

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

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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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List of Acronyms and Initialisms

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 and Traditional Knowledge
MRB	Mackenzie River Basin
MRD	Mackenzie River Delta
SLA	Sustainable Livelihood Approach
TEK	Traditional Ecological Knowledge
TK	Traditional Knowledge

Chapter 1: Introduction

Canada's North encompasses multiple ecosystems from the high Arctic as well as more southerly regions above the 50th parallel, covering up to almost two thirds of Canada's landmass, as defined by Natural Resources Canada (Natural Resources Canada, 2017). As such, it represents a variety of physical, biological and socio-economic characteristics (Environment Canada and Climate Change, 2016). While ecosystems are inherently dynamic and thus continuously experiencing change, Canada's North is pressured by the greatest and fastest biophysical changes related to climate change and other environmental pressures due notably to anthropogenic activities.

Given the interdependence of social and ecological systems, these changes disproportionately affect Inuit, the predominant Aboriginal group in the Arctic. As a group, Inuit have the lowest socio-economic indicators in the country and continue to rely in large part on subsistence livelihoods (Furgal & Seguin, 2006). Although historically, Aboriginal populations¹ have successfully responded to various environmental, social, economic and political stressors, the pace and intensity of current environmental changes raise concerns about the sustainability of Inuit social systems (Paci, et al., 2004).

1.1 A Changing North

"Climate change", defined as the changes in the global climate system related to increasing atmospheric concentrations of greenhouse gases (GHGs) that are primarily anthropogenically-driven (IPCC, 2007), has gained growing attention in scientific and

¹ Aboriginal people in this dissertation refers to all Indigenous groups in Canada, including First Nations, Métis and Inuit, while the term Indigenous People is used to name native peoples internationally, who share a collective history of colonialism regardless of political borders (CCA, 2014).

political spheres over the past two decades, becoming one of the most pressing issues of our times. The Arctic has experienced climate-related changes at a far greater rate than the rest of the world, acting as a “global ecological barometer” (ACIA, 2005; AMAP, 2012; Borgerson, IPCC 2007; 2008; Shadian, 2006; WWF, 2008). The rapidity of such warming climate is due to Arctic amplification, defined by feedback processes between the atmosphere and the reduction of the cryosphere (IPCC, 2007; Pendakur, 2017). The loss of snow and ice cover accelerates the warming process, by reducing its capacity of reflecting solar energy (ACIA, 2005; Woo, 2008).

The greatest increase of global temperatures has been observed in the Arctic, with a rise of 2° C to 3° C since the 1950s (ACIA, 2005; IPCC 2014). Projections suggest that temperatures will continue to increase at a faster rate in the North, with greatest changes in winter temperatures (Bush et al., 2014). Warming temperatures affect primarily snow and ice cover, permafrost deterioration and warmer winters, which have subsequent biophysical impacts on landscapes, fauna and flora. These impacts include increased erosion and slumping, changes in migration patterns and species habitat, shifts in vegetation composition and patterns, and spread of contaminants (ACIA, 2005; Crawford, 2008; IPCC 2014; Macdonald, Harner & Fyfe, 2005). Some northern regions have also experienced significant increases in precipitation that are projected to continue into the future (ACIA, 2005). Additionally, increases in precipitation combined with warmer temperatures are associated with unpredictable and extreme meteorological events. As such, while scientists widely recognize multiple trends of rapid and gradual environmental change in Canada’s North, it is important to note that the nature and intensity of these

changes are variable and unpredictable (ACIA, 2005; AMAP 2012; IPCC 2014; Kattsov, Kallen, et al., 2005).

While the climate system contributes significantly to the changes observed in Canada's North, there are additional factors exerting environmental pressures. Northern regions have many natural resources that are highly valuable for economic development (ACIA, 2005). Northern regions have been marked by multiple development projects since the 1950s, that have more localized impacts (ACIA, 2005; Bone, 2009; Gavrilchuk, & Lesage, 2014; Southcott & Irlbacher-Fox, 2011). Additional environmental pressures include hydroelectric development, overfishing, and an increasing human population. As such, a complex interplay of these various stressors affects the biophysical conditions of northern regions.

In light of these environmental pressures, 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). Ten percent of the world's rivers water volume flows into the Arctic Ocean, even though it contains only 1% of the world's ocean water (AMAP, 2016). Additionally, water carries multiple components such as heat, nutrients and other chemicals, that determine biophysical processes upon which life relies. As such, northern hydrological systems play a key role in the global climate system, and are reciprocally affected by broader dynamics. However, given the multiplicity and diversity of northern freshwater systems, there are multiple knowledge gaps that require more extensive research on smaller rivers, material flows, land surface effects, loss of lake and river ice, water quality, and ecosystem interactions (ACIA, 2005; AMAP, 2016).

1.2 Study Rationale and Objectives

While climate-related change has received increasing attention at the global scale over the last two decades, there has been limited focus on the human impacts of environmental change at the local scale to date (ACIA, 2005; Pearce, et al. 2011). Moreover, 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).

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.

1.3 Case Study Site

This research focuses on the local perspectives of environmental change in the MRD, as experienced by Inuvialuit People, a distinct group of Inuit living in the Inuvialuit Settlement Region (ISR) (Figure 1). Covering approximately 91,000 square kilometres in the northern Northwest Territories and Yukon, the ISR includes the Mackenzie River Delta, Beaufort Sea, and Amundsen Gulf area (Joint Secretariat, 2016). 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.

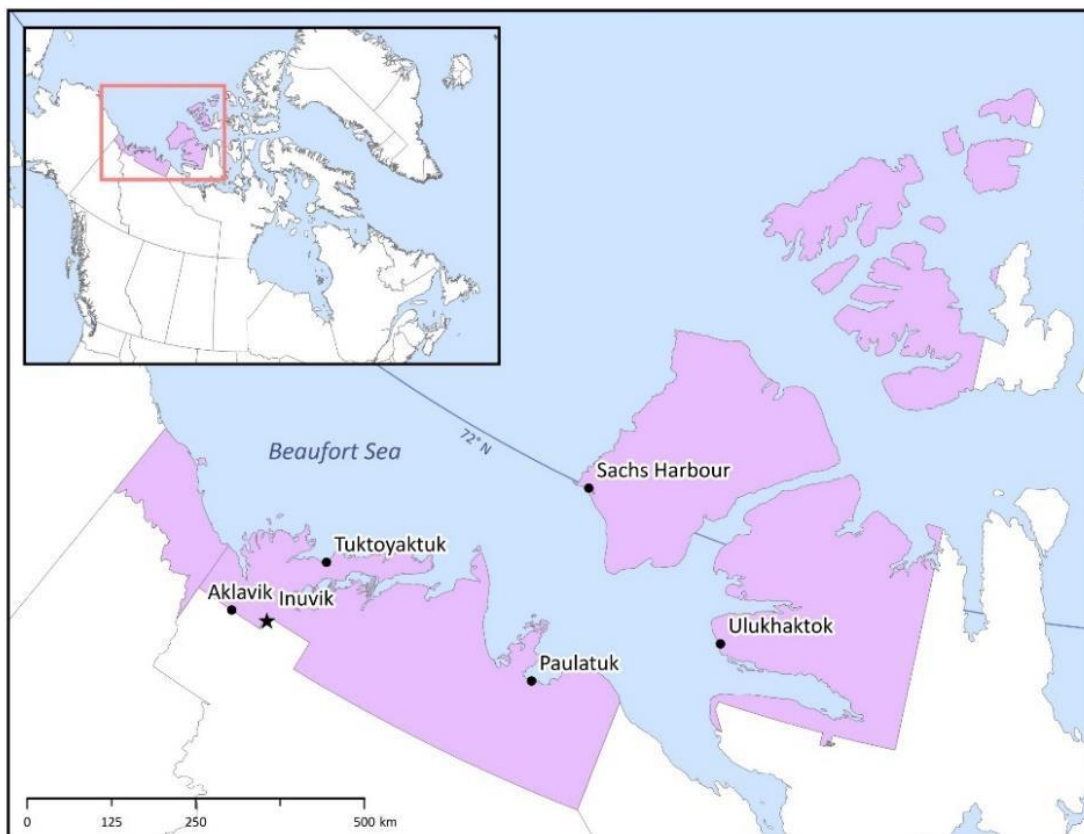


Figure 1: Location of Inuvialuit communities within the Inuvialuit Settlement Region

While it is possible that residents from other communities spend time in the MRD, Inuvik and Aklavik are the focus of this study (Figure 2). Inuvik, located on the eastern edge of the Delta, has a population of 3265 (Bureau of Statistics NWT, 2015) and acts as the administrative centre of the ISR. Although remote, Inuvik is connected by road to Canada’s highway system. Aklavik, located in the central section of the Delta, is a smaller community with a population of 668 (Bureau of Statistics NWT, 2015). There is also a winter road connecting Inuvik to Aklavik. Both communities rely mostly on-air transportation although road and barge systems are used at different periods of the year.



Figure 2: Location of Inuvik, Aklavik, and the Mackenzie River Delta (Fick, 2007)

Aklavik was founded through trading post activities of the Hudsons Bay Company in 1912 (Alunik & Morrison, 2003). The community continued to grow as the centre of the region until the mid-century, when the Government of Canada decided to relocate the town due to its vulnerability to flooding. Inuvik was then built as a planned community in 1955 with the aim of creating an administrative centre for the Western Arctic. While Aklavik's population decreased as Inuvik developed, many members decided to stay in the former community, following the motto: "Never say die" (Alunik & Morrison, 2003, p. 210). Despite the development of Inuvik and the continued flooding risks, Aklavik continues to flourish, because of the community's strong relationship to the land and the Delta.

Nowadays, approximately two thirds of Inuvik's population and more than 90% of Aklavik's population is Aboriginal, consisting primarily of those who self-identify as Inuvialuit and Gwich'in (Bureau of Statistics NWT, 2015). The majority of Inuvik's employment is related to government services, since Inuvik is the administrative centre of the ISR (Ford, et al., 2013). There are also opportunities related to resource development, most notably since oil was discovered in the area in 1970 (Alunik & Morrison, 2003). However, traditional land-based activities, such as fishing, hunting and trapping, remain important for many households in both communities.

1.4 Vulnerability of the Mackenzie River Delta

Like many hydrological systems around the world, the MRD constitutes a highly vulnerable ecosystem, with its lakes, channels and wetlands representing approximately 50% of the Delta area (AMAP, 2017). There are direct threats due to human activities such as hydroelectric development (Lajoie, et al. 2007), pollution, resource use such as fisheries,

land-use change (Tanga, et al. 2005), and mining operations (Gomes, Mendes & Costa, 2011). Global drivers such as climate change (AMAP, 2016; Feltmate & Thistlethwaite, 2012), demographic growth (Gautier, 2008), and economic structures (Gautier, 2008; Johnston & Weaver, 2009) intensify water use, and alter its quality and availability, stressing freshwater system locally. As such, the vulnerability of freshwater systems is increased by the interactive nature of these ecosystems that are subject to biophysical interactions at the local, regional and global scale (Wolley, 2004; World Water Assessment Program, 2003).

As part of the Mackenzie watershed, the ecosystem is threatened by infrastructure (e.g., dams, roads, pipelines) and natural resource exploration and exploitation activities (AMAP, 2017; Carlson, 2007). For example, a series of two major hydroelectric dams, with a third underway, change the flow of the Peace River in British Columbia at the source of the Mackenzie River Basin (MRB). Additionally, oil sands extraction is occurring in Alberta, and there are reserves of oil and gas, notably in the region of the MRD and Beaufort Sea. As such, oil and gas exploitation activities have been conducted in the Delta and more related projects can be expected to be implemented. Additionally, the soil is also rich in minerals such as lead, gold, diamond, zinc and copper, leading to numerous mining operations across the Northwest Territories, Yukon and Nunavut (ACIA, 2005). Resources development activities raise concern related contaminant risks across the watershed. In addition to climate change impacts, these various projects exert pressure on MRB ecosystems (MRBB, 2004). Since the Delta is located at the mouth of the MRB, multiple environmental pressures at the regional scale have cumulative effects on local ecosystems. As such, the Delta is marked by multiple changes in water levels, flow, biogeochemistry,

and ice cover, which ultimately affects the aquatic fauna and flora although there are several knowledge gaps related to the intensity of these changes (ACIA, 2005; MRBB, 2004).

1.5 Inuvialuit Fisheries Management

The ISR was created in 1984 following the settlement of the Inuvialuit Final Agreement between the Inuvialuit people and the Government of Canada. The Inuvialuit Regional Corporation was established to manage and control the lands outlined in the agreement. The Inuvialuit Regional Corporation aims to improve the social, economic, and cultural well-being of the Inuvialuit, by preserving Arctic wildlife, Inuvialuit cultural identity and livelihood while improving Inuvialuit participation in management and decision-making processes at regional and national levels (IRC, 2007). As such, the Inuvialuit and the federal government share the responsibility of managing natural resources in the ISR, under five co-management bodies (Riedlinger, 2001).

The Fisheries Joint Management Committee (FJMC) co-manages marine and freshwater fisheries as well as fish habitat in the ISR, including the MRD. Created in 1986, the FJMC is part of a co-management network, involving the Minister of Fisheries and Oceans Canada, and the Hunters and Trappers Committees (HTC), local Inuvialuit organizations responsible for certain harvesting rights in each community. The FJMC is composed of two Inuvialuit representatives, two federal government representatives, and one Chair, who is selected by the other four appointed members (Joint Secretariat, 2019). Its mission consists of developing effective co-management programs using both scientific

knowledge and LTK, while respecting Inuvialuit beliefs, values and practices, to maintain the sustainability of freshwater and marine resources (FJMC, 2017).

While Inuvialuit have the exclusive rights to harvest fish resources, conservation strategies such as subsistence quotas for fish and marine mammals are collaboratively implemented by the FJMC. Through annual consultations within each community, problems, concerns and needs are identified. The FJMC is then responsible to document information and knowledge, allocating federal funding for research, assessment and monitoring programs that ultimately support decision-making processes. Current structures enable Inuvialuit participation and the use of LTK in decision-making processes through an ongoing cyclical and adaptive approach, which involves community consultations, reviewing results and modifying programs accordingly (Ayles, Bell & Hoyt, 2017). Over the years, institutional networks and mechanisms have evolved, improving the participation of Inuvialuit knowledge holders and fishers in social learning processes and natural resources management (Armitage, et al., 2011).

1.6 Thesis Structure

This thesis consists of five sections (Chapters 2-6). First, the discussions related to environmental change, fishing livelihoods and food security are reviewed. Since there are relatively few studies that connect changing subsistence fisheries and food security, Chapter 2 draws from different bodies of literature to develop a conceptual framework that addresses the particularities of Inuit communities, although some key considerations are applicable to Aboriginal contexts in general. As such, following a brief overview of the main environmental changes in the MRD, the literature review brings together livelihood

approaches derived from international development studies and key considerations related to Inuit food insecurity. Chapter 3 presents the methodology used to conduct this community-based participatory research, which covers the approach, design, methods, and study limitations. Based on interviews with local fishers as well as survey responses from a complementary database of harvesters, Chapter 4 examines the importance of Inuvialuit fishing livelihoods, through an analysis of Inuvialuit fishing preferences, practices and harvest levels. It also examines the main social and environmental changes related to fishing conditions and fish quality, as well as related human impacts. Chapter 5 discusses the broader implications of local observations of change by examining vulnerability contexts, impacts on the country food system, and connections with community well-being. Chapter 6 summarizes key findings as well as theoretical, methodological and practical contributions, and provides recommendations for future research.

Chapter 2: Literature Review

This chapter provides a brief overview of the bodies of literature that underpin this research. The first section reviews the human impacts of environmental changes observed in the MRD. The second section examines the importance of mobilizing Local and Traditional Knowledge in community-based research for understanding the complexity of socio-ecological systems. The subsequent sections explore the current conceptualizations related to sustainable fishing livelihoods and food security in the Arctic. Finally, a conceptual framework for this research is introduced based on the intersections between the livelihoods and food security discussions.

2.1 Human Dimensions of Environmental Change in the Mackenzie River Delta

Drawing upon a socio-ecological system approach that recognizes the interdependence between humans and their natural environment, biophysical changes have anthropogenic impacts (Armitage, et al., 2012; Berkes, et al., 2002; Bodin & Prell, 2011). Ecological systems refer to the biophysical environment that includes wildlife, water, soil, climate and their biological processes. Social systems describe human societies that involve individuals, households, communities, and institutions, and how they function as a whole, including aspects of the economy, politics, management and culture. As such, the environmental changes previously discussed represent both challenges and opportunities for Aboriginal societies in Canada's North, that still maintain a strong connection with their natural environment (IPCC, 2014). This section examines the local impacts of environmental change on Inuvialuit communities. It then briefly reviews the core concepts related to the sustainability of social systems in the context of environmental change.

2.1.1 Human impacts of environmental change

Aboriginal cultures are embedded in a strong sense of interconnectedness, which highlights the reciprocal relationship between the people and the land (ACIA, 2005). This strong connection is part of the socio-cultural identity of Aboriginal people (Wolfe et al., 2007). Therefore, the interconnectedness of social-ecological systems implies that a healthy environment leads to healthy individuals and communities. In Canada's North, Aboriginal communities are disproportionately affected by the impacts of environmental change, in addition to presenting the lowest socio-economic indicators in the country. Northern Aboriginal populations are facing food insecurity, ongoing housing crisis, poor health and education services, health issues, and high unemployment (AMAP, 2017; Ford et al., 2010; Lemmen, Warren, Lacroix, & Bush, 2008; Seguin, 2008). The combination of these biophysical and socio-economic factors contributes to the vulnerability of northern Aboriginal communities.

Environmental changes affect traditional ways of life (ACIA, 2005; Lemmen, Warren, Lacroix & Bush, 2008; Tsosie, 2007). Changes in weather and ice conditions challenge traditional activities such as fishing, hunting and trapping by increasing unpredictability, reducing travel safety, and altering access to harvesting grounds. Ultimately, these changes threaten subsistence activities as well as cultural identities that are deeply connected to the land (Watt-Cloutier, 2015). Additionally, changes in vegetation and wildlife availability, distribution, and quality affect directly the country food system, which is an integral contributor to human health as well as cultural well-being (ACIA, 2005; Lemmen, et al., 2004; Warren & Lacroix, 2008; Wesche & Chan, 2010).

Additional impacts are observed in the infrastructure and transportation sector (Feltmate & Thistlethwaite, 2012). Weather variability destabilizes air- and land-based transportation, while the shrinking cryosphere deteriorates roads, housing, and other infrastructure. This is particularly important since most northern communities are remote, thus relying on air transportation and/or ice road webs. Additionally, many Arctic coastal communities are vulnerable to erosion, and sometimes require relocation strategies (Pendakur, 2017). The combination of these factors contributes to the ongoing northern housing crisis (Abraham, Church & Sparling, 2015).

On the other hand, some environmental impacts create new socio-economic opportunities. The reduction of ice and snow cover opens new commercial shipping routes, develops potential industries such as tourism, and facilitates access to natural resources such as oil, gas, mining, and fisheries (Dawson, Johnston & Stewart, 2017; Kaiser, Fernandez & Vestergaard, 2016). Although there is a growing interest towards these new opportunities, northern communities, and particularly Aboriginal People, have limited decision-making power over development projects that are mostly led by private organizations or state-owned enterprises in addition to having a history of harmful environmental and human impacts (Bone, 2009).

The environmental changes occurring in the MRD and subsequent impacts on Inuvialuit communities reflect the trends observed in the Canada's North (Pearce, et al., 2009). Social and ecological changes affect traditional livelihoods, including fishing (Fausch, Torgersen, Baxter, & Li, 2002). Changes in water levels, ice quality, and weather variability modify travel means and patterns for traditional hunting and trapping (Fresque-Baxter, 2015; Nickels, et al., 2005; Riedlinger, 2001). Additionally, communities have

expressed concerns for water safety and ultimately wildlife health (MRBB, 2004). The observed changes increase mistrust about traditional sources of food, which directly affects the well-being of Aboriginal communities (Fresque-Baxter, 2015; Guyot et al., 2006; Wesche, 2009). In addition to these ecological pressures, Inuvialuit land users have experienced a long history of economic, social and political change, disrupting traditional ways of life, knowledge and practices (Pearce, et al., 2009). A combination of environmental and social factors contributes to undermining fishing livelihoods, although subsistence activities remain important for many households. As such, subsistence fisheries in the MRD highlight the interdependence between Arctic communities and freshwater systems, both exposed to a set of social and environmental stressors at local, national and global scales (Bodin & Prell, 2011).

2.1.2 Underlying concepts: adaptation, adaptive capacity and vulnerability

Scholars focusing on the human dimensions of environmental change developed new approaches and concepts that reflect the complexity of dynamic and interactive socio-ecological systems. Adaptation, adaptive capacity and vulnerability represent key interconnected concepts that are part of the theoretical background required to understand the human dimensions of environmental change. While this chapter doesn't discuss the bodies of theory behind those concepts, it is important to briefly define them, as they are recurrent underlying themes throughout this research.

In the context of environmental change, a socio-ecological system approach recognizes the dynamic nature of a system, that is constantly changing. Derived from the natural sciences, and more specifically from the field of ecology, resilience refers to a

system's capacity to absorb any disturbance caused by an external change that can be more or less radical (Cote & Nightingale, 2012). In other words, it describes the ability of a system to absorb change while maintaining its function, structure and identity (Walker & Salt, 2012). As such, resilience provides a holistic understanding of the system, as a unit, involving socio-ecological interrelationships, ecological thresholds and feedback loops (Miller, et al., 2010).

Vulnerability is a complementary concept, that examines how social groups, which are subjected to different historical and contemporary processes, are affected by a given threat. Vulnerability is thus defined as a function of exposure-sensitivity to risk and the adaptive capacity to deal with that risk, representing an essential concept to understand the degree to which a system is unable to cope with change (Ford & Smit, 2004; Pearce, 2011). This concept emerged from hazard studies and has been commonly applied in the study of disaster risk, livelihoods, poverty and food security. Based on an actor-oriented approach, vulnerability emphasises the social dimensions of a system, valuing the interest, knowledge and agency of the social group (Miller, et al., 2010).

In response to stressors and shocks, adaptation and adaptive capacity are identified as core concepts for socio-ecological systems to deal with environmental changes and impacts. The social-ecological system approach recognizes an inherent adaptive capacity within each system, which is defined by the ability to respond to existing or anticipated changes (Ford & King, 2015; Brooks, 2003). Socio-ecological systems are dynamic, complex, interconnected and thus constantly evolving through adaptive cycles (Bodin & Prell, 2011). As such, adaptive capacity describes attributes within a system, that determine its potential to adapt. On the other hand, the concept of adaptation describes actual

processes and actions taken in order to minimize impacts of change (Adger, et al. 2005; Lemmen, Warren & Lacroix, 2008). It thus describes a set of planned adjustments developed in social systems in response to change. As such, both concepts, adaptation and adaptive capacity, reflect the social, political, economic, technological, and institutional particularities of each system and its ability to respond to environmental changes (Engle, 2011; Ford, McDowell & Pearce, 2015).

2.2 Mobilization of Indigenous Knowledge (IK)

Over the past decade, Indigenous Knowledge (IK) has gained a growing recognition in academic and political spheres. This recent interest implies that IK will increasingly inform adaptation strategies and ultimately influence policy-making processes. This represents an important shift, especially when working on issues that affect Indigenous communities (ACIA, 2005). While this research doesn't aim to address the challenges of defining and working with different knowledge systems, it inherently draws upon IK, by focusing on local observations and experiences of change in fishing livelihoods in the MRD. The following section discusses IK as a different way of knowing as well as its importance in the production of knowledge and adaptation strategies.

2.2.1 Indigenous knowledge systems

Over generations living on the land, Indigenous communities have developed and shared a body of knowledge that is identified by scholars as Traditional Knowledge (TK) or Indigenous knowledge (IK)². TK/IK refers to systems of knowledge that are rooted in

² TK and IK are interchangeable terms. IK is more broadly used on a global scale, while TK is often used in Northern Canada (Grenier, 1998).

cultural traditions and experiences, both built and coherently transmitted over generations (Abele, 1997). These knowledge systems involve observations, information, beliefs, norms, practices and representations that link communities with the world (Warren, Slikkerveer, & Brokensha, 1995). IK/TK is a holistic system, covering various fields such as medicine, spirituality, astronomy, and ecology. IK/TK is embedded in Indigenous cultures, marginalized populations that have historically been excluded from the process of making science (Semali & Kincheloe, 2002). Indeed, the production of science reflects historical power structures, embedded in western imperialism, where local knowledge systems were historically disregarded (Smith, 2012).

In the context of environmental change research, academics recognize the importance of the knowledge within IK/TK about the biophysical environmental and human-nature relationships. Berkes introduced the concept of Traditional Ecological Knowledge (TEK) in an attempt to encapsulate ecological knowledge that is part of broader Aboriginal knowledge systems. TEK is thus categorization of IK/TK that is oriented towards ecology (Berkes, 1999). TEK underlies a cumulative body of knowledge towards the sustainability of the environment and local resource use (Berkes, 2009). Maillhot defines TEK as a “sum of the data and ideas acquired by a human group on its environment as a result of the group's use and occupation of a region over many generations” (Maillhot, 1993: 11). In other words, a community develops its own system of knowledge through its social, cultural and economic interactions with the social and physical environment (Howitt, 2001: 35). As such, TEK does not only represent a set of data but is also a culturally coherent way of seeing, understanding and living facing a dynamic cosmic, social and physical environment. It is thus a dynamic process that produces a set of

information, ideas, beliefs, values and practices, deeply embedded in Indigenous ways of life, that structures traditions, practices, knowledge, institutions and norms (Berkes, 2009; Howitt, 2001).

TEK is a concept that emerged in the 1980s from two research traditions: ethnohistory and cultural ecology (Maillhot, 1993). These research fields explored an awareness of the history of non-Western science that contributed to the increasing interest in TEK. It contains empirical and conceptual elements that are cumulative over generations and dynamic, in that it evolves in response to various changes (Neis, Felt, Haedrich & Schneider, 1999). TEK is increasingly considered as an important source of information about the environment and the relationship that communities have with the land and to each other by academics and institutions. Additionally, TEK contributes to acknowledging the validity of a distinct system of knowledge. Given the history of Indigenous People's marginalization, TEK was not recognized or respected prior to and during most of the twentieth century (ACIA, 2005; Smith, 2012). This actual recognition is thus a way to hear, consider, respect and value Indigenous voices.

However, the use of TEK has been criticized by many Indigenous scholars. As the concept is rooted in western political and scientific frameworks, its use reproduces new forms of colonialism. As such, it raises the issue of cultural appropriation and ownership. Academics and institutions examine and exploit TEK, dispossessing Indigenous people of their intellectual rights, which is seen as a form of cultural imperialism (Ermine, Sinclair, & Jeffery, 2004). Additionally, McGregor argues that TEK compartmentalizes Indigenous cosmologies, by extracting ecological components, which ultimately goes against the holistic nature of Indigenous knowledge systems (McGregor, 2004). While the recognition

of TEK is an important epistemological shift, its definition misses important dimensions. Indeed, this fragmentation ignores the “wholeness” and “connectedness” of Indigenous knowledge system (Ermine, 1995). Indigenous people maintain strong reciprocal relationships with the nature, rooted in cosmologies and worldviews that shape Indigenous knowledge systems as experiential and spiritual ways of life rather than just bodies of information (Cajete, 1999; McGregor, 2004; Whyte, 2016).

In view of this ongoing discussion, I prefer to use the terminology of ‘Local and Traditional Knowledge (LTK)’ for this research. I understand tradition as dynamic and cumulative over generations even if it is likely to undergo some changes and adaptations. The locality of LTK refers to a community-scale approach that provides a relevant scope to address observations, understandings and experiences of fishers on the land. By saying so, I frame LTK as a holistic system of knowledge that is both embedded in Aboriginal ways of life and based on local observations and experiences from the land. Since this research focuses on changing fishing systems in the MRD, I recognize that Inuvialuit fishing experiences are embedded in LTK, whereas I do not attempt to define Inuvialuit ways of knowing.

The strengths of this concept rely on the adaptive, local and participative approaches that are implied by valuing alternative voices (Armitage, 2008; Marschke & Berkes 2006; Ross & Berkes, 2013). However, there are two main challenges when working with LTK. First, the idea of tradition is ambiguous (Von der Porten, 2012). In Canada, Aboriginal communities share a history of cultural extermination, which weakened the traditions’ continuity (Graham, 2012). The concept of tradition implies a reality that is stable over time. This understanding can lead to a form of idealization of

LTK that denies the historical marginalization and the ongoing inequities of Aboriginal people. Second, the mobilization of different systems of knowledge has methodological implications related to the gap between western science and LTK that correspond to completely different worldviews (Riedlinger & Berkes, 2001; Smith, 2012).

2.2.2 The role of Local and Traditional Knowledge in adaptation strategies

Aboriginal populations have long faced and continue to experience multiple challenges such as environmental variability, extended winters and fluctuations in animal populations (Newton, Paci & Ogden, 2005; Paci, et al. 2004). The changes that Aboriginal people have faced are not only related to the biophysical environment but also to anthropogenic factors. In more recent times, the history of colonization represented a major threat for Aboriginal communities through the implementation of a sedentary lifestyle, wars, diseases, new values, economies, and technologies, among other factors (Guimond, et al., 2009; Giles, Castleden, & Baker, 2010; Rotarangi & Russell, 2009). As a result, Aboriginal communities have developed the capacity to adapt to the slow and sometimes radical changes in the circumpolar world. They have implemented different cultural mechanisms to build an adaptive capacity over generations, and reduce their vulnerability (Newton, Paci & Ogden, 2005). These skills, practices and understandings are part of LTK acquired over generations as people lived in close contact with nature (Cobb, Kislalioglu & Berkes, 2005). For instance, place names represent one of such cultural mechanisms, that reveals historical information about both Indigenous history and local environmental conditions. As such, place naming constitutes one way of perceiving the environment and transmitting information about it, thus representing a source of accumulated knowledge

(ACIA, 2005). Additionally, LTK systems offer some responses to environmental risks by adapting housing to local conditions, shifting camp locations, or avoiding places associated with natural hazards. The survival of Aboriginal Peoples thus relied on LTK (Johnson, 1998).

While LTK was historically valued within Aboriginal communities for survival and well-being, it is now recognized as an important source of knowledge in the world (Johnson, 1998). It offers local expertise about social and ecological changes, informing us about processes, causes, predictions and possible adaptations. Studies about LTK provide insights into the identification of geographic locations for research, issues, new hypotheses, priorities and solutions (Riedlinger & Berkes, 2001; Berkes, 2009). Moreover, the mobilization of LTK contributes to establishing frameworks and indicators, and to pursuing data collection and monitoring (Boyd & Charles, 2006). However, the principal value of LTK remains within the community, where it represents a means for strengthening adaptive capacity based on a socio-ecological systems approach.

Recognizing the importance of Indigenous knowledge systems in responding to change leads to a growing interest in political and academic spheres in scaling up LTK for policy-making in different sectors such as resource management and public health (Johnson, 1998). As management is part of adaptation strategies, LTK is mobilized by stakeholders for decision-making processes (ACIA, 2005). The value of LTK is then recognized at higher political levels. For example, the Government of the Northwest Territories has recognized that "Aboriginal Traditional Knowledge is a valid and essential source of information about the natural environment and its resources, the use of natural resources, and the relationship of people to the land and to each other" (GNWT, 1993). The

mobilization of LTK for decision-making processes represents a redistribution in the balance of power. This shift of power evolves from centralized political structures to shared decision-making structures at the local level that involve strong partnerships (Manseau, Parlee, & Burton, 2005). As such, the effective use of LTK in policy-making relies on knowledge holders' strong relationships that involves community members, scientists, and decision-makers (Cobb, Kislalioglu & Berkes, 2005). In the ISR, a co-management plan for the Beaufort beluga whale population has been implemented over the past two decades in reaction to oil and gas activities in the 1970s (FJMC, 2013). This experience represents a successful ongoing engagement of LTK holders, scientists and policy-makers with the aim of collaboratively ensuring the sustainable use of a culturally important local resource such as the beluga whale (Adams, Frost & Harwood, 1993; Berkes, Berkes & Fast, 2007).

However, there are several challenges in using LTK in policy-making at a broader political level. First, unsettled land claims increase tensions around an effective mobilization of LTK in policy-making (Cobb, Kislalioglu & Berkes, 2005). Aboriginal and non-Aboriginal political actors recognize the importance of including LTK in land claim discussions. Stakeholders negotiate formalized structures and mechanisms ensuring that LTK is included in wildlife and resources management (Armitage, et al., 2011). In the Inuvialuit Settlement Region, co-management bodies such as the FJMC resulted from the land claim agreement and represent a mechanism through which LTK informs decision-making processes. However, changing economic opportunities for community members sometimes conflict with co-management initiatives. As such, increasing privatized and individualized interests interfere with the collective nature of co-management bodies, which are fueled by LTK (Armitage, 2005).

There are also some methodological challenges regarding the use of LTK as a sound source of knowledge in scientific realms as well as political spheres. While LTK is shaped by spiritual and experiential interactions with the social and physical environment, the scientific community is concerned with “accuracy” and “objectivity”, in the production of rational knowledge (ACIA, 2005). As such, there are methodological discrepancies between LTK, and scientific and institutional frameworks. Additionally, there are barriers to building collaborative networks that gather Aboriginal People, scientists and policy-makers (Berkes, 2009). Since both western and Aboriginal cultures are based on very different worldviews, bringing these distinct paradigms together raises methodological, institutional and logistical problems. Finally, there is a general distrust from Aboriginal communities regarding the more recent scientific interest in LTK given the history of ethnocentric science and policy that benefited primarily the non-Aboriginal population (Smith, 2012). Regardless, scientists and government officials rely increasingly on TK for field observations, management strategies and monitoring programs given the declining resources for such programs (Parlee, et al. 2014).

2.3 Northern Fishing Livelihoods

Fishing livelihoods are an important part of subsistence and culture for northern Aboriginal communities (Wesche & Armitage, 2010). Given the environmental pressures in Canada’s North, there are concerns about the sustainability of traditional livelihoods which affect community well-being and cultural identity (Fausch, et al., 2002; Paci, et al., 2004). However, scientific reports outline several gaps in the assessment and prediction of ecological changes in northern freshwater systems as well as in fisheries, thus highlighting

the unpredictability of these changes (ACIA, 2004; AMAP, 2016). Although relatively few studies focus on northern fishing livelihoods, there are different approaches that tackle the sustainability of subsistence fisheries worldwide. This section discusses some key dimensions of the sustainable livelihood approach as well as of the well-being approach to fishing livelihoods, that are applicable in the context of northern Aboriginal subsistence fisheries.

2.3.1 Subsistence livelihoods in northern Aboriginal communities

In Canada's North, Aboriginal societies have experienced a wide range of cultural, political, social, environmental, and economic changes throughout history (Giles, Castleden & Baker, 2010; Guimond, et al., 2009). However, while there is indeed an increasing reliance on wage economies, Aboriginal people maintain a strong relationship with the land through subsistence activities that address their multiple social, cultural and physical needs (ACIA, 2005; Natcher, 2009). As such, northern Aboriginal communities are characterized by a mix of formal economies, such as the exploitation of natural resources or tourism, and informal economies, such as hunting, fishing and gathering (ACIA, 2005). Subsistence activities encompass a large body of activities that consist of harvesting and processing locally natural resources, which includes hunting, fishing, trapping, gathering, food processing, or skin tanning (Natcher, 2009). Moreover, they represent a complex interplay of environmental, social, cultural and economic aspects, such as sharing networks, cultural values and practices, ecosystem health, and technologies to hunt, fish or travel (ACIA, 2005; Ksenofontov, Backhaus & Schaeppman-Strub, 2017; Natcher, 2009). While it is challenging to assess how traditional livelihoods will be stressed

by the multiple socio-ecological pressures previously discussed, subsistence activities clearly continue to play an important role in Aboriginal health and well-being (AMAP, 2017).

Native fishing economies, and in particular non-coastal fisheries, have been traditionally overlooked in the literature (Todd, 2016). However, some studies in historical ethnographies have examined the role of fishing activities in Aboriginal societies in Canada (Tough, 2000; Harris, & Millerd, 2010; Holzkamm, Lytwyn, & Waisberg, 1988). Tough argues that Aboriginal fisheries have always been essential contributors to the food system and traditional ways of life, although this was overshadowed by an over-emphasis on big game hunting activities (Tough, 2000). Most importantly, Tough and Harris demonstrate in their respective work how colonial structures challenged Aboriginal fishing rights, as a site of conflict (Harris, 2009; Tough, 2000). More recently, drawing from this scholarly tradition, Todd examines how human-fish relationships in Paulatuuk, in the ISR, translate into Indigenous-State reconciliation frameworks (Todd, 2014). By doing so, Todd explores the multiple ways of knowing and engaging with fish, as sentient beings, which reflects reciprocal human-nature relationships embedded in Inuvialuit cosmologies and epistemologies, ultimately shaping Indigenous legal orders (Todd 2016B; Whyte, 2016). This body of literature contributes significantly to the limited understanding of complex interactions between Aboriginal people and fishing systems, specially in relation to historical colonial structures.

While providing important background considerations, these ethnographic studies do not adequately reflect the attempts made in this research to understand the implications of changing fishing systems for Aboriginal food security and community well-being. In

fact, there are relatively few studies about northern Aboriginal livelihoods in the context of environmental change. Additionally, existing research that discusses wildlife health often fails to examine the implications for traditional livelihoods and community well-being (ACIA, 2005; Ford, 2012). Such wildlife studies focus primarily on community-based monitoring of large mammals such as caribou (Beaulieu, 2012; Parlee, Manseau & Łutsël K'è Dene First Nation, 2005), or beluga whale in the ISR (Harwood, Norton, Day & Hall, 2002) while there is little research related to fisheries (Goldhar, Bell & Wolf, 2014).

As such, in Canada's North, there is a limited understanding of changing fishing systems from both an environmental and social perspective, even though fish is an important part of the country food system for northern Aboriginal people (ACIA, 2005; AMAP, 2017; Wesche & Armitage, 2010). This research uses theoretical underpinnings from global case studies for understanding Inuvialuit fishing livelihoods, since there is a growing global interest in vulnerable small-scale fisheries, which are estimated to support over 50 million individuals world-wide (Andrew, et al., 2007; Berkes, 2015; Biswal, Johnson & Berkes, 2017; FAO, 2010; Islam, Sallu, Hubacek, & Paavola, 2014; Marschke & Nong, 2003; Plagányi, et al, 2013). The well-being approach and the Sustainable Livelihood Approach (SLA) provide useful foundations for addressing the importance of Inuvialuit fishing livelihoods, and assessing the implications of environmental pressures on such systems.

2.3.2 The sustainable livelihoods approach

A livelihood is defined by the survival strategies of an individual, a household or a community to meet their consumption and economic needs, while dealing with uncertainties and adapting to new opportunities (de Haan & Zoomers, 2003, from Marschke & Berkes, 2006). Livelihoods represent a wide range of realities that vary from paid employment to subsistence-based activities. Given their complexity and diversity, the study of livelihoods is place- and context-based (Marschke & Berkes, 2006; Morse & McNamara, 2009). The concept of sustainability is often applied in the study of livelihoods, which reflects the complex but strong relationships between the economy, society and environment in socio-ecological systems (Marschke & Berkes, 2005; Morse & McNamara, 2009). Indeed, a livelihood does not only refer to survival means, but it also implies the individuals' ability to sustain themselves in the future without undermining anyone else's capacity to do so. Additionally, sustainability describes a process rather than a state, within which a system functions (Berkes, 2015; Marschke & Berkes, 2006). As such, a livelihood is considered to be “sustainable when it can cope with and recover from stresses and shocks, maintain or enhance its capabilities, assets and entitlements, while not undermining the natural resource base” (Chambers & Conway, 1992, p. 6).

The sustainable livelihoods approach (SLA) has been widely used in development studies that focus on resource-dependent rural communities (Berkes, 2015). Ellis defines a livelihood as “the assets (natural, physical, human, financial and social capital), the activities, and the access to these (mediated by institutions and social relations) that together determine the living gained by the individual or household” (Ellis, 2000, p.10). The assets' status of natural, physical, human, financial and social capitals are fundamental

to understand the access to fishing activities that will provide food and/or income (Allison & Ellis, 2001). Natural capital outlines natural resources that include freshwater systems and fish. Physical capital describes materials and tools used to conduct fishing activities, such as nets or boats. Human capital refers to the household's members that are involved in fishing activities (e.g. education level, health condition, and knowledge). Financial capital refers to monetary resources that are necessary to acquire goods for consumption or production. Finally, social capital represents the social networks involved in fisheries, such as social groups, organizations and food sharing (Morse & McNamara, 2013). Natcher notably highlights the key role played by social capital as well as LTK in supporting traditional fishing livelihoods (Natcher, 2015). On the one hand, social and kinship networks are essential for having access to fishing activities and benefiting from the outcomes. On the other hand, LTK encompasses the skills, knowledge and practices related to fishing livelihoods that are built, shared and produced over generations in small groups and that have a structured social support and strong ties within and between their immediate communities (ACIA, 2005).

Ashley and Carney propose a SLA framework that is built upon the concept of vulnerability (Ashley & Carney, 1999), which is defined by people's exposure and sensitivity to risks along with their adaptive capacity to changes and related impacts (Berkes, 2015; Islam, Sallu, Hubacek, & Paavola, 2014). Figure 3 illustrates how livelihoods face contexts of vulnerability related to environmental, social and economic shocks or trends, as well as institutional contexts, within which they function (Ashley & Carney, 1999; Morse & McNamara, 2013). After the assessment of such system, strategies targeting assets, vulnerabilities and/or institutions can be adopted to enhance livelihoods'

outcomes, such as sustainability, food security or well-being (Ellis, 2000; Morse & McNamara, 2013).

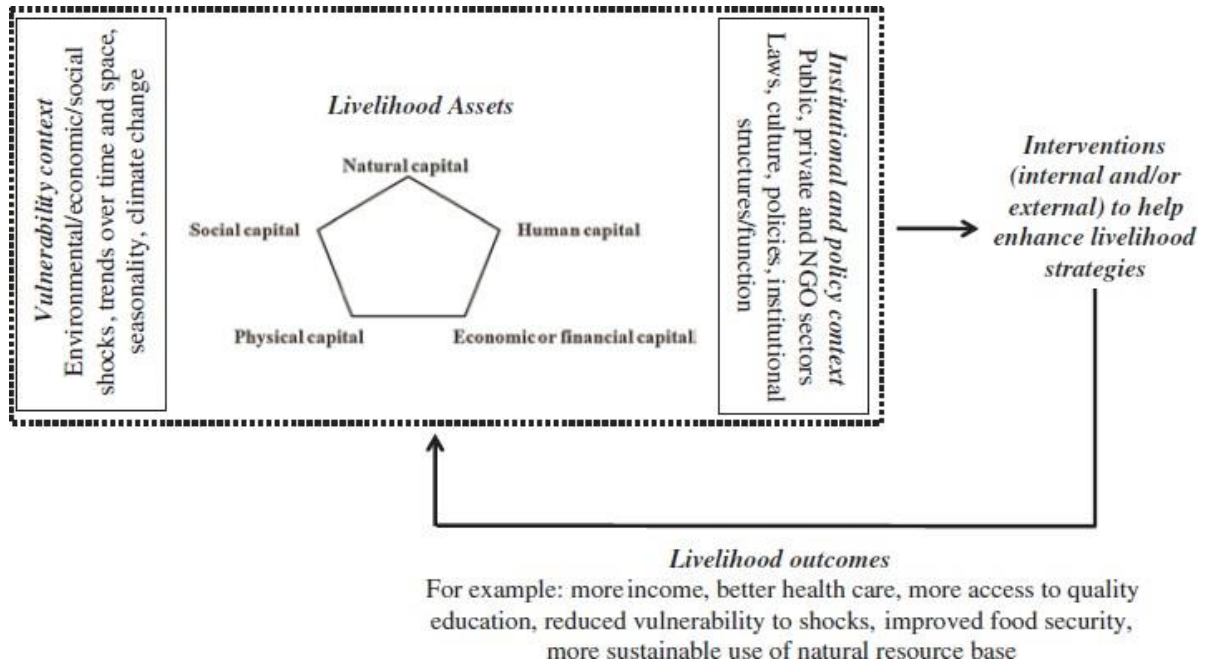


Figure 3: The SLA framework (DFID, 2009 from Morse & McNamara, 2013, p. 19)

The SLA framework originated from the fields of natural resources management and international development (Berkes, 2015). The focus on livelihoods is aimed at supporting development strategies and improve living conditions. Since this framework has been mostly applied in global contexts, where communities are more susceptible to face challenges related to a lack of infrastructure, institutions, resources or capacity, as well as some level of political instability, the suitability of centralized approaches started to be questioned. As such, there was a shift towards bottom-up approaches, by decentralizing resources and capacities, and engaging with local organizations (Berkes, 2015; Morse & McNamara, 2013). While some considerations that emerged from the field of international development cannot be applicable in Canada’s North, Indigenous people internationally

share similarities in terms of colonial experiences and ongoing social and economic inequities. Indeed, Manuel argues that local communities that were historically under colonial domination share common experiences and struggles, and therefore, there are lessons to be learned regarding development strategies for Aboriginal people in Canada from “Third World” countries (Manuel & Posluns, 2019). As such, the implementation of community-based research and the mobilization of LTK represent key lessons learned from SLA that can be mobilized in northern Aboriginal contexts.

The SLA offers a useful conceptual framework, which tackles the complexity and dynamism of livelihoods. However, Morse & McNamara (2013) highlight several limits. First, there is an emphasis on the socio-economic indicators of livelihoods’ assets, while the assessment of cultural factors is limited. This framework lacks the flexibility to address the complexity of cultural components, such as beliefs, values, or leisure. Second, although the scope of analysis can be theoretically individual-, household- or community-based, it is challenging to adopt a community level of analysis (Ellis, 2000). Finally, it is challenging to conduct such holistic analysis that covers complex and diverse realities. Translating SLA into practice is an ambitious undertaking, given the difficulty of gathering such comprehensive information and assessing vulnerability contexts, especially for unpredictable shocks such as environmental changes (Morse & McNamara, 2013).

2.3.3 A well-being approach to understanding fishing livelihoods

Socio-ecological systems provide various resources and services that enhance human well-being, whose components such as quality of life, health, security and social relations, are strongly linked with livelihoods (Millennium Ecosystem Assessment, 2005).

As such, over the past few years, the concept of well-being has contributed increasingly to the discussion of sustainable livelihoods (Coulthard, 2012; White, 2009). According to Coulthard, a scholar in the international development community who worked extensively on sustainable fisheries globally, well-being plays a key role in livelihood sustainability, by determining the capacity to maintain a satisfactory quality of life over time (Breslow, et al., 2016; Coulthard, 2012; Coulthard, et al., 2015). Human well-being and sustainability are highly interconnected concepts (Berkes, 2015), since well-being is considered as both a measurable outcome and driver of livelihood sustainability (Coulthard, 2012). First, sustainable systems produce material assets such as food, and intangible outcomes such as meaning and experiences, that define human well-being. Second, the pursuit of well-being shapes people's choices, actions and behaviour, to achieve outcomes and aspirations.

The concept of well-being has been widely used in the literature, although, due to its subjective meaning, it is often vaguely defined as a satisfactory quality of life (Coulthard, Johnson & McGregor, 2011; White, 2010). Breslow et al. propose the most elaborate conceptualization of human well-being as “a state of being with others and the environment, which arises when human needs are met, when individuals and communities can act meaningfully to pursue their goals, and when individuals and communities enjoy a satisfactory quality of life” (Breslow, et al., 2016, p. 251). This conception of well-being covers three main themes: human needs, autonomy and quality of life (Coulthard, Johnson & McGregor, 2011). As such, it introduces two new considerations in the approach of livelihoods (Coulthard, 2012). In addition to providing a holistic approach, that integrates previously ignored socio-cultural dimensions, there is an interest towards people's subjective experiences and perspectives.

In an attempt to conceptualize empirically a well-being framework, the Well-being in Developing Countries Research Group identified three interrelated dimensions: material, relational and subjective (Coulthard, 2012; White, 2009). Figure 4 represents the interdependence of the three components of well-being with the material and relational dimensions at the base, rising to the subjective dimension at the apex (White, 2010; Britton & Coulthard, 2013). The Well-being in Developing Countries Research Group defined material well-being as the tangible resources such as food, assets, shelter and natural environment. The relational dimension describes how actors pursue well-being through social interactions, which includes personal relationships, kinship, relations of power, institutions and cultural norms. Finally, subjective well-being evokes actors' perceptions and feelings towards their life conditions, which mobilizes a system of values and beliefs.

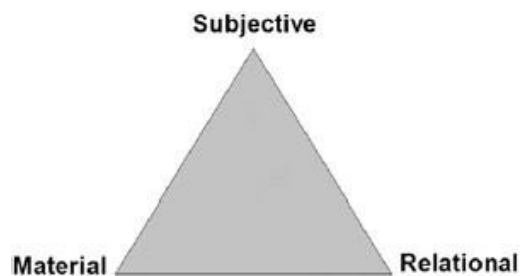


Figure 4: The three dimensions of well-being (Britton & Coulthard, 2013, p.29)

The well-being framework derives from the fields of health and international development (Coulthard, 2012). A significant part of the debate around well-being draws upon the premises developed by Amartya Sen, who shifts the analysis towards a multidimensional approach that considers wealth, utilities, rights, freedoms and values (White, 2009). As such, this approach examines well-being beyond the absence of disease and illness in health studies or economic growth in development studies. However, the mobilization of a well-being approach in sustainable livelihoods has only been recently

discussed in the literature and its application is thus limited (Britton & Coulthard, 2013; Coulthard, Johnson & McGregor, 2011; Coulthard, 2012; Coulthard, et al., 2015; Biswal, Johnson & Berkes, 2017).

The well-being approach has been particularly useful in the management of fisheries, given their importance as a way of life and the vulnerability of fishing ecosystems globally (Coulthard, et al., 2015; Biswal, Johnson & Berkes, 2017). In comparison with the SLA framework, this approach puts a greater emphasis on fishers' subjective realities, in that it recognizes their values, beliefs, aspirations, socio-cultural norms and identities (Coulthard, Johnson & McGregor, 2011). These considerations are particularly relevant in northern Aboriginal fishing livelihoods given the fishing ecosystems' exposure to ongoing pressures and unpredictable changes as well as the socio-cultural importance of traditional livelihoods.

2.4 Food Security in Canada's North

Food insecurity is a recurring theme in the literature related to traditional livelihoods and human impacts of environmental change in Canada's North. It has become a major public health issue among Aboriginal communities, that are disproportionately affected in comparison with other Canadian households, given the lack of access to affordable, culturally acceptable and nutritiously adequate food along with multiple socio-economic and environmental changes (Kenny, et al. 2018; Papatsie, et al. 2013). This section examines a conceptualization of food security, that is adapted to Northern Aboriginal realities, considering the social, cultural and nutritional importance of country

food systems as well as the state of Inuit food insecurity (Lambden, Receveur & Kuhnlein, 2007).

2.4.1 Defining food security

Food security occurs “when all people, at all times, have physical, social, and economic access to sufficient, safe and nutritious food which meets their needs and food preferences for an active and healthy lifestyle” (FAO, 2015). Conversely, food insecurity results from a limited or uncertain access to healthy foods, which can lead to broader food-related issues, such as poor diet quality and chronic health issues, including diabetes, obesity, distress, depression (Kenny, et al. 2018; Tarasuk, 2005; Thompson, 2012). Health Canada identifies three categories of food security status: food secure, moderately food insecure and severely food insecure (Health Canada, 2012). Moderate levels of food insecurity refer to a lack of food diversity and quality, while severe levels of food insecurity are determined by insufficient amounts of food intake and disrupted eating patterns (Schuster, et al., 2011).

Food security is a determinant of human health and well-being, that requires a holistic multi-dimensional approach (Islam & Berkes, 2016; Wesche & Chan, 2010). Gregory et al. argue that food security is the result of robust food systems, defined as “a set of dynamic interactions between and within the biogeophysical and human environments, which result in the production, processing, distribution, preparation and consumption of food” (Gregory, Ingram, & Brklacich, 2005, p.2141). This holistic conceptualization recognizes complex environmental, economic and sociocultural

dimensions of food systems, which connect food security with well-being (Wesche & Chan, 2010).

Food security is considered a fundamental human right and is thus a global issue (Nesbitt & Moore, 2016). The Food and Agriculture Organization of the United Nations identifies four pillars of food security: availability, which refers to supply stocks and production levels; accessibility, which describes the financial and physical means to procure food; utilization, which encompasses skills, knowledge, and practices used to obtain and prepare sufficient and preferred nutrients; and finally, stability over time (FAO, 2008; Power, 2008). Since food insecurity is often related to poor economic conditions, this issue was considered to be solely experienced in developing countries. However, it has also become a growing concern in developed countries (Maxwell, 1996).

In Canada, some groups, such as Aboriginal people, are disproportionately affected by this issue. Drawing upon the four pillars of food security recognized by the Food and Agriculture Organization, new considerations are introduced to reflect the socio-cultural and ecological characteristics of traditional Aboriginal food systems, that strongly rely subsistence products (Wesche & Chan, 2010). As such, Ford introduces food quality as a new pillar, which refers to the nutritional quality and safety of the products (Ford & Berrang-Ford, 2009; Kenny, et al. 2018; NFSC, 2014). Additionally, stability is here considered as a component of each of the other four pillars: availability, access, use and quality; rather than a determinant on its own. These considerations aim to address the complexity of Aboriginal food systems, resulting from dynamic human-environment interactions following a socio-ecological approach (Wesche & Chan, 2010).

The development of a national food policy represents one mechanism by which the Government of Canada is attempting to address this issue. However, food security scholars identified governance structures and policy as key factors of food insecurity (Loring and Gerlach, 2015). Centralized decision-making processes, excessive regulation or lack of thereof, and lack of collaborative approaches to governance contribute to food insecurity (Loring & Gerlach, 2015; McConney, Cox & Pasram, 2015; Reedy, 2016; Theriault et al., 2005). As such, collaborative and community-based approaches are required for future policy on food security. Agriculture and Agri-Food Canada is currently responsible to develop the Food Policy for Canada, with an emphasis on addressing Aboriginal and northern vulnerabilities (AAFC, 2018). Moreover, it includes explicit references to food sovereignty, which describes a human rights approach to food security. As defined in the World Forum on Food Sovereignty, the concept of food sovereignty refers to:

The peoples' right to define their own policies and strategies for the sustainable production, distribution and consumption of food that guarantee the right to food for the entire population, on the basis of small and medium-sized production, respecting their own cultures and the diversity of peasant, fishing and Indigenous forms of agricultural production, marketing and management of rural areas, in which women play a fundamental role. (WFFS, 2001, p.5).

This concept was developed in 1997 by La Vía Campesina, a grass-roots global movement representing farmers' organizations from more than 80 countries that coordinate efforts to defend their right to define their own food and agriculture systems from a community perspective (Vía Campesina, 2007). This approach tackles the political and economic structures that shape production, distribution and consumption processes in the food system, while promoting the importance of local actors in decision-making (CCA, 2014; Epting, 2018). There is thus an emphasis on local and sustainable food systems, by strengthening communities, mobilizing local skills and knowledge, and improving

livelihoods (Wittman, Desmarais & Wiebe, 2011). In Canada's North, food sovereignty reflects the need for Aboriginal people to control their own food systems, as part of self-government agreements or co-management regimes (CCA, 2014). Although this is not examined in this thesis, food sovereignty is a critical consideration to address food security in northern Aboriginal communities, by valuing the rights, autonomy and culture of Aboriginal people (Vía Campesina, 2007; Wittman, Desmarais & Wiebe, 2011; WFFS, 2001).

2.4.2 Food security challenges in northern Aboriginal communities

Food insecurity is a critical issue for northern Aboriginal people. Using the Household Food Security Survey Module, a self-report tool to monitor experiences of food security across Canada, the Canadian Community Health Survey estimated that 12% of all Canadian households experienced some level of food insecurity in 2014, representing approximately 3.2 million individuals across Canada (Health Canada, 2012B; Tarasuk, Mitchell & Dachner, 2016). This rate is significantly higher in northern regions (CCA, 2014). The same survey indicates that in 2014, 46.8% of all households in Nunavut and 24.1% in the Northwest Territories experienced some degree of food insecurity (Tarasuk, Mitchell & Dachner, 2016). Additionally, the Inuit Health Survey 2007-2008 highlights the prevalence of this issue among Inuit. Across the four Inuit Land Claim regions (Nunatsiavut, Nunavik, Nunavut and the ISR), 62.6% of Inuit households are affected by food insecurity, with 33.6 % facing a moderate level of insecurity and 29.1% a severe level (Rosol, et al., 2011). In the ISR, in 2008, 31.1% of Inuit households reported moderate levels of food insecurity and 12.2% reported severe levels of food insecurity (Egeland,

2010). Given the significant discrepancy in food security rates between the average Canadian household and Inuit households in northern communities, this issue has been examined more thoroughly over the past decade by scientists and policy-makers (AAFC, 2018; CCA, 2014; Duhaime, 2002; Rosol, et al., 2011; Tarasuk, Mitchell & Dachner, 2016).

The Inuit maintained seasonally migratory lifestyles as hunters, fishers and gatherers for thousands of years (CCA, 2014). However, colonization, federal assimilationist policies such as residential schools, environmental change, as well as industrial development have drastically shifted the way of life of the Inuit and affected their physical, nutritional, mental, social, cultural and spiritual health (CCA 2014; Duhaime, 2002; Giles, Castleden & Baker, 2010; Reading & Wien, 2009). As a determinant of health, Inuit food security results from a complex interplay of multiple socio-economic, cultural and environmental factors. Nowadays, the Inuit food system is characterized by both country foods from local natural resources that are collected, processed and distributed within a culturally coherent context, and market or store-bought foods introduced to communities through colonization and settlement processes. A third dimension of the food system consists of locally-produced food, such as greenhouse growing, although this is not further discussed here since it represents only a very small part of the overall food system in the Arctic.

The country food system represents a critical determinant of nutritional health as well as social and cultural well-being, as its use sustains strong, meaningful connections with the environment through traditional livelihoods and on-the-land activities (Guyot, et al. 2006; Paci, et al., 2004; Schuster, et al., 2011; Wesche & Chan, 2010). Additionally,

country food systems remain embedded in sharing practices (CCA, 2014; Wesche & Chan, 2010). In food-sharing networks, kinship appears as a major factor of distribution even though food is sometimes shared with vulnerable groups such as Elders (Collings, Wenzel & Condon, 1998; Duhaime, 2002). As such, Natcher argues that social capital, through durable social networks, facilitate alternatives to access country foods, while reinforcing family and community ties (Natcher, 2015). Although stressed by the growing commodification of traditional foods, country food systems contribute to social relationships and community life, (Kenny, et al., 2018).

The Inuit food system is facing significant ecological, socio-economic and cultural pressures. As a collaborative governance process involving government departments, Inuit organizations, non-government organizations, and the private sector at the territorial scale, the Nunavut Food Security Coalition outlines some local factors affecting the four pillars of Aboriginal food security: availability, access, use and quality, to illustrate the complexity of factors at play (Figure 5) (NFSC, 2014). Market foods access and availability are limited given the remoteness of northern communities and high costs of transportation (CCA, 2014). For instance, in this case study, although Inuvik is served by an all-season road, Aklavik is only connected by road in winter. Furthermore, available market foods often have poor nutritional value and a short shelf-life for perishable items such as vegetables and fruits (Kenny, et al. 2018). Finally, market foods have been introduced relatively recently in the Inuit diet, and as a result, there is a lack of knowledge and skills about how to select, prepare, and consume them (Duhaime, 2002).

While focusing on some socio-ecological factors of food insecurity at the household level, the Nunavut Food Security Coalition recognizes policy and legislation as a key theme

to address food security at the territorial scale (CCA, 2014; NFSC, 2014). In fact, food security scholars identify governance structures and policies embedded in colonial legacies as primary drivers of food insecurity (Loring and Gerlach, 2015). For instance, some legislations such as restrictive conservation policies affect access and availability of country foods. While acknowledging the key role played by policy and legislation in shaping country food systems, this thesis focuses on the impacts of local socio-ecological changes on food security.

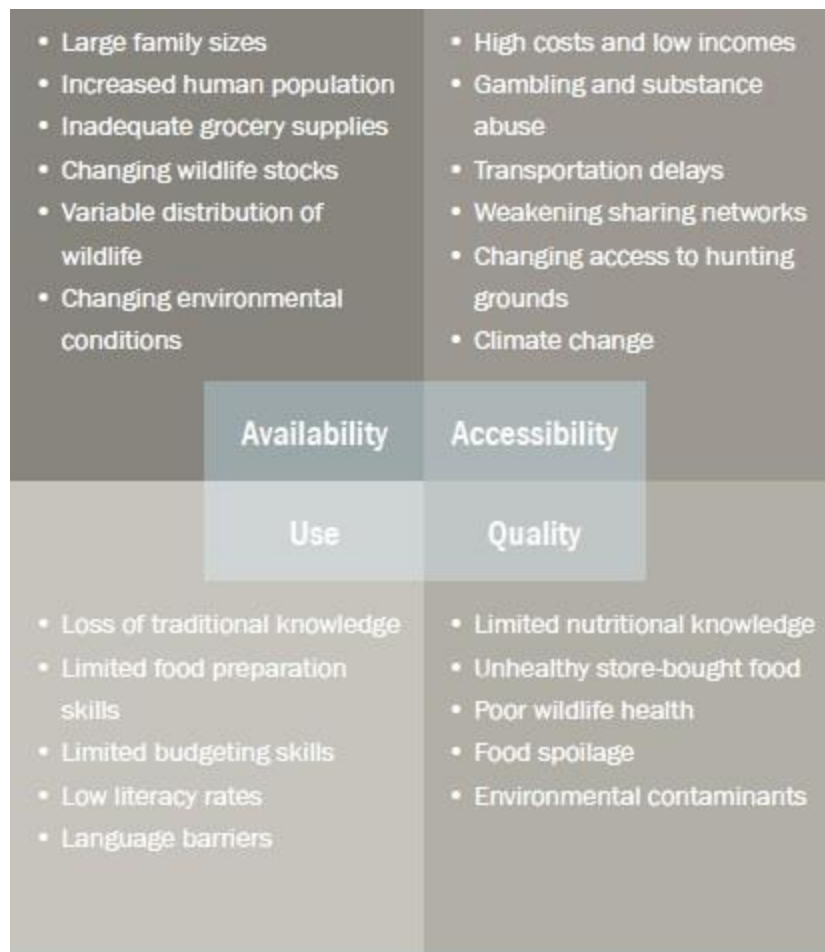


Figure 5: Four pillars of Northern food security and relevant factors (NFSC, 2014, p.3)

Environmental changes affect access and availability of country foods, by limiting the travel safety of harvesters as well as altering the health, distribution and abundance of wildlife (Kenny, et al. 2018; Lambden, Receveur, & Kuhnlein, 2007). Additionally, there is an increasing mistrust towards sources of food from the land due to contamination risks and resource development (McAuley & Knopper, 2011; Wesche, 2009). Socio-economic conditions such as employment in the wage economy or conversely, poverty contexts, reduce the financial means and time available for harvesters to access food (Collings, Wenzel, & Condon, 1998; Duhaime, 2002; Mead, et al., 2010). Finally, cultural factors such as the loss of LTK, skills, and practices limit the effective use of culturally preferred food (CCA, 2014; Pearce, et al., 2011; Wesche & Chan, 2010). These interrelated challenges lead Inuit households to consume low-priced store-bought food, that is less nutritious than both country foods and other healthier but more expensive market products, which ultimately contributes to undermining food security.

In the context of fishing livelihoods, Nilsson et al. highlight the interdependence between water and food security, since country food systems rely on aquatic ecosystem services, although only few studies discuss this matter in northern regions (Nilsson, et al. 2013). For instance, aquatic systems contribute to transporting anthropogenic contaminants that can affect wildlife, vegetation, and ultimately the Aboriginal communities that depend on them (Berner, et al., 2016). However, as previously stated, there is still a limited understanding of hydrological changes in northern regions and subsequent effects, while it is common knowledge that freshwater systems provide critical services to communities, such as water for drinking, cooking and cleaning as well as healthy habitats for wildlife

and vegetation (White, et al., 2007). As such, there is a need to improve our knowledge about the interactions between changing aquatic ecosystems and food security.

LTK, and particularly fishers' knowledge, can play a key role in addressing this gap (Hanjra & Qureshi, 2010). As they are dealing directly with highly sensitive freshwater systems, fishers are LTK holders and the primary experts to face changing water ecosystems (Neis, Felt, Haedrich and Schneider, 1999). Their knowledge involves an understanding of climate, wind, water quality and quantity, floods and ecosystem relationships, that is essential to ensuring the safety of travel as well as the success of fishing and other types of harvesting (ACIA, 2005). Fishers' LTK also includes ecological information such as fish categories, populations, behaviour, cycles, and distribution, which represents a necessary body of knowledge for procuring country foods (Neis, Felt, Haedrich and Schneider, 1999). As such, in the context of changing fishing livelihoods, LTK offers key insights to understand human-nature relationships that enable the procurement, preparation and distribution of foods, thus contributing to the sustainability of the country food system.

2.5 Conceptual Framework

This research draws its conceptual framework from the different bodies of literature discussed in previous sections. Since there is a limited understanding of the effects of environmental change on Arctic fishing livelihoods and the role of subsistence fisheries in food security is understudied (Islam & Berkes, 2016), key theoretical considerations are combined to develop a framework that conceptualizes the vulnerability of Inuvialuit fishing livelihoods to socio-ecological changes and related impacts on the country food system.

Figure 6 frames fishing livelihoods through a socio-ecological systems approach, which outlines the dynamic interdependence of the fishing community, as the social sphere, and freshwater ecosystem, as the ecological sphere (Berkes, Colding, & Folke, 2002). LTK lies at the heart of the framework, as it plays a key role in understanding the interconnectedness of the fishing system. Simultaneously, local fishing systems are integrated within larger-scale dynamics that determine vulnerability contexts, drawing from the SLA framework (Figure 3). As a system’s vulnerability is determined by its exposure to risks, such as socio-ecological changes, as well as its adaptive capacity (Morse & McNamara, 2013), this framework represents complex multi-scale interactions, although this research focuses on the community level.

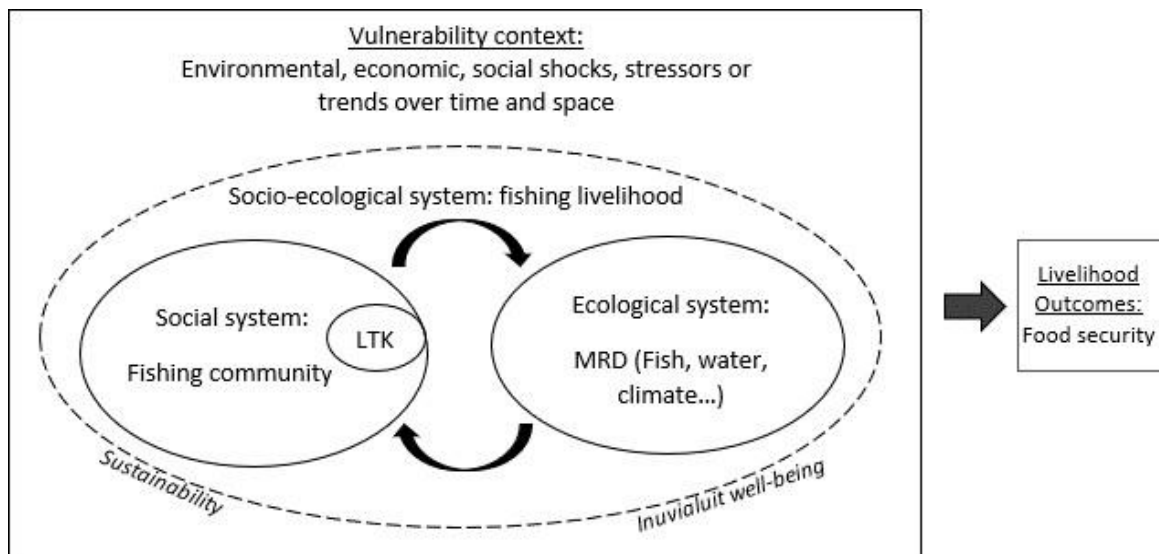


Figure 7: Conceptual framework for a socio-ecological system approach to fishing livelihoods and food security in the MRD

Following Coulthard’s well-being approach to fishing livelihoods, I propose a framework that recognizes sustainability and well-being as processes within which the system functions and generates outcomes (Berkes, 2015; Coulthard, 2012). Both processes are interconnected since Inuvialuit well-being depends on fishing livelihood sustainability,

by maintaining a satisfactory quality of life over time. Additionally, the subjective dimension of well-being recognizes fishers' subjective experiences and behaviours, that shape the socio-ecological system. Finally, as the fishing system interacts within these parameters, which include the vulnerability context, sustainability and well-being, livelihood outcomes are produced. In this research, I ultimately focus on food security, as one livelihood outcome, by examining the importance of subsistence fisheries in the country food system (Islam & Berkes, 2016).

Chapter 3: Methodology

This chapter discusses the methodological details of this research. The first section explores some ethical considerations such as power dynamics in the scientific production of knowledge and the researcher's positionality, which led to a community-based participatory research (CBPR) approach. The next section describes the methods used, which include accessing existing data from the Arctic Borderlands Ecological Knowledge Society (ABEKS), conducting interviews, data analysis and reporting results to communities. The final section discusses the challenges, validity and limitations of the methods highlighting the need for methodological flexibility, given the unpredictable nature of community-based research.

3.1 Ethical Considerations

Working with Aboriginal communities requires ethical and methodological considerations prior to the research design. An important first step consists of acknowledging the importance of colonialism and its geographies of power in the process of building knowledge (Castleden, Sloan Morgan, & Lamb, 2012). The scientific production of knowledge has a long history of western imperialism, and has historically disregarded local systems of knowledge. As such, research about Aboriginal people has mostly been conducted through a western perspective, which is embedded in relations of power (Smith, 2012). As a result, as "outsider" and "Southerner" researchers, there are challenges in mobilizing LTK due to concerns about cultural misinterpretation and/or appropriation.

Additionally, the historical way of conducting research ‘on’ rather than “with”, “for” or “by” Aboriginal people has contributed to the negative reputation of academics among communities (Smith, 2012; Castleden, Sloan Morgan, & Neima, 2010). The lasting effects of colonization and current socio-economic inequities in Aboriginal societies have led many social science scholars, particularly in the field of health studies, to investigate different aspects of Aboriginal communities (Castleden, Sloan Morgan, & Lamb, 2012). However, Castleden et al. argue that a significant proportion of this research tradition is characterized by negative experiences, raising several ethical issues. Such practices include forms of cultural appropriation, neglect of Aboriginal intellectual property, harmful results for participants, misrepresentation of communities or absence of local engagement.

To avoid the above issues, community-based research with Aboriginal people requires preliminary considerations related to the articulation of the research agenda and the researcher’s positionality. First, the research articulation must reflect the assumptions, values, concepts, priorities and needs of Aboriginal people (Smith, 2012). Meaningful local engagement during the research design, data collection and results’ dissemination phases has been identified as key factors for ensuring research success (Brunet, Hickey, & Humphries, 2016; Wesche, et al. 2010). Additionally, the research must fulfill ethical standards in Indigenous studies (Innes, 2004). According to Innes (2004), responsibility and accountability to both the studied community and Aboriginal people in general must be explicit during all the stages of the research process. The Canadian Institutes of Health Research, the Natural Science and Engineering Research Council, and the Social Science and Humanities Research Council proposes adopting “the four Rs” approach: respect, relevance, reciprocity, and responsibility, for engaging in Aboriginal research (CIHR,

2013). The First Nations Information Governance Centre promotes the OCAP principles of ownership, control, access and possession, as an expression of self-determination in research (FNIGC, 2019). Overall, these various ethical guidelines draw from the key consideration that research must be conducted ‘with’ and ‘for’ Aboriginal people, as its outcomes must benefit the communities involved (Ball & Janyst, 2008; Castleden, Sloan Morgan, & Neima, 2010; Pearce, et al., 2009).

Second, as outsiders from the communities of research, it is important to understand our role and impact in the research process. The researcher’s positionality defines his/her individual position in society marked by a set of social, economic, cultural relationships, and identities that can affect the research process, analysis and outcome (Wesche et al., 2010). As such, there is an inherent subjectivity in community-based research due to our individuality as researchers. An exercise of reflexivity becomes necessary to unveil our constructed identities, which are multiple and dynamic (Haraway 1988). Such practice consists of critically thinking about our own subjective understanding of reality, shaped by our research status, position as outsider/insider, ethnicity, gender, values, beliefs and experiences. Recognizing this, critical reflexivity was used during all the stages of the research to acknowledge issues of cultural difference, trust and power (Dowling, 2010).

In light of these ethical considerations, I briefly present myself as a researcher from the southern Canada working with Inuvialuit communities in order to mobilize LTK about changes in fishing livelihoods. I am a Master’s candidate in the Department of Geography, Environment and Geomatics at the University of Ottawa. I am non-Aboriginal female who was born and raised in Switzerland by Spanish immigrant parents. Although I come from a low-income and mixed cultural background, I never lacked any basic resources and never

experienced any form of discrimination due to my ethnicity. I am fully aware of my privileged position towards an Aboriginal population that has been historically abused, and continues to be marginalized. Although my research interests and intentions are fair, I was concerned throughout the entire research process about my ethical legitimacy and credibility in conducting this research.

While I cannot fully address this concern, I tried to follow ethical principles in Indigenous Studies, which involve humility, respect, accountability and responsibility (Innes, 2004). Recognizing my position as an outsider and my relative ignorance towards northern Aboriginal realities, I engaged with research partners, participants and community residents with respect and empathy. As such, I valued and adapted to local needs, priorities, and agendas, knowing that the limited timeframe of my research does not always fit in people's lives. Additionally, I committed to maintain reciprocal relationships with local partners throughout the entire research process, to improve my work's pertinence and avoid any misinterpretation.

3.2 Community-Based Participatory Research

To achieve this research objectives, I undertook a community-based participatory research (CBPR) approach, which is considered both a philosophy and research methodology (Castleden, Mulrennan & Godlewska, 2012). Emerging from social movements that tackle social justice's issues and question science's objectivity, CBPR relies on the communities' capacity to identify both problems and solutions, by drawing upon local partners' knowledge and experiences, building local capacity and sharing decision-making power (Castleden, Garvin & HUU-ay-aht First Nation, 2008).

Additionally, CBPR offers co-learning opportunities for communities as well as researchers (Castleden, Sloan Morgan, & Lamb, 2012). Indeed, new knowledge, research skills and communication tools are introduced to communities, while researchers are exposed to LTK and local procedures such as cultural protocols and ethics. As such, the research process as well as its outcomes are mutually beneficial (Brunet, Hickey & Humphries, 2016). In practice, CBPR requires values of respect and understanding beyond the scope of the research, ongoing communication efforts, and significant time to be present in the communities involved to listen, develop trust and build relationships (Tondu, et al., 2014).

This thesis relies on a qualitative research design that involves an inductive analysis based on experiences, meanings, values and interpretation of the participants (Creswell, 2013). In other terms, this type of approach enables an open discussion inspired by participants who introduce concepts that are experience-based and relevant to them. Additionally, according to CBPR approaches, this research involved a high level of participation in its process (Pearce, et al., 2009). As such, this research has been developed in partnership with the Fisheries Joint Management Committee (FJMC) of the ISR that, by participating to the Tracking Change project, sought to assess: (1) Inuvialuit priorities for research about fish in the MRD; (2) social and ecological changes relating to freshwater fish and ecosystems based on observations of Inuvialuit harvesters; and, (3) the transmission of LTK and skills regarding fishing livelihoods from experienced fishers to Inuvialuit youth. Furthermore, the FJMC was not only involved in setting research priorities and collecting data but also during the analysis and evaluation process. Results and analysis were regularly communicated for reviews and feedback.

This research was conducted over a three-year period (2016-2018) and has involved three main phases. During this first phase, a preliminary literature review was conducted, exploring key concepts and relevant LTK-related case studies in the Mackenzie River watershed. The aim was to identify the strengths, limitations, and gaps in the literature about LTK and socio-ecological changes related to freshwater systems and fishing livelihoods. Then, the research was designed in collaboration with the FJMC, coordinating research agendas and developing the interview guide. There was an ongoing consultation process with the FJMC in order to articulate the research design, liaise with the community, and coordinate the fieldwork. Additionally, the Tracking Change project directed by Dr. Brenda Parlee from the University of Alberta secured a scientific research license from the Aurora Research Institute for all its sub-projects and this thesis received the certificate of ethics approval from the University of Ottawa Research Ethics Board (Appendix A).

The second phase consisted of two months of fieldwork in Inuvik over the summer of 2016 that involved building local relationships and conducting interviews. The goal was to engage fully in community and harvesting activities and incorporate participant observations into this process. The final stage involved an ongoing process of adjustments that included clarifying the conceptual background, collecting complementary data, and refining the analysis. Transcribed interviews and fieldwork notes were analyzed, so that common themes and indicators of environmental change and impacts were identified. Additionally, I committed to both verifying and disseminating research results with our partners and communities. Over the course of the research process, results were regularly reviewed by the FJMC and communicated twice to the Hunters and Trappers Committees (HTC) in both Inuvik and Aklavik, through brief reports and oral presentations.

3.3 Methods

This research used 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 (Appendix B) 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.

Fieldwork was conducted in Inuvik over a two months period from July 2016 to September 2016 in Inuvik. Since the research success relies on a trusting relationship between the participant and the researcher (Grenier, 1998; Smith, 2012; Wesche et al., 2010), as an outsider researcher, it is essential to take some time to build relationships and

spend time in the community. Additionally, our partnership with the FJMC played a key role in organizing the fieldwork, liaising with informants and ensuring the significance of this research. During the interviewing process, it is common practice for researchers in northern Aboriginal communities to offer some form of financial compensation for their time. As such, upon recommendation from the FJMC, a CAN\$25 gift card for the Northern Store was offered to each participant, who was also entered into a draw following all interviews. From all participants, five names were randomly selected from each community for a CAN\$100 gas card. No translation services were necessary since there was no difficulty to communicate in English with participants. Finally, according to ethics requirements, participants provided informed consent, documented via consent forms (Appendix C).

CBPR relies on the engagement of local partners and community residents who have their own agendas and cannot be expected to adapt to the limited timeframe of a Master's research project. As such, the fieldwork was marked by a series of unexpected developments, primarily related to the FJMC staff's agenda. As such, I connected directly with the HTC in Inuvik and received access to the list of their members after approval from the Committee board. Additionally, the HTC staff helped to identify experienced fishers amongst their members that I tried to reach. Additionally, I distributed letters of information (Appendix D) and placed posters (Appendix E) about the research in multiple public spaces. I also posted a digital version of the poster on relevant Facebook pages such as the FJMC's and the HTC's. Furthermore, I was advised by local friends to reach potential participants directly via social media since it is an important tool in the North for sharing information and engaging with community members. Unfortunately, these

methods met limited success since I was not personally known in the community. Simultaneously, many active harvesters were busy with the beluga whale hunting season on the coast during the summertime.

However, some key informants were successfully contacted and several interviews could be conducted during the latter phase of the fieldwork. Additionally, after a brief training, a Gwich'in-Inuvialuit youth intern from the FJMC was sent to Aklavik, her home town, for two weeks, where she conducted six interviews on her own with eight participants, as a means of engaging local youth in the research processes. 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 HTCs 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.

3.4 Analysis

The fieldwork notes taken by myself, interviews conducted in 2016 and 2017, and ABEKS database provided the content for data analysis. Approximately half of the

interviews were audio-recorded, transcribed and entered into the qualitative data analysis software program Dedoose. This program enables qualitative analysis through an iterative coding process. The software helps to organize, compile, and communicate the results (Cope, 2010). Primary or “root” codes were developed to organize the data by major themes related to my research, such as, for instance, food/diet, learning and transmission, quality of life, relationships, fishing practices, observations of changes in fish, observation of changes in the environment. As the analysis progressed, new codes were generated for each root code to cover emerging and underlying themes. The process of coding and organizing data is thus non-linear and flexible, which is appropriate for qualitative participative approaches.

Following the coding process, interview transcripts were excerpted, which consists of searching for content that addresses research objectives through code tags. Additionally, pseudonyms were assigned to anonymize informants (IN1 to IN7 for participants from Inuvik and AK1 to AK6 for participants from Aklavik). For all interviews, responses were summarized in Microsoft Excel. As such, a consistent database was built, allowing a mixed analysis based on tools such as dynamic pivot tables that can include qualitative variables. The ABEKS database allowed for a quantitative analysis based on simple data processing techniques such as pivot tables. Finally, in accordance with Indigenous studies methodologies and ethics, I shared results with participants and partners for review and approval, to ensure involvement in all the stages of the research (Smith, 2012).

3.5 Research Limitations

As one of the first “Tracking Change” sub-projects, this study represents a preliminary effort to examine social and ecological changes in the MRD based on LTK. As such, there are several limitations that must be addressed. A first limitation is related to the profile of participants. Elder participation was limited and therefore longer-term knowledge related to change was lacking in the analysis. As such, results cover primarily short-term socio-ecological changes. Additionally, this study presents local observations and experiences of changes in fishing livelihoods, that reflect unique place-based understandings. As a result, generalizing these results would misrepresent the nuances of complex personal stories (Todd, 2014).

Other limitations are related to the collaborative nature of this research, which consisted of sharing decision-making responsibilities with local partners in the design and implementation of the project, as well as capacity building (Castleden, Garvin & Huu-ay-aht First Nation, 2008). Our research partner organization had limited experience in LTK-based research, and social sciences in general. As the FJMC defined the data collection process and developed the questionnaire following its priorities and expertise, the quality of the data relevant to this study was affected. Additionally, local research assistants conducted the majority of interviews, as part of capacity building objectives, and as a response to the time constraints of my fieldwork. Ultimately, this led to discrepancies in the way interviews were conducted and recorded. Although these challenges reflect expected outcomes from early-stage partnerships, and CBPR in general, this study paves the way for the ongoing documentation of LTK in the region to understand human dimensions of environmental change.

Finally, a further limitation of this research is related to my positionality as an outsider to the communities of Aklavik and Inuvik. This situation affected my capacity to reach out potential informants. The development of relationships with participants, and to a greater extent within the communities, takes time. However, fieldwork is time-limited, which increases the challenge of building trust and relations (Tondu, et al, 2014; Wesche, et al. 2010). Our partnership with the FJMC aimed to overcome this barrier but this relationship was still at an early stage since there was not any previous affiliation with the FJMC or the HTC's in Aklavik and Inuvik. Additionally, there were some internal challenges related to staff transitions, as well as complex layers of actors to navigate within each local organization, that affected the research process. At another level, it is important to note that there is significant research "fatigue" in Inuvik (Ball & Janyst, 2008). The amount, repetition, and lack of continuity of research projects, such as "parachute" scientists disappearing after data collection, contribute to a sense of fatigue towards research in some communities (Pulsifer, et. 2012). This is the case of Inuvik since it represents a large base for Western Arctic research. As such, it is more challenging to engage with community members. The barriers discussed affected the quality of my fieldwork and the interviewing process. However, CBPR takes patience (Tondu, et al, 2014). Therefore, this thesis represents a stepping stone in an ongoing collaboration with its own set of challenges and successes.

Chapter 4: 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).

4.1 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.

4.1.1 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 anadromous³ 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:

³ Anadromous fish refers to fish species that are born in freshwater, grow in salt water and migrate back into freshwater to spawn (Fishionary, 2019)

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:

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.

4.1.2 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.

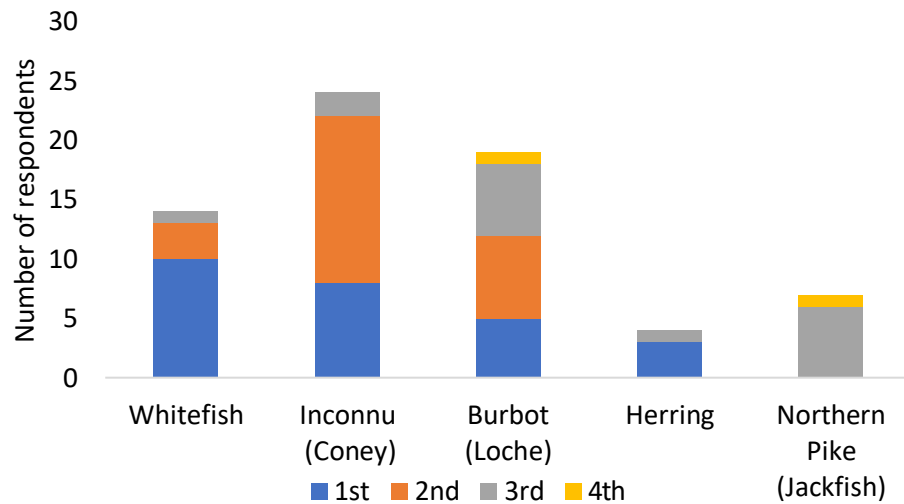


Figure 7: Ranking distribution of fish species contributing the most to participant diets, where 1st-4th indicate the rank of a particular species in terms of prominence in the diet (based on interviews, N=28)

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).

Fish Species	Aklavik (Inuvialuit)	Inuvik (Inuvialuit)
Whitefish	2,494	18,358
Inconnu	3,208	6,125
Burbot	422	1,404
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
Grand Total	9,204	29,135

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.

4.1.3 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.

4.2 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.

4.2.1 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)

Theme	Indicator	Observations	Livelihood impacts
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).

4.2.2 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.

4.2.3 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).

4.2.4 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.

4.2.5 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).

4.3 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.

4.3.1 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.

4.3.2 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.

4.3.3 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.

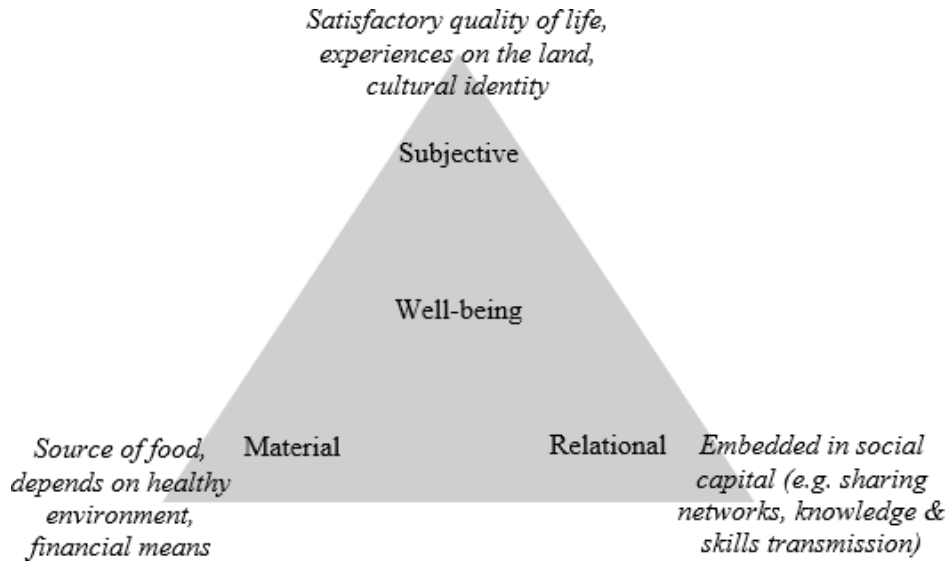


Figure 9: The three dimensions of well-being in Inuvialuit fishing livelihoods

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).

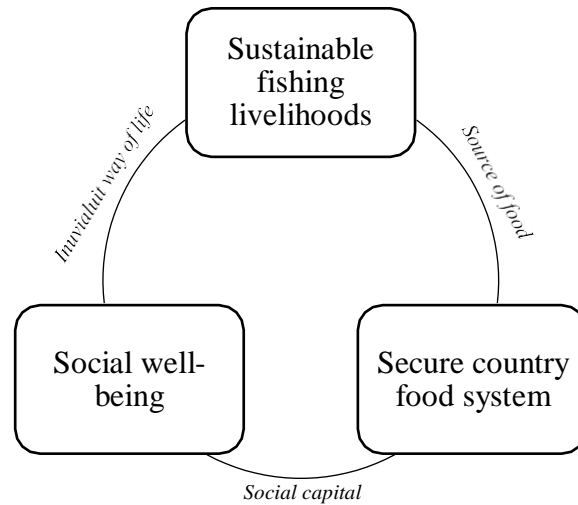


Figure 10: Wheel of sustainable fishing livelihoods, country food security and social well-being

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.

Chapter 5: 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.

5.1 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).

5.2 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.

5.3 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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Appendix A University of Ottawa Ethics Approval

File Number: 06-16-10

Date (mm/dd/yyyy): 08/10/2016



Université d'Ottawa
Bureau d'éthique et d'intégrité de la recherche

University of Ottawa
Office of Research Ethics and Integrity

Ethics Approval Notice **Social Sciences and Humanities REB**

Principal Investigator / Supervisor / Co-investigator(s) / Student(s)

First Name	Last Name	Affiliation	Role
Sonia	Weesche	Arts / Geography	Supervisor
Iria Heredia	Vazquez	Arts / Geography	Student Researcher

File Number: 06-16-10

Type of Project: Master's Thesis

Title: Fishing livelihoods in the Mackenzie River Basin: the role of local traditional knowledge for tracking environmental changes and improving community resilience

Approval Date (mm/dd/yyyy)	Expiry Date (mm/dd/yyyy)	Approval Type
08/10/2016	08/09/2017	

Special Conditions / Comments:
N/A



Ethics Approval Notice
Social Sciences and Humanities REB

Principal Investigator / Supervisor / Co-investigator(s) / Student(s)

First Name	Last Name	Affiliation	Role
Sonia	Wasche	Arts / Geography	Supervisor
Iria Heredia	Vazquez	Arts / Geography	Student Researcher

File Number: 06-16-10

Type of Project: Master's Thesis

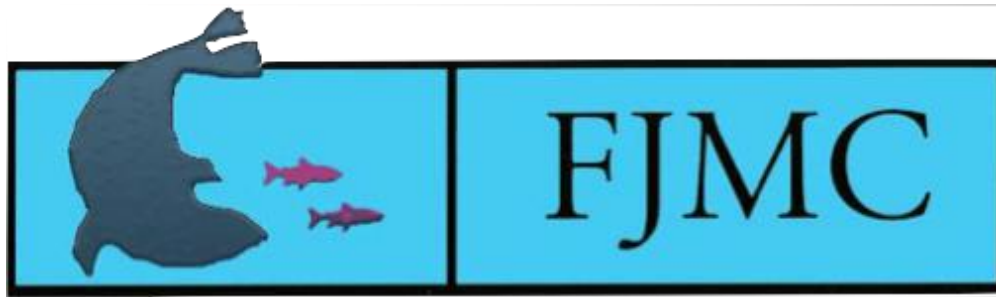
Title: Fishing livelihoods in the Mackenzie River Basin: the role of local traditional knowledge for tracking environmental changes and improving community resilience

Renewal Date (mm/dd/yyyy)	Expiry Date (mm/dd/yyyy)	Approval Type
08/10/2017	08/09/2018	Renewal

Special Conditions / Comments:

N/A

Appendix B Inuvialuit Traditional and Local Knowledge Questionnaire



Inuvialuit Traditional and Local Knowledge Questionnaire – Fish and Fish Habitat 2016

Dear Research Participant,

You are participating in this study because you are considered to be knowledgeable about the importance of the changes occurring in the Mackenzie Delta region of the Mackenzie River Basin. We are interested in interviewing you about your observations and experiences or other knowledge you think would be relevant to this study. Our objectives are:

- To collect information on community priorities for fisheries management in the Mackenzie Delta
- To determine the local importance of Mackenzie Delta fisheries for Inuvialuit subsistence and livelihoods
- To document Inuvialuit knowledge on past and present harvest levels of subsistence fish species
- To map Inuvialuit observations of environmental change related to fish habitat (e.g., beaver dams, water level and temperature changes, slumping, erosion, etc.)
- To provide local organizations (FJMC, HTC, IRC, DFO) with information that can support regional management, programs, and the development of future initiatives.

About the study:

Many communities in the Mackenzie River Basin are experiencing changes in the environment and their communities. A major concern expressed by many Aboriginal organizations is about the sustainability of water, fish and fishing livelihoods. The Fisheries Joint Management Committee is working with researchers from the University of Alberta, the University of Ottawa and other universities in Canada and internationally to help document the importance of water, fish and fishing livelihoods to you and your community as well as document any changes you have seen or experienced in your lifetime. Other Aboriginal organizations in the Mackenzie River Basin are also involved such as our neighbouring communities of Aklavik, Inuvik, Tsiigehtchic and Fort McPherson. There are ten projects this year in which communities are going to be asking similar kinds of questions about the water, fish and fishing livelihoods. The study is funded by the University of Alberta through an organization called the *Social Sciences and Humanities Research Council*. Together we will be able to link our stories together to get a much better understanding of how the Mackenzie River Basin as a whole is changing. You can find out more about the project at www.trackingchange.ca

Methods:

- This questionnaire will be used to interview Inuvialuit from Inuvik and Aklavik in 2016. A harvester list from each HTC will be used to select interviewees, with an effort to target more active harvesters first. Time constraints of project staff and interest from community members to provide information will determine the total number of interviewees in each community.
- You will be asked to participate in a conversation (narrative interview) lasting approximately one and half-hours. We would like to audio record the interview and ask you to record information on maps if possible upon your consent for accuracy and research purposes only. This interview will focus on your observations and experiences of areas that are important to you and/or changes in the Mackenzie Delta.
- This survey includes questions about the general amount of fish species harvested each year. This is not intended to duplicate the efforts of the ISR CBMP (Community-Based Monitoring Program) harvest survey program, which we fully support, but to give us a general idea on the importance of different fish species to Inuvialuit harvesters. As the CBMP is a relatively new program, we do not have an estimate on harvest for a full year at this time.

Benefits:

- A \$25 Northern gift card will be provided as a thank you to each person interviewed. Each person interviewed will also be entered into a draw following all interviews (likely in late September); five names will be randomly selected from each community for \$100 gas card.
- A summary report of the main findings of this program will be provided to all participants (likely in December 2016). Information regarding further follow up reports will also be provided to participants.
- The information collected in this program will contribute to multiple programs:
 - General co-management of ISR fisheries by HTCs, FJMC and DFO
 - Inuvialuit knowledge and use of fisheries in the Mackenzie River Delta (Tracking Change funded program between AHTC, IHTC, FJMC, University of Ottawa)
 - Inuvialuit monitoring and management of the Big Fish River (CIMP funded program between the AHTC and FJMC)
 - IRC socio-economic indicators work led by Bob Simpson
 - Master's thesis for Iria Heredia Vazquez, graduate student and Tracking Change program partner from the University of Ottawa

Anonymity:

- Harvester names will be kept confidential in any reports or data sheets that are generated from this program or shared with program partners, unless the harvester approves the use of their name. FJMC will replace harvester names with a harvester code for information that is shared, unless approval is provided.
- Unless outlined by the interviewee that some or all information provided should be kept confidential with the local HTC and FJMC, please note that some information may be

made available on publicly available websites (e.g., CIMP, Tracking Change), reported at conferences, and/or published in a masters' thesis or other journal articles.

Data ownership, access and use:

- Information from Inuvik harvesters will be owned by the FJMC and IHTC
- Information from Aklavik harvesters will be owned by the FJMC and AHTC
- Access to information from Inuvik and Aklavik harvesters will be provided to Iria Heredia Vazquez and Dr. Sonia Wesche from the University of Ottawa for use in a graduate thesis, unless outlined from those interviewed that they would like to keep some of their answers restricted to the local HTC and FJMC.
- Results from this program may be presented at conferences, public websites, in publications or reports outside of the region. Names will be kept anonymous for any publications or reports, unless approved in writing by the interviewee. All participants will receive a summary report on the program once available, either by mail or email.

INTERVIEWEE INFO

Name:

Mailing address:

Email:

How would you like to receive information or reports on the results of this program?:

Mail or Email

Community of residence:

How long have you lived in your current community:

Gender:

Birth year:

Number of people in household:

Number of active fishers in household:

MAPPING

I would like to ask you to record on maps some information that you would like to share if possible. Various maps are provided. You are welcome to use them as a support during the interview and record any information that you find important. Please, let me know if there are sites recorded on the maps that you do not want made publicly available. The information that can be mapped includes:

1. Presence of observed beaver lodges, beaver dams, beaver dams blocking fish passage
2. Notable changes to fish habitat / environment (examples below)
 - Slumping
 - Erosion
 - Water temperature changes
 - Water level changes

- Water quality changes
 - Timing of break-up / freeze-up
 - Other
3. Fishing sites (past or present)
 - Broad whitefish
 - Loche / burbot
 - Lake trout
 - Coney / inconnu
 - Crooked backs / Lake whitefish
 - Other
 4. Fishing sites where poor fish condition have been observed (list species, time of year, gear type)

FISHING BACKGROUND

1. How important are fishing activities to you and why?
2. What are your earliest memories of fishing in this region? When, Where, What for?
3. Why were these important areas for fishing? Are they still important?
4. Why were these places important to you/your family/your community? Are they still important?
5. Do you remember the fishing quality at these places changing from year to year or over time?
6. Have people stopped fishing in some areas? If so, why?

CHANGES IN FISHERIES

7. What are the main places where you go fishing now?

8. What fish species do you currently harvest in the Husky lakes and/or Mackenzie River Delta (broad whitefish, loche/burbot, lake trout, coney/inconnu, crooked backs/lake whitefish, jackfish/northern pike, etc.)?
 - Husky lakes:

 - Mackenzie River Delta:

9. Describe the type of fishing you do in the Mackenzie River Delta (time of year, gear type (net, jigging under ice, fishing rod), target species):

10. Of the fish species that you harvest, which ones contribute the most to your subsistence (rank fish in order of the general amount harvested each year, 1 being the highest)?

11. Do you think there has been a change in the number of harvesters fishing in the Mackenzie River Delta in recent years? – If yes, why?

12. Have you observed changes in the different fish species you actively harvest in the Mackenzie River Delta throughout your lifetime (e.g., numbers, health, new species, etc)? – Explain.

13. What observations of poor fish condition, would result in you not consuming a fish that you harvested?

14. Have you observed notable changes in fishing habitat in the Husky lakes and/or Mackenzie River Delta? (e.g. slumping, erosion, water temperature changes, changes in places where fish spawn, feed, breed) – Describe

15. Have you observed notable changes to fishing conditions in the Husky lakes and/or Mackenzie River Delta? – Describe (when and where changes observed).
 - Husky lakes:
 - Water quality

 - Water quantity

- Ice
- Others
- Mackenzie River Delta:
 - Water quality
 - Water quantity
 - Ice
 - Others

16. How do you identify these changes?

17. What do you think cause these changes?

HARVEST – Mackenzie River Delta & Husky Lakes area

18. Broad Whitefish / anaakiq



- Which months in a year and how many days in a month do you harvest broad whitefish? (note number of days under corresponding month; use extra space to note gear types used or locations if they are specified)

Mackenzie River Delta											
Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec

--	--	--	--	--	--	--	--	--	--	--	--

Husky Lakes Area (Husky Lakes, Sitidgi, Noell, Parsons)											
Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec

- How many broad whitefish do you harvest on average each month?

Mackenzie River Delta											
Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec

Husky Lakes Area (Husky Lakes, Sitidgi, Noell, Parsons)											
Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec

- Has this harvest decreased/increased in recent years? (if so, when and ask general amount of decrease/increase)
- How do you use your broad whitefish harvest each year – provide the general proportions (%):
 - Subsistence for your own household (%):
 - Gift - subsistence for others (%):
 - Trading - subsistence for others (%):
 - Dog food (%):
- Have you observed any changes to the condition of broad whitefish? If yes, describe and note specific questions below. For changes in condition, note whether or not observations are specific to lakes or rivers, and specific harvest areas or times of year:
 - Size of fish (general length increase or decrease observed in catch):
 - Fatness (general increase or decrease observed in catch):
 - Scars, sores, lumps, deformities (description and location on fish; increase or decrease in prevalence):

- Parasites (record description and location on fish where they are observed; increase or decrease in prevalence):

- Liver (e.g., discoloured, spotted; increase or decrease in prevalence):

- Gills (e.g., discoloured; increase or decrease in prevalence):

- Eggs (e.g., discoloured; increase or decrease in prevalence):

19. Loche / burbot / lingcod / tittaaliq



- Which months in a year and how many days in a month do you harvest loche? (note number of days under corresponding month; use extra space to note gear types used or locations if they are specified)

Mackenzie River Delta											
Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec

Husky Lakes Area (Husky Lakes, Sitidgi, Noell, Parsons)											
Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec

- How many loche do you harvest on average each month?

Mackenzie River Delta											
Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec

Husky Lakes Area (Husky Lakes, Sitidgi, Noell, Parsons)											
Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec

--	--	--	--	--	--	--	--	--	--	--	--

- Has this harvest decreased/increased in recent years? (if so, when and ask general amount of decrease/increase)

- How do you use your loche harvest each year – provide the general proportions (%):
 - Subsistence for your own household (%):
 - Gift - subsistence for others (%):
 - Trading - subsistence for others (%):
 - Dog food (%):

- Have you observed any changes to the condition of loche? If yes, describe and note specific questions below. For changes in condition, note whether or not observations are specific to lakes or rivers, and specific harvest areas or times of year:
 - Size of fish (general length increase or decrease observed in catch):

 - Fatness (general increase or decrease observed in catch):

 - Scars, sores, lumps, deformities (description and location on fish; increase or decrease in prevalence):

 - Parasites (record description and location on fish where they are observed; increase or decrease in prevalence):

 - Liver (e.g., discoloured, spotted; increase or decrease in prevalence):

 - Gills (e.g., discoloured; increase or decrease in prevalence):

 - Eggs (e.g., discoloured; increase or decrease in prevalence):

20. Lake trout / iqaluakpak



- Which months in a year and how many days in a month do you harvest lake trout? (note number of days under corresponding month; use extra space to note gear types used or locations if they are specified)

Mackenzie River Delta											
Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec

Husky Lakes Area (Husky Lakes, Sitidgi, Noell, Parsons)											
Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec

- How many lake trout do you harvest on average each month?

Mackenzie River Delta											
Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec

Husky Lakes Area (Husky Lakes, Sitidgi, Noell, Parsons)											
Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec

- Has this harvest decreased/increased in recent years? (if so, when and ask general amount of decrease/increase)
- How do you use your lake trout harvest each year – provide the general proportions (%):
 - Subsistence for your own household (%):
 - Gift - subsistence for others (%):
 - Trading - subsistence for others (%):
 - Dog food (%):

- Have you observed any changes to the condition of lake trout? If yes, describe and note specific questions below. For changes in condition, note whether or not observations are specific to lakes or rivers, and specific harvest areas or times of year:
 - Size of fish (general length increase or decrease observed in catch):
 - Fatness (general increase or decrease observed in catch):
 - Scars, sores, lumps, deformities (description and location on fish; increase or decrease in prevalence):
 - Parasites (record description and location on fish where they are observed; increase or decrease in prevalence):
 - Liver (e.g., discoloured, spotted; increase or decrease in prevalence):
 - Gills (e.g., discoloured; increase or decrease in prevalence):
 - Eggs (e.g., discoloured; increase or decrease in prevalence):

21. Coney / inconnu / higaq



- Which months in a year and how many days in a month do you harvest coney (note number of days under corresponding month; use extra space to note gear types used or locations if they are specified)

Mackenzie River Delta

Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec

Husky Lakes Area (Husky Lakes, Sitidgi, Noell, Parsons)											
Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec

- How many coney do you harvest on average each month?

Mackenzie River Delta											
Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec

Husky Lakes Area (Husky Lakes, Sitidgi, Noell, Parsons)											
Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec

- Has this harvest decreased/increased in recent years? (if so, when and ask general amount of decrease/increase)
- How do you use your coney harvest each year – provide the general proportions (%):
 - Subsistence for your own household (%):
 - Gift - subsistence for others (%):
 - Trading - subsistence for others (%):
 - Dog food (%):
- Have you observed any changes to the condition of coney? If yes, describe and note specific questions below. For changes in condition, note whether or not observations are specific to lakes or rivers, and specific harvest areas or times of year:
 - Size of fish (general length increase or decrease observed in catch):
 - Fatness (general increase or decrease observed in catch):

- Scars, sores, lumps, deformities (description and location on fish; increase or decrease in prevalence):
- Parasites (record description and location on fish where they are observed; increase or decrease in prevalence):
- Liver (e.g., discoloured, spotted; increase or decrease in prevalence):
- Gills (e.g., discoloured; increase or decrease in prevalence):
- Eggs (e.g., discoloured; increase or decrease in prevalence):

22. Crooked backs / lake whitefish / humpbacks / pikuktuq



- Which months in a year and how many days in a month do you harvest crooked backs? (note number of days under corresponding month; use extra space to note gear types used or locations if they are specified)

Mackenzie River Delta											
Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec

Husky Lakes Area (Husky Lakes, Sitidgi, Noell, Parsons)											
Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec

- How many crooked backs do you harvest on average each month?

Mackenzie River Delta											
Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec

Husky Lakes Area (Husky Lakes, Sitidgi, Noell, Parsons)											
Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec

- Has this harvest decreased/increased in recent years? (if so, when and ask general amount of decrease/increase)

- How do you use your crooked back harvest each year – provide the general proportions (%):
 - Subsistence for your own household (%):
 - Gift - subsistence for others (%):
 - Trading - subsistence for others (%):
 - Dog food (%):

- Have you observed any changes to the condition of crooked backs? If yes, describe and note specific questions below. For changes in condition, note whether or not observations are specific to lakes or rivers, and specific harvest areas or times of year:
 - Size of fish (general length increase or decrease observed in catch):

 - Fatness (general increase or decrease observed in catch):

 - Scars, sores, lumps, deformities (description and location on fish; increase or decrease in prevalence):

 - Parasites (record description and location on fish where they are observed; increase or decrease in prevalence):

 - Liver (e.g., discoloured, spotted; increase or decrease in prevalence):

- Gills (e.g., discoloured; increase or decrease in prevalence):
- Eggs (e.g., discoloured; increase or decrease in prevalence):

LIVELIHOODS

23. Was fishing an important part of the community's economy in the past?
24. Is it still important today?
25. Were there times historically when people only ate fish (for example, because there were fewer caribou or fewer moose to harvest)?
26. Did men and women have the same roles in fishing?
27. Do you share your harvests with others in the community?
 - If so, who? (family, friends, co-workers, etc.)
28. How many individuals do you share with in your community?
 - Do those individuals you share with support families?
29. Do you share your harvests with other communities?
 - If so, which communities and who (family, friends, co-workers, etc.)?
30. Do those you share with also fish?
31. Do you get anything in return for sharing your harvest? If so, what?

32. Do you sell your fish harvest for money?
- If so, what price do you charge for specific fish species (per fish or specify if another unit or amount)?
 - Broad whitefish:
 - Loche / burbot:
 - Lake trout:
 - Coney / inconnu:
 - Crooked backs / lake whitefish:
 - Herring / Arctic cisco:
 - Other (specify):
 - Have you noticed these prices change in recent years?
 - If yes, approximately what species, when, in what direction (increase, decrease), and by how much?
 - If yes, has this had an impact on your livelihood? – Describe.
 - If yes, has this caused you to harvest more, less, or about the same amount of fish?
 - Approximately how much money do you make from selling fish in a year?
 - Is this your main source of income?
33. Do you trade your harvests for other items?
- If so, what?
34. Approximately what portion of your food consumption is from your harvests (fish and other animals) or connected to your harvesting activities (e.g., trading)?
35. If so, approximately how much money does this save you from not needing to purchase market foods?

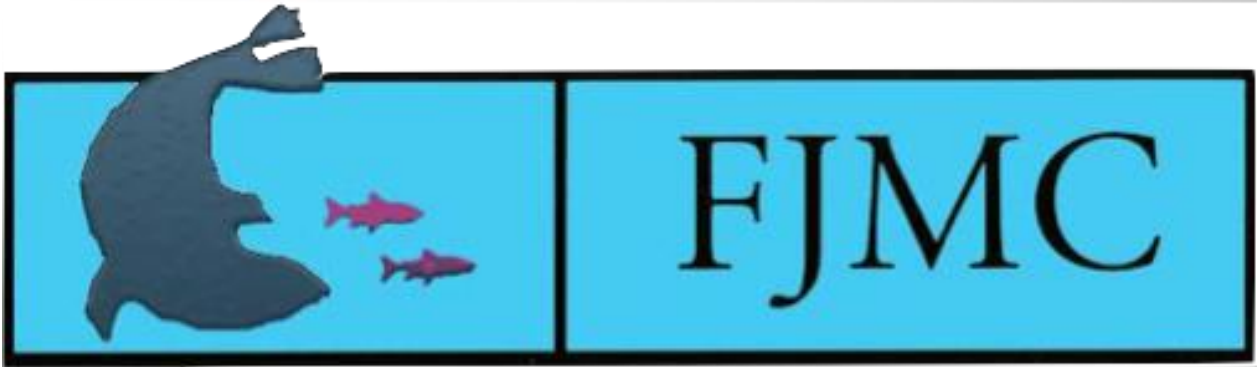
MEANING OF CHANGE

36. What do these changes mean for you and your community (i.e., food, well-being, way of life, passing of knowledge, etc.)?
37. How do you deal with these changes? Have you adapted your fishing practices, and if yes, in what ways?
38. How did people deal with changes in the past?
39. How should these areas be cared for in the future?
40. What can you/your community do about these changes?

PRIORITIES

41. Do you have concerns about fishing conditions (e.g. weather, water levels, water quality) in the Mackenzie River Delta? – If yes, describe.
42. Do you have any concerns related to fish (habitat, population, health) in the Mackenzie River Delta? – If yes, describe.
43. Do you think there is a need for any specific research to support the management of fisheries in the Mackenzie River Delta? (what research questions do you have?)
44. Do you have any advice on how we can incorporate more local knowledge of fishers into fisheries co-management in the ISR?

Appendix C Consent Form



PARTICIPANT CONSENT FORM

Tracking Change in the Mackenzie River Basin

Research Lead / Organization

Kristin Hynes
Fisheries Resource Specialist
Fisheries Joint Management Committee
P.O. Box 2120
Inuvik, NT, Canada X0E 0T0



Principal Investigator

Sonia Wesche & Iria Heredia Vazquez
University of Ottawa
Faculty of Arts, Department of Geography
60 University (047)
Ottawa, ON Canada K1N 6N5



- | | <u>Yes</u> | <u>No</u> |
|--|--------------------------|--------------------------|
| Do you understand that you have been asked to be in a research study? | <input type="checkbox"/> | <input type="checkbox"/> |
| Have you read and received a copy of the attached Information Sheet? | <input type="checkbox"/> | <input type="checkbox"/> |
| Do you understand the benefits and risks involved in taking part in this research study? | <input type="checkbox"/> | <input type="checkbox"/> |
| Have you had an opportunity to ask questions and discuss this study? | <input type="checkbox"/> | <input type="checkbox"/> |
| Do you understand that you are free to leave the study at any time, without having to give a reason? | <input type="checkbox"/> | <input type="checkbox"/> |
| Has the issue of confidentiality been explained to you? | <input type="checkbox"/> | <input type="checkbox"/> |

Do you consent to the interview being audio recorded?

Do you consent to the results of the interview being stored at the University of Alberta?

Would you like your name to be included in the public use of information from your interview?

Who explained this study to you?

I agree to take part in this study:

Signature of Research Participant _____

(Printed Name) _____

Date: _____

Signature of Witness

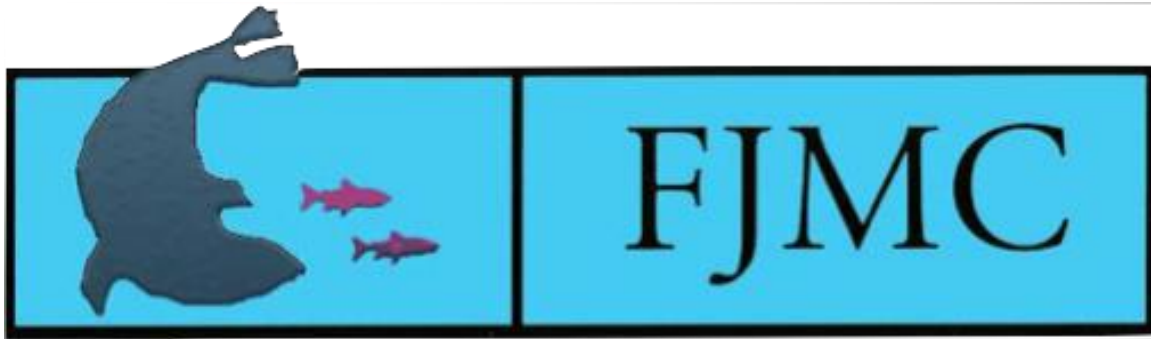
Only required if you anticipate that your participants will be unable to read the consent for themselves. If so, an impartial witness (i.e. not associated with the study team) must be present during the entire informed consent discussion and is witnessing that the participant understood what was discussed (i.e. not just witnessing the signature process).

I believe that the person signing this form understands what is involved in the study and voluntarily agrees to participate.

Signature of Investigator or Designee _____

Date _____

Appendix D Letter of Information



TRACKING CHANGE IN THE MACKENZIE RIVER BASIN

Dear Potential Research Participant,

You are being asked to participate in this study because you are considered to be knowledgeable about the importance of the changes occurring in the Mackenzie Delta region of the Mackenzie River Basin. We are interested in interviewing you about your observations and experiences or other knowledge you think would be relevant in respect of:

- historical and contemporary observations and perceptions of conditions and change in the health of the **aquatic environment** (e.g., water quality, quantity, flow, groundwater, permafrost conditions);
- historical and contemporary observations and perceptions of conditions and change in **fish species** (population, movements, diversity, invasive species) and other **aquatic species** (e.g., geese, beaver);
- sustainability of **fishing livelihoods** (e.g., harvesting levels and practices, diet, health, access issues, perceptions of change in the health of valued fish species);
- implications of change for **governance** (e.g., how to maintain healthy relationships to the aquatic ecosystem, maintaining respectful and spiritual relationships, respecting treaty rights);

Before you make a decision, a researcher will go over this form with you. You are encouraged to ask questions if you feel anything needs to be made clearer. You will be given a copy of this form for your records.

Why is this research being done?

Many communities in the Mackenzie River Basin are experiencing changes in the environment and their communities. A major concern expressed by many Aboriginal organizations is about the sustainability of water, fish and fishing livelihoods. The Fishing Joint Management Committee is working with researchers from the University of Alberta, the University of Ottawa

and other universities in Canada and internationally to help document the importance of water, fish and fishing livelihoods to you and your community as well as document any changes you have seen or experienced in your lifetime. Other Aboriginal organizations in the Mackenzie River Basin are also involved such as our neighbouring communities of Aklavik, Inuvik, Tsiigehtchic and Fort McPherson. There are ten projects this year in which communities are going to be asking similar kinds of questions about the water, fish and fishing livelihoods. The study is funded by the University of Alberta through an organization called the *Social Sciences and Humanities Research Council*. Together we will be able to link our stories together to get a much better understanding of how the Mackenzie River Basin as a whole is changing. You can find out more about the project at www.trackingchange.ca

What will I be asked to do?

You will be asked to participate in a conversation (narrative interview) lasting approximately one and half-hours. We would like to audio record the interview and ask you to record information on maps if possible. This interview will focus on your observations and experiences of areas that are important to you and/or changes in the Mackenzie Delta area.

What are the risks and discomforts?

There are no risks or discomforts that may result from the study.

What will you need to do?

You will sit with an interviewer and you are free to tell him/her anything that you think is relevant to the study.

What are the benefits to me?

You will receive a **\$25** Northern gift card to compensate you for your time. Additionally, each person interviewed will also be entered into a draw following all interviews (likely in late September); five names will be randomly selected from each community for \$100 gas card.

Do I have to take part in the study?

You do not have to participate in the study, and you can stop the interview anytime.

What will happen to the information?

- The stories that you share including any mapped, audio and video recordings will be held by the University of Ottawa and Fisheries Joint Management Committee. Another copy will be held at the University of Alberta for a minimum of 10 years. These transcripts will not be used for any other purpose.
- We would like to acknowledge you by name in these reports. If you do not wish your name to be included, we will give you an anonymous identity (e.g., A1).
- You will receive a copy of the transcript of your interview after the interview is completed. If you decide to withdraw or edit your transcript, you will have 30 days to do so; after that

30 day period, however, we may not be able to remove information from reports etc. if it has already become public.

- A summary from the project will be developed and shared with other communities in the Mackenzie River Basin so they can learn more from you about changes you are experiencing; you will receive summary reports from the other regions as well. The lead organization will not include information in the summary reports that it considers confidential or information you do not wish to be shared publically.
- In addition to the summary reports from your region, the University of Ottawa and The Fisheries Joint Management Committee will work with other organizations and universities to create academic outcome as well as a book and video documentary that shows how changes occurring in your region are the same or different from other areas.

What if I have questions?

If you have any questions about the research now or later, please contact us.

Warm regards,

Research Lead / Organization

Kristin Hynes
Fisheries Resource Specialist
Fisheries Joint Management Committee
P.O. Box 2120
Inuvik, NT, Canada X0E 0T0



Principal Investigator

Sonia Wesche & Iria Heredia Vazquez
University of Ottawa
Faculty of Arts, Department of Geography
60 University (047)
Ottawa, ON Canada K1N 6N5



Appendix E Poster of Information

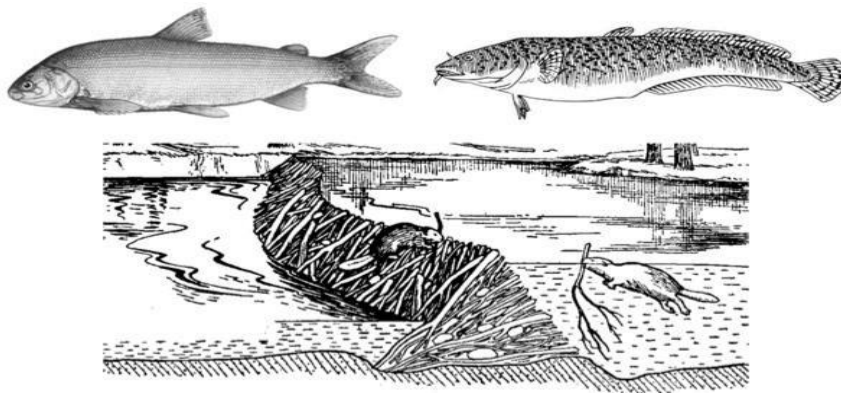
Inuvialuit Traditional and Local Knowledge (TLK) Questionnaire – Fish and Fish Habitat: Summer-Fall 2016

Invitation to Participate:

You are invited to participate in an interview conducted by Iria Heredia Vazquez, as part of a participatory research project aimed at collecting local knowledge from Inuvialuit harvesters, on: fish, fishing, observed changes to fish or fish habitat, the importance of fish to Inuvialuit livelihoods, and any concerns or priorities for fisheries in the Mackenzie River Delta. The information collected will inform Inuvialuit organizations and support the direction of future research programs in the ISR. The questionnaire was developed as part of the **Tracking Change program**, *Inuvialuit knowledge and use of fisheries in the Mackenzie River Delta*, a partnered program between the Fisheries Joint Management Committee (FJMC), Inuvik HTC, Aklavik HTC, the University of Ottawa and the University of Alberta. Many communities in the Mackenzie River Basin are experiencing changes in the environment and their communities. A major concern expressed by many Aboriginal organizations is about the sustainability of water, fish and fishing livelihoods. There are ten projects this year in which communities are going to be asking similar kinds of questions about the water, fish and fishing livelihoods. Together we will be able to link our stories together to get a much better understanding of the changes in the Mackenzie River Basin and the importance of water, fish and fishing livelihoods. You can find out more about the project at www.trackingchange.ca

Participation

If you would like to participate, you would take part in a semi-structured interview administered in person in summer 2016 based on your availability. The interview will be audio-recorded upon your consent for accuracy and research purposes only. You will receive a \$25 Northern gift card to compensate you for your time. Additionally, each person interviewed will also be entered into a draw following all interviews (likely in late September); five names will be randomly selected from each community for \$100 gas card. To learn more about this program, please call the Joint Secretariat office in Inuvik (867) 777-2828; your name and contact number will be recorded and we will be happy to follow up with you to answer any questions you may have or to set up an interview time and place.



Appendix F ABEKS Community Ecosystem Monitoring Interview Questions

SECTION A: Time on Land

I would like to start by asking a couple of questions about you.

A1. In what year were you born? _____

A2. First, I'd like to get a sense of how much time you spent on the land and what things you were doing.

In the last winter (January to March), how many days did you spend out on the land hunting, berry picking, fishing or doing other activities?

How many days in the spring (April to June)?

How many days in the summer (July, August, September)?

And how many days in the fall (October, November and December)?

***INSERT "0" IF NO DAYS – DO NOT LEAVE BLANK.**

(Max. = 90 days/ per season)	Fall 2017 (Oct-Dec)	Winter (Jan-Mar)	Spring (Apr-June)	Summer (July-Sep)
Total days on Land	#	#	#	#

A3. For each season, how many of those days included: (read each activity)

Note: Enter "0" if none. Do not enter ranges. Number of days should match A. 2.

Type of Activity:	# of days spent at activity:				Did not do this activity (in any season)
	Fall	Winter	Spring	Summer	
Hunting					<input type="checkbox"/>
Trapping					<input type="checkbox"/>
Fishing					<input type="checkbox"/>
Berry picking					<input type="checkbox"/>
					<input type="checkbox"/>

Hauling wood					
Harvesting bark, sap, etc. (not berries)					<input type="checkbox"/>
Camping					<input type="checkbox"/>
Hiking					<input type="checkbox"/>
Other: _____					
Other: _____					

SECTION D: Fish

D1. Did you go fishing this year?

- Yes → Go to D2
- No → Go to E1

D2. About how many of each kind of fish did you catch this year? *(Enter all that apply.)*

(If given a range, use the mid-point. Enter only a whole number for each. Enter “0” if none)

Type of Fish	Enter the number of fish caught (no range, mid-point # is okay)
Whitefish (broad whitefish)	
Crooked Back (lake whitefish)	
Coney (inconnu)	
Arctic Char	
Lake Trout	
Bull Trout	
Salmon (Record by type)	
Coho	
Chinook/King	
Chum,	
Pink	
Sockeye	

Kokanee	
Unknown type	
Grayling	
Dolly Varden	
Jackfish	
Loche burbot	
Herring	
Other (specify):	

D3a. Did you meet your needs for fish this year?

Yes **No** **Don't Know**

Including yourself, how many people are you providing fish for this year?

D3b. _____

D3c. Are you providing fish for dogs this year?

Yes **No** **Don't Know**