of GIS tools that extends ArcGIS functionality. The output files from this process were converted and saved in a standard geodatabase format.

A number of Excel spreadsheets were developed that include detailed attribute information regarding each mapped feature. This enables database users to list geographic features by land use code while including the participant identification number. This information was then linked to the GIS database through a table relate operation within the ArcGIS program. This provides the user with the option of exporting a new dataset that includes the descriptive, experiential information provided by each respondent. This process was completed with each of the features and then saved en masse in the geodatabase. Each feature in the geodatabase can be queried for a summary of this attribute information, allowing for various reporting options. The selection of features can be accomplished using a number of different survey attributes or through the use of spatial criteria. The GIS database makes it possible to produce maps with a number of different data combinations of interest to the project database users, including:

- a map with every site identified during the project (i.e. total survey area map);
- a map with all the sites identified by a single individual or a family group (i.e. map biography);
- a map with a specific site type or combination of site types (i.e. land use map);
- a map of a specific geographic location including all or a selection of the sites identified for that location (i.e. site-specific map).

Once the surveys were completed, project participants and interested community members were invited to visit a selection of the sites identified by the participants. These site visits were used to informally "ground truth" a subset of the mapped locations. As part of this process GPS points were collected at various sites and then compared to the corresponding map locations provided during the surveys. Although the GPS positions did not correspond exactly to the mapped locations, the process enabled verification of accuracy in a general sense. For the type of land use information collected, the 1:250,000 scale maps utilized in the survey ensure that a mapped location can be considered reasonably accurate if it can be used to successfully locate a real-world feature. Once the review of the mapped features was completed a series of maps was produced, both in digital and hard copy formats. These finished maps were provided to the survey participants at a public meeting, which was attended by the members of the project team.

4.4 Sociospatial Grounded Theory and Spatial Analysis

The impetus for the research project was not academic. Efforts were focused on documenting local TEK and recording it for the benefit of future generations. SICC was aware of and open to the potential of sharing the products of their research with interested parties. When I approached the research coordinator and the chairperson of the SICC with the idea of utilizing the products of the project for my graduate work, I was encouraged without hesitation. The prospect that the databases developed through the project would be of interest to, and utilized by, individuals outside the immediate community was a consideration from the start. This is in part why they had originally partnered with the LI to vet research design, data collection and analysis ensuring that the final product would be within acceptable standards for this type of work. The geodatabase was designed to include land-use information of interest to researchers from a variety of disciplines with the intent that it be readily accessible to potential researchers. The design of the overall project was driven by a community based agenda to obtain and utilize TEK to better understand aspects of local environmental change. The product, although structured around specific survey questions, allowed for varied responses that are well suited to analysis using grounded theory.

Grounded theory analysis can be used to determine overarching themes that become evident during detailed review of the data. This is an inductive process of information gathering and analysis that provides insights not readily apparent with initial review. Grounded theory as an inductive research model aims to uncover patterns from existing data (Steinberg and Steinberg, 2005; Charmaz, 2006). Charmaz (2006) states that "grounded theory methods consist of systematic, yet flexible guidelines for collecting and analyzing qualitative data to construct theories 'grounded' in the data themselves." Figure 4.1 shows a diagram outlining her approach to grounded theory. This figure is a simplified flow chart of the process from defining a research problem through to a draft of results.

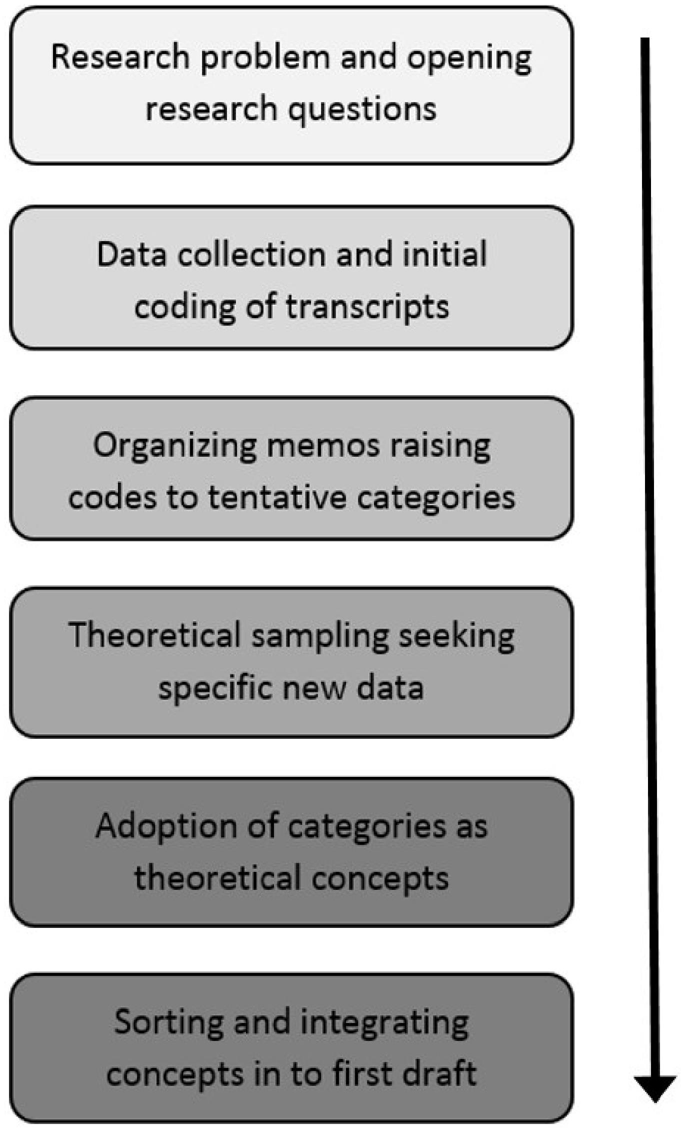


Figure 4.1: Grounded Theory Process - Adapted from Charmaz (2006)

Steinberg and Steinberg (2005) outline a similar process for the use of sociospatial grounded theory utilizing GIS. The approach they outline is essentially a spatially focused outline of the process outlined by Charmaz. They provide steps specific to the inclusion of spatial data. The following steps outline their simplified summary of the SGT process:

1. Determine a topic of interest.
2. Determine a geographic location of interest.
3. Collect the data (qualitative, spatially linked social data).
4. Geocode the data.
5. Ground truth the data.
6. Analyze the data and look for spatial and social patterns.
7. Generate theory (spatial and social). (Steinberg, and Steinberg, 2005)

The work completed for this thesis using SGT methods is an amalgam of the frameworks presented by these authors. In this case the topics were already defined by the survey and the location was predetermined. I generally followed the approach in Figure 4.1 but many of the themes were predefined by the survey questions and the results obtained were heavily influenced by spatial patterns.

The survey itself was developed around basic themes that established a general thematic coding at the outset without any detailed analysis. This simplification helped to avoid a common problem with the coding process in which many researchers focus on only general thematic content and detailed thematic content is never explored (Glaser, 1978). The analysis by coding within each of the general themes ensured that a more detailed approach was undertaken. After completing a first reading of the transcripts to outline the major themes, each was examined in turn to determine further details. These details included the nature of change under each major theme with focus on the timing and scope of the changes discussed.

Use of the MaxQDA software package for qualitative text analysis enabled the classification of recurring topics throughout the transcripts by selectively coding the appropriate text (Figure 4.2). This process is time consuming but makes subsequent analysis much easier. Once all forty-nine transcripts had been coded for general thematic content, the coded sections were recorded in the geodatabase with the appropriate descriptors.

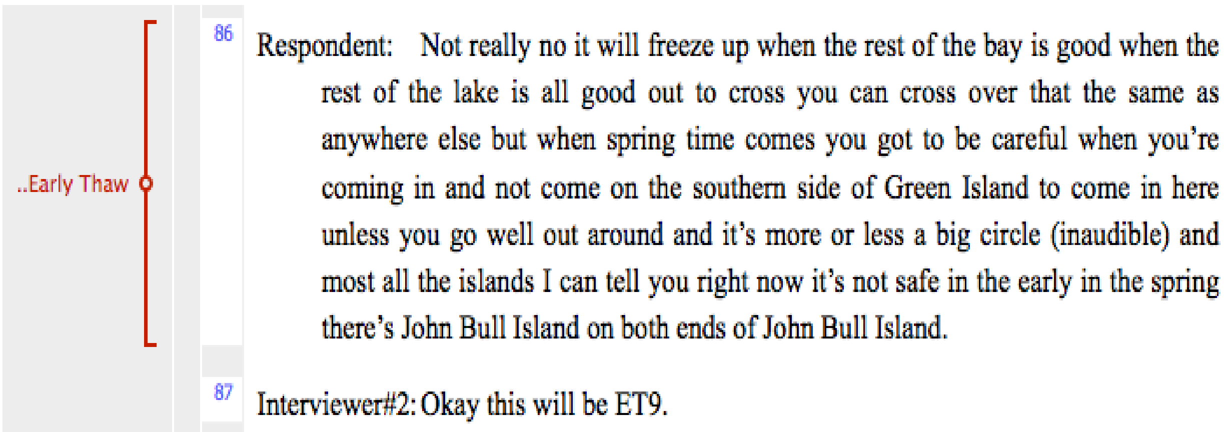
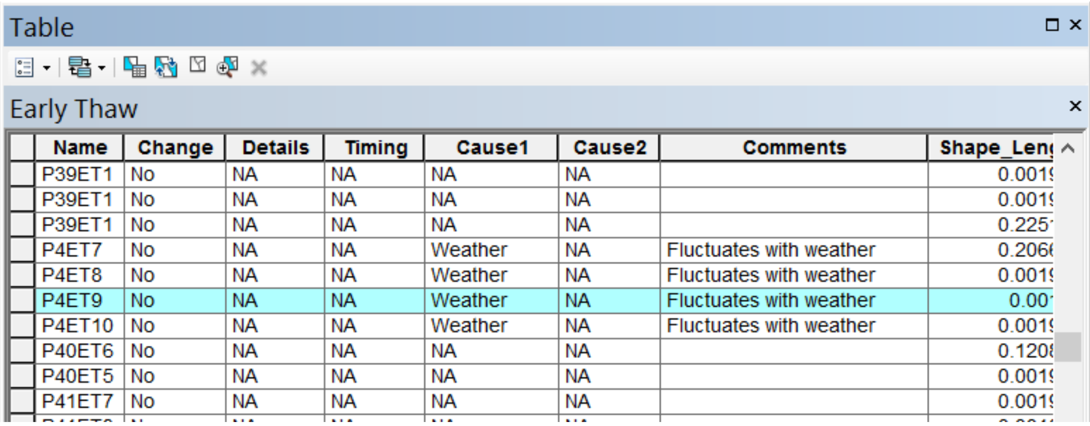


Figure 4.2: Example of coding text using MaxQDA

Subsequent axial coding was used for the text provided in Figure 4.2 and was used to code ET9 (early thaw). This feature identification number was combined with a survey identification number such as P4 (Participant 4) to create a unique identification number for every geographic feature that was recorded during the surveys. In this example participant 4 described an area of ice cover that illustrates early thaw (ET) characteristics. Figure 4.3 shows attribute information linked to the feature in the geodatabase where the ID number is listed as P4ET9.



Table

Early Thaw

Name	Change	Details	Timing	Cause1	Cause2	Comments	Shape_Len
P39ET1	No	NA	NA	NA	NA		0.0019
P39ET1	No	NA	NA	NA	NA		0.0019
P39ET1	No	NA	NA	NA	NA		0.2251
P4ET7	No	NA	NA	Weather	NA	Fluctuates with weather	0.2066
P4ET8	No	NA	NA	Weather	NA	Fluctuates with weather	0.0019
P4ET9	No	NA	NA	Weather	NA	Fluctuates with weather	0.001
P4ET10	No	NA	NA	Weather	NA	Fluctuates with weather	0.0019
P40ET6	No	NA	NA	NA	NA		0.1208
P40ET5	No	NA	NA	NA	NA		0.0019
P41ET7	No	NA	NA	NA	NA		0.0019

Figure 4.3: Example of a portion of a coded attribute table from GIS

Using the unique identification number, a detailed map can be produced that illustrates the feature location in the context of the community of NWR and its surrounds (Figure 4.4).

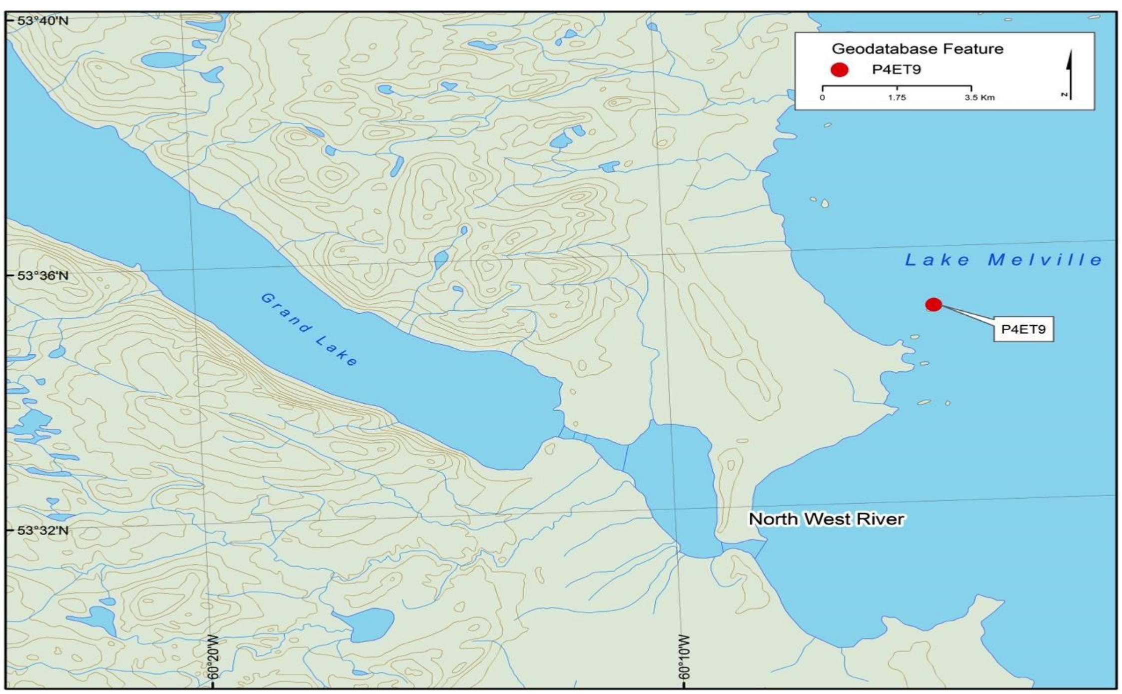


Figure 4.4: Feature ID P4ET9 in relation to the community of North West River, Labrador

The original purpose of the data collection was to investigate the effects of climate change in Lake Melville related to the following broad themes: locations of safe and unsafe ice for travelling, sensitive animal habitats and potable water locations. Relationships among a number of these areas were investigated in order to better understand the nature of change in the study area. Many of the themes are interrelated and exploring these relationships required a method of spatial analysis that would help identify spatial patterns in the geodatabase.

Silverman (1986, p. 2) suggests that density estimates are useful "in the informal investigation of the properties of a given set of data" and "can yield conclusions that may be regarded as self-evidently true." Density surfaces can help to illustrate concentrations of phenomena to aid in the further study of distributions (Tobias, 2009; ESRI, 2014). The ESRI ArcGIS Desktop software used for this analysis was further enabled with the Spatial Analyst extension which provides the user with access to the kernel, line and point density tools. I opted to use the kernel density analysis (KDA) tool to help illustrate the attributes of collected land use features. Worton (1989) suggests that the kernel estimation of a target land use area is often all that is required to interpret the data. The KDA tool requires the dataset to be represented by either points or polylines. This process could have been handled in many different ways, but I chose to utilize the sampling tools within ET Geo Wizards to provide a random sample of points for each polygon in the dataset. This decision was based on the inclusion of a large number of polygon overlaps in the NWR geodatabase, which posed some difficulty in the creation of density surfaces.

Many large polygons were captured through the survey process. This presented a challenge when trying to produce suitable visual representation. Tobias (2009, p. 384) identifies a number of concerns with the use of large polygons related to “accuracy, precision and reliability.” Smaller polygons or points are more conducive to spatial analysis (Tobias, 2009). In order to reduce the complications associated with both the polygon overlaps and the presence of large polygons, each feature was subjected to a conversion process resulting in a representation by randomly sampled points. There are many different ways that such a conversion process can be completed. I elected to use another GIS software tool for the conversion to point datasets. Each polygon data set was put through the “Random Points in Polygons” tool available through the ET Geo Wizards toolset.

ET Geo Wizards provides a set of customized tools developed for users of the ArcGIS platform. The “Random Points in Polygons” tool allows the user to create random points representing a set of polygon features based on a number of user specified parameters (Figure 4.5). The number of points per polygon was determined from the Area attribute of each polygon with a minimum of one point per square kilometre and a maximum of five. This process ensured that particularly large polygons would not be overrepresented in the output. Figure 4.6 shows a set of polygons before sampling. The default settings were used for the remainder of the parameters for the process. The resulting set of point features was then split by the land use attribute. Fourteen separate classes were produced using the “split by attributes” tool in ET Geo Wizards. A sample of the output for this process is provided (Figure 4.7).

The KDA tool provided through ESRI's spatial analyst extension in ArcGIS requires the user to specify information for a number of fields. For the most part the default settings were used. The two exceptions to this were the cell size and search radius. The cell size was reduced to 30 metres to provide a smoother output. The search radius was set to 564 metres so the point count output would correspond to approximately one square kilometre. The final product is a density surface that provides a subjective interpretation of a large and complex dataset (Figure 4.8). The KDA process was then applied again to a subset of the original points to create a similar density surface that included only areas identified by respondents as illustrating some degree of environmental change, as indicated by change attribute (Figure 4.9). Maps for each category were created in this manner and areas showing concentrated change are discussed in detail in the Results chapter.

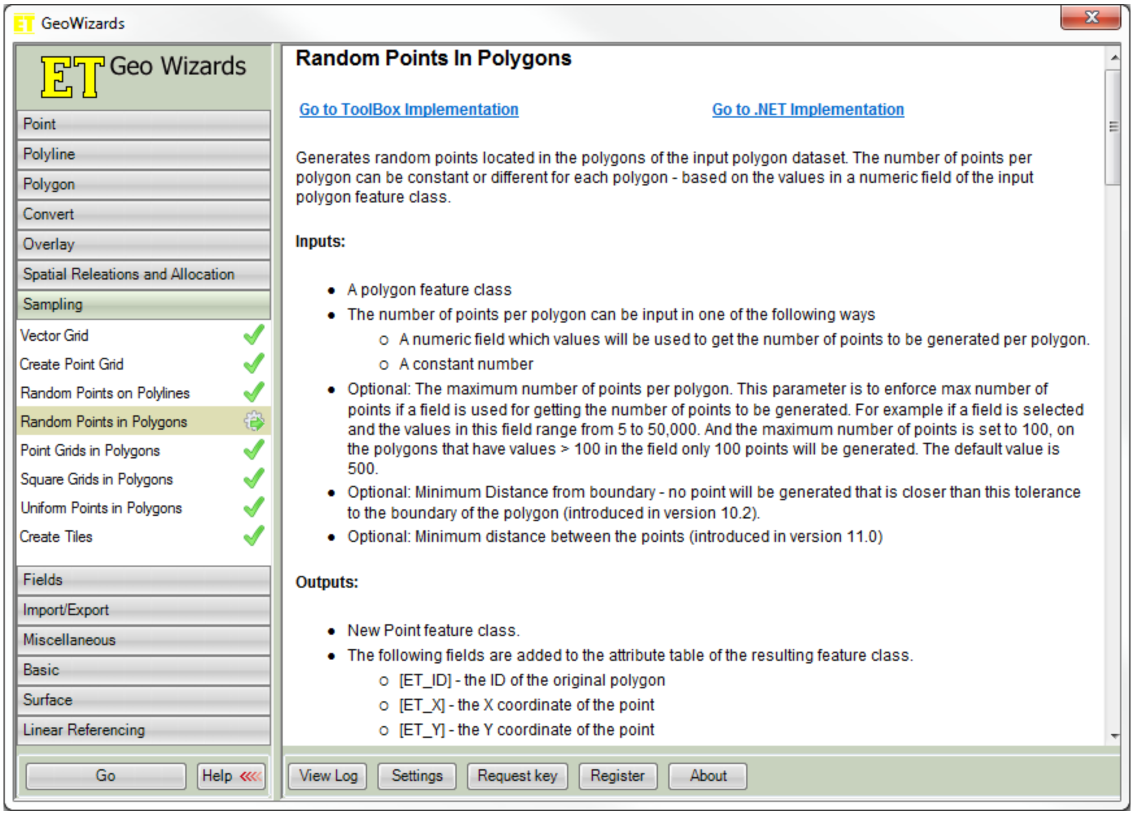


Figure 4.5: ET Geo Wizards start screen

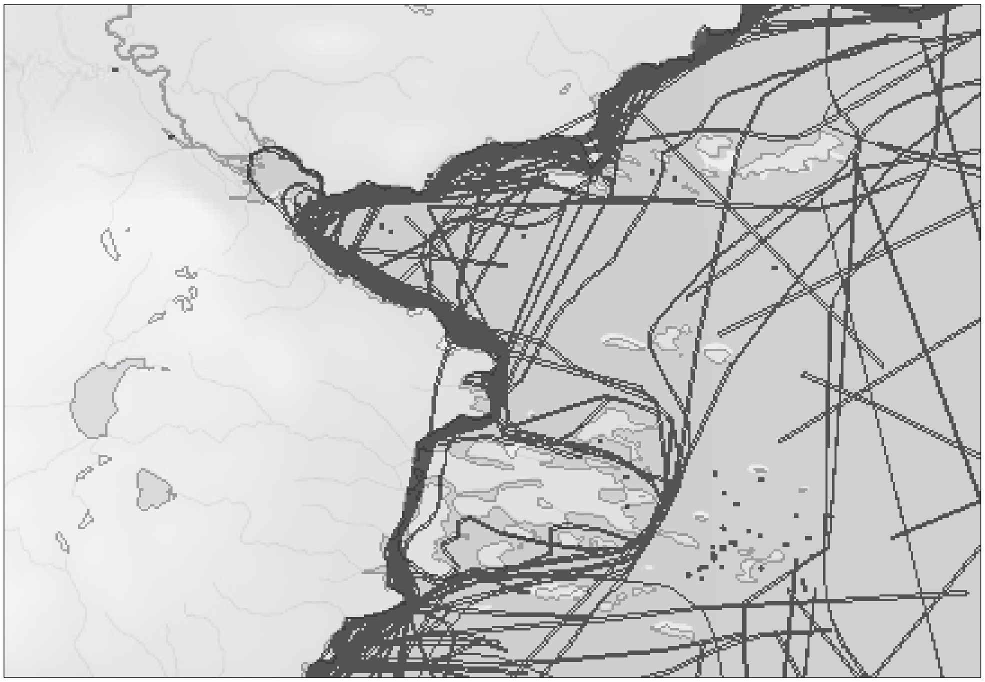


Figure 4.6: Sample selection of polygon dataset

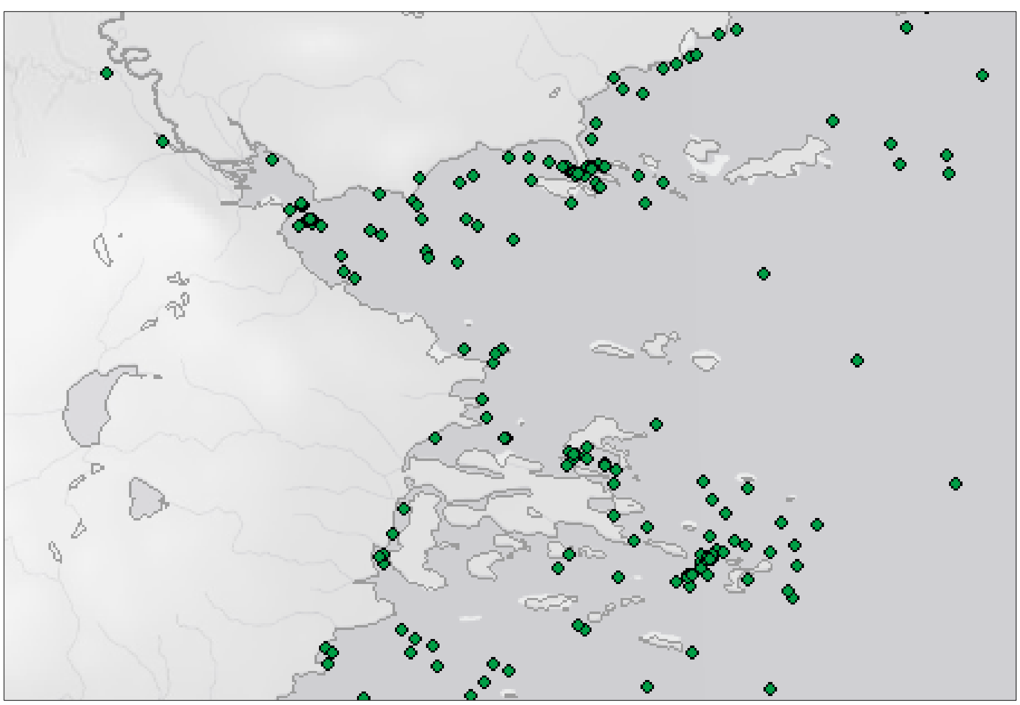


Figure 4.7: Sample selection of random points from polygons

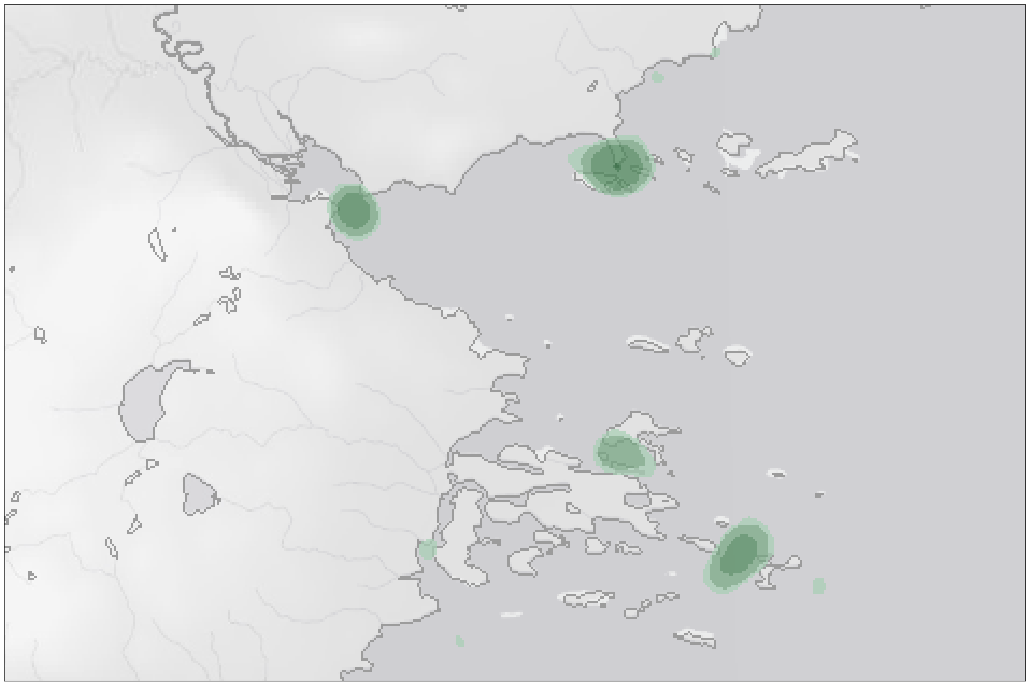


Figure 4.8: Sample set of KDA output

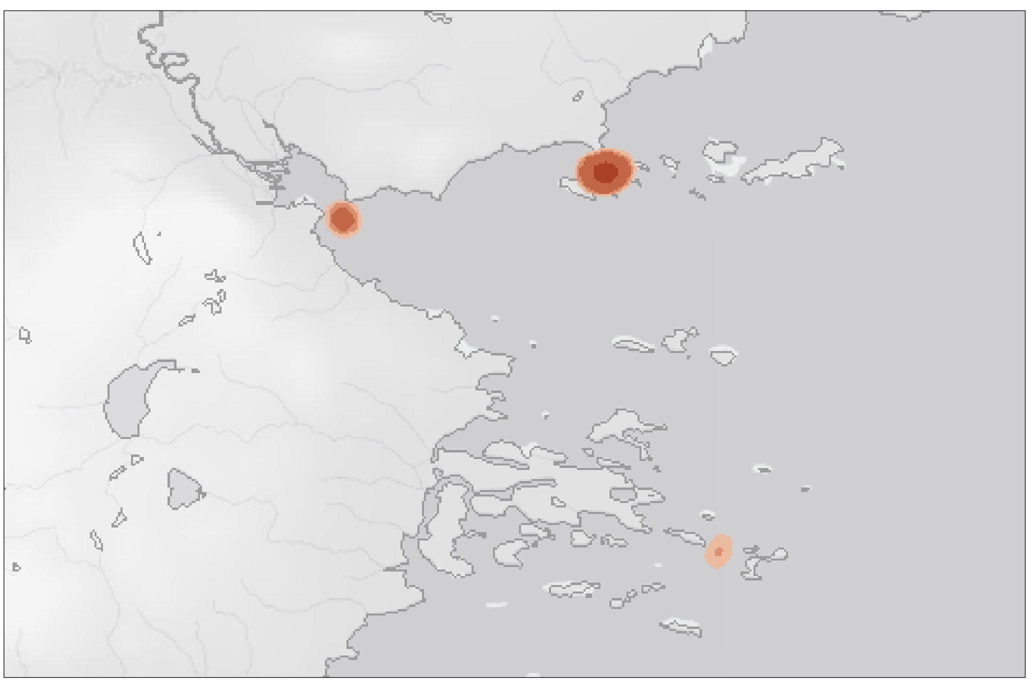


Figure 4.9: Sample set of KDA output denoting environmental change

CHAPTER 5: Results

5.1 Introduction

The data collected during the *Traditional Knowledge: A Blueprint for Change* project lends itself well to qualitative analysis. The forty-nine surveys that were completed provided a suitable platform for the development of transcripts and for detailed mapping. The survey and mapping process provided a simple but effective method for the collection of Inuit land use information. The surveys produced a total of 1814 pages of text when transcribed and the subsequent review of the transcriptions resulted in the production of 947 segments of coded text.

The collected data were based on a survey that investigated aspects of a few broad categories. The categories include ice conditions, sensitive wildlife habitat and potable water sources. The ice conditions and sensitive wildlife habitat categories can be further subdivided. Ice for example includes areas of early thaw, late freeze, never freeze, reliable ice and pressure cracks. The birds category includes migratory birds, nesting birds and other birds. Within the migratory bird section there was a separate category for Scaup (a diving duck) of specific interest locally due to a perceived change in numbers. The original codes for these categories can be found in Appendix B. In the data collection phase, the coding was simplified to reduce confusion and included the land use codes included in Table 5.1.

The geodatabase is comprised of a total of 1839 points, 484 polylines, and 419 polygons. Due to the number of respondents and the repetition of the survey questions there are many overlapping features. These geographic features represent the primary land use areas used by Inuit residents of NWR that were discussed in the surveys. In order to work with one consolidated geodatabase, I buffered the points and polylines provided by the respondents to form polygons. For the buffering process, I used a measure of twenty-five metres to obtain a dataset that was entirely comprised of polygons.

Table 5.1: Geodatabase Codes for Land Use

Land Use	Code
DW	Drinking Water
ET	Early Thaw
LF	Late Freeze
RI	Reliable Ice
NF	Never Freeze
PC	Pressure Cracks
SP	Seals Present
OF	Other Fish
OT	Other Trout
OR	Other Runs
SF	Salmon Fishing
TP	Trout Present
MB	Migratory Birds
NB	Nesting Birds
OB	Other Birds
SL	Scaup Locations

To put this in perspective the width of a pencil line on the 1:250,000-scale topographic maps used in the survey process represents approximately fifty metres on the ground. In total, the geodatabase is comprised of 2695 polygons obtained from forty-nine surveys. The minimum-bounding convex polygon (MBCP) illustrating the Lake Melville TEK geodatabase can be seen in Figure 5.1. Approximately eighty percent of the features within the MBCP fall within fifty kilometres of the community of NWR.

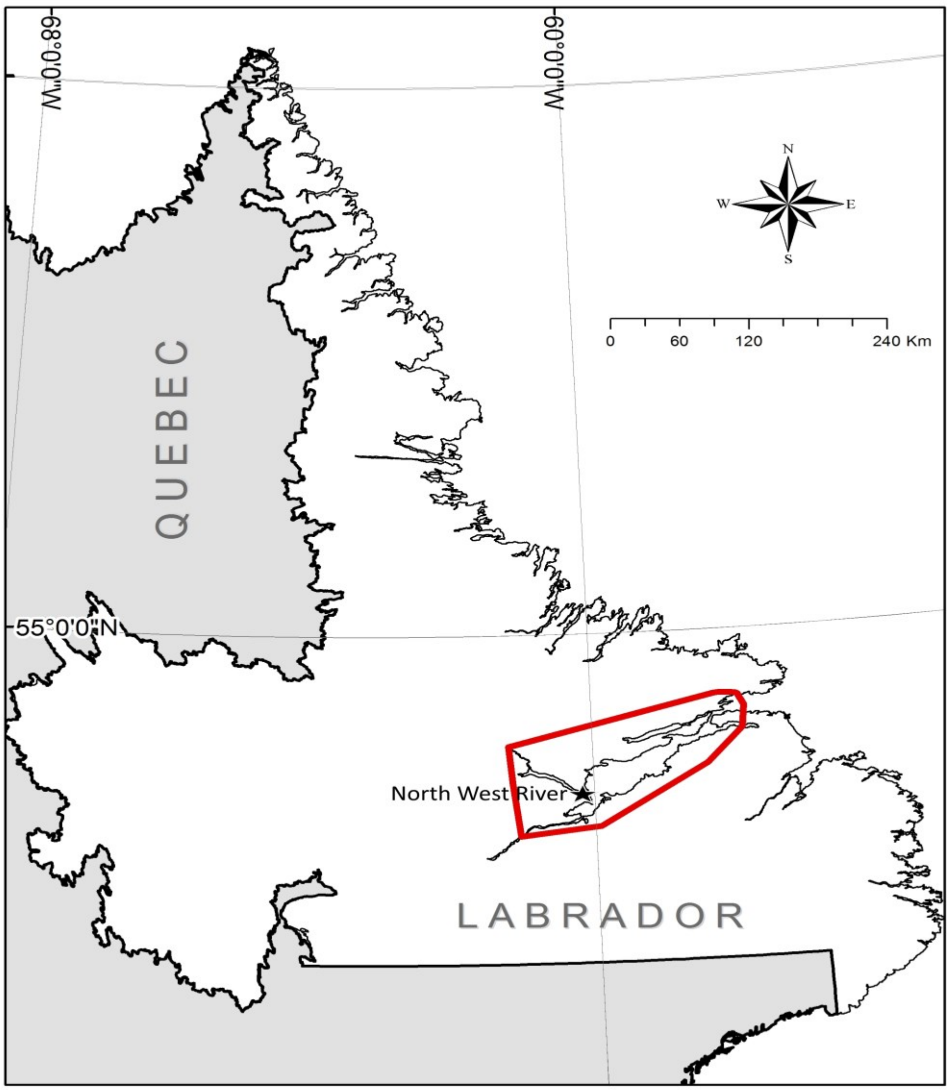


Figure 5.1: Minimum bounding convex polygon of land use area in relation to NWR

5.2 Qualitative Analysis

In an effort to examine the major drivers causing change that affects residents of NWR, the survey responses were carefully examined for themes. As an inductive and iterative process, grounded theory can illuminate many themes. These themes are presented as results but are indistinguishable from aspects of method, due to the iterative nature of the grounded theory process (Steinberg and Steinberg, 2005). In order to examine each of the features in the dataset in a systematic way I applied my understanding of the themes generated during the process to each feature. This process enabled the categorization and coding of features with the following attributes: change, details, timing and cause.

Change

This attribute records the survey respondent's description for each geographic feature with regard to illustrating evidence of change. This attribute was necessary in order to highlight those features for further analysis. The responses obtained for this question included 'Yes', 'No', 'Unsure' or 'Not Applicable'. The response of 'Not Applicable' was included for instances where the question regarding change was not recorded. In some cases, the surveyors did not follow up on questions where responses were not forthcoming. In a few of the surveys the surveyor missed certain questions and there was no response recorded.

Details

This attribute allows for additional information that denotes the way in which the associated geographic feature has changed. Responses for this descriptor were classified as 'Less,' 'More' or 'Timing.' Less or more of a given feature type refers to quantity and was required to illustrate potential differences between geographic areas. The 'Timing' response refers to a change in timing of the occurrence of that feature. The survey did not request further elaboration regarding the nature of the change in timing. There were also instances where no response was provided for this attribute. This occurred when a respondent was unsure or where the question was simply omitted during the survey process.

Timing

This attribute was divided into three simple categories and describes whether the change associated with each geographic feature discussed is a 'contemporary', 'historical' or 'recent' change (approximate). These classifications were estimated and based on the 2010 survey date and were developed based on a review of every survey and a general sense of how participants responded to the questions. Those classified as 'contemporary' changes are defined as having occurred within approximately the last four to thirty years. 'Historical' changes are defined as having occurred within approximately thirty-plus years. Finally, those listed as 'recent' are changes defined as having occurred within the last one to three years.

Cause

This attribute provides a simple descriptor denoting the cause of the environmental change. Through the qualitative analysis process a list of these classifications was collected. This process provided another way to distinguish between features and provided opportunity to add depth to the spatial analysis based on drivers of change. Each recorded cause was compiled and listed in Table 5.2:

Table 5.2: Primary Causes of Change Identified by Respondents

CAUSE	DESCRIPTION
Abandoned	Land use areas abandoned for varied reasons.
Accessibility	Areas exhibiting change identified as being related to levels of accessibility.
Cabin Development	Areas exhibiting change due to an increase in cabin development.
Causeway	Environmental changes identified as being related to the recent installation of the causeway crossing the Churchill River.
Climate	Areas showing change that have been attributed to a changing climate.
Commercial Fishery	Areas that have shown environmental change related to the closure of the commercial fisheries once present in Lake Melville.
Contamination	Contaminated areas related to salt water encroachment or to sewage outflow.
Fire	These areas are primarily discussed in reference to the fire in the Sebaskachu River area in Lake Melville in 1967.
Habitat Loss	Areas commonly discussed in reference to cabin or road development.
Harvest Pressure	These areas commonly refer to increased pressure from people outside of NWR or to changing harvest practices.
Less Harvesting	Primarily refers to changing harvest practices.
More Prey	Areas described as being affected by an increase in animal population due to an increased availability of prey species.
NA	In these cases, the question was not asked or no response was recorded.
Natural Fluctuations	Areas described as related to natural climate or population cycles.
Offshore Ice	In these areas the presence or absence of offshore ice was discussed as a source of change for salmon.
Predation	In these areas more or fewer predators are related to subsequent changes in the animal populations discussed.
Regulations	Areas that display environmental change based on a change in legislation governing the areas under discussion.
Salt Water	Encroachment of salt water in areas where it was not present before.
Technology	Areas affected by the introduction of new technology which has been a factor in environmental change.
Tides	Areas where changes were attributed to the tides.
Unsure	Areas where respondents noted changes but were unsure what the cause may be.
Upper Churchill	Areas where changes were attributed to the development of the Upper Churchill hydroelectric development or an outcome of its effects.
Uranium	Areas where uranium exploration was described as a possible source of contamination in one area.
Water Temperature	Areas where a fluctuation in water temperatures was discussed as a possible source of change.
Weather	Areas where the weather was identified as cause for environmental change.

Detailed examination of the transcripts using grounded theory methods illuminated many other themes that are relevant to the discussion. An in-depth list of the primary themes related to environmental change including causes, types and locations was created through the coding process and is outlined in Table 5.3.

Table 5.3: Identified themes related to environmental change

1. Accidents
2. Agriculture
3. Brooks
4. Cabin Development
5. Climate
6. Commercial Fishery
7. Early Thaw
8. Experience
9. Fire
10. Harvesting
11. Ice Conditions
12. Late Freeze
13. Methods
14. Natural Cycle
15. Nesting
16. Never Freeze
17. Pollution/Contamination
18. Portage
19. Predation
20. Pressure Cracks/Ridges
21. Resource Pressure
22. Salt Water
23. Scaup
24. Seasonal Changes
25. Spring Hunt
26. Technology
27. Tide
28. Travel Hazards
29. Travel Routes
30. Unknown Cause
31. Upper Churchill
32. Water Temperature
33. Wildlife

5.3 ICE

Responses regarding ice conditions necessarily resulted in considerable duplication. For example, areas that are late to freeze are often the same areas that are early to thaw and to some participants the same areas were considered as areas that never freeze. Also, areas that are safer to travel (reliable ice) were sometimes associated with pressure ridges. Due to the often-overlapping nature of these features I combined the features for the density analysis (Figure 5.8) but precede the discussion of this analysis with a detailed description of each category to provide a background for the reader.

5.3.1 Early Thaw

Early thaw areas are typically described as areas of ice that are the first to give out in the spring. A number of factors can cause this tendency to thaw early. Often this can occur in areas where there is significant spring runoff, typically around features such as brooks and streams. In some cases, it might occur in areas where heavy currents work to undercut the ice. Other factors discussed include thinning around shoals:

"In the spring time it eats out the tide around those islands and all around those shoals especially the shoals worse than what the islands are"- Respondent 04, NWR.

Other areas are identified as being under the influence of warming from natural spring waters:

"Well, it's about the first place to open right here. It always opens early. I think there's a lot of spring holes in it – a lot of springs keeping the water warm" – Respondent 39, NWR

In this section of the survey 48 respondents provided a total of 261 features. Of these features 100 (41%) show change, 139 features show no change (59%), 5 (2%) show areas where the respondent was unsure and one response was not elaborated upon.

The areas described as changed are represented by a total of 100 polygons. These indicate change in the form of less ice overall. 30% are polygons for which respondents describe a change in timing, and for all but two polygons these are of areas that have started thawing earlier. One respondent associated the reduced tidal action with the development of the Upper Churchill hydroelectric project. The two polygons that indicate later ice cover suggest that the cause is related to a lessening of tidal action. 87% of polygons were described as having undergone recent changes. 11% are illustrative of contemporary change while two percent were described as examples of historical change. The primary cause for change was attributed to the weather (88%). The drivers of change discussed are listed in Figure 5.2. These drivers include: weather, the Upper Churchill hydroelectric development, and tides.

Recent atypical weather was commonly referenced as a driver of environmental change. Most respondents described the winters of 2009 and 2010 as abnormal years for winter weather in Labrador (Finnis and Bell, 2015). In fact, the winter of 2009-2010 was the lowest maximum ice coverage season on record with Environment Canada. Much of the month of February was 12-15°C warmer than normal for the Labrador coast (Canadian Ice Service, 2010). The 2010-2011 winter in Labrador did little to improve upon the situation with temperatures approximately 5°C warmer than average (Canadian Ice Service, 2011). This abnormal winter weather trend was a common factor in much of the discussion during the survey process:

"Now all of Grand Lake for the last two years has been very late, very late, and I'll say all of Grand Lake…the bottom part here even as far as Cotter's Point is even late, but all the rest of it is very late…you should be able to get out there again in late November, early December, or mid-December. You should be able to putter out around that way, but you can't… not the last couple of years you couldn't." – Respondent 44, NWR.

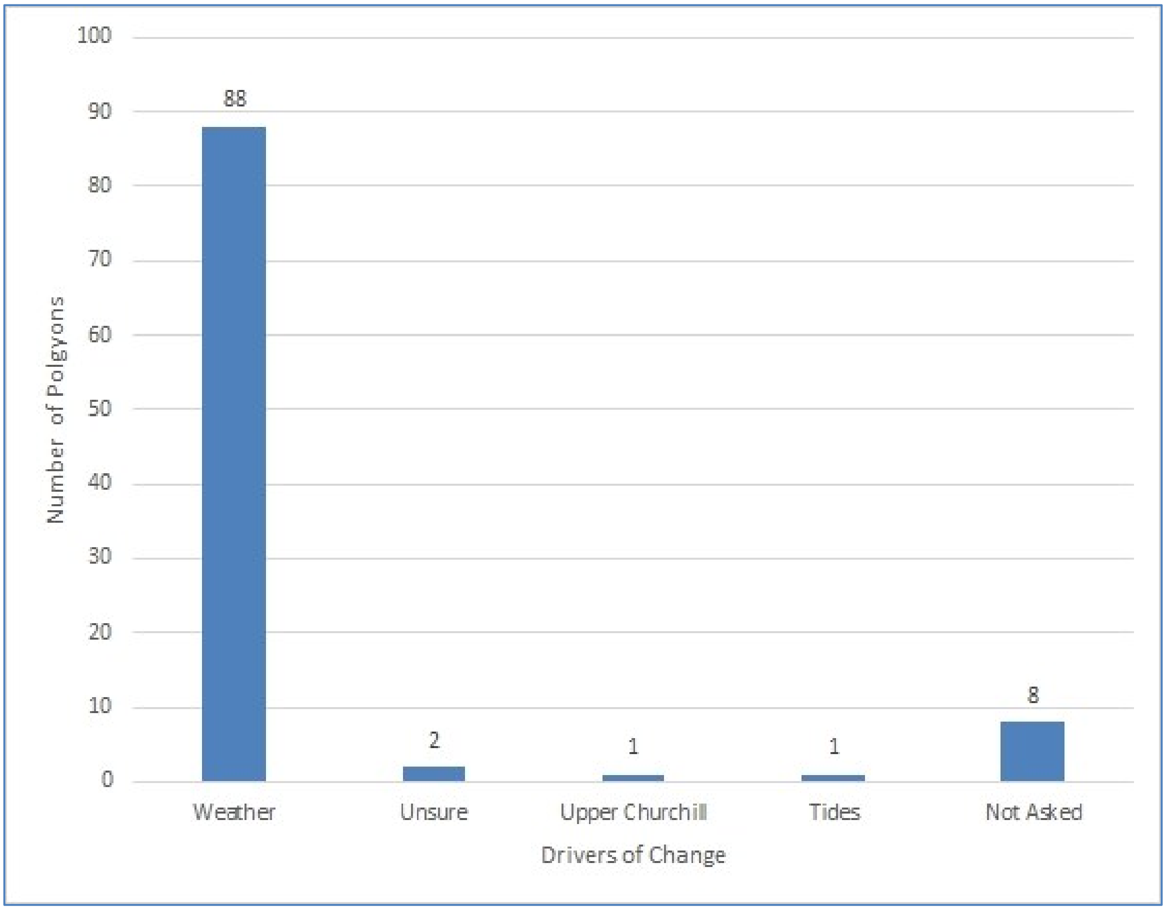


Figure 5.2: Drivers of change (early thaw)

5.3.2 Late Freeze

Late freeze areas are typically described as those areas that remain ice free longer than most other areas but do completely freeze over for prolonged periods during the winter months. 44 respondents provided 173 features when discussing late freeze areas. Of these features, 101 (58%) represent areas respondents described as being affected by environmental change. The areas illustrative of change were provided by 33 (75%) of the 44 respondents. 61 features (35%) represent areas that were described as showing no change, one respondent was unsure and for 10 of the surveys the response to this question was not recorded.

Of the polygons illustrative of environmental change 60% are described as having less ice overall. 31% are described as areas having more ice and nine percent are described as illustrative of a change in timing for the development of ice cover.

The primary cause noted by respondents for the change in environmental conditions was the weather (65%). The drivers of change discussed during the surveys are listed in Figure 5.3. These include weather, climate, and the Upper Churchill hydroelectric development.

The very unusual winters of 2009 and 2010 described earlier were fresh in the minds of respondents when the survey was conducted. A large number of responses attributed the entirety of the observed changes to an unusual weather event.

"Well I hasn't been down there that much the last few years last five years for sure I hasn't travelled that much like last I said the big change last two years." – Respondent 22, NWR.

"Again, over the last two winters – yeah, over the last two winters it's been a bit later, yeah, for sure. Now all of Grand Lake for the last two years has been very late, very late, and I'll say all of Grand Lake. Usually the bottom part here even as far as Cotter's Point is even late, but all the rest of it is very late." – Respondent 44, NWR

Despite a very common tendency to focus on the last couple of years, some respondents stated that environmental change is part of a long-term pattern:

"Well some years it was earlier depends on the year right like I said since I've moved down here I've been seeing some early freeze so everything froze up earlier and then by December well everything was froze up but the last 15 years it's more like Christ January the middle of January before things are freezing up and every year it's getting worse yeah every year is getting worse by." – Respondent 08, NWR

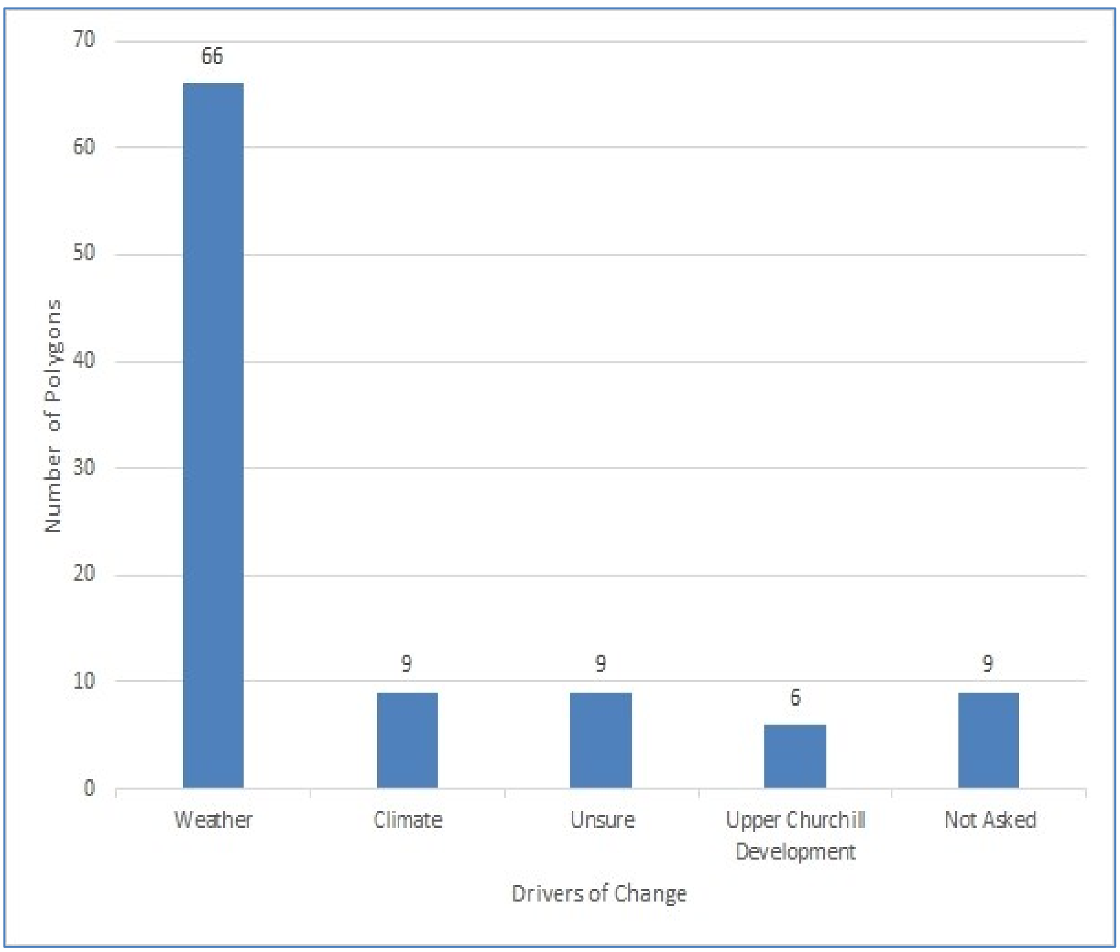


Figure 5.3: Drivers of change (late freeze)

5.3.3 Never Freeze

Never freeze areas typically remain free of ice year-round. However, a number of respondents noted that many of these areas will freeze over for very short periods and once snow-covered they can be very treacherous for travelers who are unfamiliar with the areas they are travelling in. These areas are typically reliable features that remain predictable from year to year.

48 respondents provided 178 features for this section of the survey. Of these, only 13 (7%) indicated change. These features are split almost evenly between areas that show more (five polygons) or less ice (seven polygons). Six of the areas denoting change are listed as recent and one as contemporary, while six are attributed as historical. Six of the polygons show areas described as changed due to the effects of the Upper Churchill hydroelectric development and different individuals identified four of these within a few kilometres of NWR (Figure 5.4). The results were clarified when participants discussed the perceived causes of the described changes. These drivers of change are listed in Figure 5.5 and include the Upper Churchill hydroelectric development, weather, climate and the causeway.

The Upper Churchill Development is listed as the primary driver of change for a significant subset of areas described as having changed. One of the respondents described the area as having undergone significant change due to a dramatic shift in the way the watershed functions:

"Yeah and the North West River right now you see tide flowing in the rivers as fast as it flows out the river… 50 years ago when you never seen it flow in the river. That's not a very long time in history for a big change like that" – Respondent 03, NWR.

Figure 5.4: Example of Upper Churchill hydroelectric development as a driver of change

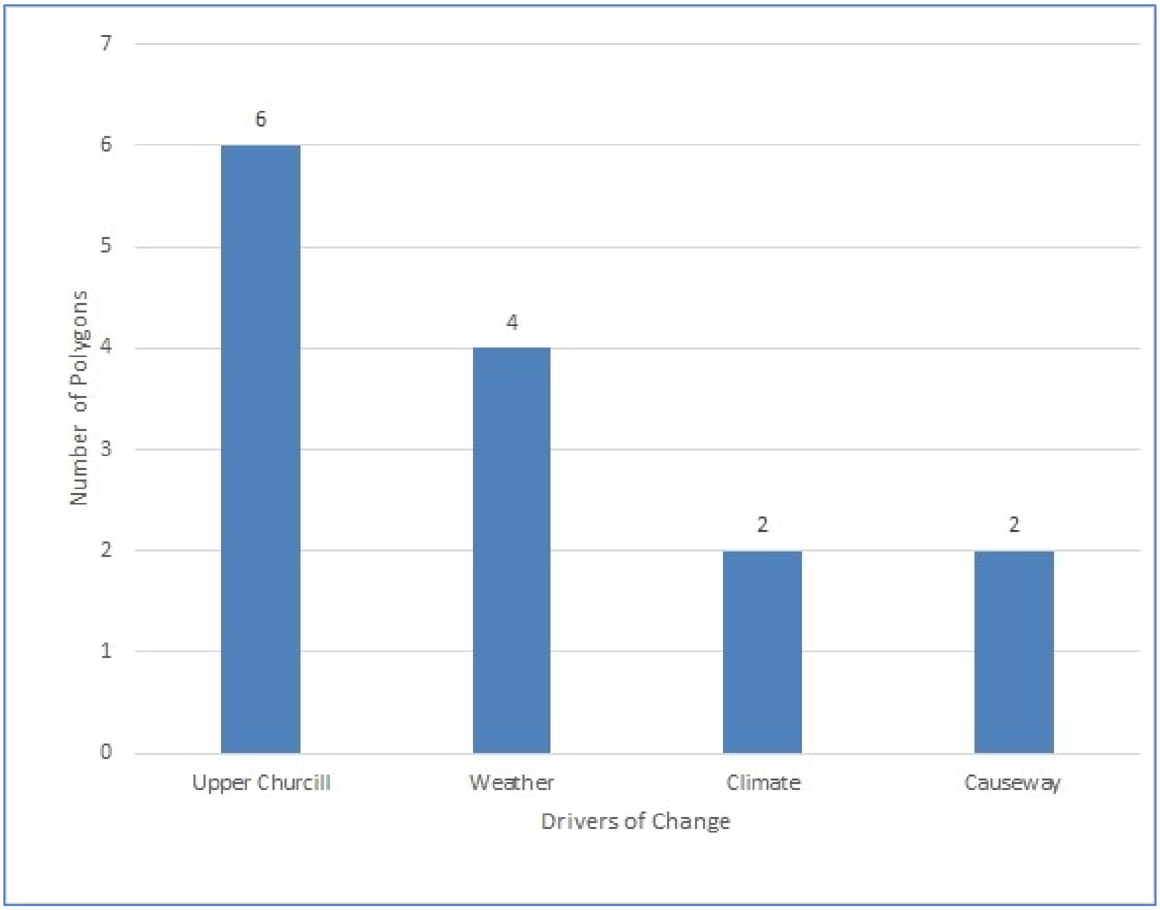


Figure 5.5: Drivers of change (never freeze)

5.3.4 Pressure Cracks

Pressure ridges or pressure cracks are a commonly used landscape feature familiar to the majority of the respondents. 44 (90%) respondents provided 183 features regarding pressure cracks. According to the respondents these features typically occur in the same areas from year to year and are dependent on tidal action and prevailing wind direction in relation to land based features. Most respondents were confident in saying these features have remained consistent over time. Only 11 (25%) respondents identified pressure crack features that had changed. 25 features showed change, 105 features showed no change, respondents were unsure regarding 2 features and for 51 features the question was not asked.

Of the 25 features that denote change eleven of these areas illustrate contemporary change, 12 recent change, and one historical. There was one case where the respondent was not asked to elaborate. The primary causes for change for the features provided were listed as weather (eight respondents), two were described as areas where the respondent was unsure and finally for two of the features the question was not adequately followed up (Figure 5.6).

There were examples of pressure cracks appearing in areas where they had not been seen before:

"Last year there was a bad crack down here to Sabaskachu just above Sabaskachu and ran out to the islands there eh and that was a new one the first one I ever see of that one forming there just above Sabaskachu… But he never formed there this year yet anyway last year that was the first time I ever seen that one there…Yeah that was a bad one it was dangerous yeah dangerous in the nighttime driving and stuff he never ever formed there before you know." – Respondent 35, NWR

"And lately we've seen them down this way. There was one in particular right off this point here. They heaved up last year. Like, no one's ever seen that before. A lot of people haven't seen that before." – Respondent 48, NWR

"There was always big cracks out in the bay it's hard to say where they're going to be too but last year we had some strange ones no one could explain what the hell they were but the ice just I went down one day around the shore I always stay in around the shore hunting everything is fine two days later I went down and there's a point just below Old House Brook and I looked in the ice and it was piled up that high all around the point I said what the hell I must have been blind when I went down the day before yesterday I suppose and I was looking at that and I looked in front of me and Christ it was 20 feet wide open water about 30 foot wide and that went out close to a kilometer (inaudible) and the same thing happen down in the Bight down to North West Islands and no one ever got an explanation of what caused it." – Respondent 06, NWR

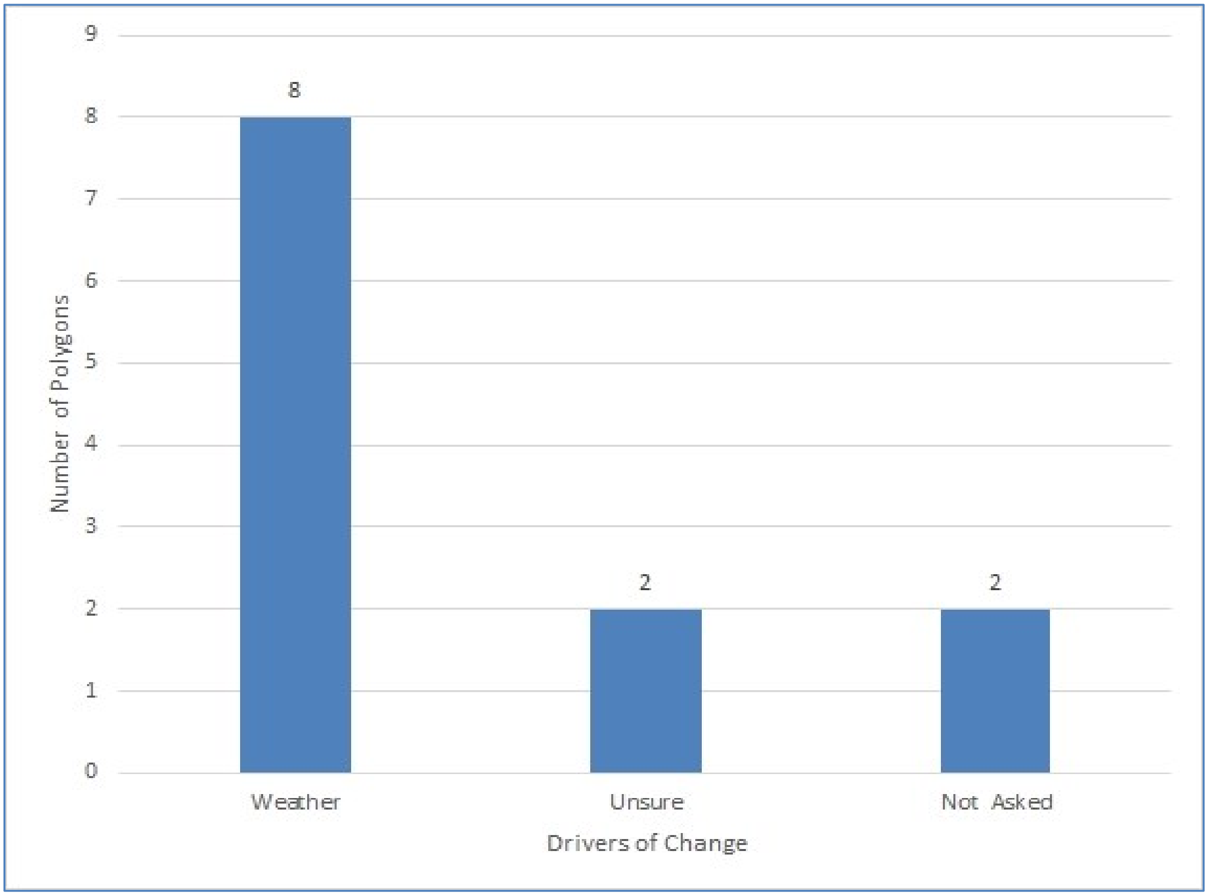


Figure 5.6: Drivers of change (pressure cracks)

5.3.5 Reliable Ice

The survey question regarding the location of reliable ice was brief and open to a variety of answers. Respondents were able to point out a number of areas they travel that are reliably frozen each winter. In fact, each of the 49 participants provided input with regard to areas of reliable ice. A total of 102 separate polygons were provided that represent areas considered as being reliable ice. Seven of the participants (14%) indicated that areas of reliable ice have been subject to change. These areas were illustrated using nine different polygons. 45 polygons were provided indicating there has been no change. 48 polygons were provided with no follow up regarding change.

The areas provided that are indicative of change show only recent or contemporary examples. The nine polygons illustrating change describe the cause as almost exclusively recent weather (Figure 5.7). One individual mentioned the effects of this recent change:

"Honest to goodness but it ah it's been pretty precarious like last year and this year you know"- Respondent 24, NWR

There were five separate individuals who said there has been no change but qualified this with statements about recent weather as affecting travel plans. The instances of change discussed are surprising given the nature of the question. Participants were asked to provide examples of reliable ice areas. For the most part, this precludes discussion of change. The inclusion of some discussion regarding change was somewhat surprising.

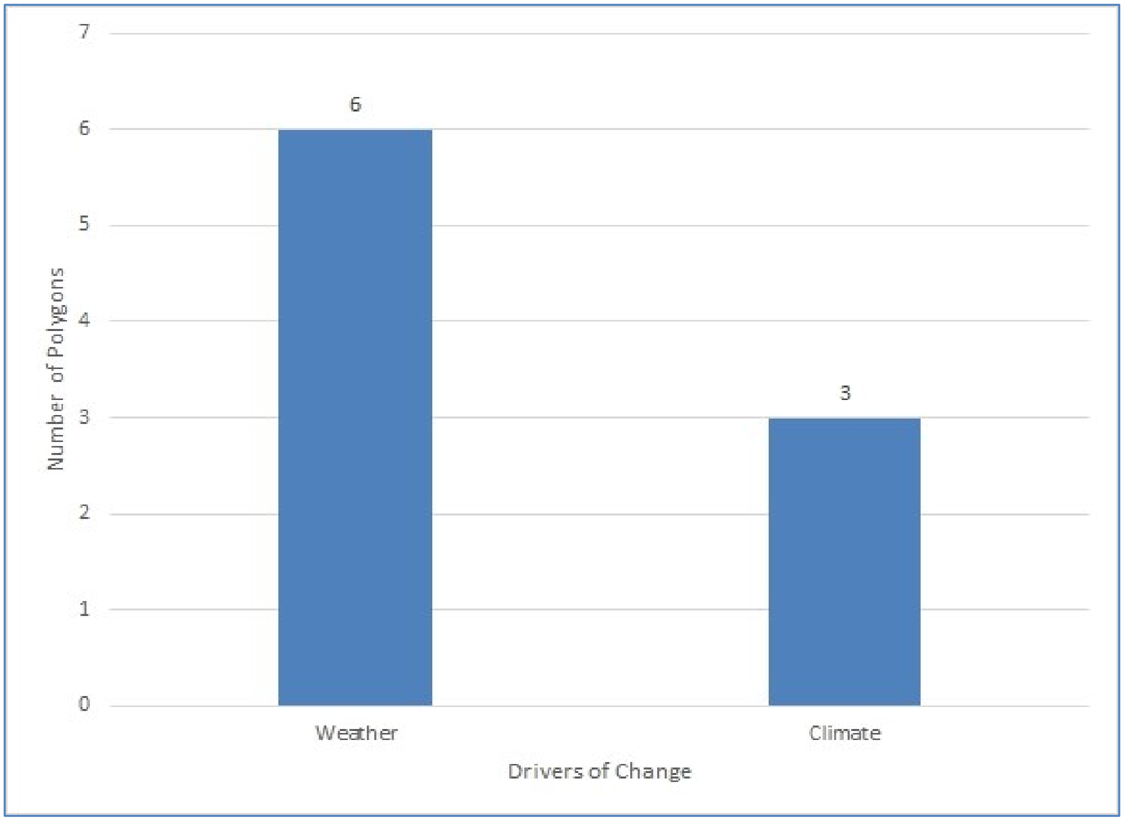


Figure 5.7: Drivers of change (reliable ice)

5.3.6 Kernel Density Analysis of Ice Features

The kernel density analysis of points completed for the ice features (Figure 5.8) highlights four primary geographic locations depicting concentrations of environmental change. These include Northwest Islands (1), Sebaskachu Bay (2), North West River Narrows (3) and McLean Point (4).

The Northwest Islands were identified by respondents as showing change in both early thaw and late freeze features. The changes described are linked to less ice or to a change in the timing of ice production or thaw. These changes were primarily identified as a result of unusual weather patterns combined with the strong tidal current in the area.

The significant tidal current promotes earlier thawing and later freezing during the winter months. A number of respondents identified the typical safe ice conditions to be from late December until mid-to-late April. Warmer weather events such as those of 2010 contribute to safety concerns and force users to adapt to unpredictable conditions. When discussing changes in travel routes as a result of ice conditions, respondents said the area was still accessible but that it was accessible for less time and included a smaller area. This points to an increased level of risk for users.

"the last 15 years it's more like Christ January, the middle of January before things are freezing up and every year it's getting worse, yeah, every year is getting worse." – Respondent 08, NWR

Sebaskachu Bay includes the early thaw areas associated with the outflow of the Sebaskachu River. As with the North-West Islands respondents mentioned later freezing and earlier thawing due to a combination of shoals and the influence of the river. There was some speculation that the later freezing and earlier thawing conditions in this area may be exacerbated by the unusually warm weather conditions:

"there's a shoal like you go when you're going into this through channel here the shoals come out (inaudible) and there's a big shoal comes out of ... say 100 yards." – Respondent 17, NWR

"And whether or not we're getting more water running through there because of early mild earlier in the spring it could be but it's definitely wearing out quicker in the spring in those areas." – Respondent 03, NWR

"well last same thing the last two years have been well the year before wasn't too bad but I mean it's still early you can see it's a lot early than what it was." – Respondent 09, NWR.

The North West River Narrows are roughly 130 metres across and separate the communities of NWR and Sheshatshiu. The narrows are the last barrier crossed by the waters of Grand Lake before they meet Lake Melville. The current generated from the narrowing of the waterway in this location is significant and prevents or delays freezing. Some participants identified the area as never freezing while others classified it as both an area of late freeze and early thaw. The conditions in this area due to the changes associated with the installation of the bridge infrastructure in the early 1980s add complexity. Some respondents associate the bridge placement with subsequent formation of shoals in the area, which have made ice conditions less predictable.

"Sometimes you get a lot of in-tide and it tends to eat it out different places, eh, and that little shoal has developed there as well. When I was a young fellow, there was never a shoal there, ever."- Respondent 43, NWR

There have also been impacts on the area associated with the development of the Churchill Falls Hydroelectric project:

"Not a climate change it's changed drastically when they damned off the Naskapi you know when the built the Upper Churchill they damned off the Naskapi River I mean prior to that it would hardly ever freeze over the river but since that it has frozen over and stayed frozen over for a few months at a time on occasion." – Respondent 34, NWR

The bulk of the references to environmental change in this area were associated with the unseasonal weather patterns:

"well within the last couple of years like the same thing I mean it's getting worse and worse every year." – Respondent 09, NWR

"No well this year is awful strange then like there's too much tide there and then we didn't have the weather for it to freeze see yup it's unbelievable. – Respondent 38, NWR

Discussion regarding the McLean Point area was limited to the effects of the Kenamu River. The strong current creates an area of open water that several respondents mentioned. This was identified as an area that freezes late, thaws early or does not freeze at all depending on the weather. The area at times can be crossed by snowmobile but most people traveling on the south side of Lake Melville give the area a wide berth.

"I know it's a bad place, right? You just don't want to be crossing there all the time." – Respondent 43, NWR

As previously mentioned the marginal conditions in this area were also influenced negatively by the unusual weather conditions in 2009-2010. One respondent also mentioned the influence of brackish water as adding to the unpredictability of conditions in the area. This phenomenon refers to the influence of salt water, which is not abnormal. However, the current extent of brackish water is in question.

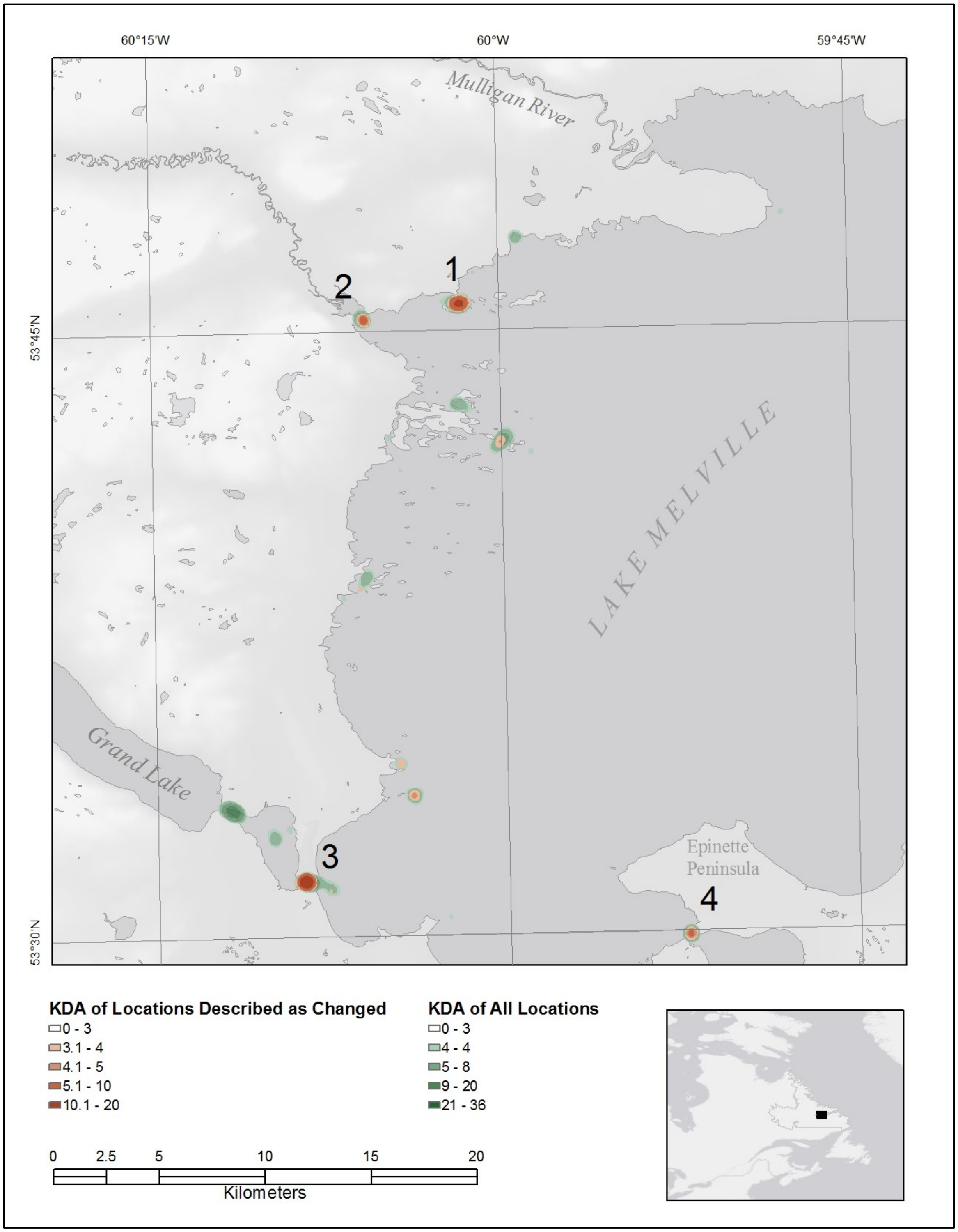


Figure 5.8: Kernel density analysis (points/km^2) of ice areas

Note: Describes the following locations: (1) Northwest Islands (2) Sebaskachu Bay (3) North West River Narrows and (4) McLean Point.

5.4 SEALS

5.4.1 Seals

The section of the survey regarding seals dealt primarily with their location and the participant's knowledge of birthing areas and the best locations for hunting. In many cases these areas overlap. The dominant species discussed in this survey are the Ringed Seal *(Pusa hispida),* commonly referred to as "Jars" and the Harp Seal *(Pagophilus groenlandicus)*, and commonly referred to as "Harps."

The 48 respondents to this question provided 154 features regarding seals and seal habitat. Features described as changed were identified by 33 respondents (69%). 115 of the features show change and 29 features show no change. In eight features the respondent was unsure and for 28 features the question was not asked.

Of the polygons described as having changed, 80% were described as contemporary changes. 18% were described as having changed recently, and two percent of the polygons provided were illustrative of areas of historical change.

When describing these areas in view of the nature of the change, 50% were indicated by the respondents to show a decrease in seals. 49% were indicated by respondents as showing and increase in seals, and one percent of the areas show neither an increase or decrease but rather a change in the timing for arrival or departure of seals. Many of these areas overlap, so there is some ambiguity regarding the results. A number of drivers were given for the perceived changes (Figure 5.9). These drivers include more harvest pressure, weather, the commercial fishery, less harvest pressure, technology and more prey. Most commonly, respondents were unsure regarding the cause of the change.

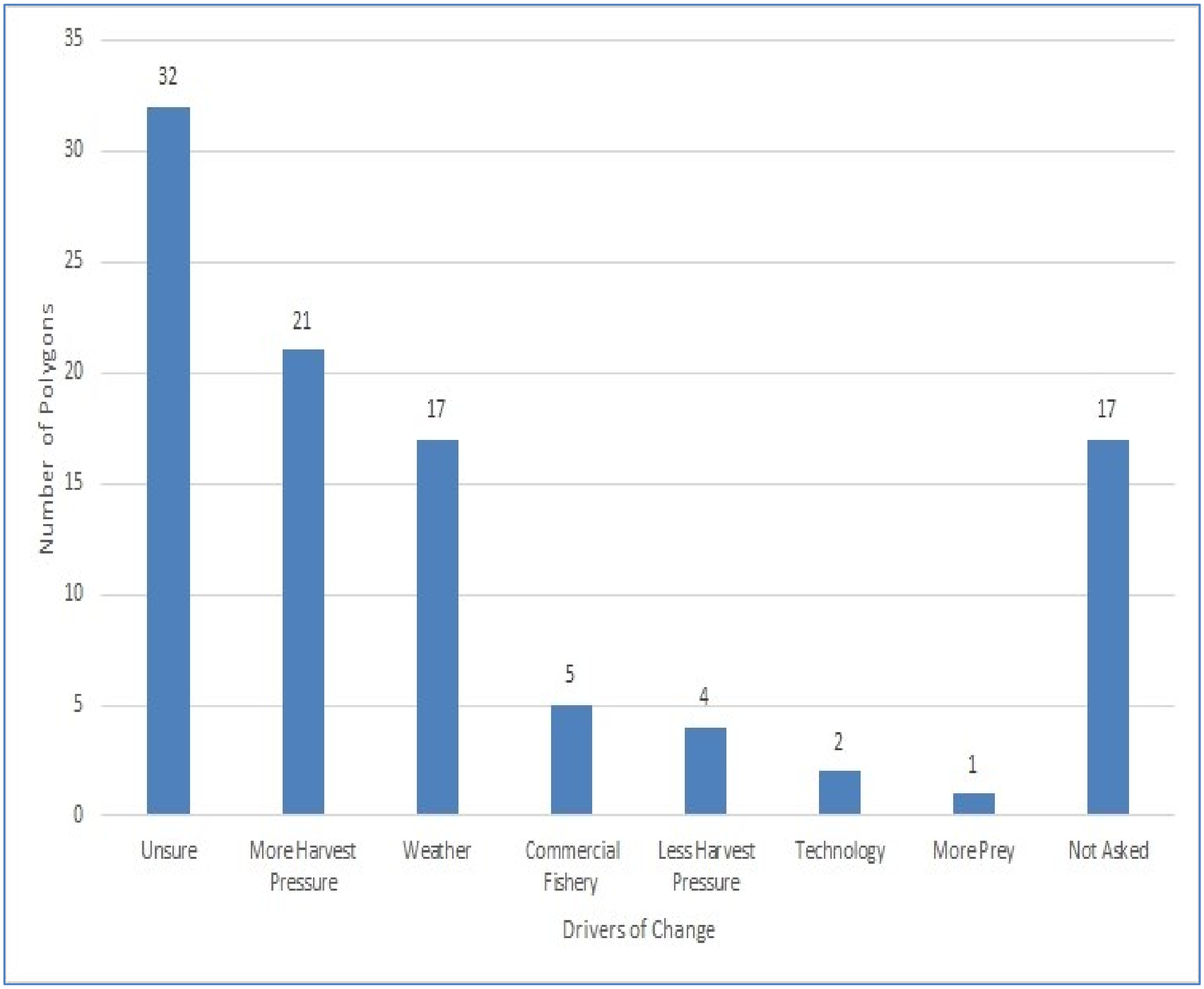


Figure 5.9: Drivers of change (seals)

5.4.2 Kernel Density Analysis of Seal Features

The kernel density analysis of points completed for the seal areas (Figure 5.10) highlights three primary geographic locations depicting concentrations of environmental change. These include the Nebavik and Mulligan shoals southeast of Mulligan Bay (1), southeast of North West Islands (2), and the Montagnais Shoal (3).

The Nebavik and Mulligan shoals comprise a relatively large area that was difficult for respondents to precisely identify. A significant number of large polygons resulted from the mapping of this area. Figure (5.10) illustrates this dispersion of points over a relatively large area. Respondents' descriptions of the area vary in detail:

"All from this area up in Mulligan Point oh my that would be a big circle if I got to make a circle where I thinks that's when you first that's like when we first leaves North West going for our first hunt in the year kind of a thing down around here close and if you're going for a proper good hunt I would say anywhere from Mulligan Point right along down Upper Long Point right on down to oh Highlands". - Respondent 15, NWR.

"it's really too hard anyway to pinpoint because there's so many places for seals"- Respondent 29, NWR.

Respondents described the shallow depth and abundance of natural prey as a common feature of shoals. Shoals also provide rough ice areas when combined with natural tides, wind and wave action. These areas of rough ice provide good habitat for seal populations:

"it's rough ice and that's why it is, it's a couple shoals and stuff like that and makes real good rough ice." – Respondent 13, NWR

"Yup, yeah a lot of houses now that's another place where there's usually a good place for rough ice and that's where they makes their dens in the rough ice eh." – Respondent 17, NWR

"I think it must have something to do with the depth and the same thing as the late freeze and the year and must be something to do with the feed I guess.. – Respondent 15, NWR

Discussion of changes to seal populations was common but ideas around the nature of these changes varied. Those respondents who identified a decrease in the population mentioned the inclement weather of the last two winters.

"It could be early it could be late it depends on the year eh you know you see sometimes you see them under the lack of snow you might see a lot of young ones dead... no cover can't survive."- Respondent 28, NWR

"I think there's less ah well I think there's certainly more in the fall but I don't think they've been having so many young in the winter around here so it's hard to tell what's going on really." – Respondent 25, NWR

The same inclement weather was given as the cause of an increase in the population. Respondents suggested that the lack of access to the resource due to poor ice conditions meant that fewer seals were being hunted:

"No. Like I said, the last two years… or last year nobody got out seal hunting. Nobody got out on the bay because everything just gave out, so I can't say that I've noticed anything; but where there was so little snow last year and the pups need the snow to live in, that had to be hard on the pups last year. It had to be." – Respondent 44, NWR

Discussion regarding the area south-east of the North-West Islands included similar comments regarding the qualities of shoals as habitat for seal populations. There was also discussion of the seals making use of pressure cracks that are common in that location. Respondents suggested that food sources for seals such as salmon, trout and rock cod are all accessible in these areas along with capelin and smelt:

"They eats small tom cods and flat fish I guess and trout, smelt, salmon I've seen them eat salmon in the summer." – Respondent 30, NWR

The seal population here was primarily described as decreasing with harvest pressure an obvious concern:

"I think too many people hunting and killing them too young - you know, killing the ones they don't need to kill". – Respondent 42, NWR

"Well it seems like to be first when I started hunting around and that with father and them there was a lot of seals and now you don't see so many I don't know if it's just a lot of hunters and they're getting killed up faster or they're not ah having young ones like they used to or something I don't know you know but...But I think's there might what I'm thinking is there cycle is up and they're starting to slowly die off you know that's my theory anyway." – Respondent 30, NWR

Much of the discussion for the Montagnais shoal is similar to that of the other two shoals. The habitat is suited to the seal population. There was some ambiguity regarding the change in populations. Some feel the population is increasing. This is due to the end of the once common practice of netting seals for feed for dog teams and for selling pelts to the Hudson's Bay Company. Others describe the population as decreasing:

"I can remember home sitting home in the spring on a fine evening and you could hear them you couldn't see them but you could hear them they're be that many rushing in the water….. but after Goose Bay came here they started to not come in not so many" – Respondent 04, NWR.

"there used to be big schools of them …they used to come in and they used to form circles all heads stuck up all together all around you know and they're certainly not coming in like that..." – Respondent 35, NWR.

Many of the comments regarding seals were not specific to location but were more generally related to seal populations. Many factors affecting the population came up in the survey responses but the discussion around the decrease in local harvesting was quite common:

"*The ban on the harvesting of seals of course affected everybody you know like we used to sell our seal skins to the Hudson's Bay Company right but then when that was given up then not so many people were interested in seal hunting for a living."* – Respondent 31, NWR

"I don't think there's any more um but they're still well it depends on the time of year eh it seems like there's a lot more sometimes like you see a lot more in the fall or different kinds you know but when you're hunting in the spring well I never hunted last spring either see but it seemed like the numbers were just as good as years gone by if not better." – Respondent 28, NWR

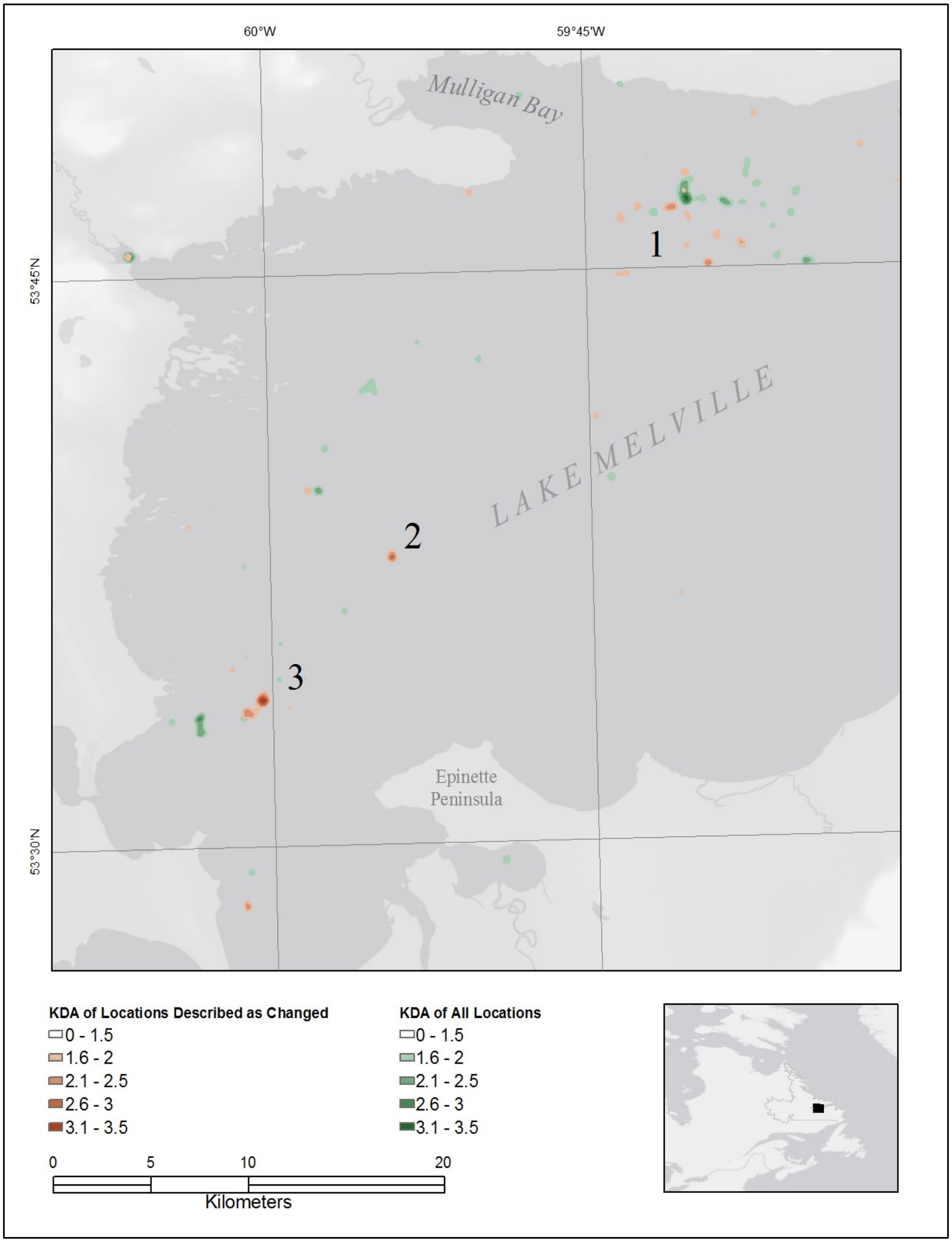


Figure 5.10: Kernel density analysis (points/km^2) of seal areas
Note: Describes the following locations: (1) The Nebavik and Mulligan shoals southeast of Mulligan Bay (2) southeast of North-West Islands and (3) the Montagnais shoal.

5.5 BIRDS

5.5.1 Migratory Birds

Respondents to the migratory birds question included a number of species in their discussion. The primary species discussed included Black Ducks (*Anas rubripes)* and Canada Geese (*Branta canadensis).* Less commonly Common Eiders (*Somateria mollissima*) were discussed and the discussion of Scaup (*Aythya marila)* often overlapped with these responses as well, despite there being a specific question related to the subject.

49 respondents provided 267 geographic features regarding migratory birds. Of these features 104 areas are described as having displayed no evidence of change, while 32 respondents (65%) provided 137 areas that are representative of locations where change has been observed. There were twenty-six instances where the question regarding change was not asked.

Of the 137 polygons representing areas with identified change 53 were indicated to have fewer migratory birds and 80 are illustrative of changes with regard to the timing of arrival or departure of migratory birds. Only two areas were described as showing an increase of migratory birds. In two instances, there was no recorded response. The primary drivers of change discussed during the survey (Figure 5.11) include climate, weather, harvest pressure, natural fluctuations, cabin development, the Upper Churchill hydroelectric development and habitat loss.

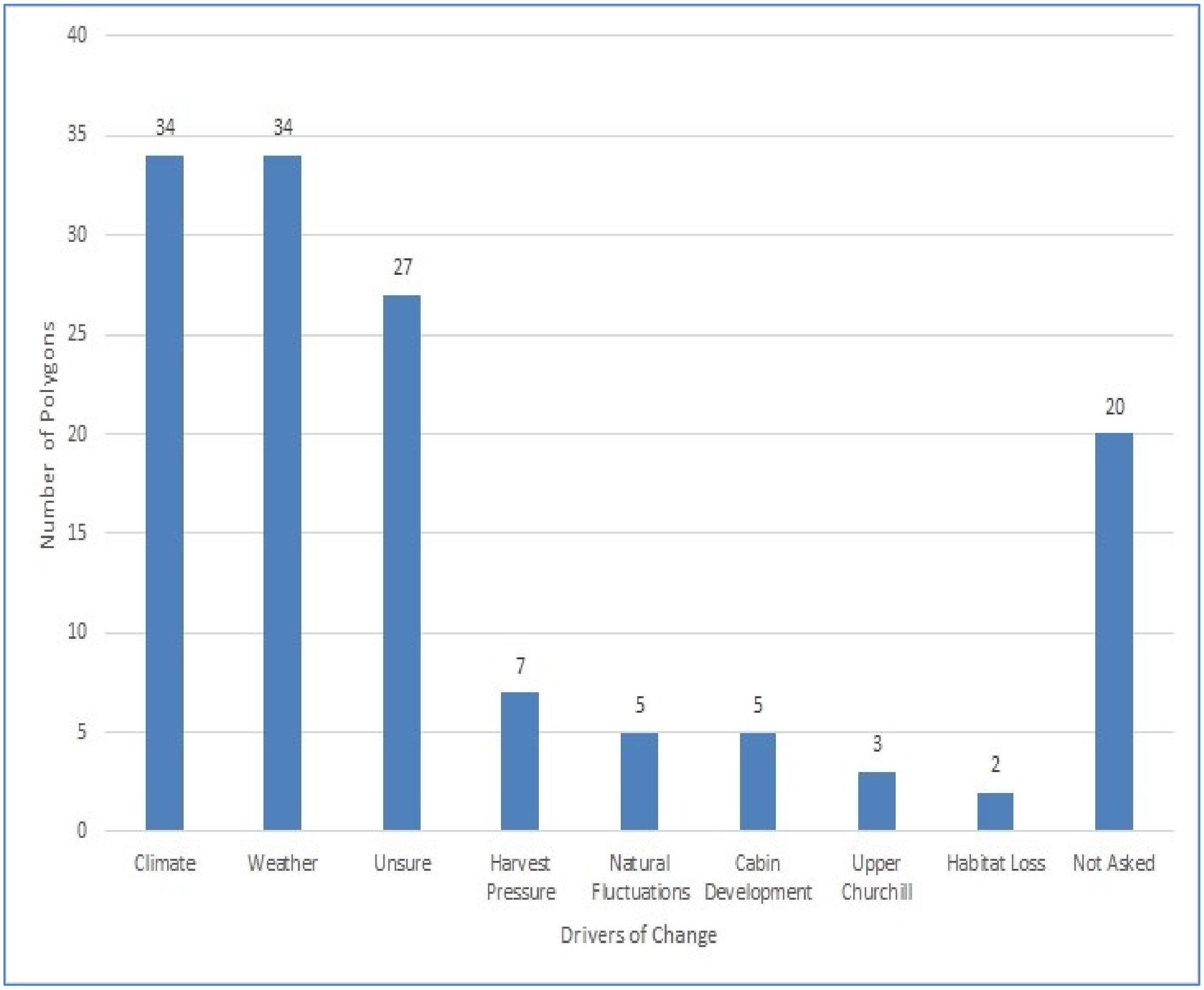


Figure 5.11: Drivers of change (migratory birds)

5.5.2 Kernel Density Analysis of Migratory Birds Features

The kernel density analysis of points completed for the migratory bird locations (Figure 5.12) highlights three primary geographic locations depicting concentrations of environmental change. These include the North-West Islands (1), Sebaskachu and surrounding area (2), and Little Lake near the community of NWR (3).

Many respondents described the availability of prime migratory bird habitat in the North-West Islands. The abundance of forage and cover from predators ensures that migratory birds can be found here through the early spring and into the late fall. The area is used as a breeding area as well as by birds transitioning to other locations:

"They breed there there's a fair number of them breed now the geese don't breed there usually the second-year geese hang out there they're not breeders eh they don't breed but ducks they're all breeders pretty well except the scaups seem to go somewhere else to breed. Shell birds and black ducks and pintails and teals they all breed in this area they often I used to be sitting up in the cabin you see ducks swimming around everywhere."- Respondent, NWR

When discussing the nature of change in the migratory bird population for the North-West Islands specifically there was some agreement that the population had decreased due to the encroachment of cabin sites on suitable habitat:

"there's so many cabins coming down there now it's changed the course of where the birds hang out."- Respondent 03, NWR

The locations identified near Sebaskachu were similarly described as excellent migratory bird habitat due to forage and protection. Much the same as the North-West Islands, these locations also provide early spring access to open water. Respondents noted the advantage of being less affected by anthropogenic disturbance:

"I think it's because it's enclosed and it's hid away good in there it's out of the way of boat traffic and everything in there and it's kind of in out of the wind and it's good feed shallow water." – Respondent 15, NWR

Despite the difficulties in gaining boat access in proximity to those locations near Sebaskachu there were a number of comments regarding the increased harvest pressure as having a negative effect on the population.

"And it used to be real good until all the cabins got in here there's too many people there now." – Respondent 28, NWR

"the geese are here and gone a lot earlier like I mean even before the season opens it seems like they're gathering up and getting ready to move right and within the first weekend once everything is shot at" – Respondent 09, NWR

Little Lake was described by one respondent as "a big huge hole of water" available to migrating birds when there is nowhere else available in the early spring:

"Just the open water I would say, so they're very early migrants and they have very few places to land, so if they face open water they'll plunk down." – Respondent 40, NWR

There is some concern in the community that the early spring thaws are enabling birds to bypass their typical spring locations. As other sites become available the birds will move on.

"*Yes well like last year they were a little less because of all like everything is opening up all the ponds everything else is opening up and they can land anywhere so it's not quite as many but there was some every year."* – Respondent 22, NWR

In all three locations many respondents described migratory bird populations to be declining, while others mentioned changes related more to timing. The change of timing often applied to both the arrival and the departure of migratory birds for the season. The reasons for these changes varied with many respondents attributing the changes to inclement weather:

"I guess something that got to do with the weather change the weather patterns whatever I'm not sure but I know in the last 4 or 5 years we've been doing down there the geese have been coming a lot earlier… In the last 4 or 5 years they've been coming different…from my take on it it's a lot to do with the weather, temperatures and that eh warming up."- Respondent 05, NWR

"it don't seem like there's much around anymore unless they're using different spots but you know what I mean that's what it seems like to me and then the spring I mean there wasn't any ice around last year when we were able to by the time the birds started moving so it seemed like there was less but I think they just were able to use a lot more different spots right even the marshes and that were open up inside" – Respondent 09, NWR

There is a difference of opinion on whether or not the changes are merely temporary and part of a larger cycle or of a more permanent nature related to a changing climate.

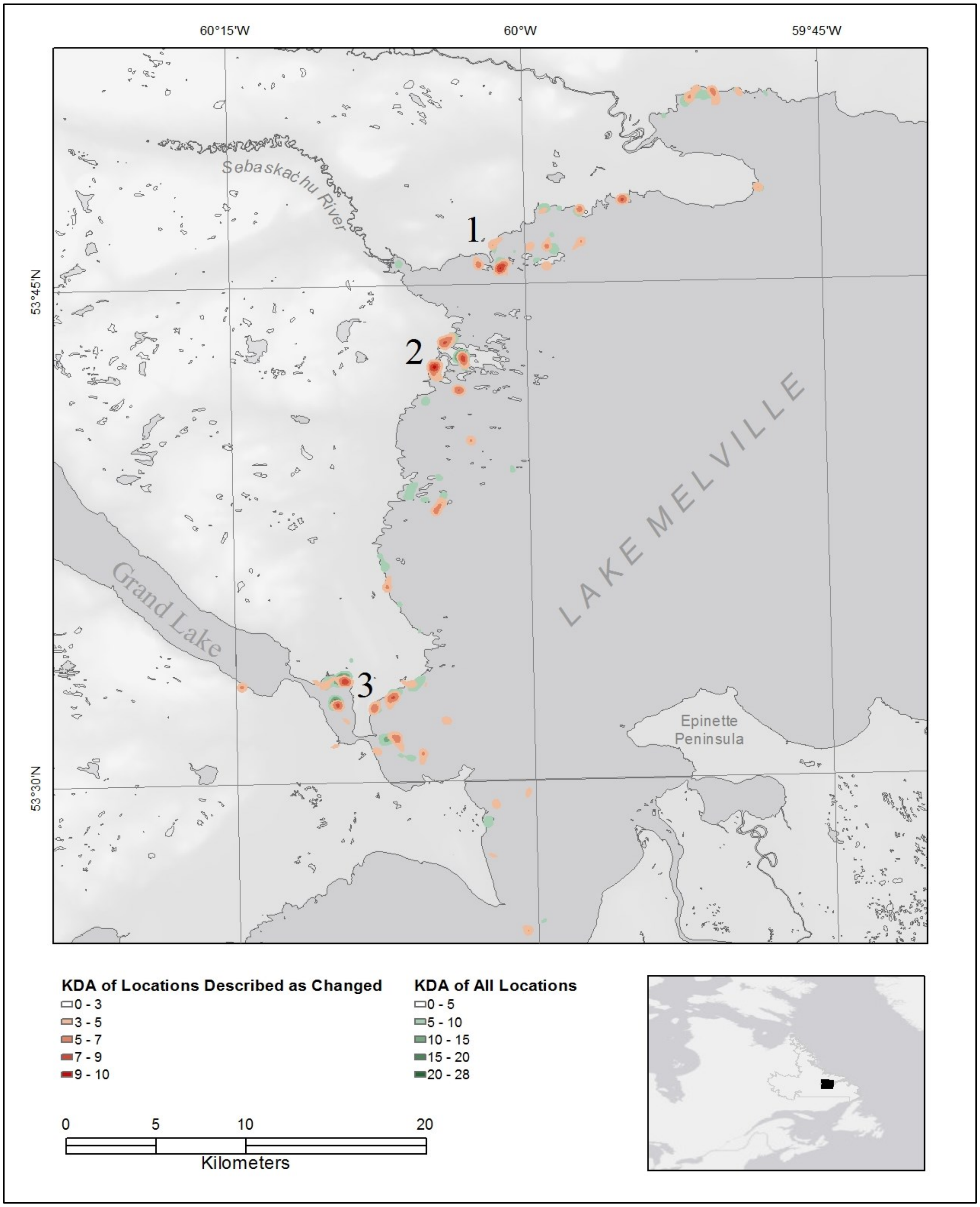


Figure 5.12: Kernel density analysis (points/km^2) of migratory bird areas

Note: Describes the following locations: (1) North-West Islands (2) Sebaskachu and surrounding area (3) and Little Lake near NWR.

5.5.3 Scaup

There were a total of forty (82%) respondents who provided a total of 92 features regarding the presence of scaup. These features could be divided into either nesting areas or sightings people had made while travelling in the survey area. 70 of the 92 polygons (76%) are illustrative of some change. Seventeen out of ninety-two polygons describe areas of no change, and in five cases the respondent was unsure. 30 out of 40 (75%) respondents who participated in this section of the survey identified areas that illustrate change.

The majority of the areas (92%) described are illustrative of an increased presence with only five of 70 polygons describing areas with a reduction in scaup. On an individual basis 70% of those asked stated that they had noticed more scaup. The causes of change were not well discussed for this question but the primary drivers are provided in Figure 5.13. These include the commercial fishery, harvest pressure and natural fluctuations.

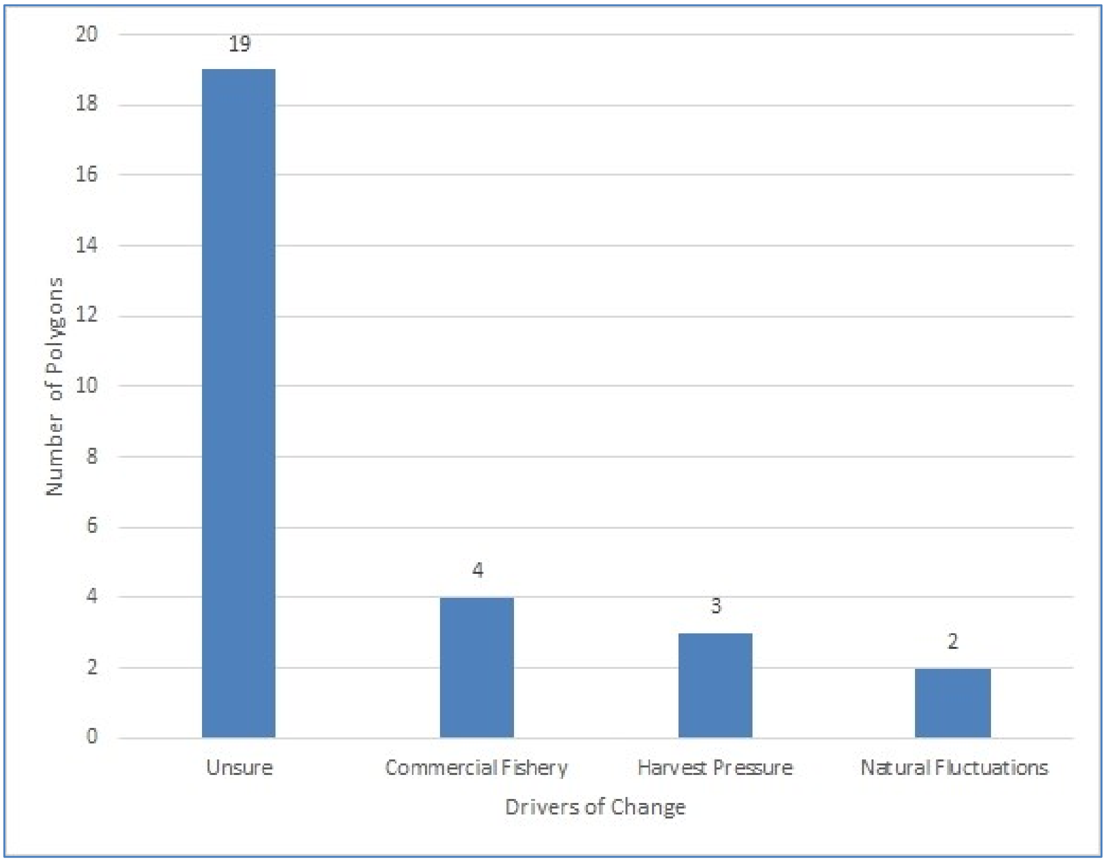


Figure 5.13: Drivers of change (scaup)

5.5.4 Kernel Density Analysis of Scaup Features

The KDA exercise for scaup locations (Figure 5.14) shows a clear concentration of points in and around the North-West Islands. The survey respondents were quite positive that the scaup population in the Lake Melville region is increasing. A concentration of this increasing population can be found in the vicinity of the North-West Islands. The increase in cabin development was mentioned as a negative influence on bird populations in general. As discussed in the migratory birds section, the excellent forage and safety provided by the islands ensures that the area remains popular habitat:

"Yeah ah seems like getting more there lately like probably the last oh let me see probably the last 20 years I would say they're getting more plentiful everywhere same thing up around Back Run up around are way to." – Respondent 15, NWR

"well we always called them wild loons but I guess that's what they are scaups I guess yeah yes, yes like first when I started hunting the first I hardly ever seen any now they're getting to be more." – Respondent 15, NWR

The survey design did now allow for a detailed discussion regarding scaup and many of the responses were intermingled with migratory bird comments. Many respondents pointed out that scaup were always present in Lake Melville but were fewer and known by other names:

"Oh there's definitely more scaup than what there used to be I think because although we, we used to call them canvass backs and nobody got many canvass backs hunting in the spring but now there's ah you know you see a lot of these scaups and it's the same bird." – Respondent 18, NWR

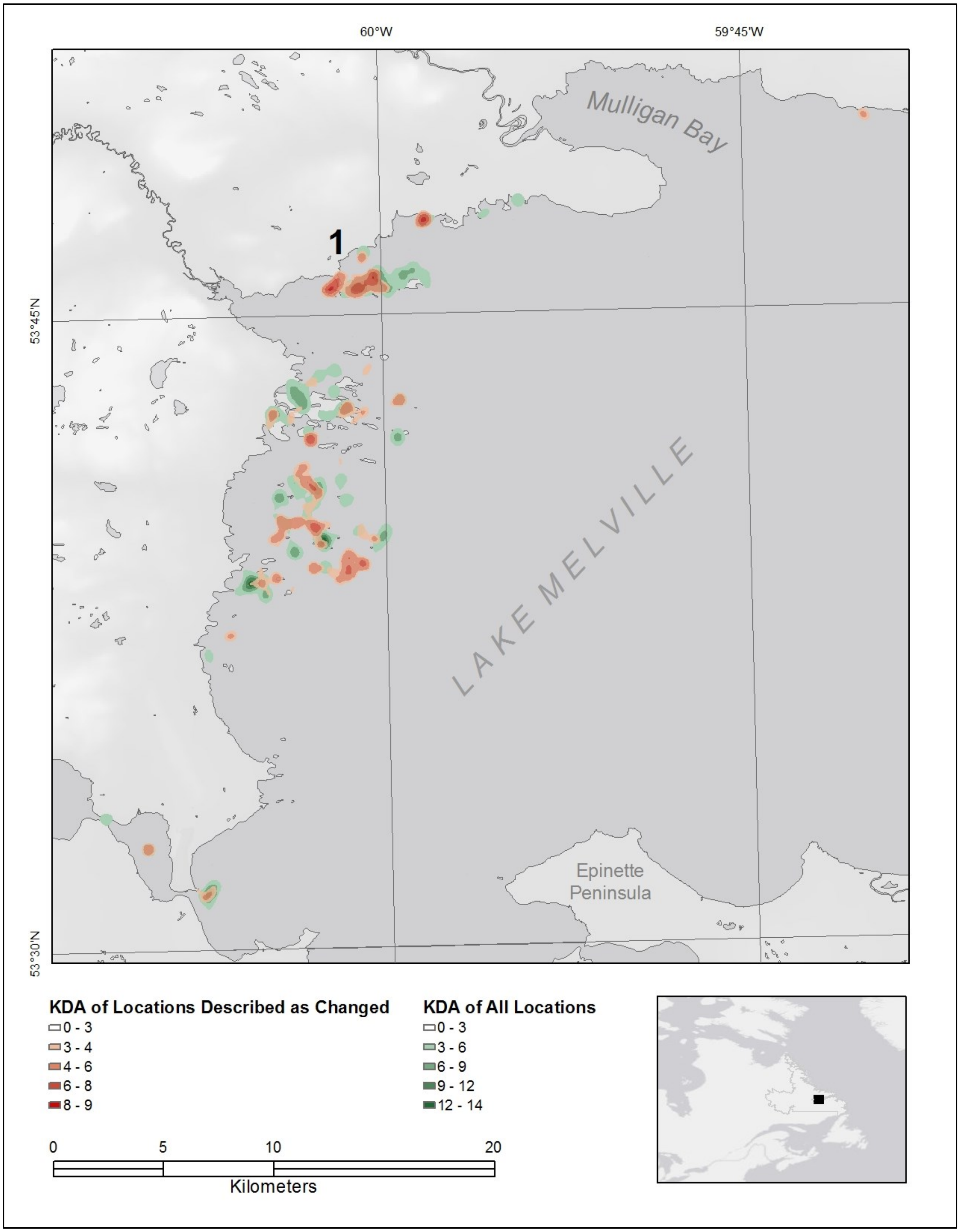


Figure 5.14: Kernel density analysis (points/km^2) of scaup areas.
Note: Describes the following locations: (1) North-West Islands.

5.5.5 Other Birds

The other birds section of the survey was concerned primarily with small game species such as willow ptarmigan (*Lagopus lagopus)* and rock ptarmigan (*Lagopus muta)*. 49 respondents provided a total of 261 features. Of these features 140 (54%) show change, 101 features show no change (39%), 15 (6%) show areas where the respondent was unsure and five (2%) were not elaborated upon.

The areas described as changed are represented by a total of 140 polygons. Respondents identified decreasing populations using 124 polygons (89%). The remaining polygons include three features that describe an increasing population and two features that indicate a change in timing. There are 11 polygons for which the question was not asked. The primary causes for the identified changes are outlined in Figure 5.15. These include natural fluctuations, harvest pressure, weather, technology, climate and fire.

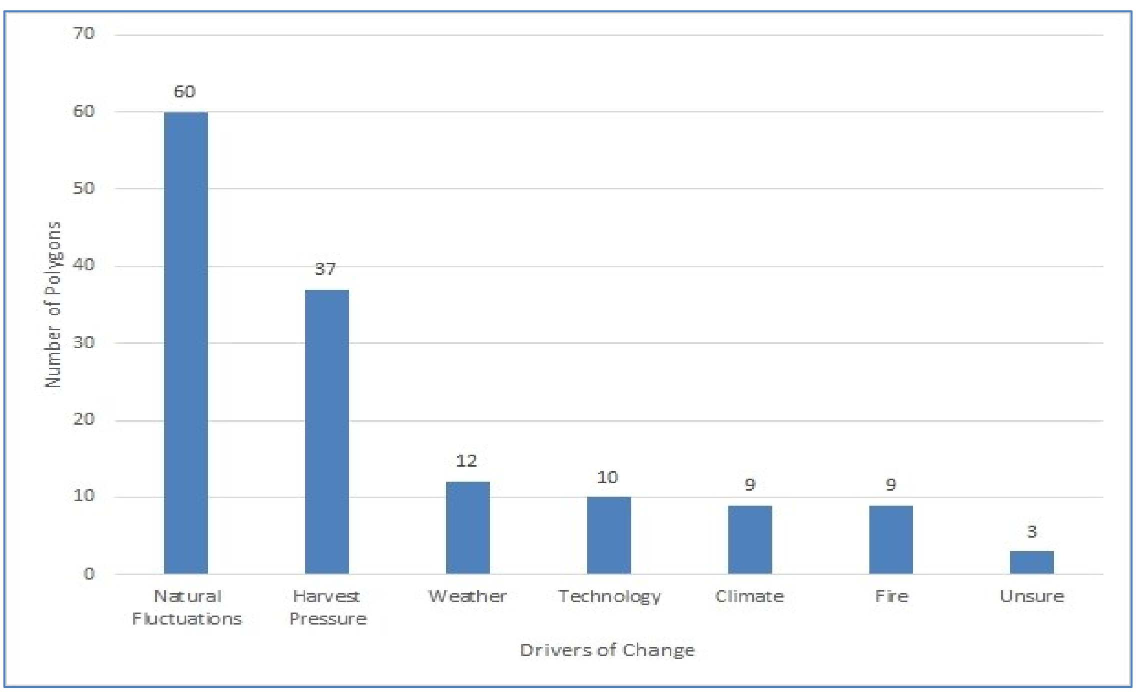


Figure 5.15 - Drivers of change (other birds)

5.5.6 Kernel Density Analysis of Other Birds Features

The KDA of points describing other bird features was split into two maps. The first map shows the area north east of NWR and includes Sebaskachu Bay, Mulligan Bay and the headwaters of Double Mer (Figure 5.16). This map highlights the Sebaskachu Bay (1) concentration of change observations. The second map focuses on the western end of Grand Lake and highlights the Berry Head (2) concentration of change observations (Figure 5.17).

There was limited specific discussion of the areas identified in the Sebaskachu Bay area. One common theme discussed was harvest pressure. Increased pressure in the area of Sebaskachu was described in terms related to changes in technology, evolving hunting practices, trail development and outside hunting pressure. With regard to technology, snowmobiles and boats are much faster and have a greater range than in the past:

"Yeah, I would say yeah since people got better snowmobiles and faster outboards there's more people getting to those exact locations where you find partridges."- Respondent 07, NWR

"the same thing down around Sabby there's always a good spot there early in the fall the first people down there will clean up on them and the same thing along the brooks down along right…"- Respondent 37, NWR

Changes in hunting practices included the development of a Labrador moose hunt which is bringing hunters from neighbouring communities who would likely not venture into the area otherwise:

"Yeah and where they're going on skidoo and they're coming from, one time we never get anyone from Goose Bay hardly until recently and they're getting to know it a lot because they had moose license and that now so they're up there looking for moose… there's so darn many hunters now wherever you go someone is in ahead of you. I don't know if that

did or not although of course like when I was growing up there wasn't many people hunting them kind of birds only the people living here at that time…" – Respondent 06, NWR

General discussion in the section regarding changes in "other bird" populations included many comments about the abundance of hunters. The dramatic increase in harvesting in the vicinity of NWR is of concern to many residents:

"they're scarcer now I think ah I've seen a couple of when three times in my lifetime seen them really think spruce ones you know white ones too sometimes but ah they always said they went on a cycle but I don't think the cycle can ah a handle like they use to I think there's too many hunters now and it makes ah it makes a difference." – Respondent 17, NWR

There are many respondents who cite the cyclical nature of migratory bird populations as the primary or only reason for the state of the population:

"they vary, they are cyclical up and down for sure, seem to be in a down cycle right now." – Respondent 07, NWR.

"it's more or less the cycles and what the marten and the fox population is doing too." – Respondent 37, NWR

"Human activity does play a part, but I don't know how big. It's hard to say. A lot of other animals involved there too killing partridge like the marten and that, eh, because when they're young… the foxes kills an awful lot when they're young." – Respondent 39, NWR

Discussion regarding the locations near Berry Head in Grand Lake (Figure 5.17) included many of the same concerns as other areas with regard to overharvesting. Comments specific to this area were related to a major forest fire in the 1970's. There was a significant loss of habitat as a result of this burn. This is one example of a 'historical' change that caused a reduction in the spruce partridge population:

"this year they're awful scare and scare last year too not very many you know I blames it for up in Grand Lake where it's always so good I blamed it on the forest fires a few years ago in the '70's and that the whole thing was burned out in there… and it burnt all back on their breeding ground and I think whenever the trees start to grow up to a little size

it's all growing back good now after 30 years but whenever they get up to a good size they'll start breeding after again but the spruce partridge he won't breed on barren land no way unlike the ptarmigan but that's what I blames on the whole bit so them fires it was 35 years ago it burned out the whole length of Grand Lake there right down to Doublemer." – Respondent 14, NWR

With regard to more 'contemporary' environmental change there was mention of recent atypical weather enabling birds to forage inland. With less snow cover there is more food available, which may mean that fewer animals are seen in the typical hunting areas:

"*I don't think the white partridges like no snow I suppose I don't know maybe they got better feed and that in the country because there's no snow so they're not coming out to the shore."*- Respondent 32, NWR

"I mean, you can go out there for days and hunt hard and only get a few when any other time you could up… and you and your buddy go up and spend a weekend up there and get your winter supply. This year you might go up and you might get one, two or three partridges." – Respondent 44, NWR

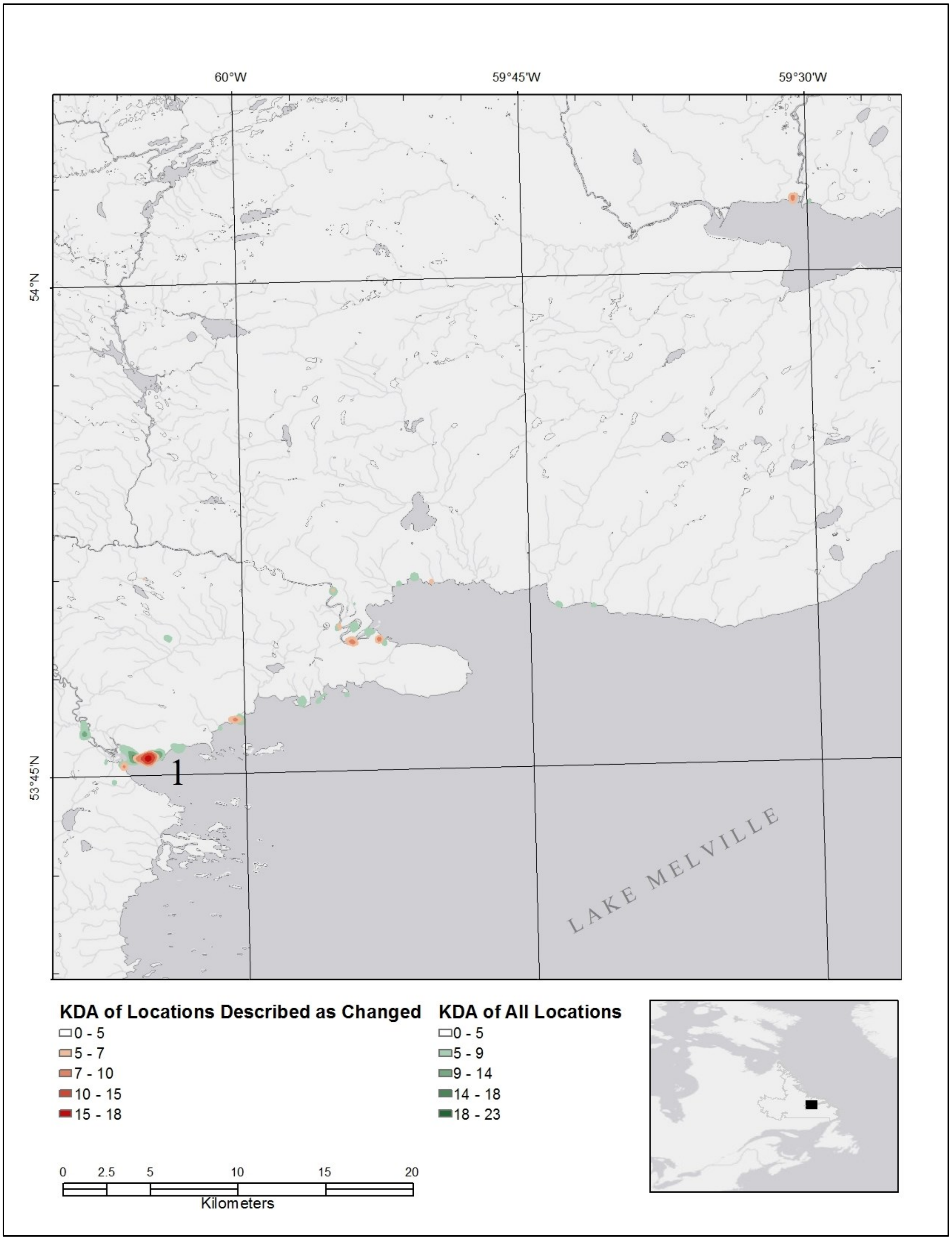


Figure 5.16: Kernel density analysis (points/km^2) of other bird areas (east)
Note: Describes the following locations: (1) Sebaskachu Bay

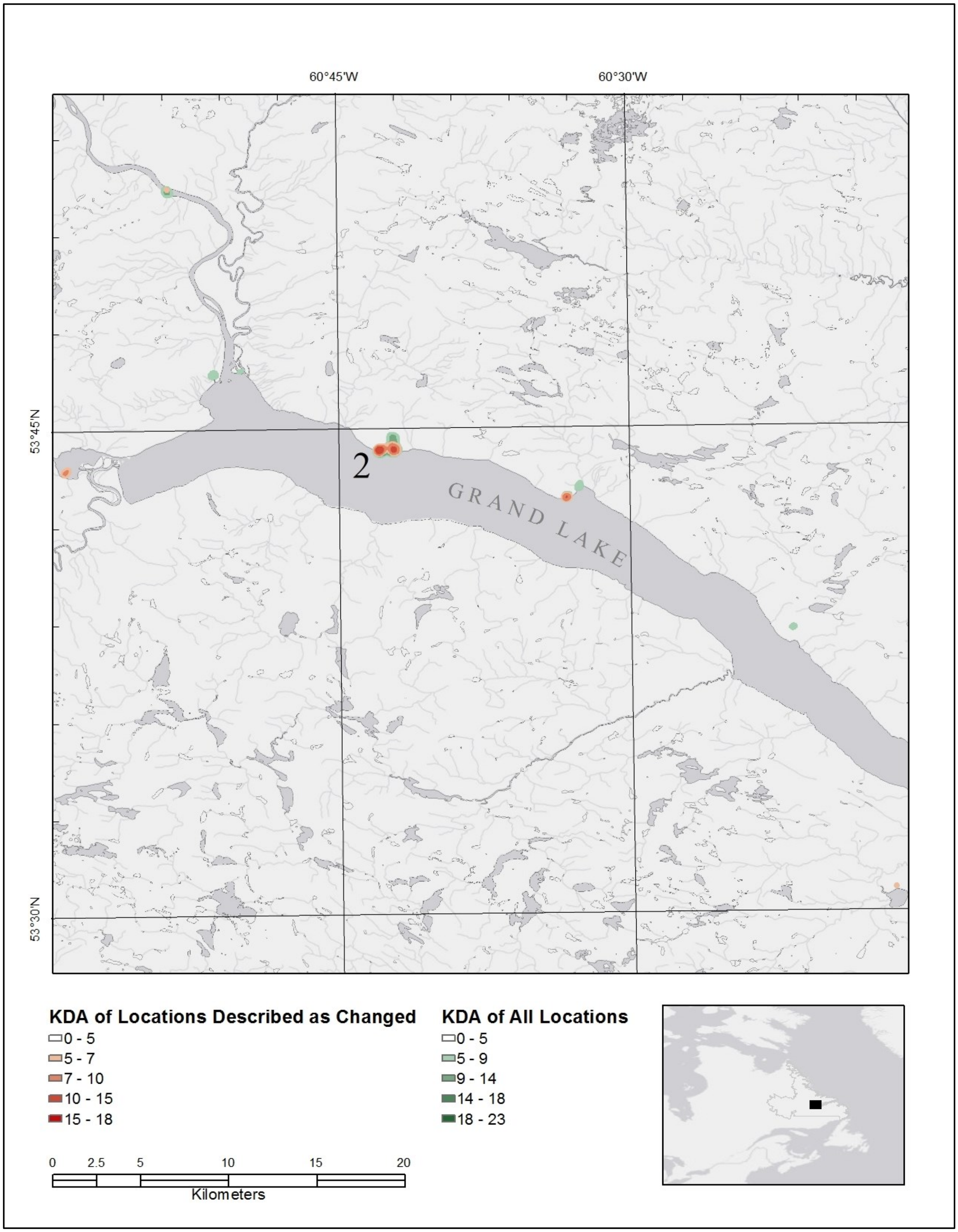


Figure 5.17: Kernel density analysis (points/km^2) of other bird areas (west)
Note: Describes the following locations: (2) Berry Head

5.6 FISH

5.6.1 Trout

The question regarding the occurrence of trout included net fishing, ice fishing and some rod fishing. Responses were primarily focused on brook trout *(Salvelinus fontinalis)* but the survey questions were not specific to this variation. Rod fishing is not nearly as popular as the other methods for residents of NWR. The responses regarding trout produced a total of 293 polygons, provided by 49 participants. 22 (45%) of the 49 who provided input describe some level of change.

For 77 of the polygons the follow up questions regarding change were not asked. 76 features describe areas that show no change. 32 of the polygons denote areas where the respondent was unsure regarding presence of change. Areas described as illustrating some level of change were represented by 110 features. The majority of this change (70%) was described as areas with less trout while 27% of the areas described had fewer trout. There was one instance where a respondent described the timing as having changed. The remainder of the respondents were unsure as to whether change had occurred. The primary causes for the described changes are outlined in Figure 5.18. These include harvest pressure, predation, less harvesting, the commercial fishery and regulations.

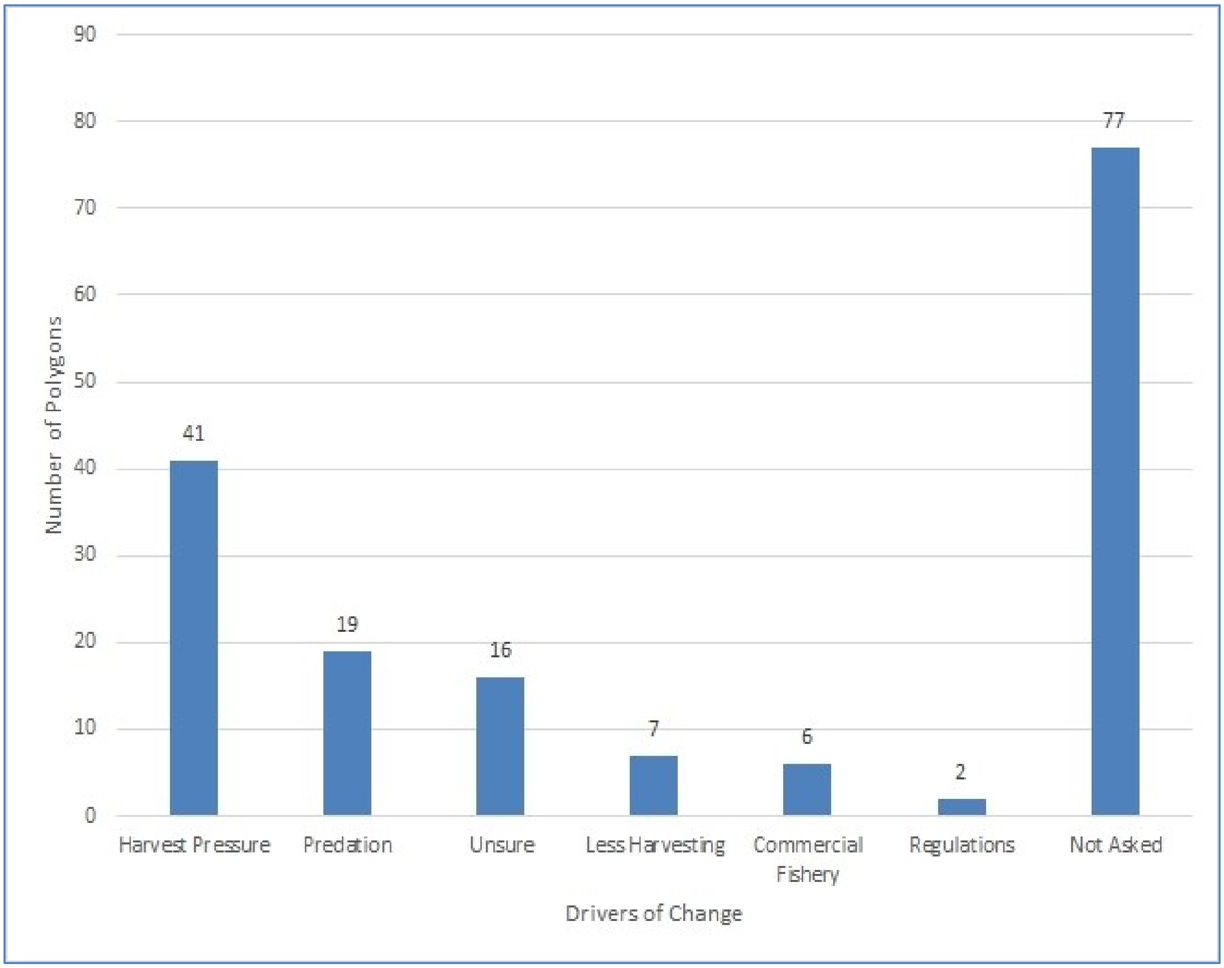


Figure 5.18: Drivers of change (trout)

5.6.2 Kernel Density Analysis of Trout Features

The kernel density analysis of points completed for the trout areas (Figure 5.19) highlights one geographic location of concentrated observations of environmental change at the mouth of the Mulligan River (1). The Mulligan river provides quality habitat for salmonids and is a known spawning river (Anderson, 1985).

Many of the survey responses related to environmental change for the Mulligan River mentioned a long-term decline of the population:

"just about all those places for winter fishing and rod fishing it used to be good but there's not as many as there used to be now today…" – Respondent 04, NWR

Most of these respondents suggested that the population may have begun to increase again somewhat over the last decade or so and that this change may be related to more stringent regulations on the net fishery:

"But I know again it's coming back to increase use like I mean in the early '60's when I fished there you could catch all the trout you want and really big trout but then it declined you know over the years now I mean it's really scarce same as here you know."- Respondent 31, NWR

"first when I moved down here in '66 the first few springs we go down my Jesus by' you'd get some lot of big trout through the ice but then things went dead it's like the salmon but with this net staying out of the water now in the summer for 10 or 12 years now it seems like the fish are coming back trout and good trout now and big trout." – Respondent 08, NWR

A number of respondents also mentioned that the trout had started arriving later in the summer. There was no reason offered for this change in timing:

"the last couple of summers we had we never got no trout at all in the beginning of the salmon run you know but it was in the latter part of the salmon run that we got schools trout that were coming in. They were coming in too because we always got them in the lower side of the net eh yup and they were big schools too." – Respondent 24, NWR

"Trout there wasn't a whole lot of trout around this year and then last year wasn't a bad year for trout but this year I know it was a pretty poor year for trout and that for the summer time anyway." – Respondent 37, NWR

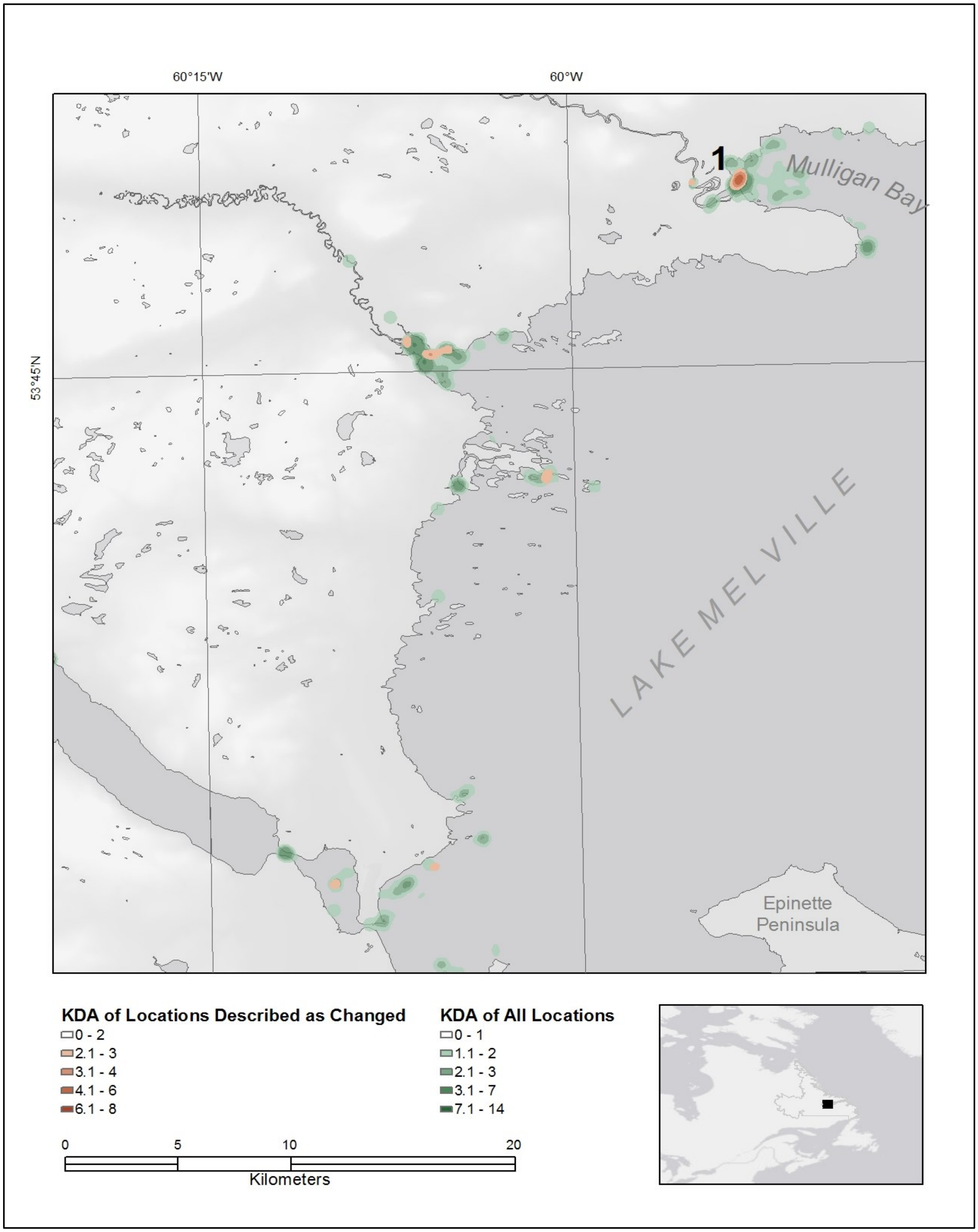


Figure 5.19: Kernel density analysis (points/km^2) of trout areas
Note: Describes the following locations: (1) Mulligan River

5.6.3 Salmon

Participation in the questions regarding salmon *(Salmo salar)* was excellent with a total of 189 polygons having been provided by all 49 participants. Of these features 29 features show no evidence of change and 124 areas were representative of locations where change was observed. There were 28 instances where the question was not asked. Of those who were asked the question, the majority (77%) were convinced that there has been a change in the salmon population. The majority of these respondents (81%) describe the areas as seeing an increase in the population. The remaining areas were described as reduced in population.

Discussion regarding salmon often overlapped with trout responses. Residents primarily engage in net fishing and catch both trout and salmon in this way. The primary drivers of change are listed in Figure 5.20. These include the commercial fishery, natural fluctuations, regulations, harvest pressure and less harvesting.

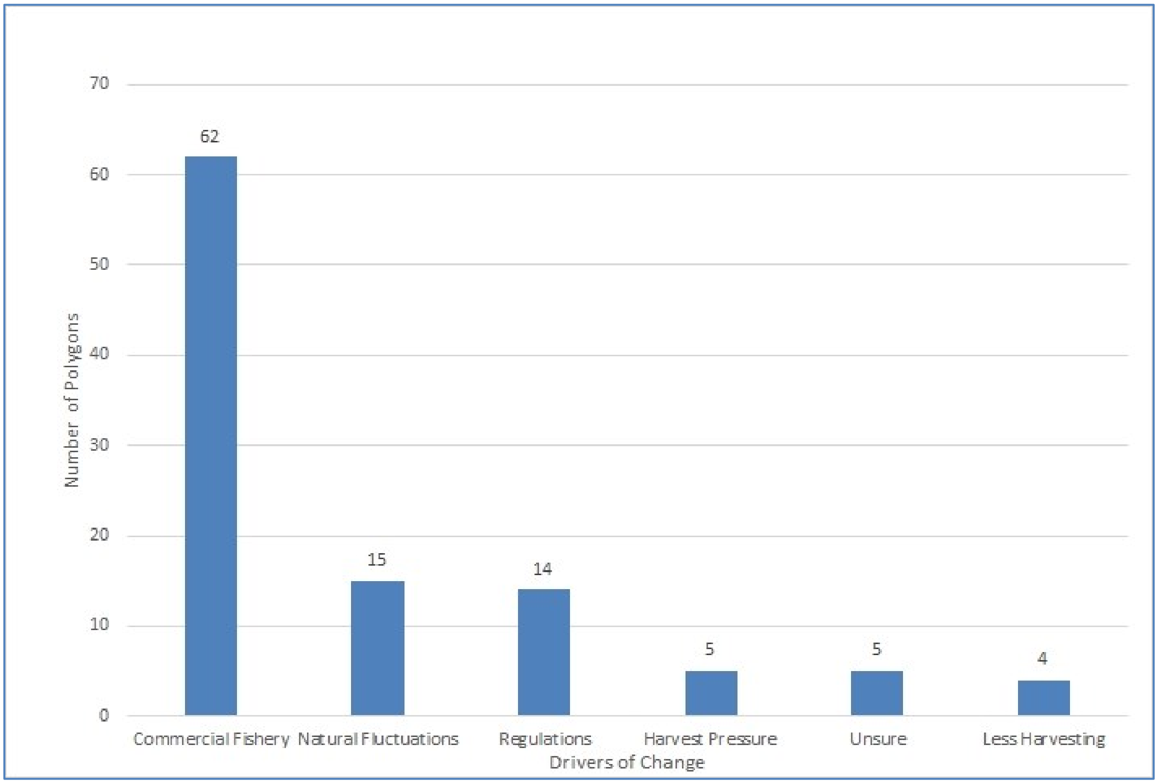


Figure 5.20: Drivers of change (salmon)

5.6.4 Kernel Density of Salmon Features

The kernel density analysis for the salmon areas (Figure 5.21) highlights two primary geographic locations depicting concentrations of environmental change. These include Mulligan Bay around the mouth of the Mulligan River (1) and Kenamu Point at the mouth of the Kenamu River (2). Survey respondents identified both of these locations as being part of salmon migration routes. Each river associated with these locations is listed by Anderson (1985) as having salmon spawning habitat.

Mulligan Bight was described as providing an abundance of salmon for net fishing. Respondents typically described the salmon run as occurring in the middle of

July and finishing in August. Some of the older respondents made reference to larger populations in this area in the past. According to these respondents the current upswing in the population has yet to reach historic levels:

"In my lifetime the salmon went from high to low and is climbing back up." – Respondent 04, NWR

Most of those surveyed consider the population to be healthy and some respondents thought the quota for salmon should be increased:

"Well we only had our nets out for one night and it was we had our quota and we had to take it up by 11:00 the next morning we was full we couldn't do no more and the fish was only jumping out of the water I figured they were going jump aboard the boat there was so many." – Respondent 21, NWR

"Yeah that's right you can only get seven and that yeah but when I used to salmon fish I wouldn't get half as many as what we're getting these days and last year at Mulligan there was ah wicked I never seen the likes." – Respondent 21, NWR

"Yeah and they're only basing it on one river they're studying I think Flower's River or something and all down here there's millions now and all on the south coast of Labrador they never seen like Cartwright and all Eagle River, Sand Hill by' what big salmon come here and yet they won't up our quota I don't understand it."
- Respondent 08, NWR

The area described around the mouth of the Kenamu River was similarly described as hosting an abundance of salmon:

"My god the last few years they're everywhere." – Respondent 19, NWR

"There seems to be more and more these years than there used to be with the I find them anyway because it don't take you very long to catch your amount you know."- Respondent 35, NWR

Other comments included some dissatisfaction with the number of people utilizing salmon areas:

"I don't bother to go over there now because there are too many people and I got a good place down by the cabin." – Respondent 06, NWR

General comments for both salmon populations as a whole seemed to focus on change as being related mostly to the end of the commercial salmon fishery in the 1990's. This policy change has greatly reduced pressure on the stocks and respondents feel that this has enabled the population to rebound. This trend has been aided with the addition of more stringent policies for local food fisheries set by the Federal Department of Fisheries and Oceans.

"*Ah I've noticed the amounts when I was a kid ah say 40 years ago they're certainly more plentiful the last ah 8-10 years. I presume because of the commercial fishery and the ah winter fishery out in the ocean has stopped you know eh."* – Respondent 19, NWR

"Yup there's a lot more salmon now…the green land fishery is over so there's no more salmon fishing there and there's only more or less aboriginal fishing now for salmon." – Respondent 21, NWR

"because our quota of course…we're limited but there's nobody has a problem getting their quota and many people get them in one haul in one day." – Respondent 18, NWR

"they put these restrictions on for the last 10 years you got take your net up for a week or two during the main run maybe that's something you know the only thing I can see yes by' the last four or five years the salmon have been unreal down here lots of them." – Respondent 08, NWR

There was some discussion of ice conditions affecting the timing of salmon runs, with later ice melt on the Labrador coast being related to a later run.

"*I think it may it has to do with the ice offshore…out on the coast because the salmon have to come in from the Atlantic and if the ice is there it just blocks them if the ice goes out early they probably come in earlier if the ice stays in late then they come in later."* – Respondent 10, NWR

There was also a response related to the effects of the Upper Churchill hydroelectric development.

"what the Upper Churchill did was it minimized the flows from all of these river systems that came out through into the lake upper end of Lake Melville especially and I think it changed the water temperatures…There wasn't as much cold water coming out…so it changed the water temperatures in the lake and you know with fish habitats."- Respondent 03, NWR

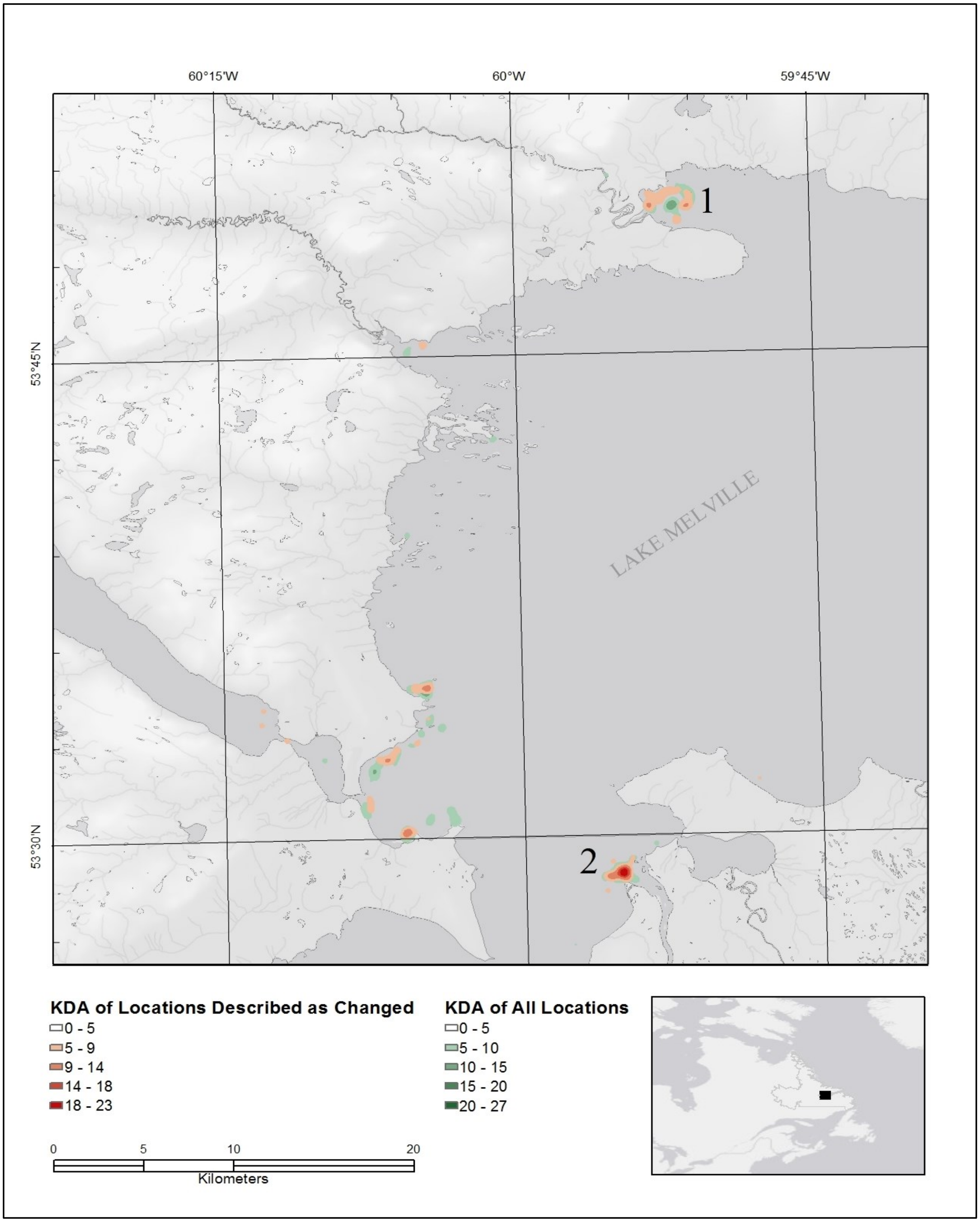


Figure 5.21: Kernel density analysis (points/km²) salmon areas
Note: Describes the following locations: (1) Mulligan River and (2) Kenamu Point

5.6.6 Other Fish

The "Other Fish" category is representative of locally fished species such as Rock Cod (*Microgadus tomcod)* and Smelt (*Osmerus mordax*). There were a few responses regarding other species such as Char *(Salvelinus fontinalis)* and Sucker *(Catostomus commersonii).* There was significant overlap in the mapping for this question with regard to each species. This overlap may not have been due to ecological factors but rather the format of the survey itself.

There were 47 participants who provided a total of 202 polygons representing "Other Fish." Of these respondents, 28 (59%) provided examples of areas that describe some form of environmental change. 66 of these features are areas described as showing no change and six features were provided where the respondent was unsure regarding change. Areas described as changed were denoted by 96 features. For 34 of the polygons the question was not asked and no further attribute information was collected.

Of those features that describe environmental change 86 show areas of less fish and nine show areas of more fish. There was one example describing a change in timing. The primary drivers of change are outlined in Figure 5.22. These include predation, harvest pressure, the commercial fishery, contamination, water temperature, less harvesting, climate and natural fluctuations.

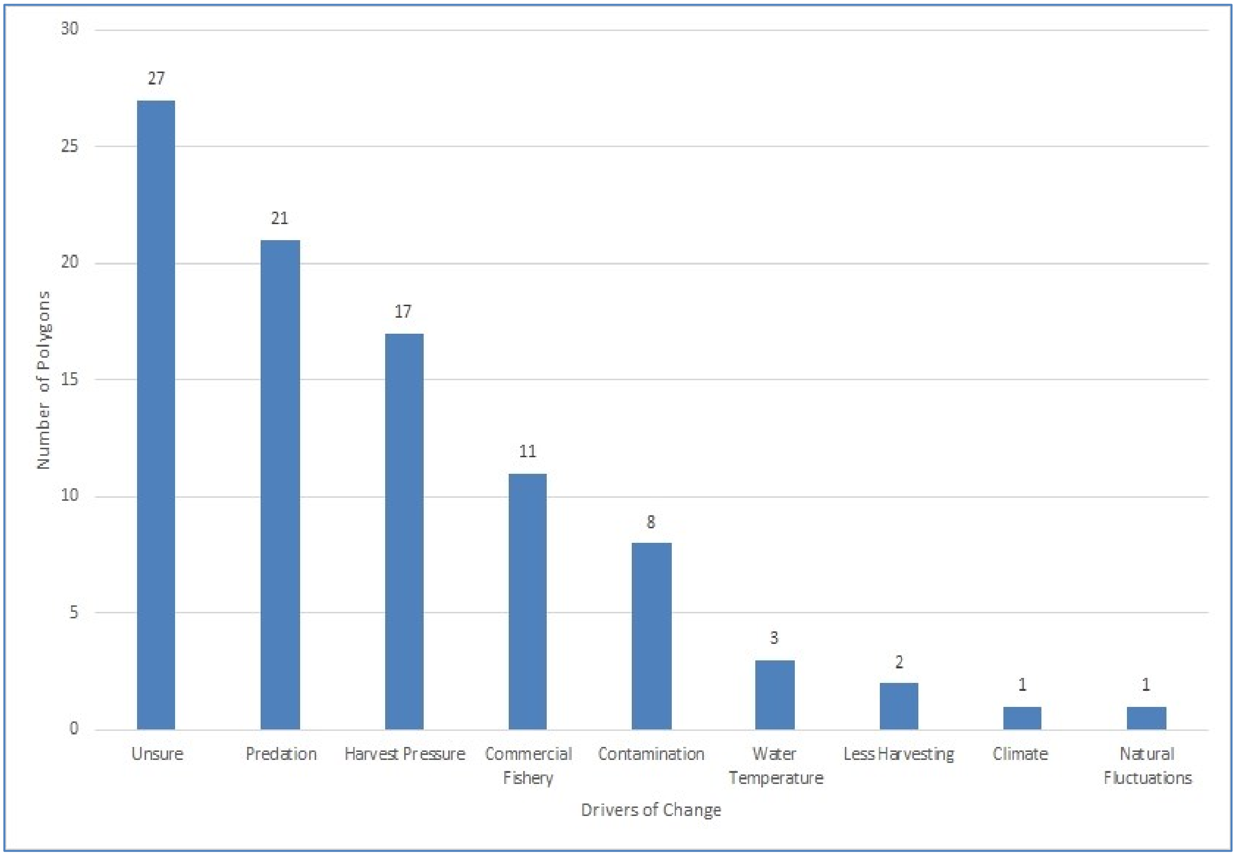


Figure 5.22: Drivers of change (other fish)

5.6.7 Kernel Density Analysis of Other Fish Features

The kernel density analysis for the other fish areas (Figure 5.23) highlights two primary geographic locations depicting concentrations of environmental change. These include Green Island (1) and Big Point (2).

Green Island is popular for fishing for rock cod. Most respondents participate in this fishery in March or April when the weather begins to warm. There is general agreement that the population has declined but there are a few different reasons provided for these changes. The abundance of seals and their impact as predators on the cod was mentioned:

"I don't know if seals got an effect on it or what I know seals sometimes hangs around in closer in the spring I noticed old jars and that" – Respondent 17, NWR

"Maybe there's more seals causing the lack of rock cod and lack of smelts. There could be more seals, you know. Like there's an awful lot of seals now." – Respondent 39, NWR

The influx of residents from surrounding communities and the increased harvest pressure in this area and others is of concern to a number of respondents. This concern is often strengthened by observations of poor conservation practices by harvesters:

"A few years ago, I had people came from Goose and all over to catch them. Too many people came." – Respondent 40, NWR

"some people used to go to hell with it, eh – go catch… loads and boatloads. I don't what they were doing with them… They'd have almost like a little mini factory set up. They'd have jiggers hung over these willows. When they see the willow moving, then… and another feller… two or three fellers … all they'd be doing is filleting…well, they needed to do something… regulating that, but it's too late now anyway." – Respondent 42, NWR

Other factors mentioned during the survey process included contamination. Respondents mentioned raw sewage from NWR and HVGB as affecting the water quality in the area. There was also mention of a brief commercial fishery for rock cod that was conducted over two summers:

"they had this commercial rock cod fishery in Rigolet to open a plant… they bought a long liner… and they fished all around here for rock cod and they caught two hundred thousand pounds in a couple of summers and then all of a sudden they were gone…what it was the tom cods are plentiful up here but they're a local fish they don't migrate and once they were caught up that was it there was no more to come back." – Respondent 08, NWR

Big Point is a common location for smelt fishing. In the fall nets are sometimes used for harvesting smelt. In the later part of the winter when the weather warms many people fish with hook and line. Most respondents stated that the smelt population had declined as well:

"Ah smelts let me see smelts by god I can remember when the net was full every morning but nowadays you might get a net full once you know in the fall." – Respondent, NWR
"And out here out off the point there in front of the houses used to be one of the best spots around for smelts and we used to catch them through the ice and in fall we put the net out and we used to catch them at Rocky Beach but you don't see that now you don't get that many"- Respondent 30, NWR

Many of the respondent comments related to the decline of cod around Green Island were also mentioned for Big Point. The seal population was one of these, along with sewage contamination. There was mention of change (increase) in salinity as having some effect on smelt habitat. Another factor related to the decline mentioned in this location was anthropogenic harvest pressure combined with poor conservation practices:

"Oh, they're wicked. That's something really… same with the smelts – they declined over the years too, eh, but you can see what's happened. Some of the people are just catching just for the… because they're easy to catch and… for fun, you know, more than anything, and I bet you a lot of that ends up in the dump. I know about people who caught them smelts in particular by the thousands and dump on their gardens for manure. You can't do that anymore, eh? One time when there was 50 people in the bay you could do that. You couldn't buy any fertilizer anyway, but it's foolishness this day and age." –
Respondent 42, NWR

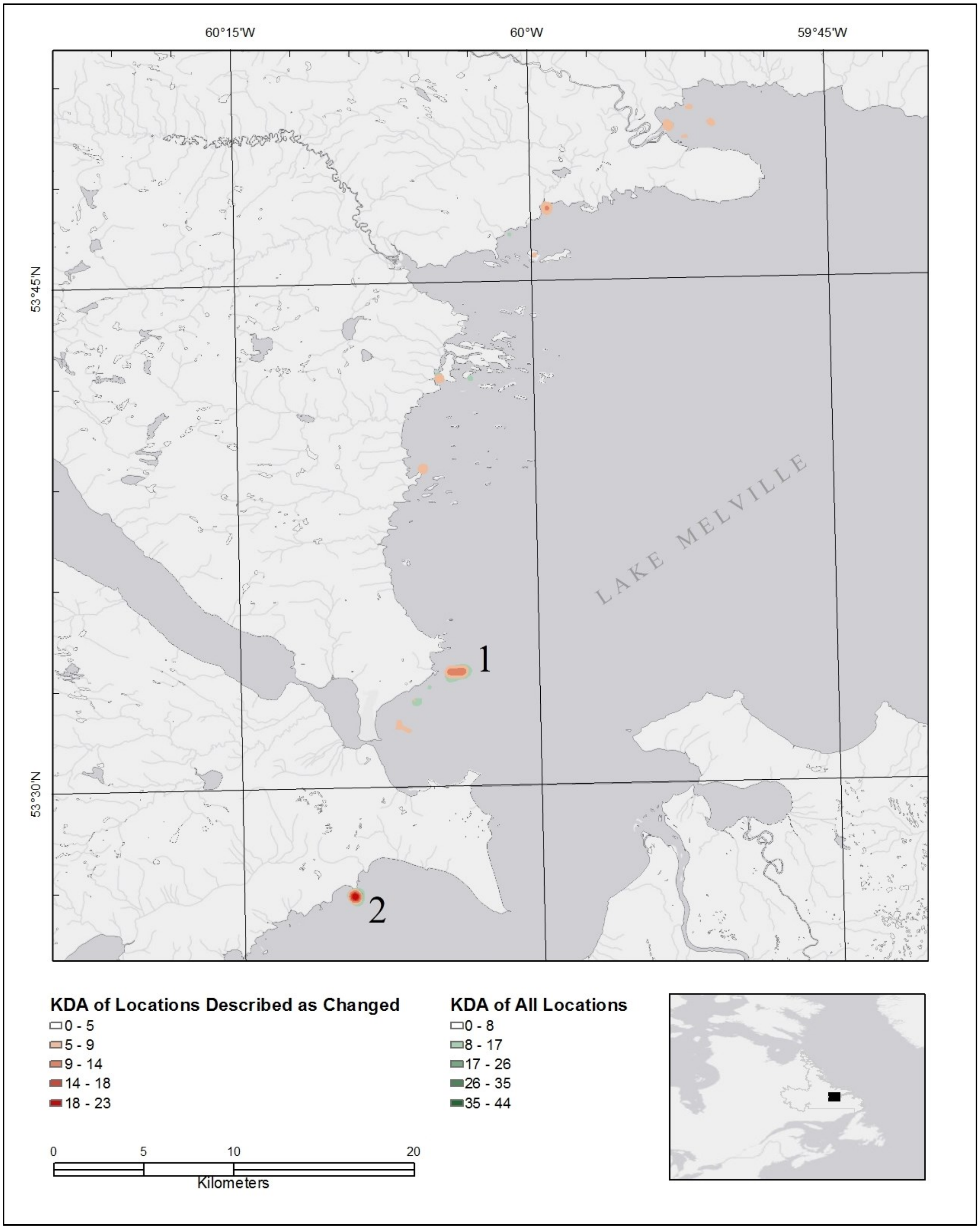


Figure: 5.23: Kernel density analysis (points/km²) of other fish areas
Note: Describes the following locations: (1) Green Island (2) and Big Point.

5.7 Potable Water

The survey question regarding potable water locations asked respondents to identify areas where they have collected drinking water. Each of the forty-nine respondents provided input on this question with a total of 242 features. The majority (82%) of these features do not describe a change. The other forty-three (18%) of these features were identified as showing change, either in quality or access. In most cases the change was due to contamination either from salt water or sewage outflow. Two locations had been simply identified as abandoned, but the respondent was not sure why. The survey questions were not designed to complete a detailed follow up. The primary drivers of change that were mentioned are listed in Figure 5.24. These include contamination, the Upper Churchill hydroelectric development and abandonment.

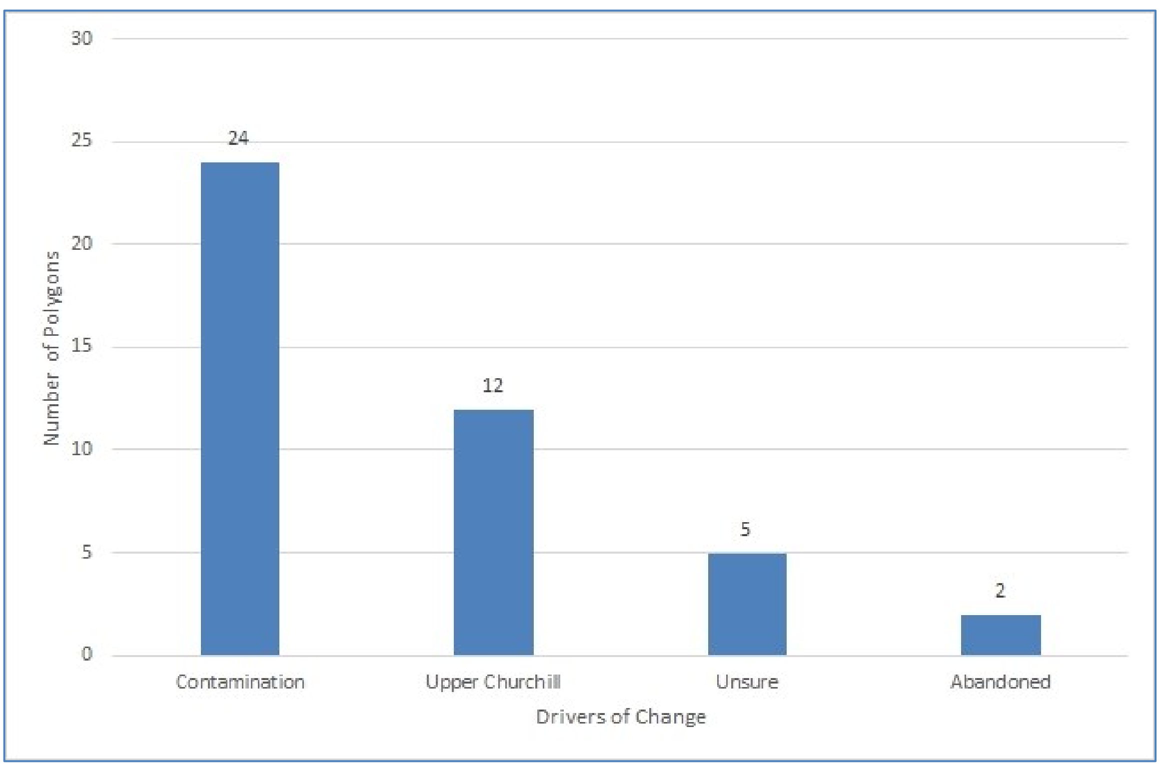


Figure 5.24: Drivers of change (potable water)

5.7.1 Kernel Density Analysis of Potable Water Features

The kernel density analysis of points completed for the potable water locations (Figure 5.25) highlights three primary geographic locations depicting concentrations of environmental change. These include Mulligan (1) NWR in the vicinity of the bridge (2) and Little Lake (3).

The responses regarding change in the Mulligan area referred to contamination of the water supply from salt water. Respondents described using river water next to the cabin sites for fresh water; however, this is no longer a reliable source:

"when I was growing up we walked down the river and get up out of the water anytime you wanted to now we can't you got to go to a well now it's all salt water. There was about 20 families there one time and everyone was getting water out of that river would walk down the river get a bucket of water cut a hole in the ice and get a bucket of water now you can't do it no more because of the salt water you got to have a well"- Respondent 16, NWR

Two wells were mentioned in relation to Mulligan. One of these was also described as unreliable due to periodic contamination from salt water. Respondents attribute this influx of brackish water to the development of the Upper Churchill hydroelectric development. This large-scale hydroelectric project required the diversion of water from both the Churchill and Naskaupi rivers (Anderson, 1985). This diversion of two of the largest rivers in Labrador has reduced the rivers' output and allowed the backward movement of salt water into Lake Melville.

Near the bridge in NWR the river was once used for the collection of fresh water. This is no longer possible due to contamination from sewage from the community as well as brackish water. Technology has also changed with regard to the supply of fresh water for the community. In a generation, residents have seen the community move from carrying water in buckets to using hand pumped well water and finally to contemporary plumbing sourced from a local water tower:

"But ah it would be a long time ago that we got water from the river because we eventually put down ah pipes and with a hand pump you know that kind of way and got water from underground but that was real in the late years it's only since that dam water is going in full speed from the ah no water coming from Naskapi very little eh." – Respondent 24, NWR

Discussion around the weakened flow as a result of the Churchill Falls hydroelectric development was common here as well as for Little Lake:

"The reason for that now ah mostly and mainly ah since they built the Churchill Falls Hydro Electric Power ah they shut off the ah they built two dams one over on Fremont Lake was there was the head waters and the Naskapi River and since then the tide goes the rising tide from the Atlantic Ocean flows in through North West River at about 6 or 7 knots at its peak and when the tide falls it comes back out again." – Respondent 24, NWR

"Of course, you could probably still drink it at certain times even now but ah you know there's a lot of sewer goes back and forth through that river because the tide goes in and out which years back it never did then this of course has happened mostly since Churchill Falls the upper Churchill was constructed." – Respondent 18, NWR

"Oh yeah. Northwest River, Little Lake - one day it could be fresh; the next day it's salt, right? There's a big tidal influence now in the Grand Lake and it's a big change I've noticed in the last 15 or so years. You could have water rushing up Grand Lake now as quick as it comes out." – Respondent 43, NWR

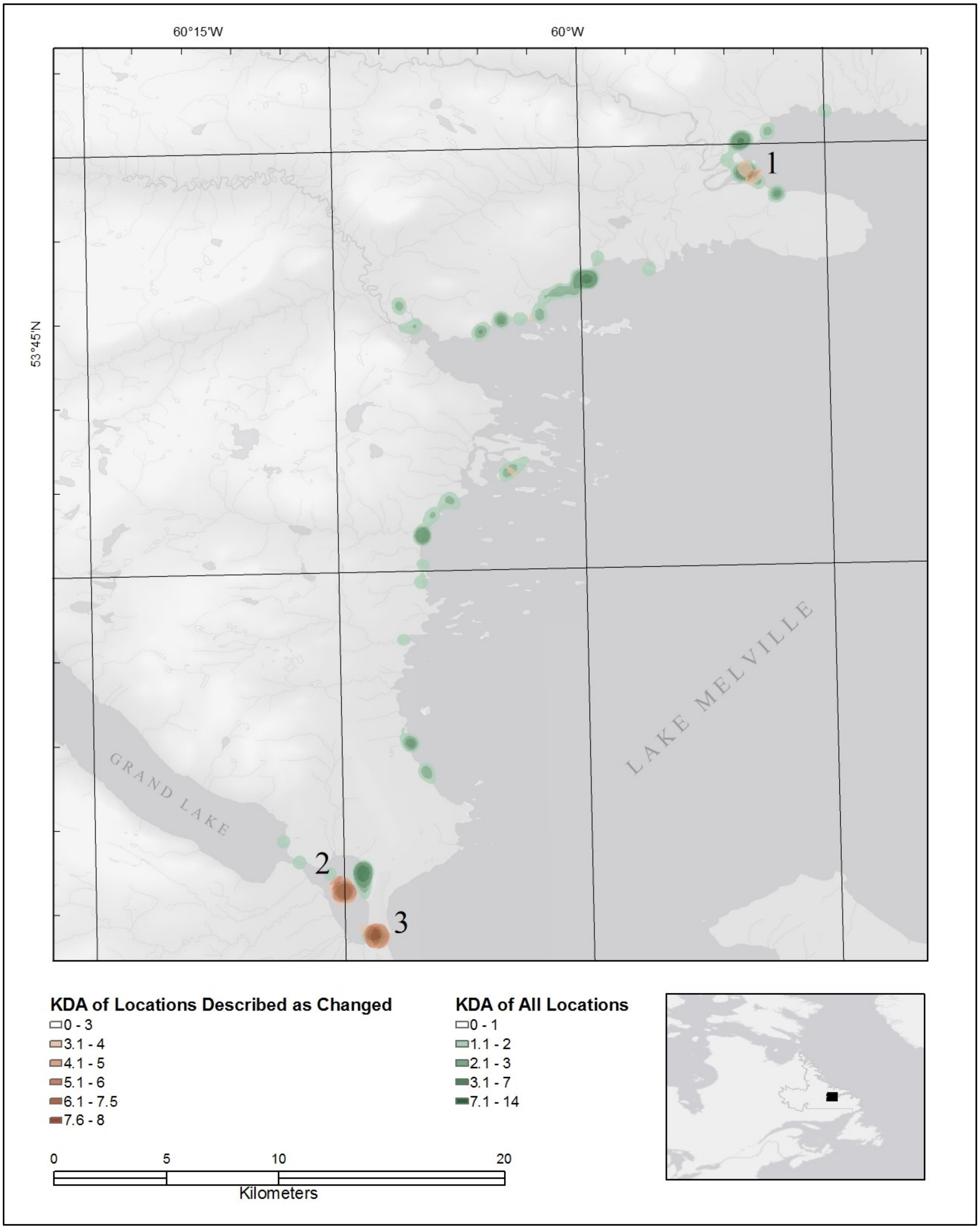


Figure: 5.25: Kernel density analysis (points/km^2) of potable water areas

Note: Describes the following locations: (1) Mulligan (2) NWR in the vicinity of the bridge and (3) Little Lake.

5.8 Perceptions of a Changing Environment

When discussing ice conditions people are generally concerned that conditions are less predictable. Residents have less confidence when travelling in these areas as there is either less ice or it is forming later than they are accustomed to. Discussion further identified that reports of unusual pressure cracks can complicate travelling by altering the normal winter icescape. Respondents primarily attributed changes in ice conditions to unusual weather events. The discussion would sometimes move to explore the potential influence of climate change on ice formation but this was not the norm. It is also important to mention the change in tidal movement associated with the Upper Churchill hydroelectric development. The influence of this infrastructure has been felt for some time. The full effects of this development on Lake Melville and the nearby watersheds have not been well studied but the effects are very clear to a number of residents of NWR.

There were many conflicting interpretations of the status of the seal population in Lake Melville. Significant negative and positive factors are both present and forecasting the net results for the seal population is difficult. The parameters affecting seal populations are much more complex than those influencing ice conditions. There was concern that a lack of snow from recent mild winters had reduced winter habitat for seal pups and that this may reduce the overall population. This may be offset by the reduction of harvesting due to the same mild winter conditions. The abundance of available prey species for seals was noted by respondents as having a buoying effect on populations. Historic uses of seal such as food for dog teams or commercial harvesting for pelts for the Hudson's Bay Company have also dwindled, which may increase seal numbers. However, as noted by some respondents, this effect is likely ameliorated by the increasing numbers of hunters that harvest from communities around Lake Melville.

More than half of the areas denoting migratory birds were illustrative of change. Respondents described either decreasing populations or a difference in expected arrival or departure times during migration. The early thaw common with mild winters is of concern for most residents. The early availability of open water provides birds with the opportunity to spread out and bypass areas once frequented for habitat. When this occurs, hunters have to go farther to obtain animals. These effects are compounded by the general perception that there is too much harvest pressure from an increasing number of hunters. Finally, an increase in cabin development also has many respondents concerned that the amount and quality of habitat for migratory birds is decreasing.

It is interesting that despite the decrease in migratory birds in general that scaup were described as increasing. The respondents were mostly unsure as to why there were more scaup. Some suggested that the population might be on the rise due to the availability of forage that may be related to the increased availability of open water in the spring. Less competition for habitat in the spring may provide the scaup population in Lake Melville opportunities for growth.

The responses regarding the small game bird species describe these populations as being cyclical. The populations were described primarily as decreasing and many respondents attribute this to a downward trend in the cycle. There were a number of respondents that were concerned that the current low levels were also due to overharvesting. Recent mild weather may also allow for better forage inland. This may mean birds will travel less and this would reduce presence in areas they would normally frequent.

The Mulligan River is mentioned frequently by respondents as a great location for brook trout. It was also the main area identified as having changed. The trout population was described by many as low but increasing over time after having been on a downturn for an extended period. The increasing population can be attributed to changing regulations in the net fishery that have reduced harvest pressure through the shortening of the net season. Salmon were similarly described in the Mulligan River as increasing from a low point. This increase was attributed primarily to the closure of the commercial salmon fishery in Lake Melville. Other species of fish such as rock cod and smelts were described by respondents as being in decline due to overharvesting. Seal predation was also mentioned as having a negative influence on these populations. Finally, a number of people considered contamination from municipal sewage outflow or from an influx of brackish water as having a deleterious effect on populations.

Most of the responses regarding potable water described areas that had not changed. Those that had changed were related primarily to contamination from either salt or sewage. Salt contamination was described as an influx of brackish water resulting from reduced output from watersheds influenced by the damming of the Upper Churchill hydroelectric development.

5.9 Adaptations to Environmental Change

The preceding sections of this chapter describe geographic hotspots that were identified by survey respondents as having been impacted significantly by environmental change. The identification of these hotspots allows for subsequent focused analyses of the surveys, highlighting a number of specific factors influencing each hotspot. With information regarding the *where* and *why* of environmental change in this manner it was possible to identify *how* the residents of NWR have adapted to and are continuing to adapt to these ongoing environmental changes.

As previously discussed, Berkes and Jolly (2001) describe adaptation as falling within two main categories. These include "adaptive strategies" that consist of community actions in response to changes and "coping mechanisms," or adaptive actions made at a smaller scale or individual level.

A number of adaptive strategies that residents discussed during the survey process were thematic. As an example, the effect of regulations concerning areas such as the commercial fisheries both offshore and within Lake Melville influenced the conversation around fishing. Harvesting trout is regulated now and these regulations influence the timing and methods by which individuals can carry out harvesting.

"we don't catch as many at any one time it's like we wouldn't get a whole lot (inaudible) fall or maybe some people do but ah most people now will catch the I suppose I think twelve is supposed to be a limit for the day so pick out for two or three days you may have twenty trout or something like." – Respondent 18, NWR

The moratorium on caribou hunting is another example of government regulation that has had a significant impact on the harvesting practices of residents of NWR. Residents of NWR used to hunt Mealy Mountain Caribou and are no longer permitted to harvest from this herd. The number of George River Caribou have also been declining. Due to these factors there has been a corresponding increase in moose hunting. There are limited licenses for moose in the Lake Melville Region and residents from NWR have started travelling to Gros Morne National Park in Newfoundland to hunt to provide meat for the community freezer. This is a departure from the typical caribou hunting practices and timing differs for the hunt between species. This is without considering the dramatic change in location as Gros Morne is over 800 kilometres away via highway and requires a ferry to cross the Strait of Belle Isle. As it is a regulated hunt that is conducted a long way from home, many residents are unable to participate. This adaptive strategy provides access to meat, but does little to maintain harvesting traditions.

Another adaptive strategy adopted by many residents that I have observed is the use of social media. A Facebook group called "North West River Ice and Trail Conditions" was created by local residents of NWR. The group hosts upward of 260 members and is used to spread seasonal information regarding trail conditions and groomer operations of interest to residents or people travelling in the vicinity of NWR. The discussions regarding ice and trail conditions can be very detailed and offer increased safety for travelers who would otherwise have to check the conditions in situ.

One of the most influential adaptive strategies would be the development of the groomed snowmobile trail network itself. The trail network was developed and financially supported through the provincial government as a means of improving safety and access for traveling between Labrador communities. For almost two decades trail development has helped to provide improved access as planned but has also encouraged increased use through tourism, military use, and the development of offshoot trails. There are also a number of new trails that have been cut by individuals to increase access in the Lake Melville area that likely would not exist if not for the groomed trails network.

"... he got a path cut in I don't go out the Sabby River because there's always a friggin mess on that he got his path cut in here and this all burn and new growth now the last forty years well (inaudible) my Jesus by this is where I've been getting my partridge now the last twenty years in there. You go in there you get all you want." – Respondent 08, NWR

"When we have conditions like that yes, I used it for a few years once I knew it was there right once I knew Pat had it cut we was all wondering who done it Pat did because it seemed like it was later getting froze up and we wanted to get on now eh and old Pat' don't mind taking a chainsaw." – Respondent 08, NWR

When combined with today's modern snowmobiles and all-terrain vehicles, increasing access through new trails allows people to travel farther and in much less time. This has led to interest in additions to the trail network that are both official and unofficial:

"...obviously, human impact has changed things. Access is the key. Like when I was growing up a young fellow, there was never any people from Goose Bay up in Grand Lake, right? You didn't see nobody. It was just the few trappers and local people mostly from North River who were there; but nowadays, geez, everybody and their dog is cruising around, right? A few trails have been cut too, right, that's made it accessible. Like, there's one from L6 down to Grand Lake; I know a lot of Goose Bay people use that, right?" – Respondent 43, NWR

Some examples of common specific coping mechanisms were illustrated through the survey process. The adoption of new technology and tools to simplify harvest practices is common. Travel by dog team that was once commonplace has become a novelty. It has been supplanted by the use of snowmobiles, the evolution of which has helped to ensure that snowmobiles have been fully embraced by NWR residents as the primary mode of winter travel on Lake Melville. This has made it much easier to travel farther distances in shorter periods of time and what once took days may take hours. This has helped to lessen the burden on people with increasingly less preparation time required to travel.

"one time you used to go here this is far as you used to get on dogs see and dog team and just to go out around this area like this to hunt seals now we go down here and camp we can do all that in the whole thing on skidoo." – Respondent 22, NWR

These changes in technology have accompanied the development of new travel routes. The faster, more powerful snowmobiles which enable resource users to travel much farther in shorter periods of time also require that those travelling gain familiarity with a larger land base. Harvesting technology has also improved. Ice fishing, for example, is now easier with the use of ice augers rather than chisels and gasoline augers are now very common leading to the same results with considerably less effort:

"Ah I don't really know… I think there's more, maybe they're just fished a little bit more like these years many of us have we're staying in one place more and we're able to travel you know faster and easier and more often than we used to years ago." – Respondent 18, NWR

The adoption of global positioning system technology allows users to return to locations with a precision that was difficult to manage in the past:

"we camp down there in the tent and every year you mark it out on your GPS your same route and you got back and I saved it in my GPS and we always go back to the same place and they're always there right." – Respondent 05, NWR.

"Yeah I know when I came back in the night from Mulligan I mean you can see lights everywhere and sometimes you kind of don't know where you are unless you're GPS." – Respondent 03, NWR

These factors combined with larger numbers of resource users are significant contributors to increased harvesting pressure. There is an element of competition for some:

"…now it's only just because you wanted to get in there quicker to get the animals instead of waiting a little later in the year when everyone else been up there and got them to go wild" – Respondent 37, NWR.

Other coping mechanisms included changing routes or just waiting longer in order to avoid hazards such as open water or unsafe ice:

"Oh yes well they go out farther than when we used to go around the whole of it I think especially snowmobiles you had to go way out almost out to North West Point before you come in." – Respondent 06, NWR

"Oh well like if it was a normal year about the middle of January and then I might cross right but not no way would I ever cross Sandy Point right here I would never do it I know young people do it a lot on the high-speed machine but I wouldn't do it." – Respondent 08, NWR

"The places that I've crossed over the years past… to always be safe is a week or week before ah start practicing the thing that you would of practiced later other years you know. That's all that's all starting to seem to be giving out earlier" – Respondent 17, NWR.

"…usually go up through Sabby River there and get up in the Sabby Lake and then if not we'll come up through L6 and then take the portage down from L6 and get down to Cape Law there but then the same sort of question then to is that one right here it all depends on that spot right there freezes over or not…" – Respondent 37, NWR

Other coping mechanisms are a product of safety concerns resulting from awareness of changing conditions. In addition to the Facebook group previously mentioned there have been occasions when individuals have notified authorities in order to warn others regarding potential hazards:

"That usually opens in late April you'll see it normally it opens but last year as you know it opened in March because I was down on the 6th I came back on the 16th of March last year for my last trip and while I was there it opened from the end of what we call Thistle

Island which is this one right up along what we call Sherlock's Island where you cross now when you're going on ice you cross Sabaskachu Bight and you cross Sherlock's Island and then across the tickle well it was it opened in one day it opened from Thistle Island right up near the end of Sherlock's Island the west end of Sherlock's Island in one afternoon because I crossed it in morning and that afternoon I noticed and there was just a very small hole of water at the end of Thistle Island and in the afternoon my god it was opening up fast so I went up and I drilled a couple of holes where I cross and there was only two inches of ice and so I notified the RCMP and asked them to notify the public not to pass there… the next morning…they got a hold of CBC and it was broadcast…" – Respondent 34, NWR

Others are coping with increased risk by minimizing their exposure:

"Like I haven't been hunting much the last few years. I get in and out quick as I… out and back in as fast as I can. I don't trust it at all anywhere out there nowadays." – Respondent 42, NWR

CHAPTER 6: Discussion

6.1 Introduction

The environment around Lake Melville is changing. Residents enumerated some level of environmental change for each topic covered in the survey and through the analysis highlighted a number of geographical areas that have been most impacted. This chapter describes in further detail the implications of the results discussed in chapter five. What follows focuses on summarizing those results as a starting point to highlight and examine the major themes that were identified. This illuminates the many connections between drivers of change, the environment and the residents of NWR. These relationships are complex, variable and open to interpretation. I have incorporated some examples of survey dialogue that support the results. The addition quotes within this chapter supplement my interpretation of the results. Ultimately the relationships that exist between people, their environment and the ways that they navigate the effects of environmental change are the reason for this research.

6.2 Environmental Change

In this thesis I have utilized GIS and grounded theory along with TEK to examine the topic of environmental change as perceived by the residents of NWR. The primary drivers of change highlighted in the previous chapter are not exhaustive. They are limited by the structure of the survey. Nevertheless, they help to illuminate the complex nature of the parameters that influence environmental change in the Lake Melville Area. The use of GIS in highlighting the hotspots of environmental change was useful for developing subsets of the full dataset to focus examination of the transcripts and provide structure for the analysis.

The survey results show a number of patterns regarding environmental change based on traditional knowledge provided by residents of NWR. Kernel density mapping provided ‘areas of interest’ denoting where examples of change occur most frequently. Comparing the themes defined using grounded theory across the examples of density analysis found in the results section reveals that there are some common elements amongst these areas of interest.

6.2.1 Weather Events and Climate Change

Respondents described there being less ice overall primarily due to weather. While there seemed to be reluctance by many to refer to climate change, many respondents discussed environmental changes in light of weather events and suggested that they represent cyclical patterns. This is not inaccurate as the North Atlantic Oscillation and the Atlantic Multidecadal Oscillation are the primary drivers of weather patterns for the Lake Melville area (Durkalec et al., 2016). Some residents are hopeful that the abnormal weather events they have experienced are part of a pattern that may eventually return to previous conditions. When asked if these changes were permanent on respondent (36) replied: *“That’s a tough one, I think so, but I hope not.”* For some, the idea was that it may be part of a cycle is based on personal experience:

"One thing about like the climate change they're saying there is a change for damn sure but we used to always have mild year we might have two or three cold ones and then we'd have a mild one" – Respondent 6, NWR.

Resident descriptions of ice features suggest there has been an increase in uncertainty regarding ice conditions. Primarily as a result of mild weather events, early thaw areas are opening earlier, late freeze areas are freezing even later, and in some cases pressure cracks are appearing in new locations. Some residents are not travelling because of the tenuous conditions:

"Last year now it was so late freezing up and the weather was so warm upon 'til late that I wouldn't even take a chance of going up because I was too afraid of the bad ice even though I would have tried it when I was younger yeah."- Respondent 24, NWR.

This loss of access has made traditional hunting and gathering activities more difficult and in many parts of the north is forcing a greater reliance on store bought items (Ford et al., 2009; Ostapchuk et al., 2015). Less time on the land is a negative factor in the transmission of TEK between generations. Finding innovative ways to aid in the transmission of TEK to youth in northern communities is becoming a priority (Pearce et al., 2011; Sheremata et al., 2016).

The TEK provided was seen to be describing affected areas that illuminate the complex nature of the factors that influence ice production and longevity. For example, shoals, tides and other physical elements in the environment influence the areas highlighted by the kernel density analysis, but it was clear from NWR respondents that mild winter weather was an extremely influential factor for all areas. The ability to highlight these areas in a systematic way with GIS and TEK can aid the community in determining potential adaptations and help to focus planning around problem areas. This work is important as it relates to safety and reducing risk, which is often higher in Inuit communities (Laidler, 2006; Durkalec et al., 2014; Riedlsperger, 2014).

"The older guys says the younger crowd got it luckier now because they can adapt to this stuff. They have no idea what's happening… like what they've always found to be safe… it's all changed now." – Respondent 43, NWR.

Other drivers of change influencing ice conditions, such as the Upper Churchill hydroelectric development, have been described as having a dramatic effect on watersheds to the point of changing typical tidal action. The introduction of brackish water and altered tidal action influences the reliability of ice conditions.

6.2.2 Infrastructure Development and Groomed Trails

The Upper Churchill hydroelectric development dramatically changed the watersheds of the Churchill and Naskapi Rivers through the construction of control structures (Bajzak and Roberts, 2011). The main reservoir, completed in 1972, included 88 dykes. The process of filling the Smallwood reservoir reduced previous flow levels to the point where the Churchill Falls was merely a trickle (Bajzak and Roberts, 2011). This is a historical change that has had significant and under-studied impacts on residents downstream through changes in ecosystem services and ice conditions.

NWR has seen significant changes in community infrastructure over a relatively short period of time. For example, drinking water was once taken directly from the river but with the growth of municipal infrastructure residents moved to well water and now running water from a reservoir. Sewage contamination has become a concern for many community members due to a reduction in flow described as a result of the Upper Churchill hydroelectric development.

Another significant change includes the shift in transportation. Travelling was once completed primarily by boat or by dog team. The installation of a cable car, which was subsequently replaced by a permanent bridge within living memory, has brought with it a substantial change in lifestyle for residents of NWR. The changes in community infrastructure opened up travel by road between communities and promoted participation in a wage economy. These changes were the result of economic and political drivers outside of the community.

Similarly, in recent years, ongoing groomed trail development and use has brought more people to the area and prompted further change. The residents of NWR have utilized the groomed snowmobile trails system as one method of adapting to environmental change with mixed results. The trail system can aid travelers in avoiding marginal conditions on Lake Melville. This, as mentioned by several respondents, is dependent on suitable snow cover. The former Provincial Minister of Government Service and Lands, the Honourable Ernest McLean, who is also a resident of the community of NWR, described the groomed trails project in this way:

> *"From a community perspective this project will link communities across Labrador during the winter season and provide greater access to the land for residents. For tourists, a groomed trail will make the region a winter tourism destination."* - (Government of Newfoundland and Labrador, 1999).

This has proven to be true on all counts and these trails continue to influence land use in new ways and have become important infrastructure for many communities in Labrador (Riedlsperger, 2014; Ford et al., 2016). The groomed trails are not without their own issues and climate can affect their usability. Some respondents point out that a lack of snow or ice to cover over stumps or brooks throughout parts of the winter trail system can make these trails unusable.

> *"…usually there's not enough snow on the groomed trail anyway so we can't go on the groomed trail…"* – Respondent 37, NWR.

There are other considerations that are associated with increased trail access. The popularity of these trails among travelers who are less familiar with the area allows for increased traffic and overall harvest pressure for limited resources such as small and large game, wood harvesting, fishing locations and cabin development. Trails commonly encourage the creation of more trails, and increased access leads to further development.

> *"Twenty years say twenty-five years ago you could go from North West there was like a place Butter and Snow probably a cabin or two at Old House Brook ah then you went on to Sabasquasho before you seen another cabin and then you may have been one or two on Ambrose's Tickle and then you got to the islands and now there's hundreds of them, every island's got a cabin or a dozen cabins you know like that sort of thing."* – Respondent 3, NWR.

Historically habited areas in Lake Melville tended to be settled by families with family owned traplines which ran in accordance with commonly accepted guidelines for harvesting:

"generally speaking, like we got a lot of ground, like trapping ground, so most of our hunting is kind of concentrated in the vicinity of our trapping grounds, right, and we wouldn't, you know, generally go hunting partridges and stuff on other people's grounds, so to speak. So for us guys, my family anyway, it's been like up around here. Spruce ones in particular - you know, all up around the Crooked River here." – Respondent 43, NWR

These safeguards for resource utilization are no longer being followed in many cases and there is an influx of people from outside of the community who are often not familiar with long-standing practices regarding resource use.

The network of trails is well used; this use will continue and will likely grow especially with decreasing reliability of ice conditions due to climate change. A preference for well-marked trails that reduce safety concerns and improve access will ensure they remain popular.

6.2.3 Habitat and Harvesting

There is clearly some worry that current harvesting practices and levels of harvesting are having a negative influence on harvest species and resident experiences on the land. Competition for resources is common and in some cases residents indicated that if they are not first to visit certain resource areas they are unlikely to bother at visiting at all as the resource in question will likely have already been harvested or have fled from harvesters to another location. The constant pressure from harvesters or simply presence of people on the landscape is often enough to influence species to move to another location:

> *"if you leave them up there and stay out here they're back and forth and you get a lot of flying shots but when they're up there feeding there's thousands and thousands there and you drive them out of there it frigs everything up. Oh, it used to make the old fellas some cross eh so everybody abided by it but things changed…it's not good to go out there no more when the young fellas goes up they goes right to the bottom."*- Respondent 8, NWR

It is difficult to know for sure why respondents are seeing fewer migratory birds but human presence is likely part of the equation. The explosion in cabin developments around Lake Melville is a clear sign that pressure for limited resources has increased.

There is an interesting anomaly in the downward trend in migratory birds. Respondents were clear in reporting more scaup in general and especially in the vicinity of the Sebaskachu River. There is a significant human presence in this area with new cabins being added currently. Scaup populations are likely to be competing with other migratory bird species with similar habitat requirements. Drever et al. (2012, p. 480) states that "the population growth rates of scaup and scoter were positively linked to spring snow cover duration." Perhaps conditions in Lake Melville have been changing to accommodate this species over time.

When discussing salmonids, respondents reported seeing an increase in salmon but a decrease in trout populations. The removal of the commercial fishery for salmon and increase in management regulations for salmon is likely the primary cause for the upswing in numbers. Similarly, the continued harvest pressure and lack of regulation has likely caused a decrease in trout stocks. The seal population is blamed by some residents as leading to a decline in fish stocks, which may be mitigated in the case of salmon by the limited influence of a human harvest. Respondents related the timing of salmon runs to the ice on the coast:

> *"Out on the coast because the salmon have to come in from the Atlantic and if the ice is there it just blocks them if the ice goes out early they probably come in earlier if the ice stays in late then they come in later."*- Respondent 10, NWR

This is corroborated by Dempsey et al. (2017), who found that the earlier arrival of salmonids was related to warmer climate conditions while significant ice on the Labrador shelf could delay arrival.

6.2.4 Future Change Drivers

There are many potential factors that will influence future environmental change for residents of NWR. The obvious major drivers of change in the near future include the completion of the Lower Churchill hydroelectric development. The work to determine the effects of this project are still ongoing. Methylmercury (MeHg) contamination is a factor that has the potential to affect many harvested species. Once flooded, the Muskrat Falls reservoir will cause an increase in MeHg:

> *"Even under the low methylmercury scenario, which requires complete removal of topsoil, vegetation and trees, and rapid decomposition of methylmercury in downstream environment, there will be an overall increase in methylmercury exposures."* (Durkalec et al., 2016, p. vii)

Durkalec et al. (2016, p. ix) also states that the Lower Churchill hydroelectric development "has a strong impact on seasonal variations in Churchill River discharge" and this variation has the potential to alter ice conditions. There is potential for the project to have impacts on freshwater resources and other downstream effects (Goldhar et al., 2014; Durkalec et al., 2016).

Continued trail and potential road development between NWR and coastal communities is another likely future scenario. The Nunatsiavut communities of Rigolet and Postville are destinations for potential road development and advocacy to develop said infrastructure is ongoing from both community governments. Roads to these communities would have broad implications for resource utilization practices in Labrador. Road construction of the magnitude that would be required for connecting these communities would open up large swaths of now mostly inaccessible land for people to travel. The long-term effects of this are impossible to predict but would likely be dramatic based on similar changes felt in central Labrador as a result of the development of the Trans Labrador Highway (Armitage and Stopp, 2003). The further development of roads to the coast of Labrador is a very real possibility that has been discussed in each community with residents having varying views on the potential pros and cons (Goldhar et al., 2012).

Continued population growth in the Lake Melville region is another potential contributor to environmental changes for residents of NWR. Between 2011 and 2016 the community of HVGB grew by over seven percent (Statistics Canada, 2017a). Natural resource utilization through cabin development, hunting, fishing and other outdoor recreational activities will continue to affect residents of NWR. With the potential development of nearby projects such as the Gull Island Hydroelectric Development and the Akami-Uapishk^{U}-KakKasuak-Mealy Mountains National Park, growth of the resident population in the Lake Melville area can be expected and subsequent impacts on the local environment unavoidable.

6.3 Research Limitations

Limitations of this research revolve primarily around the use of grounded theory on a dataset compiled from structured survey responses. The survey format limited the length and detail of responses on many topics of interest. The selection of relevant themes using grounded theory was tenable only through the significant number of participating respondents (n=49).

Obtaining detailed responses from a series of survey transcripts was hit and miss. In reviewing for thematic content, a particular detailed response might approach a topic of interest only to have the interviewer purposely guide the respondent back to the next section of the structured survey. This was a common occurrence during the 49 surveys.

The practice of leaving out a survey section occurred more frequently than one would hope for. The interviewer, in the midst of juggling the survey questions with the spatial component of map biography, could easily miss follow-up questions within the survey. In some cases, the interviewer had to judge the ability of the respondent to participate further in the survey process due to fatigue or loss of interest. These complications all lead to gaps in the dataset that may have otherwise been avoided. In order to avoid these gaps, it would be advisable to use multiple sessions to complete each survey. This would entail further cost in time and resources and that would have to be weighed against the potential value of added detail. The use of detailed interviews rather than structured surveys would be another way to avoid these gaps. Detailed responses are critical when conducting grounded theory analysis especially when developing a geospatial database focused on specific attribute data. Free flowing discussion would allow for more complete responses but would add more work in transcribing and analysis.

Another obvious limitation of the dataset is illustrated through the gender gap of selected respondents. There were only two female respondents, although a number of respondents had their spouses present and contributing for at least part of the survey process. The limited inclusion of female perspectives within the survey development and responses is a glaring omission in design. With just a handful of female respondents the survey was clearly not as robust as it could have been. Reed and Christie (2009) reviewed the status of the inclusion of gender identity in relation to environmental change research in a western research context. Their review showed a clear gender gap in contemporary environmental geography. This gender divide is more prevalent when discussing hunting practices (Reed and Christie, 2009). They point out that "As geographers, we need to consistently ask how gender shapes the human experiences of environmental change, conflict and management, and how it influences the commitments of women and men participating in these enterprises." Although women are less likely to hunt they are integral to the system of hunting and bring their own perspectives regarding environmental change (Reed and Christie, 2009). Hunting was one of the primary response focus areas in the survey. Women contribute to traditional harvesting for small game, water and fish, and details regarding these activities would have been captured more thoroughly if more female respondents had been included. One way to address this issue would have been to survey households rather than individuals.

CHAPTER 7: Conclusion

7.1 Introduction

This thesis examined a body of knowledge acquired through community participatory research initiated by residents of NWR, Labrador. Although the original objective of the project was to collect local TEK in light of the ongoing effects of climate change, the resulting database has helped to enumerate a number of significant environmental, technological and social changes that are shaping resident experiences on the landscape. I have examined the drivers of change affecting the traditional harvesting activities of residents of NWR and highlighted the areas in which the effects have been concentrated. I have also identified many of the parameters leading to the degree of change in these areas. Finally I have examined some of the adaptation measures used by residents of NWR to maintain their close connections to their environment in the face of dramatic environmental, economic and social change.

7.2 Contribution of Research

The collection and application of TEK on environmental change has been carried out in many parts of the Arctic at different scales. As mentioned in chapter two, Inuit living in the near Arctic were considered to be understudied (Ford et al., 2012; Sheremata et al., 2016). Reviewing similar populations in the north dealing with environmental change helped to compare and contrast drivers of change with regard to NWR. This community survey and subsequent analysis represent a southern Inuit context that has not been adequately represented in the knowledge base to date. The use of TEK provided by residents of NWR helps to illuminate the links between environmental change, adaptation strategies and coping mechanisms in this region, providing a unique perspective.

In order to examine the survey dataset fully, I used density analysis to illustrate concentrations of phenomena in a spatial context. Density analysis is commonly used as a method in GIS to aid in the study of distributions (Tobias, 2009; ESRI, 2014). Utilizing kernel density analysis with spatial data derived from TEK is not common practice. The visual patterns produced within these spatial datasets offer an excellent way to explore themes corroborated through the grounded theory approach. The utility of the process in helping to focus the review of the data to specific areas of interest was significant. Maps can be coded for themes in the same way that transcripts can be coded for themes. Similar examples of TEK used with density analysis are not commonplace in existing literature. GIS density analysis has been used in Alaska to map "lifetime use areas" for Indigenous people on coastal islands in the Bering Sea (Huntington et al., 2013) and important subsistence use areas for fishing for the community of Gambell on the Bering Sea as well (Fidel et al., 2012). This thesis adds an Inuit perspective from their southern bounds in eastern Canada. The analysis presented in this thesis is an example of GIS analysis in an uncommon context and may help to encourage other TEK holders to approach their datasets in new ways.

7.3 Research Implications:

Developing an understanding of environmental change through the consideration of social, cultural and environmental parameters is a daunting task. The level of complexity involved is heightened by the inclusion of political and economic factors. Community perceptions of environmental change are important to gaining this understanding. CBPR is an approach that makes this process easier for everyone. It is clear that future research should continue to pursue a high level of community involvement in order to maintain community support and remain relevant to those most affected.

In NWR there was a palpable fear that much of the distinct culture in the community is going to be lost through ongoing technological and environmental change. In an effort to maintain their close connection to their environment the community of NWR orchestrated the collection and dissemination of TEK. This adaptation occurs in light of the potential loss of this information for future generations. For this reason, permission from respondents to conduct the survey was usually easy to obtain and participants generally were very positive about the project. The goal of collecting TEK to create a repository was made clear from the outset and its potential use for further research was noted. It is clear that researchers pursuing projects that are of benefit to or are at least relevant to the community are more likely to meet with success.

I have examined the ways in which environmental change has been observed by NWR community members. It is possible that the outcome of this analysis may be used for community planning and to inform policy while providing potential opportunities for the mitigation of risk and the enhancement of personal safety. The development of safer travel routes could be focused around areas identified as problematic or potentially risky. Further to this, communications regarding areas of concern for travel advisories could be improved based upon knowledge of the same high-risk areas or prevailing conditions. These potential adaptations would allow individuals more choices when coping with travelling decisions. This would be a step toward reducing risk exposures and improving the adaptive capacities of the residents of NWR.

Given the concern raised by many survey participants regarding the development of cabin properties in Lake Melville and the associated loss of habitat for many species, consideration might be given to developing some policies with regard to new developments or policy regarding the protection of over utilized species. For example, a possible moratorium on further cabin development within a portion of the Lake Melville Lowland ecodistrict may help with conservation measures. This would help the Province of Newfoundland and Labrador help meet Canada's obligations as a signatory to the Aichi biodiversity targets, which require that the province protect seventeen percent of its land and inland waters by 2020 (MacKinnon et al., 2015). A protected area had been considered within this ecodistrict in the past but has yet to be established. Some of these actions may be applied through the development of the Akami-Uapishk^{U}-KakKasuak-Mealy Mountains National Park.

7.4 Future Research

In this thesis, the dataset and analysis were focused on the residents of NWR. This is an isolated view that could easily be compared and contrasted with other communities in the Nunatsiavut region and throughout Labrador. The areas identified as most impacted could be examined in order to identify potential similarities with similar locations in other jurisdictions. One obvious example would be a comparison between the communities of NWR and Rigolet as they have very similar situations historically but are currently very different now due to road access. Rigolet continues to be the focus of ongoing climate change related research (Riedlsperger et al., 2017; Goldhar et al., 2014; Cunsolo Willox et al., 2012; Cunsolo Willox et al., 2013a; Cunsolo Willox et al., 2013b) and this work may simplify a comparison of both communities and assist with documenting environmental change over time.

Similar work could be conducted in a national and international context with other communities in the circumpolar north. Similarities and differences among the communities with regard to their responses to environmental change, as related to the adaptive capacity of those communities and based on varying degrees of isolation, would be interesting to investigate further. This could provide some support for proactive management decisions. As an example, a no hunting area or period could be established in particularly sensitive area.

In addition, the results obtained from the survey provide a starting point for the community to determine further research needs. This review has led to further detailed interviews with individuals identified as the most knowledgeable based on the original survey. These detailed interviews, combined with the existing database and a recently collected repository of place name locations, constitute a significant resource for the community and have become a foundation for Sivunivut's TEK geodatabase housed at the research station in NWR. This research has been collected with the goal of monitoring and documenting environmental and cultural transformation in the face of environmental change in an effort to help maintain the unique cultural identity of the residents of NWR.

The mixed method approach undertaken for this thesis could be applied to many existing datasets. There are a number of examples within Labrador of large detailed TEK collections being underutilized. Recently the NG digitized TEK from *Our Footprints are Everywhere: Inuit Land Use and Occupancy in Labrador* (Brice-Bennett, 1977). Similar underutilized datasets include Lawrence Jackson's (1982) *Bounty of a Barren Coast: Resource Harvest and Settlement in Southern Labrador* as well as a survey completed by Petro Canada: *Resource Harvest Areas of Coastal Labrador* (Northcott, 1982). Internal datasets to Indigenous groups such as the Innu Nation and Nunatukavut could be similarly examined in this way. As well there are unpublished coastal resource inventory datasets housed with the federal Department of Fisheries and Oceans for Labrador. Also, Laidler (2006) states that remote sensing "can be integrated with ethnographic research to study cultural perception of physical change." This is something that could easily be undertaken for other locations with previously recorded TEK data.

It would be of great utility to bring together many of the datasets that exist within Labrador to paint a picture of change over time. Labrador as a whole remains comparatively untouched with regard to development and developing a baseline would aid in the management of future developments. Ongoing efforts of community minded organizations such as Sivunivut can enhance and add new dimensions to our knowledge of Labrador as a whole.

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APPENDIX A

INTERVIEW QUESTIONS

Blue Print for Change: Research Questions
The research questions below are organized by survey topic. The three survey topics are:

1. Locations of safe/unsafe ice, relating to travel routes.
2. Sensitive animal habitat (i.e. seal whelping locations, bird nesting areas, migratory bird staging areas, fish spawning locations, and fish pools (summer/winter)).
3. Potable water sources on the land (where you collect drinking water).

Each survey will be administered by the two Sivunivut researchers, and supervised by myself (at least at first). The two researchers and the individual participant (the person being surveyed) will sit around a table with 1: 250 000 scale maps of the study area (one set for each participant). The researchers will ask each of the questions listed below, and record each of the participant's responses (i.e. the locations they identify) onto the map, in the spot they indicate (each session will be audio recorded as well). Each survey session will last no longer than two hours.

Be certain to have all the required supplies on-hand at the beginning of each survey. This includes: audio recorder/tape (unless digital), markers, pencil, fresh maps, markers, ruler, and the survey handbook.

Introduction Questions:

Please state your name, age and where you live.
Would you say you are very familiar, somewhat familiar or not very familiar with the land covered by these maps?

Would you say you are very familiar, somewhat familiar or not very familiar with Inuit land practices and customs?

1. ICE

Do you know of any places on this map where the water never freezes?

- Have you ever know the water to freeze here? If yes, when?

Are there any places on this map where the water doesn't freeze until late in winter?

- Is this place ever safe for travel on foot or skidoo? If yes, when, and for how long?
- Has the timing changed over the years?

What about places where the ice breaks up early in spring, do you know of any of those on this map?
- Is this place ever safe for travel on foot or skidoo? If yes, when, and for how long?
- Has the timing changed over the years?

Have you ever had to make any adjustments in the travel routes you use to get around in the winter because of changes in ice conditions?
- Were these permanent changes?

Are there any locations on this map where, as far as you know, the ice is always reliable for travel on foot and skidoo?

Are there locations on this map where pressure cracks typically cause problems for winter travel?
- Has the location and extent of these areas changed over time? If yes, when did the major changes occur?

As far as you know, did developments in Labrador over the 1960s and 70s (e.g. upper Churchill, CFB Goose Bay, uses of snow-machines and out-board motors, etc.) have any impact on the timing of freeze-up/break-up and ice conditions. Give some examples.

2. SENSITIVE ANIMAL HABITAT

Seals:

Are there locations on this map where you have seen seals birthing and looking after their pups?
- What species of seal was it?
- What time of year was this?
- Do they often whelp in this location, or was it only once or twice? If yes, what characteristics do you think attract them to this location? For example: are there pressure cracks here?

Have you noticed any changes in the location or timing of the seal whelping? What do you think has caused this change?

Are there locations on this map where you have hunted seal?
- What time of year was this?
- Do you target any specific age group?
- What attracts them to this location? Are they feeding here? What do they feed on?

As far as you know, did developments in Labrador over the 1960s and 70s (e.g. upper Churchill, CFB Goose Bay, use of snow-machines and out-board motors, etc.) have any impact on seals and the areas they use? Give some examples.

Birds:

Can you show me some locations on this map where you commonly encounter migratory birds (geese, black ducks, etc.)?

- What kind of birds were they?
- Is this a staging area, i.e. a place where they congregated on their way north or south?
- Do they stop here every year? Spring or fall?
- What attracts them to this location?

Are these areas where you go to hunt? If no, can you show me some locations on these maps where you would go to hunt ducks and/or geese?

Have you noticed any changes in the timing of bird migrations in the region, i.e. do the birds show up in spring earlier or later, and leave in fall earlier or later?

- If yes, were these changes associated with any significant human events, such as construction of the base in Goose Bay, low level jet training, the Upper Churchill project, or something else?
- Were these changes permanent or have you noticed old patterns returning as base traffic has decreased in recent years?

Are you aware of any islands, or other locations on these maps which are popular for nesting birds?

- What kinds of birds are typically present here, and when?
- Why do you think they choose this location?
- Have you ever collected eggs here or anywhere else? Where?

Have you ever seen scaup anywhere on this map?

- If yes, can you show me some of the locations?
- What time of year was this?
- Have you noticed any changes in the population size of these birds?
- Have they always been present here? If no, when did they start to appear?

What about other birds such as ptarmigan, partridge or grouse – are there locations on these maps where they are typically present?

- What time of year do you normally see them here?

Have you ever had to rely on any other species of bird for food? If yes, when was this and where?

As far as you know, did developments in Labrador over the 1960s and 70s (e.g. upper Churchill, CFB Goose Bay, low-level flying, use of snow-machines and out-board motors, etc.) have any impact on the birds in the region? Give some examples.

Fish:

Can you show me some rivers on this map that get salmon runs?
- Has this always been a good salmon river?
- Do they spawn here?
- Are there rivers that use to get salmon runs, but don't anymore?
- Are there any other locations where salmon are often present? What time of year are they most plentiful here?

Do you know any of the migration routes the salmon typically follow through Lake Melville and Grand Lake?
- Has this changed over time?
- When do they typically enter the lake, and then pass into the rivers?

What about trout, are there any locations on these maps that you would say are good trout pools?
- Are these locations the same in summer and winter? If no, can you show me some summer locations and some winter locations?
- Are there places in the lakes that are good for netting trout? Can you show me some?
- Are there places in the lakes, brooks and rivers that are good for catching trout on pole? Can you show me some?

Do trout spawn in any of the brooks and rivers on these maps? If yes, which ones?

Can you show me some of the locations on these maps where you go ice fishing?
- What type of species would you catch here?
- Are there locations that use to be good for ice fishing, but no longer are?
- Is this because the fish are not present anymore, or the ice is not safe enough?
- When did you notice this change?

Are there any species of fish beside salmon and trout that you like to fish, such as smelt and rock cod?
- How and what time of year do you fish for them? Can you show me some locations where you catch them in summer and winter?
- Have you noticed any changes in the amounts of these fish around?

As far as you know, did developments in Labrador over the 1960s and 70s (e.g. upper Churchill, CFB Goose Bay, low-level flying, use of snow-machines and out-board motors, etc.) have any impact on fish in the region? Give some examples.

3. POTABLE WATER

Are there any locations on this map where you have collected water for drinking? (Both in the past and today)

- Is this a brook, river, pond, spring, or some other type of source (such as a well)?
- Is the water always good at this location?
- If no, what times of year is the water best here?
- Do you know of any drinking water sources (wells, springs, brook, ponds, etc.) where you can't drink the water anymore because it is salty? When did this change occur? Why do you think this happened?

Concluding Questions:

Can you recommend other people in the community that you think we should talk to about the subjects we have just discussed?

- Why do you think it is important that we include them in the survey?

APPENDIX B

MAPPING CODES

Ice
NF (never freezes)
LF (late freeze)
ET (early thaw)
RI (reliable ice)
PC (pressure cracks)

Sensitive Animal Habitat
SB (seals birthing)
SH (seal hunting)
MB (migratory birds)
HB (hunt birds)
NB (nesting birds)
SL (scaup locations)
OB (other birds)
SL (scaup locations)
SR (salmon run)
OR (old runs)
SP (salmon present)
SM (salmon migration)
TP (trout pools)
TS (trout summer)
TW (trout winter)
NT (netting trout)
RT (trout on rod)
TS (trout spawning)
IF (ice fishing)
OI (old ice)
OS (other fish summer)
OW (other fish winter)

Potable Water
DW (drinking water)
SW (salt water)
BW (bad water)

APPENDIX C

CONSENT FORM

Consent Form

Title: Traditional Knowledge: A Blueprint for Change

Researchers: Sivunivut Community Corporation
Chairperson: Ed Tuttauk
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North West River, Labrador, NL
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You are invited to take part in a research project entitled "Traditional Knowledge: A Blueprint for Change."

This form is 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 choose to take part. If you would like more detail about anything mentioned here, or information not included here, just ask. Please take the time to read this carefully and to understand any other information given to you by the researcher. It is entirely up to you to decide whether to take part in this research. If you choose not to take part in the research or if you decide to withdraw from the research once it has started, there will be no negative consequences for you, now or in the future.

Introduction:
Sivunivut and the Labrador Institute have been given money by Health Canada to record land use information from people who live in Northwest River. The information collected will be used to plan more research projects, and help Sivunivut develop a climate change action plan for Northwest River.

Purpose of study:
Sivunivut wants to record knowledge community members have about the animals, water and ice in the area around Northwest River. They believe climate change will impact these resources and that these changes may pose health and safety risks for the Inuit of Northwest River. Learning about these resources will enable Sivunivut to develop programs that will help the community adapt to changes in the environment, and therefore maintain their ties to the land.

What you will do in this study:
You will be asked to identify spots on maps of the area around Northwest River, relating to: safe and unsafe ice conditions, sensitive animal habitat (such as bird nesting locations, seal birthing areas and fish spawning grounds), and spring-water sources. There will also be some discussion around the specific characteristics of each location, and the changes you have witnessed to these locations in your lifetime.

Length of time:
The map survey will not take any longer than two hours.

Possible Benefits:
By participating in the project you will ensure that your knowledge about the land, animals and water is taken into account in future research projects and any climate change action plans for the community. Your knowledge about the land will also be preserved for future generations.

Possible risks:
Although no one will know which spots you identified, they will appear on the maps produced at the end of the project, and people will be able to see these maps in the report we produce and at the town office.

Confidentiality:
Your name will not appear in any of the public documents, and the data you provide will not be available to the public. Anyone who wants to use the information you provide will have to get your approval in writing.

Anonymity:
No one else in the community will be present during your map survey, and your name will not be used in any public form or report. If we do want to use your name we will have to get your written permission. Please note that we cannot keep your participation

anonyms when you speak up in any of the public meetings or talk about the project outside this map survey.

Recording of Data:
The locations you identify during this map survey will be marked on see through map overlays, with a marker dot and a code to identify what it is. Also, the map survey session will be audio taped. No video recording or photographs will be collected.

Reporting of Results:
The locations recorded during this map survey will be placed on the project maps along with all the locations provided by the other participants. They will also be included in a document reporting the results on the project. As mentioned above, your name will not be included in the report or on the map, so people will not be able to tell which spots you identified.

Storage of Data:
The information you give us will be kept at the Labrador Institute. No one will be able to see or use this information without Keith Chaulk's approval. If anyone wants information about you and the other participants, or to know what information you provided Keith will have to get your written permission. Public documents such as the final report and maps will be available at the Sivunivut office in Northwest River and the Labrador Institute library in Happy Valley-Goose Bay. Computer information, such as the GIS database, and the audio cassettes will also be stored at the Labrador Institute. The public and other researchers will need permission to see and use these, also. All the information in the database, and written on the cassettes will be coded so no one, other than the project research team will know which information you provided for the database, or which cassette has your map survey on it.

Questions:
You are welcome to ask questions at any time during your participation in this research. If you would like more information about this study, please contact:

Ed Tuttuk, chairperson
Sivunivut Inuit Community Corporation
e-mail: ed.tuttuak@nunatsiavut.com
tel: (709) 497-8444

Keith Chaulk, director
Labrador Institute
e-mail: keith.chaulk@mun.ca
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Scott Neilsen, researcher
Labrador Institute
e-mail: sneilsen@mun.ca

tel: (709) 497-8392; (709) 899-3362

The proposal for this research has been reviewed by the Interdisciplinary Committee on Ethics in Human Research and found to be in compliance with Memorial University's ethics policy. If you have ethical concerns about the research (such as the way you have been treated or your rights as a participant), you may contact the Chairperson of the ICEHR at icehr@mun.ca or by telephone at 737-2861."

Consent:
Your signature on this form means that:

- You have read the information about the research
- You have been able to ask questions about this study
- You are satisfied with the answers to all of your questions
- You understand what the study is about and what you will be doing
- You understand that you are free to withdraw from the study at any time, without having to give a reason, and that doing so will not affect you now or in the future.

If you sign this form, you do not give up your legal rights, and do not release the researchers from their professional responsibilities.

The researcher will give you a copy of this form for your records.

Your Signature:
I have read and understood the description provided; I have had an opportunity to ask questions and my questions have been answered. I consent to participate in the research project, understanding that I may withdraw my consent at any time. A copy of this Consent Form has been given to me for my records."

______________________________ ______________________________
Signature of participant Date

Researcher's Signature:
I have explained this study to the best of my ability. I invited questions and gave answers. I believe that the participant fully understands what is involved in being in the study, any potential risks of the study and that he or she has freely chosen to be in the study.

______________________________ ______________________________
Signature of investigator Date

APPENDIX D

Nunatsiavut Government

Interim Research Guidelines

UPDATED January 2008

The Nunatsiavut Government (NG) receives numerous requests each year from universities, and other researchers to conduct research in Nunatsiavut. Any research conducted in Nunatsiavut should happen only with the full knowledge and participation of the NG, and first and foremost, the Labrador Inuit community.

In order to ensure that any research conducted involves working together to answer research questions of mutual interest for the benefit of Nunatsiavut, a standard set of Nunatsiavut Research Guidelines is being developed.

Until the guidelines are completed, **we ask any researcher who has a request to conduct research in Nunatsiavut to contact the Inuit Research Advisor.** A review process specific to each case will be initiated, involving appropriate staff. A reply will be sent to the researcher with next steps as soon as possible. This will help ensure the review process is as thorough and fair as possible in the absence of finalized guidelines.

Our review of the proposed research will be more comprehensive and timely if we have some general information on the research for reference. We ask that you provide us with a short non-technical proposal that outlines:

1) Research project title

2) Applicant(s) name and contact information (address, phone, fax, email)

3) Purpose of the research (research question or hypothesis)

4) Activities/methodology

5) Who/what will be the participants/subjects of the research. Include number of participants/samples, and the communities to be included

6) Anticipated research start and end dates

7) The benefit of the project to Nunatsiavut, and/or specific communities within Nunatsiavut

8) Any community representatives you have already contacted regarding this research (name, community, when).

9) How the community or NG will be involved in the planning/conduct of the research

10) How the results will be shared with the individual participants, community, and NG

11) The ownership, access to, and other potential uses of the data

12) The consent process

13) If you already applied for funding to conduct this research, and if so, if the funding has been approved

14) How Labrador Inuit traditional knowledge will be considered and/or incorporated into the research

The Inuit Research Advisor will contact you to confirm that your proposal was received, and will provide you with an estimated time for reply. During this interim research process, this will be determined on a case-by-case basis. NG requires the time to give the research the consideration it deserves.

The NG is very interested in being part of research that involves working together for the benefit of the people of Nunatsiavut. We look forward to receiving research requests that meet this principal requirement.

Please Contact:

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Web site: http://www.nunatsiavut.com/en/lnr_research.php

For more information on Nunatsiavut, you may visit the Nunatsiavut Government website at www.nunatsiavut.com