

**Implications of Socio-Ecological Changes for Inuvialuit Fishing Livelihoods and the  
Country Food System: The Role of Local and Traditional Knowledge**

**Executive Summary**

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## **Abstract**

The Mackenzie River Delta is an ecologically rich freshwater environment in Canada's Northwest Territories. It is vulnerable to multiple stressors such as climate change, resource development activities (oil and natural gas) and upstream-downstream linkages related to extraction activities in the southern part of the Mackenzie River watershed. Resultant socio-ecological impacts affect fishing livelihoods, which represent a significant component of the country food system and ways of life for Inuvialuit (Inuit of the Western Arctic), whose Settlement Area overlaps with the Delta. This thesis analyzes the implications of socio-ecological changes in the Mackenzie River Delta for Inuvialuit fishing livelihoods and the country food system, drawing from Local and Traditional Knowledge.

In collaboration with the Fisheries Joint Management Committee in the Inuvialuit Settlement Region, the westernmost Inuit region in Canada, I undertook a participatory-qualitative research, while also drawing on relevant literature and complementary data. Using 28 semi-structured interviews about changes in the Mackenzie River Delta and the importance of fishing livelihoods, results indicated that fishing livelihoods are essential contributors to the Inuvialuit food system, as well as cultural practices surrounding fishing as an activity. Moreover, some results imply the importance of previously ignored species for food security, such as burbot and inconnu, which receive limited attention in other studies.

Key findings also indicate that multiple environmental changes are occurring in the Delta, including lower water levels, increasing land erosion, decreasing fish populations, and changes in Delta-reliant wildlife populations (e.g. more beavers), warmer water

temperatures, poorer fish quality (e.g. softer flesh, parasites), thinner ice, climate variability, and an escalating cost of living. These changes affect primarily fishing access and raise important concerns about the safety of fish consumption for human health. Ultimately, limited access and declining fish quality have a negative impact on food security, given the key role of fish in the country food system and the importance of socio-cultural dimensions such as fishing knowledge and skills, and sharing practices.

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## **Acronyms**

ABEKS	Arctic Borderlands Ecological Knowledge Society
CBPR	Community-Based Participatory Research
FJMC	Fisheries Joint Management Committee
HTC	Hunters and Trappers Committee
IK	Indigenous Knowledge
ISR	Inuvialuit Settlement Region
LTK	Local Traditional Knowledge
MRB	Mackenzie River Basin
MRD	Mackenzie River Delta
TK	Traditional Knowledge

## **1. Introduction**

Canada's northern freshwater systems are extremely vulnerable to the rapid Arctic biophysical changes related to climate change and other anthropogenic activities (ACIA, 2005; AMAP, 2016). However, uncertainties exist regarding the extent of ecological changes in Arctic freshwater systems and related human impacts. Biophysical changes in freshwater systems stress subsistence activities, which have broader socio-cultural implications related to community health and food security. Indeed, food insecurity represents a pressing public health issue among Arctic Inuit communities, where food insecurity rates are the highest in the country (Kenny, et al., 2018; CCA, 2014).

Fishing livelihoods encompass all subsistence activities that consist of harvesting and processing fish resources. As such, they lie in a complex interplay of environmental, social, cultural and economic dimensions, that depend on healthy aquatic systems. Additionally, fishing livelihoods represent an essential part of the Inuit ways of life, contributing to both the country food system and cultural well-being (ACIA, 2005). Even though fishing is an important and widespread activity that provides resources for many Aboriginal households across Canada's North (Tough, 2000; Harris, & Millerd, 2010), subsistence fisheries are only a secondary theme in the literature examining human dimensions of environmental change (Todd, 2016). The vulnerability of northern freshwater systems to environmental stressors affects the sustainability of Aboriginal fishing livelihoods, which ultimately translates into food security issues (ACIA, 2005). However, while some studies in the field of ethnographic history have focused on Aboriginal fishing economies (Tough, 2000; Harris, & Millerd, 2010), the role of subsistence fisheries in food security has received limited attention in the scientific and

governance fields (Béné, et al., 2015; Islam & Berkes, 2016; Thompson, et al., 2012). In light of these knowledge gaps, and given the current environmental pressures in the Arctic, there is a need to further explore the interconnections between socio-ecological changes, fishing livelihoods, and food security in northern Aboriginal communities.

To fill these knowledge gaps and understand the multidimensional implications of change for social systems, there is a growing interest among scholars to work with local knowledge. Over generations maintaining a strong connection with the land, Aboriginal communities have built a body of knowledge about the environment and its socio-ecological interactions, which has been only recently recognized as an essential source of information in political and scientific spheres (ACIA, 2005; Berkes, 1999).

In line with these efforts, this research is part of a broader project called “Tracking Change” that aims to determine the role of Local and Traditional Knowledge (LTK) in understanding social and ecological changes and related impacts across the Amazon, Mekong and Mackenzie watersheds, to ultimately inform watershed governance processes (Tracking Change, 2016). Since its inception “Tracking Change” has involved Aboriginal partners, LTK advisors, academics, community leaders, and government representatives, characterizing a unique collaboration which drove the development of the project and guided the subsequent sub-projects. This study contributes to one of the community-driven projects, by mobilizing and documenting LTK about social and ecological changes in the Mackenzie River Delta (MRD), the downstream portion of the Mackenzie watershed and area to Inuvialuit from Inuvik and Aklavik, in the Inuvialuit Settlement Region (ISR). Of the six communities comprised in the ISR, Tuktoyaktuk, Paulatuk, Ulukhaktok and Sachs Harbour are coastal communities, whereas Inuvik and Aklavik are located in the delta.

While some people from other communities may use the MRD, Inuvik and Aklavik are the focus of this study (Figure 1).

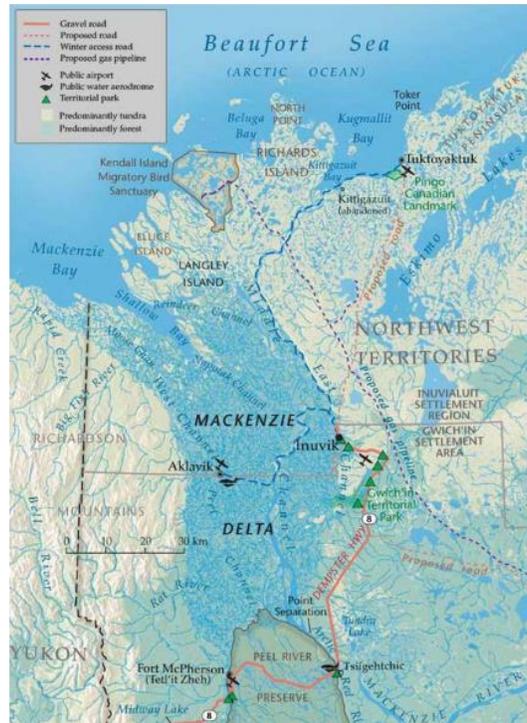


Figure 1: Location of Inuvik, Aklavik, and the Mackenzie River Delta (Fick, 2007)

As uncertainties surround the extent of environmental changes in northern freshwater systems, and subsequent impacts on subsistence fisheries, and the role of fish in Inuit country food systems has been understudied (ACIA, 2005; Islam & Berkes, 2016; Todd, 2016), this research uses the MRD, as local case study, to examine the linkages between environmental change, fishing livelihood and food security. By adopting a livelihood approach that encompasses complex socio-cultural dimensions such as the importance of social capital, this research highlights the interdependence between the Delta and subsistence fisheries, both exposed to a set of social and environmental stressors at local, national and global scales, ultimately unveiling the human impacts of changing fishing systems (Bodin & Prell, 2011; Coulthard, 2012; Ellis, 2000). As such, this

community-based participatory research draws on LTK to understand the implications of socio-ecological changes in the MRD for Inuvialuit fishing livelihoods and the country food system. The objectives of this research include:

1. Assessing the local importance of Inuvialuit fishing livelihoods in the MRD;
2. Identifying socio-ecological changes related to fish ecology and fish procurement in the MRD, and related impacts; and,
3. Understanding the critical implications of changing Inuvialuit fishing systems on food security.

This executive summary compiles the results analysis and discussion of the research project. After presenting the methodology used to conduct this community-based participatory research (CBPR), the following chapter discusses the importance of fishing livelihoods in the MRD, as well as the socio-ecological changes in the fishing system and related impacts. The chapter is structured into three main sections: the first examines the role of Inuvialuit fishing livelihoods in the country food system, providing a contextual overview of fishing practices and preferences; the second examines the vulnerability context of fishing livelihoods, through local observations of socio-ecological changes in the Delta; the third discusses the impacts of change on fishing livelihoods and implications for food security. Finally, Chapter 5 summarizes key findings as well as theoretical, methodological and practical contributions, and provides recommendations for future research.

## **2. Methodology**

To achieve this research objectives, I undertook a community-based participatory research (CBPR) approach, using ethnographic methods to capture local observations and experiences related to fishing in the MRD (Grenier, 1998; Creswell, 2013). Data collection involved semi-structured interviews that were conducted with active fishers in Inuvik and Aklavik. Interviews were developed in partnership with the FJMC following guidelines from the Tracking Change project about potential methods for CBPR on socio-ecological changes in freshwater systems such as on-the-land activities, participatory photography and interview questions adapted for oral stories (Parlee & Fresque-Baxter, 2016). The interview questions were comprehensive since the FJMC wanted to take this opportunity to incorporate different objectives. As such, the questionnaire comprised three components. The first component consisted of a series of open-ended questions about changes in the MRD, memories and experiences related to fishing, as well as the social, cultural and economic importance of fishing livelihoods. Overall, the questions offered some flexibility in participants' answers, since LTK is embedded in oral tradition and story-telling (Grenier, 1998). The second component involved participatory mapping. During the interviews, various maps of the area and markers were provided to participants to locate observations of change and experiences of fishing. Finally, the third component aimed to address the FJMC's need to collect further qualitative and quantitative data about harvests levels per fish species.

During summer 2016, 10 interviews were conducted in Inuvik and Aklavik, by a Gwich'in-Inuvialuit youth intern from the FJMC and myself. Additional interviews were conducted in Inuvik over winter 2016 by a local assistant hired by the FJMC and over

summer 2017 by a new FJMC staff member. It is important to note that fifteen interviews from winter 2016 were not audio-recorded (unintentionally), although comprehensive interview notes were completed. Throughout data collection, a snowball sampling method was used to reach out potential informants after the HTC's in Inuvik and Aklavik helped the research team to connect with primary contacts. Additionally, the research team conducted the interviews with some flexibility, adapting the length and the articulation of the questions in order to facilitate a discussion format and respect the participants' availability. Overall, the thesis comprises data from 28 semi-structured interviews with 32 participants in both Inuvik and Aklavik. Table 1 summarizes the participants' profile.

*Table 1: Participants profile*

Community	Aklavik	9
	Inuvik	23
Gender	Female	15
	Male	17
Age	< 30	4
	30-60	21
	> 60	7

In addition to the semi-structured interviews, I applied to access existing data from certain components of the Arctic Borderlands Ecological Knowledge Society (ABEKS) database. The ABEKS is a non-profit society that implements ecological monitoring programs in the MRD, Yukon and Alaska. Established in 1994, the ABEKS is the result of discussions involving Aboriginal organizations as well as federal and territorial governments about the decline of the Porcupine Caribou Herd (ABEKS, 2014). Since then, the ABEKS expanded its monitoring program to cover comprehensive information related to wildlife and weather based on both science and LTK. Community researchers conduct

annual interviews with local hunters and fishers about harvest levels per species and observations of change. Additionally, results are analyzed and reported each year.

Over the years, the ABEKS has developed an important database which compiles longitudinal data from land-users in multiple communities. With the support of the FJMC and the HTC, I accessed raw data from the fishing section of surveys (Appendix F) conducted with the Inuvialuit in both Inuvik and Aklavik from 2010 to 2015. The data contains the responses of 338 informants over the five-year period and includes indicators and observations related to environmental change, fish harvest levels, and fishing practices, such as the amount of fish caught (per specie), the amount of time spent fishing per year, or the number of persons involved in sharing networks.

### **3. Results & Discussion**

This chapter discusses how socio-ecological changes in the MRD affect Inuvialuit fishing livelihoods, particularly from a socio-cultural perspective. This chapter focuses on local experiences of change affecting fishers and fisheries in the MRD. The analysis draws on results from 28 semi-structured interviews conducted with 32 Inuvialuit fishers in Inuvik and Aklavik from 2016 to 2017, and data from 338 questionnaires carried out between 2010 and 2015 that was access from the ABEKS database. This chapter consists of three main sections: the first examines the role of Inuvialuit fishing livelihoods in the country food system (research objective 1), providing a contextual overview of fishing practices and preferences; the second examines the vulnerability context of fishing livelihoods, through local observations of socio-ecological changes in the Delta (research

objective 2); the third discusses the impacts of change on fishing livelihoods and implications for food security (research objective 3).

### **3.1 The Role of Fish in the Country Food System**

Fishing is a key traditional activity that is historically important for Inuvialuit subsistence and culture (MRBB, 2004; Papik, Marschke & Ayles, 2003). While fishing practices and harvest levels have changed, fishing livelihoods continue to represent an important contributor to the Inuvialuit country food system and well-being (Usher, 2002). Based on LTK, drawn from interviews, the ABEKS database, and existing literature, this section examines the socio-cultural importance of fishing livelihoods, by examining fishing experiences, practices and preferences.

#### ***3.1.1 Fishing practices***

Although the scope of this research focuses on the MRD, the Inuvialuit from Inuvik and Aklavik conduct fishing activities across a large territory that comprises multiple key sites along the coastline, the Yukon North Slope, and the Husky Lakes north of Inuvik. Historically, Inuvialuit fished along the coast, at places such as Herschel Island or Shingle Point, where they were also living (Papik, Marschke & Ayles, 2003). With the development of the fur trade industry and the implementation of trading posts in the region in the 1930's, many Inuvialuit started to move to Aklavik (Inuvialuit Cultural Resource Centre, 2012). Since the 1960s, the transition towards a wage economy and an increasing availability of technology, along with the construction of Inuvik as a new administrative centre, have changed the Inuvialuit way of life (Usher, 2002). The underlying consequences of such

socio-economic change like the replacement of dog teams by modern transportation and the shift from full-time to part-time hunting and fishing resulted in a decline in the number of harvesters and lower fish harvest levels (Joint Secretariat, 2003; Usher, 2002). Nevertheless, while fishing needs, locations and practices have evolved, fishing continues to be an essential component of the country food system and Inuvialuit ways of life.

Fishing practices change over time depending on multiple socio-economic and environmental factors. Drawing from semi-structured interviews and some fishing studies in the region, prevailing fishing habits related to seasonality, techniques and strategies can be identified. Although fish is perceived to be available and accessible year-round, subsistence fishing occurs more regularly from July through December, with a peak during the fall (Tallman & Reist, 1997). During the summer, it is common to fish at the mouths of rivers and creeks for sustenance, when harvesters spend time at whaling camps along the coast, (Papik, Marschke & Ayles, 2003; Norton, 1997). One participant notably described:

I used to place a net in the creek near my whaling fish camp in July. I put the net and I have to go and check time to time if I got fish. (IN1, pers. comm., 2016)

In the Delta, the principal fishing season is in the fall, particularly during October and November, a timeframe that usually corresponds to the formation of sufficient and safe ice cover, while avoiding the coldest weather of the winter months (Tallman & Reist, 1997). Traditional fishing sites are located on the channels of the Mackenzie River as well as on tributary streams and lakes, where most participants have their own cabins in addition to whaling camps along the coast.

Both historically and today, the most commonly used fishing gear remains the gill net, which can be set in open waters as well as under the ice (Norton, 1997; Papik,

Marschke & Ayles, 2003). Gill nets are typically used to catch whitefish and inconnu, whose anadromous<sup>1</sup> populations spawn in the Delta in early fall, although some populations are lake dwelling in other areas (Community of Inuvik, et al., 2008). However, in the fall and winter, if fish is abundant, jigging under ice is another fishing technique that is commonly used. Jigging is also the principal technique to target burbot, as this specie spawns in midwinter in less than three metres of water under the ice, before moving to deep waters in the summer (Community of Aklavik, et al., 2008). One fisher described the fishing methods that he uses:

Mostly jigging under ice during the fall-winter and fishing rod for the rest of the time. (IN2, pers. comm., 2016)

Another participant indicated his preferred fishing gear to catch fish:

And then, we do a lot of jigging, like I said. [...] We could jiggle all winter just, you know. IN6, pers. comm., 2017)

While results do not indicate any strategy targeting a particular type of fish (e.g. sex or size), large female whitefish are considered a delicacy because of their eggs (Papik, Marschke & Ayles, 2003; Norton, 1997). However, once the amount of fish caught is considered to be sufficient for subsistence needs, harvesters suspend their activities, for instance, by pulling the nets out, in order to avoid obstructing the fish runs, especially for the spawning fish (Tallman & Reist, 1997). Such local management strategies are common practice among harvesters. These practices reflect ethical standards to prevent the overuse of a resource in order to sustain its availability, ensuring everyone's survival, fish included. In 1997, one participant to a workshop organized by the FJMC about broad whitefish explained:

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<sup>1</sup> Anadromous fish refers to fish species that are born in freshwater, grow in salt water and migrate back into freshwater to spawn (Fishionary, 2019)

For example, when people are fishing in the fall and they want the fish eggs that are a delicacy; some people say that when they've had enough they would pull their nets to make sure that the spawning fish could travel by. They wouldn't keep fishing just for the sake of fishing. There was a consciousness that the spawning fish be allowed to continue upstream. (Freeman, 1997, p. 36).

On a similar note, one interview participant emphasised the importance of transmitting ethical values:

We would gather food when we need it. But we were taught not to over hunt. And that's what we try to pass on to the younger generation. Not to over hunt. Because some day you might need it and it's not going be there. (IN7, pers. comm., 2017)

These ethical standards are part of a complex structure of values embedded in reciprocal human-nature relationships and system of responsibilities (Todd, 2016). Fishers are responsible to support healthy fish stocks to continue to benefit from services provided by the ecosystem. This responsibility reflects a sense of “interconnectedness” and respect towards the land.

Another important fishing tradition consist of sharing. Such practices are an important part of the Inuvialuit culture and have remained essential through history (Papik, Marschke & Ayles, 2003). All interview and ABEKS participants indicated that they share their fishing harvests. Forty percent of interview participants and 30% of ABEKS participants reported sharing with more than 10 people. Based on the answers, it is unclear how the participants calculate the number of individuals with whom they share their harvests, but it is likely that they do not count the family members supported by those individuals, which further extends the sharing network. A full-time harvester described the extent of his sharing network:

But most of the time when I fish, it is mostly to feed my Elders and my family, I have a huge extended family. I am pretty much the only one that goes out and harvest for them. (IN4, pers. comm., 2016)

Another participant highlighted how her young sons reproduce sharing practices:

My son, my ten years old, fills up a whole freezer of fileted fish and dry fish and that and when he comes home he just gives it out to the elders. (IN5, pers. comm.,2017).

While only one participant started recently to sell fish for extra money for gas, all participants share their harvests with family and friends. Through these reciprocal relationships, some participants receive caribou, reindeer, salmon, char or geese in return, even though most interviewees clearly state that they do not expect anything. Some participants also share with Elders or other vulnerable community members who may not otherwise be able to access country foods. Additionally, some fishers share with members from other communities, such as Sachs Harbour, Paulatuk, Tuktoyaktuk or others in Yukon and Alaska. Kinship and family relationships, that are the primary factors of food distribution, can involve a large number of individuals in different communities. As a result, and as seen in other locations such as Cree communities in the North Peace River region of Alberta (Natcher 2015), food-sharing networks cover a significant geographical area in addition to involving a large number of individuals.

Fishing livelihoods also represent knowledge and skills learning opportunities, particularly when associated with life at whaling camps along the coast or cabins in the Delta with family members. In comparison with other traditional activities, fishing is relatively more accessible for all the household members. For instance, an interviewee shared a personal story of spending time on the land with her grandparents and learning from them:

I was always fishing since I was a kid too. (...) Yeah, I lived on the land since I was like four years old, with my grandparents. (...) Just my grandparents taught us that it's important and it's healthier to eat your traditional foods than store-bought. (IN5, pers. comm., 2017)

Fishing livelihoods comprise essential socio-cultural dimensions that are embedded in a structure of values, such as sharing, relationships and knowledge transmission (Coulthard, 2012). In fact, social networks enable access to country foods, and represent channels to share information, knowledge and skills (Natcher, 2015). As such, relationships are key components of the social capital of Inuvialuit communities.

### ***3.1.2 Fish preferences***

Inuvialuit fishing livelihoods are diverse and complex. Different fish species are targeted, and harvest levels vary by ecological system and community. Broad whitefish is considered to be the preferred species and has thus received greater attention from monitoring and research programs in comparison with other freshwater fish (Norton, 1997; Tallman & Reist, 1997). Results from the Inuvialuit Harvest Study indicate that importance of whitefish is especially important. Indeed, the ten-year (1988-1997) mean of the total estimated whitefish harvest is almost ten times higher than any other marine or freshwater fish species in Inuvik, and almost six times higher in Aklavik (Joint Secretariat, 2003). In 1997, a workshop was organized by the FJMC to discuss the results of a two years study providing a multidisciplinary assessment of the condition and life of broad whitefish, which included a traditional knowledge component (Tallman & Reist, 1997). This study recognized the importance of whitefish for food consumption as well as its potential role for supporting commercial fisheries in the MRD. While this study constitutes the most comprehensive effort on any freshwater fish in the Inuvialuit Settlement Region, it notably concluded that the single species approach to fishing livelihoods ignores the complex interactions between species as well as with the ecosystem (Tallman & Reist, 1997). As

such, there remained a number of knowledge gaps limiting the understanding of freshwater fisheries, and consequently the development of management strategies related for instance, to commercial fisheries.

In the MRD, results from both the semi-structured interviews and the ABEKS database indicate that the most important freshwater species for subsistence for the communities of Inuvik and Aklavik are: inconnu (*higaq*), commonly named “coney”; burbot (*tittaaliq*) or “loche”; and whitefish species, which comprise broad whitefish (*anaakiq*) and lake whitefish (*pikuktuq*). Figure 7 illustrates the ranking of fish species that contribute the most to participants’ subsistence, as identified by interviewees. Results clearly show that whitefish was ranked the most often as the primary contributor. However, both inconnu and burbot appear to be significant secondary species, if we take into consideration the overall number of participants ranking them in second and third positions. This is particularly significant as these results derive from an open-ended question, where participants did not have a list of predetermined species to rank.

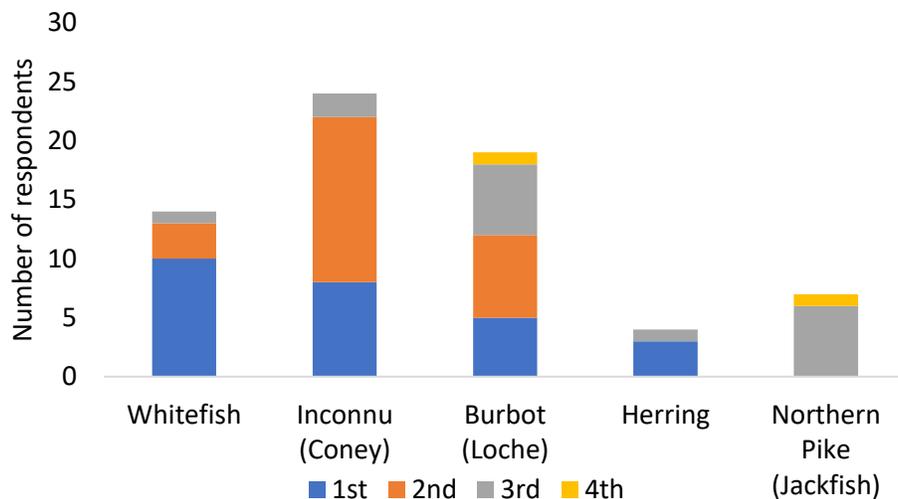


Figure 7: Ranking distribution of fish species contributing the most to participant diets, where 1<sup>st</sup>-4<sup>th</sup> indicate the rank of a particular species in terms of prominence in the diet (based on interviews, N=28)

Results from the ABEKS database corroborate the importance of inconnu and burbot. Approximately 60% of ABEKS respondents fished inconnu and whitefish, and 75% fished inconnu. Regarding harvest levels, table 2 summarizes the amount of marine and freshwater fish caught per species, by Inuvialuit harvesters from Inuvik and Aklavik. Table 2 presents the results of a fish monitoring report prepared for ABEKS, based on 156 survey responses (ABEKS, 2016). Results indicate that inconnu is the most harvested species, followed closely by broad whitefish in Aklavik, while there is a greater amount of whitefish caught, followed by inconnu and burbot in Inuvik. It is worth noting that the difference in harvest levels between the two communities reflects the size of their populations. Additionally, the category “other” reveals the difficulty and uncertainty related to the identification of fish species.

*Table 2: Number of fish caught in Aklavik and Inuvik pooled across a four-year survey period, 2009-2013 (ABEKS; N= 156).*

<b>Fish Species</b>	<b>Aklavik (Inuvialuit)</b>	<b>Inuvik (Inuvialuit)</b>
Whitefish	<b>2,494</b>	<b>18,358</b>
Inconnu	<b>3,208</b>	<b>6,125</b>
Burbot	<b>422</b>	<b>1,404</b>
Herring	990	580
Northern Pike	181	560
Dolly Varden	20	143
Lake Trout	0	182
Salmon (All)	12	8
Arctic Grayling	5	10
Other	1,872	1,765

<b>Fish Species</b>	<b>Aklavik (Inuvialuit)</b>	<b>Inuvik (Inuvialuit)</b>
Whitefish	<b>2,494</b>	<b>18,358</b>
Inconnu	<b>3,208</b>	<b>6,125</b>
Burbot	<b>422</b>	<b>1,404</b>
Herring	990	580
Northern Pike	181	560
Dolly Varden	20	143
Lake Trout	0	182
Salmon (All)	12	8
<b>Grand Total</b>	<b>9,204</b>	<b>29,135</b>

Although whitefish is one of the favourite country foods, results from both semi-structured interviews and the ABEKS database clearly highlight the importance of secondary species, such as burbot and inconnu, a finding that has received limited attention in other studies. Since the biology of these species is still little-known, some participants expressed the need to improve current knowledge. For instance, one fisher expressed an interest in expanding existing monitoring programs on burbot carried out in other Aboriginal communities:

Well, one thing that I really find intriguing was the burbot project that is run by the Gwich'in right now for their livers. They are looking at the livers of the burbot and contaminants in it. I wish that project would have gone cross-board to...onto our (Inuvialuit) side of things. (...). Because we do catch a lot and they're just a small...one community, right? And we have like 3 or 4 communities in the ISR, you know, that we fish for and we're a pretty large group of people. And we utilize all those fishing sites and they utilize all the way up the river too. So, I think that if they expand the project to include us, you know, you could have a better dataset from a larger sampling area, right? (IN4, pers. comm., 2016)

Secondary fish species such as burbot and inconnu have been overlooked in other studies. As such, there is a need for implementing monitoring programs that focus on those species, as they contribute significantly to the country food system. Since fish resources and locations are sometimes shared by different Aboriginal communities, developing joint collaborative efforts represent an opportunity to address common concerns and knowledge gaps.

### ***3.1.3 Importance of fishing for Inuvialuit people***

Results from both the semi-structured interviews and the ABEKS database confirm the current importance of Inuvialuit fishing livelihoods. Ninety-three percent of respondents to ABEKS surveys fish regularly and 40% spend more than thirty days per year fishing. Moreover, 80% of participants reported to always meet their needs for fish. Likewise, all interview participants qualified fishing activities as very important. Additionally, they identified two main reasons why fishing livelihoods are still important today: fish is a critical source of food, and fishing is essential to Inuvialuit ways of life. The majority of participants declared that more than half of their food consumption comes from harvesting. Only four interview participants estimated their country food consumption to be less than 25%. Fish is thus not only a significant source of food but also plays a key role in the country food system. The importance of fish in Inuvialuit diet is predominant in the interviews. For instance, one interview participant noted the following:

It is very important. It is part of my diet. (IN2, pers. comm., 2016)

One a similar note, an informant highlighted the frequency of fish consumption:

It's very important because we eat it all the time. We eat fish, more than like, store bought meats. (...) Like every day it's either, it's fish or caribou meat. (IN5, pers. comm., 2017)

Fish also represents a means to sustain other aspects of traditional livelihoods. Indeed, fishing requires relatively little time and effort for catching and processing, in comparison to other species, particularly in the context of seasonal sustenance at whaling camps and cabins. A participant stressed the importance of fishing as a steady source of food all year-round:

It is very important. It provides food. It provides what you get on the table. You can rely on fish all year round. I have a whaling camp on the coast. I wouldn't take a job that doesn't give my month of July off for the whaling season. I also have a year around fish camp in the Delta. But I don't go often. But I am working on it to spend more time when I retire. For example, whales and dry fish provide food for the whole winter. The quality of our winters used to depend on that. (IN1, pers. comm., 2016)

Moreover, there is a common perception that fish are immediately available. Although the peak season for freshwater species in the MRD lasts from July until December, it is possible to procure fish all year round. As such, this perceived availability provides a sense of security, in that there is always a consistent, accessible source of food, in case of need. A fisher highlighted the immediate availability of fish:

If you're going by boat or you just want to stop here or there and just fish, because there's so many places, right. (IN7, pers. comm., 2017).

Sharing a similar perspective, another participant described how he can always fish if he wanted to:

And if I really need fish and I am really dying for fish in the springtime, then I will set a net in May, late May, June. Just to get fresh fish, yeah. If I don't have any in the freezer. (IN4, pers. comm., 2016)

One interviewee also expressed confidence in the stability of fish stocks in comparison to other country foods that are perceived to be more vulnerable:

Well, it might be the only thing available someday, I guess. (AK2, pers. comm., 2016)

Additionally, perceived levels of availability of different types of fish increases harvester agency to make food choices based on personal preferences, which represents an essential component of food security (Kenny, et al., 2018; Lambden, 2007). Results from this study indicate that Inuvialuit fishing livelihoods are characterized by the relatively constant availability of different species in various locations, all year round, which is not the case for other culturally-preferred foods such as caribou (Community of Aklavik, et al., 2008; Community of Inuvik, et al., 2008; Pearce, et al., 2009). As such, since the current fishing system provides some degree of diversity, harvesters can afford to be selective, and adapt fishing practices according to their preferences. For instance, a participant notes the following:

I have been offered so many times for salmon, char. But I can't eat it. I get sick, it is too rich. And trout and... I would love to eat it but I get sick. (Laughs.) (IN3, pers. comm., 2016)

Second, fishing is considered to be part of Inuvialuit ways of life. This recurrent theme encompasses a body of culturally-rooted emotions, values and practices that include spending time on the land, fishing, hunting, trapping, plant gathering, and sharing. All interviewees shared memories of fishing places from their childhood, describing fishing as part of their upbringing. These memories are associated mainly with a good quality of fishing in addition to its importance as a source of traditional foods. Additionally, these memories reflect the importance of spending time on the land fishing with family members or the more recent accomplishments of their children. One participant stated that fishing is simply essential to his life:

I lived on fishing all my life. So, that's sort of like a (...) tradition. (AK6, pers. comm., 2016)

One fisher shared early memories of fishing associated with the value of spending time on the land with family members:

Maybe when I was seven or eight, we used to go whaling with my parents. They've always fished. They had a bush camp in the Delta so we'd go there for the holidays. (IN3, pers. comm., 2016)

Another participant outlined the importance of fishing for building good family relationships and transmitting skills:

I go every summer at my whaling fish camp with family members. My son caught his first beluga whale. He already shot one, but now he shot and harpooned it. I was not in the boat but that was an important moment. And now with boats and cars we can go and catch a whale or a caribou in one day and come back. But people like to stay in fish camps and prepare the food because it's peaceful up there. We are together and enjoy the land. IN1, pers. comm., 2016)

A participant also highlighted the role of fishing for his well-being, contributing to a sense of peace:

Just being out there and be in the environment, your brain starts flowing. (IN7, pers. comm., 2017)

Fishing experiences unveil personal feelings and meanings that ultimately contribute to the subjective dimension of well-being (Coulthard, 2012). Although it cannot be measured, there is an undeniable intimate value in such memories, in addition to the knowledge and skills required to pursue fishing. As such, while fish is an essential source of food, fishing activities are intimately related to Inuvialuit ways of life, as well as LTK transmission and learning.

## **3.2 Socio-Ecological Changes in the Mackenzie River Delta**

The current literature highlights the vulnerability of northern ecosystems to rapid and dramatic environmental changes. However, impacts on freshwater systems and fisheries are poorly understood. Since natural science is unable to generate sufficient knowledge to understand the complexity of these changes (Tallman & Reist, 1997), LTK can be used as a complementary knowledge source for collecting rich information on changes experienced in the MRD. As such, this section addresses the second objective of this research, which consists of identifying socio-ecological changes related to fish ecology and fish procurement in the Delta based on local observations and experiences. Drawn from the semi-structured interviews, the results are organized into three groupings. First, indicators of change in fishing conditions are presented, which comprises observations related to fish habitat, Delta-reliant wildlife, and climate. The second grouping encompasses the changes observed in fish quality and abundance. The third grouping examines key socio-economic changes affecting fishing livelihoods. Ultimately, these findings define the vulnerability context of fishing livelihoods, that will be discussed in a final section.

### ***3.2.1 LTK Indicators of change in fishing conditions***

Participants reported multiple environmental changes related to fishing conditions. In order of frequency, the most cited observations included erosion, increasing populations of beavers and otters, lower water levels, warmer water temperature, declining water quality, changing climate, and changing snow-ice conditions, which include thinner ice and delayed fall freeze-up/earlier spring break-up. Table 3 summarizes the recurrent changes

observed in the Delta, and related impacts, that will be examined more thoroughly in section 4.2.4.

*Table 3: Summary of observed environmental changes in the Delta (based on the interviews, N=28)*

<b>Theme</b>	<b>Indicator</b>	<b>Observations</b>	<b>Livelihood impacts</b>
Land	Erosion	Erosion & slumps	Increasing water turbidity, decreased travel safety & risks for built environment (e.g. cabin safety)
Wildlife	Beavers	Increased beaver population	Increased number of dams and lodges that affect travel access and water levels
	Muskrats	Declining muskrat population	Concerns regarding water quality
Water levels	Desiccation process	Some lakes and creeks have dried up	Loss of fishing locations
	Sandbars	Increased number of sandbars	Altered travel patterns and reduced fishing access
Water temperature	Water temperature	Warmer water, particularly during summertime	Possible effect on fish quality
Water quality	Turbidity	Dirtier water	Concerns regarding water quality and fish health
Water flow	Water flow	Places with stagnant water, bad taste, bad smell, different colour	Concerns regarding water and fish health
Climate	Climate	Increased variability and unpredictability	Decreased travel safety
Ice	Ice thickness	Reduced ice thickness in certain areas	Decreased travel safety
	Freeze-up/break-up	Longer freeze-up/break-up periods & changes in timing (e.g. earlier break-up)	Access to fishing and hunting areas is more dangerous and unpredictable, but more boating opportunities (-/+)

Increasing erosion processes represent one of the most important issues observed in the MRD, affecting homes and cabins near rivers and lakes, as well as the water quality (ABEKS, 2018; Nickels, et al., 2005). Most participants indicate observations of slumping, landslides and erosion of banks and shores (ABEKS, 2016). This concern is also shared in

coastal communities of the region, such as in Tuktoyaktuk (Riedlinger, 2001; Pearce, et al. 2011). A participant noted:

There really are some banks falling. A lot of banks falling. (IN3, pers. comm., 2016)

Another fisher expressed his concern over the increasing observations of slumps:

And we see a lot of slumping and stuff in the edges. And in the uplands, all these lakes, they have slumps on them now when they used not to have them. And that has lots to do with water quality too. (IN4, pers. comm., 2016)

Another prevailing concern derives from observations of change in Delta-reliant wildlife, such as beavers, otters and muskrats. Harvesters reported a decline of muskrats, raising concerns about water quality, since a healthy population is perceived to indicate good water quality (Nickels, et al., 2005). A fisher reflected on the importance of a healthy muskrat population:

The Delta on this side used to be... just full with muskrats. Now there is nothing. And you know, after they left, that is when our water really started dying. Really...and it had some kind of whitish stuff floating. That's happened. But now, they are starting to come back. Just the change, I guess..." (IN3, pers. comm., 2016)

However, most participants observed an increasing population of beavers, which negatively affects water quality as well as travel access. Additionally, many participants highlighted rapid desiccation processes in multiple popular fishing sites resulting from beaver dams. For instance, a fisher reported changes in the size and abundance of beavers:

Beavers. There are too many beavers and they are bigger and bigger. They are in the lakes and you can't access in some lakes anymore. My sister shot a beaver and it was 90 pounds! (IN2, pers. comm., 2016)

Another participant described the impact of beavers on fishing quality:

It used to be a hot spot. And over the past five years, four years, there's been nothing there. I think that beavers are blocking up that creek. (IN7, pers. comm., 2017)

Additionally, one interviewee discussed how beavers are indicators of water quality:

Where we haul water from for our own use, like I said, I always watch where I ... where I get water from because I watch the beavers. So if I see lots of beavers in one area, I won't get water from that area. I mean I was taught that from my grandparents. (IN6, pers. comm., 2017)

Regarding water quality, participants noticed higher levels of turbidity, which makes the water appear dirty and murky. Changes in the colour, smell and taste of water have also been observed, indicating its reduced quality. Additionally, observations of a 'swampy' taste have been previously documented in other communities such as Tuktoyaktuk, raising health concerns related to human consumption as well as risks to wildlife (Nickels, et al., 2005). A participant reported inexplicable decline of water quality:

I got a lot of dead water on my place, yeah. And I don't know who to talk to about that. But I brought it up in the HTC meeting and they are going to try to get someone to go do testing again (...) It just tastes gross. (IN3, pers. comm., 2016)

Another informant also indicated similar observations:

I know when I fish the lakes, there are smaller lakes behind our houses, we would get water from them but now they are all like green and stinky and, so I don't know what that is. (IN5, pers. comm., 2017)

The water temperature is another essential indicator of change. While several participants also highlighted warmer temperature in the ocean, the concerns focused mostly on the waters of the Delta, particularly during the summertime, which, according to some participants, results in poor fish quality. Consequently, many participants indicated that they prefer not to fish in the MRD during the summer. This finding corroborates results from other studies, which highlights the importance of this issue particularly for the residents of Inuvik (Nickels, et al., 2005; Tallman & Reist, 1997). For instance, a fisher in Inuvik discussed the importance of water temperature for the quality of fish:

But there was a time...I don't know...let's say 15-20 years ago, where the water started warming up and people noticed the fish meat becoming mushy and not so firm anymore...at certain time in the summer when the water was the warmest. To

those times, people didn't really fish too much, which was new to me because I never really thought about it like that. Because, normally our river waters were always cold and fish were always good. And now the thing is that the water level or the water temperatures is warming up so much so that the fish is not good in that period. So people have to catch their fish earlier in the spring and later in the fall. So that they can catch good quality fish. (IN4, pers. comm., 2016)

Regarding water quantity, most participants reported observations of lower levels across the Delta. Participants reported more sandbars as well as accelerated desiccation processes. One participant described how some important fishing areas have dried up:

For fishing, I don't really fish too much in that area anymore because a lot of the good fishing creeks over the years have dried up. Or the lakes have busted open in another place where... and those creeks dry because they flow somewhere else now. (IN4, pers. comm., 2016)

Another informant described how lower water levels affect access to traditionally popular fishing places:

That place down here, the mouth of big fish river, people used to fish there too, but a little bit different area, but because of low water and the way things are changing, this may be... this was 20, more than 20 years ago, but even now, through the HTC, we do allow fishing there annually for up to 30 chars, but because of low water, people can't even get into the mouth of big fish river. So, it's very rare that people will go there to fish, but it used to be a hotspot. (AK5, pers. comm., 2016)

Although a small number of participants reported higher water levels, these contrasting results were associated with observations from whaling camps along the coast and specifically attributed to heavier rains during the summer of 2016, which ultimately illustrates the increasing variability of weather conditions.

In addition to these hydrological variables, other important indicators of environmental change have indirect impacts on fishing livelihoods. Climate variability and unpredictability were discussed indirectly several times, when referencing the extreme weather conditions and high precipitation events during the summer of the fieldwork. More frequent extreme weather events as well as warming temperatures have been well-

documented in the region, with the temperature rising by an average of 3°C in Inuvik over the past 50 years, which corresponds to one of the greatest increases recorded (GNWT, 2008 & Pearce, et al. 2011). Ice conditions are also changing. Lake and river ice are thinner. Additionally, spring break-up arrives earlier in the year while fall freeze-up is a late and longer process (ABEKS, 2008). Although few participants communicated these observations, they are prevailing indicators in other studies focusing in the region (ABEKS, 2018; Nickels, et al., 2005; Riedlinger, 2001). Ice conditions, abundance and distribution as well as freeze-up/break-up timing and rate affect the safety and predictability of travel in addition to wildlife migration patterns (ACIA, 2005).

### ***3.2.2 LTK Indicators of change in fish availability and quality***

In comparison with the results discussed in section 4.2.1, there is a greater variability of responses related to changes in fish populations and quality, which reflects the complexity of fishing systems. Indeed, each harvester accesses different locations, and fish different populations during different seasons, comprising both migratory and non-migratory stocks (Norton, 1997). Additionally, tracking changes in fish quality is challenged by the uncertainty of species identification (ABEKS, 2008; Parks Canada, 2011). As such, observations of change vary. Key findings reveal some changes in the flesh texture of whitefish, fish health, abundance of undesired species, and decline of preferred species. Table 4 compiles the most recurrent changes related to fish abundance and quality observed by harvesters.

Table 4: Summary of observed changes in fish quality and population (based on the interviews, N=28)

Theme	Indicator	Observation	Livelihood impacts
Fish quality	Flesh texture	Softer flesh, particularly in whitefish during summertime	Preference for fish from the ocean during the summertime
	Fish appearance	Smaller and skinnier burbot	N/A
		Increased scars and lumps, particularly in inconnu	Not edible
	Livers	Discolouration or black spots on livers, particularly in burbot	Not edible
Parasites & worms	More fish with higher parasite loads, particularly in inconnu	Not edible	
Fish population	New species	New observations of Chum Salmon in the Delta	Additional species for consumption
	More fish	More northern pike	Imbalance in fish interrelationships
	Less fish	Fewer whitefish	Change of fishing practices and locations
Fewer burbot			

Regarding whitefish, many participants expressed concerns regarding the quality of its flesh, which is considered as softer and ‘watery’ in the MRD, particularly during the summer months. Consequently, harvesters prefer to catch fish in salt water during that period (Papik, Marschke & Ayles, 2003). For instance, a fisher observed a correlation between the season and fish quality:

I don’t know what it is. It is in the summertime that it does that. In the wintertime, when they are ice fishing, the fish is good. It is not soft. (IN3, pers. comm., 2016)

Another participant indicated her preference for fish coming from the ocean given the observations of poor fish quality in the MRD:

I am thinking maybe it is the salt water that is keeping them healthy. But in the Delta, it is really like soft...sometimes they are greyish colour. Those we don’t eat. We throw them out. (...) When they are greyish, the meat. Because that is not normal. It is supposed to be white. (IN3, pers. comm., 2016)

Additionally, the whitefish population has been observed to be less abundant. An elder reported the following:

But in the Delta, in the last three or four years now, it's been, fish is not as plentiful as it used to be. Like we used to get lots of whitefish just before freeze-up but, nowadays I'm lucky to get ... 150 maybe. Well, back in ... back to when we used to have dogs and we used to catch at least, I mean, we put away at least ... maybe 3000, over 3000. (IN6, pers. comm., 2017)

Another fisher indicated that he stopped fishing in some places because of the low fish population:

I just know about my particular world because I have a job in Inuvik. For instance, in my whaling fish camp, I used to catch a lot of whitefish. Very easy. And now not so much. It's not that I don't catch any whitefish anymore, but it is not worth as much to put nets. It's been two years since we've placed our nets. I don't know why the levels dropped. If it is the fish nets. But there are also many beavers. Maybe it is because of them. (IN1, pers. comm., 2016)

A number of participants indicated some changes in fish health, with observations of parasites and worms in the flesh, as well as fewer eggs. For instance, one informant reported the following:

Last year they (whitefish and herring) had like... lots of the fish had parasites in them. (...) So about half we had to throw away. (IN5, pers. comm., 2017)

Indicators of poor fish health were observed in burbot and inconnu. Burbot are reported to be skinnier, smaller, and with discolouration or black spots on livers, whereas inconnu are reported to be more scarred and have higher parasite and worm loads. While the inconnu population appears to be relatively stable, several harvesters indicated that they are catching fewer burbot. Regarding burbot, a participant observed recent unusual appearances:

I just finished looking up my net this morning and I caught four loche. And they don't look, they don't look too healthy. And just like they got kind of a red spots on them. I mean like their head is kind of reddish. (AK6, pers. comm., 2016)

Another fisher discussed how his fishing practices changed due to increasing observations of unhealthy livers in burbot:

It seems like the older ones (loche) are, the big ones are always...have a bad liver... bad liver. You couldn't really eat the small ones. It's changed for me because you know when we were young we used to throw the small ones out and keep the big ones and now we're...throwing the big ones in and trying to keep the smaller ones. Which is not good. (AK1, pers. comm., 2016)

Regarding inconnu, one fisher is concerned over the increase of scars:

The quality in the last at least four years anyway, back I have done this survey before and we, I've noticed when I'm fishing with gill netting, a lot of them, the whitefish and the inconnu are bruised. (...). They have bruising on them. (IN6, pers. comm., 2017)

These results stress the importance of being able to identify and understand indicators of poor fish health. A participant explained how he learned to distinguish serious problems from natural acceptable variations:

There were always spots on the livers like when you'd catch loche when I was a kid. (...) I remember my auntie would clear them up and she'd show me: "This is a clean liver, you can feel it, it's smooth. And then this one has lumps on it. And it's not smooth." (IN7, pers. comm., 2017)

Some important changes were observed in other fish species. There are increasing observations of chum salmon caught in multiple locations in the Mackenzie River, a species that was historically rare in the area (Hamilton, Shrimpton & Heath, 2006). Additionally, many participants reported an abundance of northern pike, representing a concern for ecosystem balance (Papik, Marschke & Ayles, 2003). This species is one of the least favourite foods for human consumption, and has thus long been used for dog food. As dog teams have gradually been replaced with motorized transport, northern pike populations have increased considerably. Given its role as a predator, northern pike represents a threat to the balance of interrelationships among fish species. For instance, one participant discussed how the abundance of northern pike affects other fish populations:

I noticed a lot more scarring on lots of the inconnu, the small ones. Lot of pike's scars on. Like the pikes' numbers have actually increased though, I think, because

long ago, when people fished, they used to kill them all. Every pike you caught, you killed it and fed it to your dogs. (...) People don't feed fish to their dogs anymore, because they don't have dog teams so a lot of...and actually people used to trap off those fish to catch mink, foxes, wolverines, whatever. So they kept a lot of the pikes for bait. (IN4, pers. comm., 2016.)

Limited data was collected on burbot, inconnu and other species. However, the results presented here highlight the need for further research, particularly on burbot and inconnu that yet contribute significantly to Inuvialuit diet, since the current state of knowledge is relatively dilute.

### ***3.2.3 Socio-economic changes***

Multiple socio-economic and cultural changes have affected Inuvialuit fishing livelihoods throughout history (Giles, Castleden & Baker, 2010; Usher, 2002). The most significant change relates to the gradual transition towards a settlement-based way of life. The implementation of wage economies resulted in individuals spending less time on the land to conduct traditional activities (Tallman & Reist, 1997). Additionally, increasing access to technology has shifted fishing needs and practices, as the snowmobile replaced dog teams and travel options increased, enabling shorter trips and longer distances. Lower fish harvest levels as well as fewer fishers are the main indicators reflecting these changes (ABEKS, 2008; Joint Secretariat, 2003). A participant described the historical impact of dog food on harvest levels:

If you look at the harvest stats 60 years ago, you will see higher numbers of fish. It's because before we needed dogs for transport (to travel, to trap, to hunt and to fish). We would need 6 dogs per person. So, we had more dogs than humans and we had to feed them. We used fish for our own consumption but mostly for dogs because they were so many. Now, it changed because of the boats and cars. We don't have the same population of dogs so we fish way less fish than before. It's just for our own consumption. (IN1, pers. comm., 2016)

Another informant reported a decline of active fishers and indicated how it affects Inuvialuit ways of life:

Less fishers for sure. I would say less. There are still the old faithful ones, but like, all the grandchildren of the people that I know and kids are ... more into their phones and town and all that kind of stuff (...) And then there are a lot of people that don't pass it on, too. (IN7, pers. comm., 2017)

Since individuals fish less, there is a risk of knowledge loss. Many participants shared early memories of fishing with family members, revealing indirectly processes of knowledge transmission. Nowadays, there is general concerns related to levels of engagement of youth in traditional activities. While skills and values are traditionally transmitted from Elders to younger generations through observations and practices on the land, this process has been disrupted by residential schools and fixed settlements (Pearce, et al., 2011). As such, many participants highlighted the importance of documenting LTK for youth and future generations. For instance, one participant stated the following:

Well, I think most of that is what you're doing now. You're collecting information. And you're getting another story here and there. That's basically traditional knowledge. A lot of it sometimes, a lot of good traditional knowledge. (IN6, pers. comm., 2017)

Another participant stressed the importance of on-the-land activities for transmitting knowledge and skills:

Mainly just to be able to get out there to pass the knowledge down. That's the main thing is just to get out initially. Once you're out there, it's not hard to pass on knowledge or you know, you don't even have to be fishing to tell stories and stuff. (IN7, pers. comm., 2017)

More recently, the cost of gas has become an important socio-economic concern. Most participants condemned the high cost of gas, which affects harvesters' ability to access fishing and hunting areas. All traditional activities rely on boats, trucks,

snowmobiles and ultimately gas for transportation, which represents a significant financial pressure (ABEKS, 2018). An interviewee confirmed the following:

I would think there's less due to the price of gas. People can't afford to even fish. But there's always still the same fishermen. (AK5, pers. comm., 2016)

As a result, fishers are considering selling their harvests to cover these escalating expenses.

One informant shared his necessity to generate new incomes:

And we eat, we collect a lot of fish, because we make dry fish, we make some for sale. Like, you know, times are now, you know, pretty hard. Money has become tight. IN6, pers. comm., 2017)

Another participant reported that an increasing number of harvesters is inclined to sell fish:

And now, it is that the gas costs too much and some don't have boats. So most, lots of the harvesters today they sell the fish or give fish to family. It is just too expensive for gas...to go anyplace. (IN3, pers. comm., 2016)

Although selling fish is an important economic opportunity, the commodification of country foods has negative implications for cultural sharing practices, reducing the availability of country foods for the most vulnerable groups, who are excluded from tight social networks (Kenny, et al., 2018).

### ***3.2.4 Response to change***

While some prevailing trends of socio-ecological change have been identified, the results were marked by some degree of variability of respondent answers, particularly regarding observations of fish abundance and quality (Parks Canada, 2011). Some participants did not report any particular change, while other participants provided contrasting information. Such variability reflects differences in fishing experiences, practices and places, representing the complexity of fishing livelihoods (Wesche, 2009).

Additionally, some participants highlighted the cyclic nature of environmental changes that vary from year to year or place to place. An active fisher discussed this variability:

So, it just varies from year to year. Some creeks are good and then you go back the next year, and it is not so good. And then the year after, it will be good again. So, it is kind of...it varies. Normally you have to move around. Some creeks are just good all the time, and other creeks won't be. It will be hit or miss. (IN4, pers. comm., 2016)

In light of constant environmental variations, Inuvialuit have developed local adaptation strategies (Pearce, et al., 2011; Riedlinger, 2001). Harvesters adjust the time allocated for fishing by delaying their activities, arranging earlier travel, or by spending more time on the land. Additionally, they change fishing locations, which emphasizes the importance of mobility for the sustainability of fishing livelihoods. A participant discussed the mobility of harvesters:

When we travel out, like, in...say August, when we come back from our whale camps, we come in the Delta ...we move to the Delta again to do some fishing and gather wood. When we do that we travel all over the Delta most of the coast in our areas. And when we see a creek that's, you know, kind of jumping with fish, you notice that. You're going...you're going to come back to it. You know? You notice it for a freeze up and you go back to that freeze up ends. Because we don't really try to, like, fish in one area that we know. Because it's so much....so much area that we have. I mean, there's rocks, and little channels, and lots of places to fish in our (...) Like we don't try to fish out in one area. It's always different places we go. (IN6, pers. comm., 2017)

Another interviewee outlined the positive outcomes presented by some environmental changes:

The ice melts earlier in the year than before. So, we have more access to resources. For example, we can catch beluga whales in June. Before, you couldn't see any beluga before the first week of July. And in general, some spots are accessible earlier than before. We can use our boats earlier since the ice breaks earlier. (IN1, pers. comm., 2016)

The same participant also emphasized on the diversity of services offered by the land:

We are very lucky in this area because we have everything: water everywhere, ocean and a lot of wildlife. So we can rely on fish, or whales, or caribou, or moose, or muskrats. We have a lot of different sources of food so we have alternatives if we have bad hunting, trapping, or fishing seasons. The Inuvialuit are very resilient people and were able to survive relying on the land and everything that it provides. (IN1, pers. comm., 2016)

From a holistic perspective, adaptation relies on ecosystem diversity, which provides alternatives for harvesters. As such, species preferences and harvesting methods are adjusted to improve livelihood sustainability. However, these strategies require some degree of flexibility, which can be reduced by limited financial means, loss of knowledge, or competing priorities, such as splitting time between employment and part-time harvesting.

### ***3.2.5 Understanding the vulnerability context***

The vulnerability of Inuvialuit fishing livelihoods is determined by multiple biophysical and social factors. First, ongoing socio-ecological changes stress the fishing system, which resonates with the observations outlined by harvesters in previous sections. Climate-related changes such as warmer temperature, weather unpredictability, erosion, ice reduction and lower water levels are relatively well-documented in the Inuvialuit Settlement Region (Pearce, et al., 2011). On another hand, contaminant-related risks represent additional stressors in the MRD. Given its biophysical features and exposures to external stressors across the watershed such as mining, oil, and gas development, the Delta is susceptible to such risks (AMAP, 2017; MRBB, 2012). However, studies on the local cumulative effects of contaminants on water quality and wildlife are limited. Second, social, economic, and political factors contribute to the vulnerability of the fishing system by limiting the adaptive capacity of harvesters (Ford & Smit, 2004). For instance, northern

Aboriginal populations, and particularly Inuit households, have the lowest socio-economic indicators in Canada and are consequently more marginalized, which is considered an important social determinant of vulnerability (Feltmate & Thistlethwaite, 2012; Furgal & Seguin, 2006). The fact that most participants expressed concerns about escalating gas costs illustrates the importance of socio-economic factors.

To develop adaptation strategies, it is essential to understand the vulnerability of a system by examining the factors at play, including who is affected and how (Ford & Smit, 2004). Research can play a key role in this regard, by generating awareness and knowledge (Vogel, et al. 2007). However, there are some challenges related to the availability, accessibility, and use of scientific studies. When introducing this research project to potential participants during fieldwork in Inuvik, several community residents indicated communication issues with scientists. While the knowledge produced targets academic and policy-making audiences, there is a lack of community outreach by researchers and decision-makers due to time, financial and capacity constraints. For instance, any communication related to mercury contaminants in fish raises concerns among harvesters about human health. However, individuals often lack a clear understanding of the issue or of the practical implications for fish consumption. One participant identified the importance of intelligible and accessible communication efforts towards community residents, who are ultimately the land user:

That is one thing that we have been arguing for a long time that researchers coming in, doing their work, taking away what they've learned and never ever coming back to a consultation with us about their findings. Because it is us after all that, you know, we contribute to these interviews. And we are here, we're eating the fish, we're drinking the water, we want to know if everything is safe yet, you know. (IN4, pers. comm., 2016)

LTK provides essential information about the fishing system and environmental changes (Ford & Smit, 2004). Local stories and observations at different temporal scales and locations contribute to filling scientific knowledge gaps. However, the radical social, economic, and political changes in Inuvialuit society has disrupted knowledge transmission and learning, which intensifies current vulnerabilities. Although the literature recognizes the role of LTK in addressing a system's vulnerability, its documentation is challenging given the methodological, institutional and logistical problems related to the mobilization of a different knowledge system (Berkes, 2009; Pearce, et.al, 2011). Participants highlighted the importance of ethical archiving methods as well as intergenerational knowledge. An interviewee highlighted the importance of interviewing Elders:

Interview Elders before they're gone...I mean Elders, not 60 years old...(Laughs)...before the other ones are gone or before they can't remember. (...)  
Yes. That is the only answer that I have. It is: interview the Elders. Get it down on tape, because sometimes they put it on paper and they hear that person wrong and write the wrong...the wrong sentence...it is not them. But if they hear it on tape, they know it is them speaking. (IN3, pers. comm., 2016)

On a similar note, another participant reflected on cumulative and intergenerational knowledge:

I think these interviews are beneficial in many ways because you come door to door and you talk to people that are out there using the land. You get the best information available, current information. And if you talk with some of the Elders, you might get information from years back. My information that I just gave you is relatively, you know, it is not old but it is current. I would like to see the difference between, you know, my mother's generation to my grandmother's generation, because they've lived lot longer than me and maybe what they observed is totally different than what I know, right? And I guarantee it will be because they've been around longer and they've seen a lot more. My grandmother still lives. She is 94...93 years old so she...like she probably eats almost 100% country food. And, I think that is why she is so healthy today, yes. And that is what my job is to keep bringing her country food, to keep her well fed and healthy (IN4, pers. comm., 2016)

Despite these social and environmental stressors, it appears that Inuvialuit fishing livelihoods will remain important subsistence activities in the foreseeable future. However,

serious concerns about fish health in the Delta, as well as reduced fishing access need to be addressed. In light of upstream-downstream linkages, there are lessons to be learned from southern parts of the Mackenzie River watershed. In the Athabasca sub-basin, Aboriginal residents have stopped drinking water and fishing in some areas, where deteriorating environmental health has been reported and for fear of oil sands-related contaminants (MRBB, 2012). Additionally, the Athabasca River and multiple lakes in the sub-basin are beset with fish consumption advisories due to high levels of mercury (MRBB, 2004). Despite these alarming accounts, there are substantial knowledge gaps in assessing the cumulative impacts of environmental change and contaminants in the area (MRBB, 2012).

To avoid reaching such a critical state and rather taking a proactive approach to preserving the current sustainability of Inuvialuit fishing livelihoods, increased monitoring efforts are required in the MRD. Drawing from the success of the Beaufort Sea beluga monitoring program in the Mackenzie River estuary, harvest-based monitoring offers the opportunity to collect long-term, multi-disciplinary knowledge, while building local capacity and ensuring that results are reported back to community residents (Bell & Harwood, 2012).

### **3.3 Implications of Changing Fishing Systems for Food Security**

A key part of this research consists of understanding the critical implications of change in fishing livelihoods for the country food system. Multiple socio-ecological changes such as lower water levels and quality, warmer water temperature, climate variability, declining ice conditions, increasing erosion, changing fish populations, poorer

fish quality, and high living costs are being experienced in the MRD. These findings have broader implications for the sustainability of fishing livelihoods and ultimately Inuvialuit food security. The section examines the impacts of change on fishing livelihoods and implications on food security. It then continues with a discussion about the connections between fishing livelihoods, the country food system, and Inuvialuit well-being.

### ***3.3.1 Impacts of change on fishing livelihoods***

The socio-ecological changes discussed in previous sections have multiple impacts on fishing livelihoods, as outlined in tables 3 and 4. The analysis of these results identifies two recurrent themes. First, these changes primarily affect fishing access. It has been established that fishing occurs across a large territory, which comprises the MRD, the coastline, the Yukon North Slope and the Husky lakes (Papik, Marschke & Ayles, 2003). Additionally, current changes in fish health and stocks require harvesters to adapt their fishing practices and locations. Therefore, mobility is a key contributor to the sustainability of fishing livelihoods, as the ability to travel is central to accessing diverse and intact fishing sites. However, most of the identified socio-ecological changes limit harvester mobility. Lower water levels, desiccation of lakes and creeks, increasing number of beaver dams, and abundance of sandbars affect physical access to fishing areas (ABEKS, 2017). Climate unpredictability and variability, reduced ice thickness, erosion, as well as changing pace and timing of freeze-up/break-up challenge travel safety. Finally, the high costs of vehicles and gas limit financial access to means of transportation (ABEKS, 2008).

The second recurrent theme is related to health concerns. There is some degree of uncertainty around human health impacts of declining fish and water quality. Increasing observations of turbid, smelly, stagnant water raise concerns about water quality, while

higher numbers of fish with worms, parasites, and unusual size and appearance cause harvesters to question the health of the fish. Ultimately, these concerns impact human health, since harvesters rely on fish and water for subsistence. In the MRD, this distrust of country foods derives primarily from perceived contaminant risks, which reflects concerns shared by other Aboriginal communities across the Mackenzie watershed (MRBB, 2012; Nickels, et al., 2005). For instance, one participant expressed his concern over the impacts of fish quality on human health:

I would like to know how healthy fish really are and how the health of the fish can affect us. We can only say if there are scars or how or where they are moving. (IN2, pers. comm., 2016)

Another participant communicated some degree of distrust towards country foods:

Be more, more experienced to learn what's...if the fish is bad or is it good. Like for me, I eat it once in a while, but sometimes I don't trust it because you never know what's in it. (AK6, pers. comm., 2016)

Additionally, one harvester shared his fears about the correlation between ecosystem health and high rates of cancer:

Really high levels of cancer (...) and they can't really pinpoint it to anything. Like they're saying it is from the food we eat. And another person says from the water. Another person says from the airborne pollutants. Another person says cigarettes. There are a lot of people blaming on every little thing. But, really what it comes down to, is, I am just cheerful to...I really would like to see our food source protected and making sure that is safe for us to eat. Because, you know, maybe, what we love is what is killing us. (IN4, pers. comm., 2016)

All participants indirectly communicated their strong relationship with the land, the wildlife and the water. As such, healthy ecosystems are considered to be essential for the sustainability of all beings. For instance, the same participant is also concerned for fish, as beings:

I don't think it affects me so much in my day to day life but it makes me worried about the fish in those lakes. What kind of effects it is having on them? Because, as

you know, a lot of these lakes where the trout in them are...They can only grow into a certain size because of the size of the lake and the amount of food in it. So those are really slow repopulating lakes because the fish are so small and there is not enough food for all the fish so like I said, they only grow a certain size. Those ones would be the ones that I would be really worried about. Previously, our fish are healthy and then when you go back and you can't even find the fish in them. It kind of makes me worried because they are people that utilize a lot of the lakes up here for fishing for lake trout. (IN4, pers. comm., 2016)

The predominance of health concerns in relation to changing ecosystems reflect reciprocal and interdependent relationships between humans and the nature (Todd, 2016). Embedded in Aboriginal cosmologies, these relations define how the socio-ecological system functions.

### ***3.3.2 Challenges for food security***

Given the importance of fish in the country food system, changes in fishing livelihoods have indirect impacts on food security issues. In comparison with other wild game such as caribou and beluga whale, fish represents a key contributor in meeting food needs in Inuvialuit communities, as current fish stocks are estimated to exceed greatly harvest levels (Islam & Berkes, 2016; MRBB, 2004). However, in 2008, food insecurity was experienced by 31,1% of Inuvialuit households at a moderate level, and 12,2% at a severe level in the ISR (Egeland, 2010). As such, while stocks of fish in the MRD are relatively intact, other components of food security are challenged. Indeed, the importance of fishing livelihoods goes beyond the availability of fish, but rather highlights other essential environmental and socio-cultural factors such as cultural preferences, sharing networks, fishing knowledge and fishing access.

The primary impacts of socio-ecological change affect access to fish. Environmental changes such as lower water levels, declining ice conditions, erosion,

weather unpredictability reduce travel routes and safety. Additionally, time available for fishing as well as financial means for equipment and supplies are limited (Kenny, et al., 2018). Furthermore, food access is affected by changes in cultural practices such as smaller sharing networks and the growing commodification of country foods (Kenny, et al., 2018; Natcher, 2015). One participant notably highlighted that fish is more difficult to access despite its availability:

I mean, if you really want fish, you can go and travel to get it. But it's harder to find the fish now in modern times. (IN7, pers. comm., 2017)

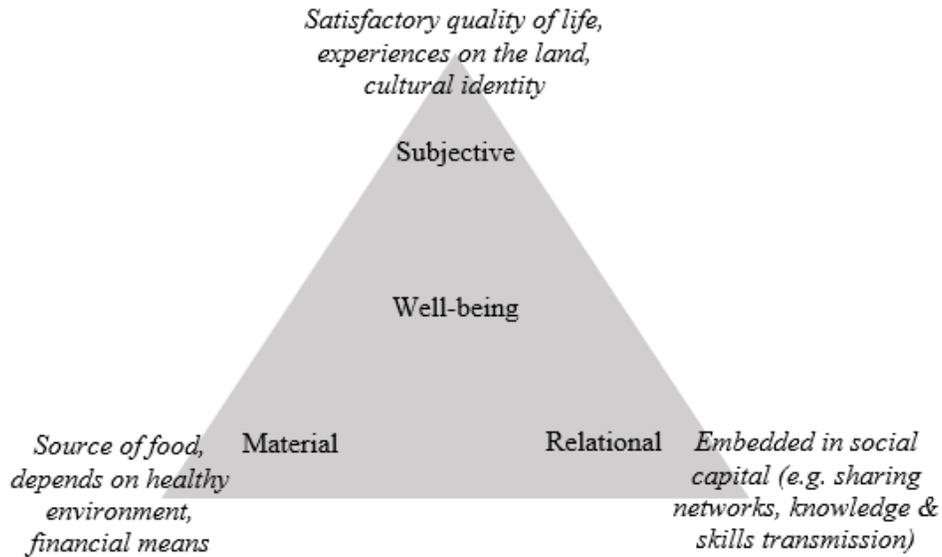
Findings also indicate that changing fish quality represents a growing health concern among harvesters; however, contaminant-related research on freshwater species is lacking (MRBB, 2012). Finally, in combination, these changes reduce the ability of Inuvialuit to effectively utilize fish, which refers to the socio-cultural dimensions of food security, such as the fishing skills and intergenerational knowledge to harvest, prepare and consume country foods (Wesche & Chan, 2010). As such, a loss of knowledge and skills, changing cultural practices, as well as lower participation in fishing activities contribute to the erosion of the country food system, and ultimately impact negatively food security.

### ***3.3.3 Bridging fishing livelihoods, the country food System, and well-being***

The current literature recognizes a simple correlation between Aboriginal well-being and food security, as the former is both a determinant and outcome of the latter (CCA, 2014). Whereas food security is determined by the access to sufficient nutritious and preferred foods, the Aboriginal country food system comprises additional socio-cultural dimensions, such as cultural practices and values, traditional livelihoods, intergenerational knowledge, and sharing networks. These characteristics reflect the socio-cultural

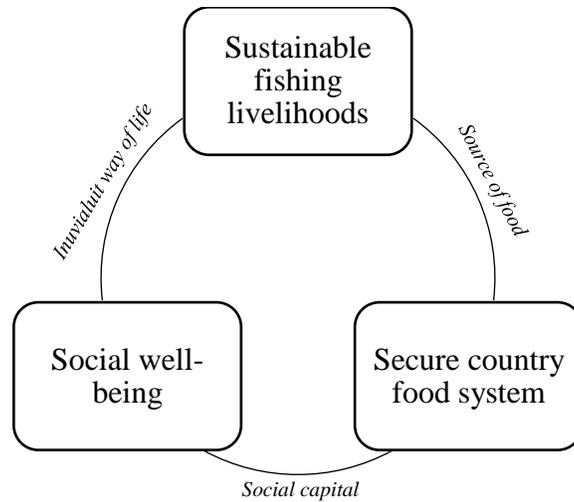
importance of harvesting, preparing and consuming traditional foods, which is intrinsically related to community wellness (Kenny, et al., 2018; Wesche & Chan, 2010). As such, given the importance of fish in the country food system, Inuvialuit fishing livelihoods contribute to both food security and well-being.

Aside from being an outcome, well-being is also part of social, economic, political and environmental processes within which a socio-ecological system, such as fishing livelihoods, functions, influencing people's behaviours and choices (Coulthard, 2012). In the context of Inuvialuit fishing livelihoods, the capacity to pursue traditional activities is interconnected with the three key dimensions of well-being. First, fishing depends on tangible assets such financial resources, equipment, supplies, and a healthy environment, and represents a steady source of food, which contribute to material well-being. Second, Inuvialuit fisheries are embedded in social relationships and sharing networks, which define social capital (Natcher, 2015). On the one hand, social networks enable knowledge and skills transmission, and subsequently the pursuit of fishing activities; on the other hand, they contribute to food sharing practices and family life. These social interactions characterize the relational dimensions of well-being (Britton & Coulthard, 2013). Finally, harvesters develop memories, feelings, and values that determine their own satisfaction and shape their fishing behavior, reflecting the subjective aspect of well-being (White, 2010). Figure 9 summarizes how Inuvialuit fishing livelihoods are intrinsically part of the three dimensions of well-being.



*Figure 9: The three dimensions of well-being in Inuvialuit fishing livelihoods*

The importance of Inuvialuit fishing livelihoods in supporting and sustaining the country food system, traditional ways of life, sharing networks, and LTK transmission highlights the dynamic interrelationship between fisheries, the food system, and social well-being. Figure 10 illustrates how the sustainability of fishing livelihoods contributes to robust country food systems, ultimately enhancing social well-being. Indeed, fish is an essential source of food that is harvested, consumed and shared, while fishing encompasses important on-the-land experiences, family memories, cultural practices and values. Reciprocally, communities that are “well” and healthy food systems enable sustainable fisheries (White, 2009). A fisher who has adequate knowledge, skills and supplies, who feels safe and confident, and who maintains strong social relationships will more likely continue to fish (Coulthard, et al., 2015).



*Figure 10: Wheel of sustainable fishing livelihoods, country food security and social well-being*

Understanding the complex implications of socio-ecological changes on the Inuvialuit fishing system requires more than examining the assets of a livelihood related to income, fish stocks and infrastructure, or measuring food security components related to nutrient intake and harvest levels (Islam & Berkes, 2016). A well-being approach provides a holistic understanding by including subjective variables such as social networks, cultural preferences, emotions, values, and personal experiences (CCA, 2014; Coulthard, 2012). As such, these considerations recognize commonly ignored socio-cultural dimensions, reflecting actual fishing practices and behaviour, which ultimately generates culturally-relevant frameworks, that are adapted to local needs and concerns.

## **4. Conclusion**

This chapter concludes this research about the implications of socio-ecological change in the MRD on fishing livelihoods and the country food system, by presenting key findings, contributions and recommendations. First, this chapter provides a brief summary of the research context followed by the main observations of socio-ecological change in the Delta and related implications for the Inuvialuit country food system, resulting from interviews with Inuvialuit harvesters. This chapter continues with a discussion about the theoretical, methodological and practical contributions to the understanding of changing Arctic fishing livelihoods. Finally, it introduces recommendations for further research.

### **4.1 Key Findings**

The MRD is a rich ecological system of critical importance for subsistence activities and Inuvialuit way of life. Like many northern freshwater systems, the Delta is highly sensitive to multiple environmental pressures such as climate change, resource development activities and upstream-downstream linkages related to extraction activities in the southern part of the watershed. These changes affect Inuvialuit communities that rely on the Delta for subsistence activities. In particular, fishing livelihoods reflect the vulnerable relationship between harvesters and freshwater systems, that ultimately contributes to the country food system as well as socio-cultural well-being (Paci, Dickson, Nickels, Chan, Furgal, 2004). The impacts of change in Arctic fishing livelihoods as well as the role of subsistence fisheries in food security has been understudied (ACIA, 2005; Islam & Berkes, 2016; MRBB 2004). As such, this research examined the implications of vulnerable fishing systems for Inuvialuit food security in the MRD.

The available literature identified a limited understanding of changing northern freshwater systems from a natural science perspective and significant knowledge gaps about related human impacts (ACIA, 2004). At the same time, northern Aboriginal food security has been primarily discussed in relation to nutrient intake or from a governance perspective with limited focus on the role of traditional livelihoods (Guyot, et al., 2006; Kenny, et al., 2018). To address these gaps, the community-based research approach of this study drew from LTK to understand the socio-ecological changes in the MRD and related impacts on Inuvialuit fishing livelihoods. Primarily developed in international development studies, the sustainable livelihood and well-being approaches to vulnerable fisheries provide useful considerations for northern Aboriginal contexts (Coulthard, 2012; Allison & Ellis, 2001), highlighting the importance of socio-cultural dimensions in the Inuvialuit fishing, and country food system.

Results indicate that fishing livelihoods are essential to sustaining a healthy and productive country food system in the ISR. Key findings also highlighted a significant use of secondary species such as burbot and inconnu in the country food system, which has been overshadowed by a disproportionate attention towards big game hunting and marine species in other studies. Additionally, it was found that fishing livelihoods consist of various cultural practices, such as sharing, time spent on the land with family members, knowledge and skills transmission, and local management strategies to maintain healthy natural resources that contribute to Inuvialuit ways of life. However, the sustainability of fishing systems in the MRD is stressed by multiple socio-ecological changes experienced by Inuvialuit harvesters including: lower water levels; increasing erosion; decreasing fish populations; changes in Delta-reliant wildlife populations such as growing beaver

populations; warmer water temperatures; poorer fish quality with softer flesh or more parasites during the summertime; thinner ice during the wintertime; climate variability; and increasing living costs. These changes affect primarily the mobility of harvesters, by reducing travel safety, shifting travel routes, and limiting financial means to access the land. Additionally, the degree of uncertainty regarding declining fish and water quality raises important concerns about the safety of consumption for human health.

These changes and related impacts define the vulnerability of Inuvialuit fishing livelihoods, which is increased by additional factors, such as socio-economic inequities and poorly communicated scientific information. The vulnerability of fishing livelihoods has broader implications for food security. Given the importance of fish in the country food system, limited access and declining quality of fish have a negative impact on food security. Furthermore, the ability to effectively use fish is challenged by socio-cultural factors such as fishing knowledge and skills, as well as sharing practices. The importance of such socio-cultural dimensions connects the country food system with community well-being. Indeed, the socio-cultural importance of harvesting, preparing and consuming fish reflects the three dimensions of well-being, as it represents a source of food (material), involving sharing networks, community life, and local knowledge (relational), and generating personal experiences and feelings (subjective).

## **4.2 Contributions**

This research makes important theoretical, methodological and practical contributions to the understanding of changing northern fishing livelihoods and related human implications. First, this research clearly links the vulnerability of fishing livelihoods

with dimensions of food security and community well-being. Most of the existing work related to the human dimensions of environmental change contributes to the field of community vulnerability and adaptation research, targeting policy-making and academic audiences (Pearce, et al., 2011). Limited attention has been paid to the direct impacts of environmental change on subsistence livelihoods in northern Aboriginal contexts. Furthermore, the food security literature has overlooked the role of fishing livelihoods in the country food system (Islam & Berkes, 2016). As such, drawing from various bodies of literature, such as environmental change, well-being approach to subsistence fisheries (Coulthard, et al., 2014), and Aboriginal food security, this research proposes a livelihood approach to Arctic food security that comprises socio-cultural dimensions of well-being. Such a multi-dimensional approach addresses the complex human implications of changing ecological systems.

Second, methodological considerations from this study add to the growing literature in community-based participatory research in Aboriginal communities. As previously stated, this thesis contributes to a multi-year project “Tracking Change”, which was initiated by Aboriginal elders and leaders from various parts of the MRB who expressed concerns about the effects of climate change, energy, and natural resource development on freshwater systems. The project was built in partnership with northern LTK experts and other Aboriginal partners with the aim of recognizing and valuing Aboriginal voices in tracking environmental change, and identifying impacts and pressures on local livelihoods. As a sub-project, this research developed a unique collaboration between academics and communities. It represents an attempt to explore new methodologies mobilizing qualitative and participatory tools that are adapted towards LTK as a valid system of knowledge

(Smith, 2012). Additionally, given the challenges experienced during the data collection process, this research offers some insights and lessons learned for further projects.

However, while LTK benefits from an increasing interest amongst researchers and institutions, there are still relatively few studies that rely on Inuvialuit knowledge, which has the potential to fill knowledge gaps in addition to providing a holistic understanding of socio-ecological processes (Wesche, 2009; Riedlinger & Berkes, 2001). With insights from other sub-projects and from local partners, this thesis contributes to identifying a set of commonly valued LTK indicators and developing a methodology for common use throughout the watershed that will feed further research of the “Tracking Change” project. By facilitating the documentation and networking of knowledge within/between Aboriginal communities and other partners, the research helps to address current and potential conflicts in meaning and experience of social and ecological change, including implications for fishing livelihoods and food security.

Finally, this research recognizes that subsistence fishers are in a unique social and geographic position to co-create, share and use knowledge about aquatic ecosystems (ACIA, 2005). Key findings contribute to the current knowledge about Inuvialuit fishing livelihoods. Results indicate the importance of secondary fish species in the MRD, such as burbot and inconnu, about which information and attention is lacking in other studies and management strategies. Additionally, the importance of social capital in Inuvialuit fishing livelihoods, which includes sharing networks and local knowledge, highlights the interdependence of food security and community well-being (Natcher, 2015). This consideration brings traditionally ignored socio-cultural practices to the forefront of discussion regarding impacts of socio-ecological change.

### **4.3 Recommendations**

Outcomes from this study lay the foundation for practical recommendations in terms of future research. While local observations of change presented in this research are not alarming, based on the degree of change, results resonate with key findings from other studies conducted across the MRB, as well as from other Arctic communities (ACIA, 2005; Fresque-Baxter, 2015; MRBB, 2004; Pearce, et al., 2011; Wesche, 2009). Community-based monitoring of freshwater systems, including the impacts related to environmental change in the MRD, would act as an early warning system to enable fishers at the individual level, and decision-makers at the regional level, which includes harvesters who are members of co-management bodies, to respond to change. Thus, effective monitoring programs would avoid reaching critical situations as currently experienced in southern parts of the watershed, where many harvesters have stopped fishing due to oil sands-related contamination risks (MRB, 2012). Given the growing concerns about water and fish quality in the ISR/MRB, and multiple knowledge gaps related to changing fishing livelihoods, community-based monitoring requires a multi-disciplinary approach that combines TK with social and natural sciences, using mixed methods approaches.

Natural science research tends to focus on singular aspects of environmental change. Given the rich diversity of the MRD, it is necessary to adopt a multidimensional, or at least, multi-species approach to understand the complexity of the ecosystem and its importance for Inuvialuit harvesters (Tallman & Reist, 1997). Additionally, as research outcomes primarily target academics and policy-making audiences, land users are often missing from the communication chain. As such, there is a need to produce knowledge that is relevant and adapted for public audiences. In this case, further monitoring projects should

respond to the practical concerns of community residents, such as water quality and fish health, and communicate clearly the implications for human consumption. Community-based monitoring programs represent an opportunity to address this gap, by building capacity around research and science at the local level. Hiring local research assistants and involving harvesters in monitoring activities could represent an effective communication bridge between scientists and community residents (Bell & Harwood, 2012).

On another level, key findings indicated that Inuvialuit fishing livelihoods represent more than a steady source of food. They also consist of various socio-cultural practices that contribute to the country food system as well as community well-being, in terms of solidarity networks, knowledge transmission, traditional lifestyle, and cultural identity. However, these considerations have been overlooked in other studies. Indeed, there is limited understanding about the role of fishing livelihoods in northern Aboriginal food security (Islam & Berkes, 2016). Additionally, there are multiple uncertainties related to the implications of socio-ecological change in Arctic fishing systems (ACIA, 2005). Further research should reflect the linkages between environmental change in fishing livelihoods, food security and well-being in northern Aboriginal contexts. As such, there is a need to develop frameworks that recognize the socio-cultural dimensions of food security, that are relevant and applicable to northern Aboriginal fishing livelihoods.

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