Examples of food[in] security drivers in Northern Canada

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ABSTRACT

The communities of Yukon, Northwest Territories and Nunavut are vulnerable to experience high food [in] security levels when both biophysical and anthropogenic aspects overlap, affecting the access, availability and quality of traditional and market-based food. This research aimed to identify information and examples of food [in] security drivers in the territories of Yukon, Northwest Territories and Nunavut, using a sample of grey literature and supplementary scientific literature sources.

The first section summarized a selection of publicly available data of Northern Canada, providing an overview of key socio-economic variables. Based on a food security framework defined by three components: food availability, food access, and food quality, information and examples of aspects influencing the availability and access to country food and market-based food were presented in the second part of the findings. Examples of food quality indicators discussed include research indicating the presence of contaminants in traditional food. The final section is a snapshot of locally produced food and how it has been explored as a potential strategy to enhance sovereignty in isolated northern communities.

Climate change is affecting the access and availability to traditional foods; however, northern communities have had the ability to adapt and develop skills and practices to survive the challenging conditions in their territories. There are examples that demonstrate that human disturbances caused by resource development are severely affecting ecosystems and declining traditional species such as caribou *(Rangifer tarandus)*. Food quality is threatened by the presence of contaminants in local sources of food and declines in the nutritional benefits of market-based foods in comparison to local foods.

In relation to market-based food, government programs such as Nutrition North Canada (NNC) have sought to subsidize food items with affordable prices, but the high cost of these, indicates that it has not fulfilled its objective. Logistics difficulties related to climate change in the transportation and distribution network affect not only the arrival of food on time, but also the quality of some perishable items like fruits and vegetables. Finally, locally produced food may offer a valuable strategy to enhance food security; however, it requires a large body of research and consistent investments on a long-term basis.

Food [in] security is a multi-dimensional topic with access, availability and quality dimensions overlapping and interacting continuously. A significant body of literature has explored food security in northern Canada. This document is not a comprehensive analysis of all the issues influencing food [in]security in Northern Canada and the findings of this study do not necessarily reflect the specific reality at a local and regional level, but it could be used as a reference to develop further work.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

Food security is an important concept that relates both to the physical and mental health of northern communities, their economies as well as their cultural and spiritual connection with the land. There are many definitions however, a common reference from the Food and Agriculture Organization of the United Nations (FAO) suggests food security is achieved when "all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO, 2003, para. 22).

A significant body of research on food [in]security in the Artic and Northern Canada can be found in different disciplines including health sciences, economics, sociology, geography, Indigenous studies and elsewhere. Although data exists in many silos of research, efforts are being made to develop an integrated conceptual framework and state of knowledge of food security (CCA, 2014; Gérad Duhaime & Bernard, 2002; Gérad Duhaime & Godmaire, 2002; Loring & Gerlach, 2015; Power, 2008). Others, have explored socio-economic dimensions (Gérad Duhaime et al., 2002; Lévesque, De Juriew, Lussier, & Trudeau, 2002; Myers, 2002) and political and legal considerations (Arbour, 2002; Fergurson, 2011; Halley & Verreault, 2002; Peters, 2002).

Many different indicators of food security have been studied for many years including interrelated questions of total caloric intake, nutritional quality, cost, food access, availability and utilization. There are also an increasing number of studies that consider cultural appropriateness of foods as important; among these are studies with Indigenous communities including those in Northern Canada (Power, 2008; Willows, 2005). An important area of study is on the importance of country foods/traditional foods and the implications of market influences on dietary patterns including food quality and health implications (Egeland, Williamson-Bathory, Johnson-Down, & Sobol, 2012; Hlimi, Skinner, Hanning, Martin, & Tsuji, 2012; Huet, Rosol, & Egeland, 2012; Rosol, Powell-Hellyer, & Chan, 2016; Schuster, Gamberg, Dickson, & Chan, 2011; Schuster, Wein, Dickson, & Chan, 2011; Sheehy, Kolahdooz, Roache, & Sharma, 2015). The socio-economic dimensions of shifts between of traditional and market-based food is also considered in the literature (Beaumier & Ford, 2010; Collings, Marten, Pearce, & Young, 2016; Ford, Lardeau, & Vanderbilt, 2012; Ford, Macdonald, Huet, Statham, &

MacRury, 2016; Gendron, Hancherow, & Norton, 2017; Harder & Wenzel, 2012; Pal, Haman, & Robidoux, 2013; Searles, 2016).

The ecological story surrounding traditional food/country food have also been studied and key species of traditional food such as caribou and fish (Islam & Berkes, 2016; Kenny, Fillion, Simpkin, Wesche, & Chan, 2018; Loring & Gerlach, 2010; Parlee, Sandlos, & Natcher, 2018) have been researched in the context of food [in]security. Traditional food, wildlife harvesting and climate change (Hori, 2010; Natcher, Shirley, Rodon, & Southcott, 2016; Statham et al., 2015) and a variety of studies about food [in]security including different dimensions and approaches (Beaumier & Ford, 2010; Chan et al., 2006; Ford, 2009; Ford & Beaumier, 2011; Rosol et al., 2012) can be found in this broad topic.

Northern food systems have long been conceptualized as an integrated system of both traditional/country foods and market-based foods with more recently consideration give to locally produced food (e.g., community gardens). The subsistence economy is a significant area of research that speaks to trends and patterns in food consumption as well as the interconnections with the health of local ecosystems and resources. The land is the base for community food systems. Hunting wildlife and harvesting native plants are traditional practices that represent a spiritual connection with the land, which is important for their physical and mental health. By developing a broad knowledge about the land and the environment, these communities adapted to a variety of changes in ecosystems and species patterns.

Traditional and country practices have changed over the last several decades with concerns growing about the health implications of increased consumption of market foods (Kuhnlein, Receveur, Soueida, & Egeland, 2004). Some of the drivers of this transition include, environmental declines and disturbance (e.g., climate change, contaminants in country food) (Furgal & Seguin, 2006), socio-economic change (e.g., increased wage employment) and other shifts in socio-cultural values associated with media and globalization (Kenny et al., 2019; Power, 2008). Despite these challenges, northerners maintain a deep connection with the environment and traditional foods still have social, cultural and nutritional relevance (Ford, Trevor, & Nicole, 2016; Myers, Powell, & Duhaime, 2004).

There are many sources of data related to food security. Some useful quantitative datasets that exist including the Aboriginal Peoples Survey (Tait, 2008), the Inuit Health Survey (Egeland, Pacey, Cao, & Sobol, 2010), the Social Living Conditions in the Arctic (SLICA) (Kruse et al.,

2008), as well as the other regional and community-based surveys. In other parts of Canada data has been collected using the Canadian Community Health Survey (CCHS); this institution has been reporting data since 2005. However this study does not including data from the Northwest Territories, Nunavut and Yukon for 2015.

During the years, food [in] security levels have had a high prevalence in Nunavut and Northwest Territories in Canada. In 2014, Nunavut reported the highest prevalence of severe and moderate household food [in] security (19.3 % and 23.5 % respectively). Northwest Territories also present a significant level of moderate household food [in] security (13.6 %) compared to other territories and provinces in Canada (Tarasuk, Mitchell, & Dachner, 2016).

Northern Indigenous people are vulnerable to experiencing high food [in]security levels when both environmental and socio-economic challenges overlap. Climate change and socio-economic stressors such as household overcrowding, high unemployment levels, several mental and physical health issues, changing economies, and conflicts related to land use and natural resource development are affecting the access, availability and quality of traditional and market-based food. Experienced together or isolated, these factors are interacting constantly and creating different dynamics within northern food systems. With the changing context of the North, food security must be assessed as a dynamic process in which people interact with different needs, preferences and vulnerabilities (Loring & Gerlach, 2015).

This thesis involves a secondary analysis of data on northern food security, focusing in particular on qualitative synthesis data from the grey-literature produced by governmental and non-governmental organizations. This focus was chosen based on the premise that such grey literature may be loss often reviewed by those interested in northern food security, and yet such reports are also highly likely to influence the direction of policy. These sources are supplemented with a selection of scientific literature. This research aims to capture different drivers influencing food [in]security in the Northwest Territories, Nunavut and Yukon. The introductory part of the document summarizes information of Northern Canada, providing some examples of socio-economic issues that have received attention in the research reviewed. The second part presents information and examples of variables altering the availability and access to country food and market-based food; some examples of the presence of contaminants in traditional food are included too. The final section is a snapshot of locally produced food and how it has been explored as an interesting alternative to pursue food sovereignty in isolated northern

communities. The discussion and conclusion sections synthetize the findings, indicating the main topics found in the literature review and its relevance in northern food systems.

2 LITERATURE REVIEW: CONCEPTUAL FRAMEWORK OF NORTHERN FOOD SYSTEMS AND DIMENSIONS OF FOOD SECURITY

2.1 Definition and context of food security

Food security has various definitions and approaches in the literature from health sciences, sociology, geography and elsewhere (Campbell, 1991; Candel, 2014; Dilley & Boudreau, 2001; Gregory, Ingram, & Brklacich, 2005; Pinstrup-Andersen, 2009). For example, there is a large body of research in land use change and agriculture development (Inuit Circumpolar Council-Alaska, 2015; Porter & Xie, 2014). In the last 40 years all these definitions have been subject to modifications considering the complexities around the subject (Inuit Circumpolar Council-Alaska, 2015).

According to the Food and Agriculture Organization of the United Nations (FAO) food security is achieved when "all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO, 2003, para. 22). Food [in]security is experienced differently by vulnerable groups such as women and children, who have limited access to any type of food; demographics is an important factor in food (in) security issues (Loring & Gerlach, 2015).

Food security has been defined in different contexts; government, researchers and organizations have evaluated and revised the concept of food [in]security multiple times. These definitions have gone from a focus on the number of calories and nutrients required, to regional assessments that incorporate the cultural relevance of some types of food and their role in lifestyles (Loring & Gerlach, 2015). Authors such as Loring and Gerlach (2015) suggest that food security implicates biophysical, psychological, psychosocial and sociocultural dimensions for an integrated approach. However, there are limited frameworks that include the dynamic processes and local experiences of northern food systems (CCA, 2014). The Inuit Circumpolar Council-Alaska (2015) has created the following definition that enhances the understanding of food security in the North.

> *"Inuit food security is the natural right of all Inuit to be part of the ecosystem, to access food and to care-take, protect and respect all of life, land, water and air. It allows for all Inuit to obtain, process, store and consume sufficient amounts of healthy and nutritious preferred food – foods physically and spiritually craved and needed from the land, air and water, which provide for families and future generations through the practice of Inuit customs and spirituality, languages, knowledge, policies,*

> *management practices and self-governance. It includes the responsibility and ability to pass on knowledge to younger generations, the taste of traditional foods rooted in place and season, knowledge of how to safely obtain and prepare traditional foods for medicinal use, clothing, housing, nutrients and, overall, how to be within one's environment. It means understanding that food is a lifeline and a connection between the past and today's self and cultural identity"* (Inuit Circumpolar Council-Alaska, 2015, p. 31) .

It is important to differentiate and take into consideration distinctions between the concepts of food security and food sovereignty. Food security is based on "food access, availability, acceptability, adequacy, and use to ensure that all people at all times have physical, social, and economic access to food" (CCA, 2014, p. xix). On the other hand, food sovereignty relies on the principle of autonomy in which people make their own decisions regarding food systems and food production approaches (CCA, 2014).

2.2 Food security

The variety of frameworks about food security, draw from different disciplines (Burchi & De Muro, 2015). One framework that is commonly cited was developed by Loring & Gerlach (2015) and focus on the themes of availability, access and quality and utilization. The findings of this study focused on the first two dimensions principally (see Methodology section).

2.2.1 Availability

Refers to the amount or quantity available at the individual or community level. Local production, distribution networks and traditional food are criteria to assess this dimension (Hansen, Linnea, & Sharon, 2018; Loring & Gerlach, 2015). The following definition was created from an Inuit perspective, but could be applicable to other Northern Indigenous communities:

> *"Availability: The ability of the Arctic ecosystems to maintain a high variety of life (biodiversity), allowing adequate transfer of nutrients and energy. It is the knowledge of seasons and how to collect, process, store and consume traditional foods, allowing for Inuit to eat what has been gathered from the previous season and harvest a variety of medicines"* (Inuit Circumpolar Council-Alaska, 2015, p. 55).

2.2.2 Access

Access entails the capacity at the individual or community level to obtain food, with the available resources. Access refers not only to economic capacity (affordability) but also to physical conditions and logistics to access the places or locations where food is produced. Other factors that influence access are subsidies and government policies (Loring & Gerlach, 2015). For instance, hunting and fishing regulations constrain the access to obtain food that fulfill subsistence needs and cultural preferences (Loring & Gerlach, 2015). Another definition is the following:

> *"Accessibility – The ability to live off the land, ocean and air and to obtain sufficient access to a diverse source of healthy food, water, animals, plants, fish, ice, etc. The ability to maintain Inuit traditional economic practices, such as trading, sharing and providing foods and medicines. It is the ability to access and maintain an economic system based on cash in connection to an Inuit traditional economic system. It is the ability to obtain skills, tools and technologies needed to collect, process and store traditional foods"* (Inuit Circumpolar Council-Alaska, 2015, p. 56).

2.2.3 Quality and Utilization

Quality food provides all the nutritional and cultural benefits at the individual and community levels. It guarantees health and respects cultural preferences. Utilization refers to the knowledge required on how to use food (Hansen et al., 2018; Loring & Gerlach, 2015).

The Inuit Circumpolar Council (2015) has also presented their own dimensions of food security for Alaskan Inuit Communities. There are six interconnecting dimensions: 1) Availability, 2) Inuit Culture, 3) Decision-Making Power and Management, 4) Health and Wellness, 5) Stability and 6) Accessibility. The third dimension is important considering that it influences strongly the other dimensions and is related to their capacity to adapt to threats and disruptions. From this framework, it is important to point out that food security does not sustain without food sovereignty.

Research about food [in]security in the North has changed from government-centered food supply chain approaches to local and qualitative assessments that consider the interactions between people and food systems and global threats such as climate change (Loring & Gerlach, 2015). The exploration of food security has used quantitative and qualitative approaches. The

first one has measured food production and availability. The qualitative approach has sought for food preferences and the meaning of food for people (Loring & Gerlach, 2015).

2.3 Northern Food Systems

Traditional/country and market-based food are part of the food systems in Northern Canada; each of these food sources are consumed differently throughout the year across communities. Country food is comprised of diverse wildlife species (non-domesticated) obtained by hunting or harvesting practices; it contains a high level of nutritional value (Ford, 2009). The processes of harvesting, preparation and consumption of country food constitute the core of the community identity (CCA, 2014).

Food-sharing practices are considered an important food security strategy among Northern Aboriginal populations (Inuit Circumpolar Council-Alaska, 2015); food sharing is a means of supporting vulnerable individuals or households, such as elders, women without a hunter in her household, and youth (CCA, 2014). Sharing food reinforces community relationships and well-being (CCA, 2014). Nowadays, this practice has extended to sharing equipment and fuel (Inuit Circumpolar Council-Alaska, 2015).

Market-based or store-bought food is defined by the Canadian Council of Academies (2014) as follows:

> *"Store-bought food refers to foods that generally cannot be sourced from the land locally. These may be healthy (vegetables, fruit, grain products, etc.) or unhealthy (items higher in sodium, fat, and sugars). In addition, although all country foods (food from the land, sea, and sky) are nutritious, not all store-bought foods are"* (CCA, 2014, p. 103).

In many regions of northern Canada, there are difficulties in achieving subsistence food security due to a number of factors including the increasing cost of hunting and harvesting and environmental changes such as climate change(CCA, 2014). To avoid the high cost of going to the land to obtain traditional foods, households have been relying more on store-bought foods, which can be equally or more expensive than traditional foods (CCA, 2014). These elevated prices are part of any discussion related to food security in the North (CCA, 2014). Market-based food also has some challenges in Northern Canada; food sales and distribution are constrained by remoteness and unpredictable weather conditions (CCA, 2014). These conditions make the northern community more vulnerable to food [in]security (CCA, 2014).

Traditional foods and market-based foods interact permanently; there have been cases in which store-bought foods are preferred due to environmental stressors that affect access and availability of country foods. On other occasions, market-based food is favoured when the hunting equipment is damaged and the costs of repairing it are high; the consumption of country food may increase when income is low and the market-based food is not affordable (Ford, 2009).

Finally, another component of the northern food system explored in this study is locally produced food, which entails food harvested for consumption in the same production area; local food systems have been gaining supporters during recent decades; the idea with these initiatives is to promote locally based food systems with a community collaborative approach (Avard, 2013).

2.4 An Overview of food [in]security in the North

The following section presents some examples related to food [in]security based on a review of the qualitative literature. Although not comprehensive, the aim is to share a brief snapshot of the current state of knowledge and common topics, and indicating the gaps needed to be addressed.

In a literature review conducted by Halselth (2015) about the nutritional health of First Nations and Métis in the NWT, 103 relevant publications were identified among scientific and peer reviewed literature. The findings provided some information regarding the state of knowledge and topic tendencies. For instance, broad groups of populations were the main focus of the literature reviewed instead of specific communities (sub-populations).

The most relevant topic of the publications was food [in]security. From this topic, the main focus was the impact of environmental contaminants on food security (66 %); despite the prevalence of this topic, only a few of the publications analyze levels of contaminants in food. Publications related with socio-economic aspects of food security were second (26 %) and finally, publications on how climate change is influencing food security issues (25 %) (Halseth, 2015). Other prevalent topics were nutrient assessments and patterns of food consumption (Halseth, 2015).

The general trends focus on broad groups of populations, with few publications analyzing the diverse experiences in specific communities and groups (gender, age, geographies) (Halseth,

2015). Therefore, according to this author, current research has a weakness in reflecting the experiences of First Nations and Métis in the NWT regarding food security and nutritional health (Halseth, 2015).

The Council of Canadian Academies (2014) has also provided an assessment of the current knowledge about food [in]security in Northern Canada. Different literature sources from traditional and western knowledge with the participation of a multidisciplinary panel of Aboriginal and Non-Aboriginal experts from a broad range of disciplines were included in the document.

Loring & Gerlach (2015) conducted a meta-analysis of peer-review literature of the progress on food security in the North American North. The findings indicated that *access* was the most common topic of discussion (26 articles) including issues such as economic obstacles, land tenure problems and hunting and fishing regulations. *Quality and utilization* (18 papers) was the second most common topic of discussion, with relevant issues such as the presence of contaminants in food, food spoilage and food preferences. Finally, food *availability* was discussed in 12 papers, especially in relation to climate change impacts on fish and wild populations.

In terms of methodologies, 28 papers used qualitative methodologies, such as photo voice, structured interviews and focus groups (Loring & Gerlach, 2015). Quantitative methods were used in 9 papers and mixed methods were used in 4; in the results, 10 papers were reviews, 11 were critiques and 8 gave frameworks for conducting research, finally, 9 of the 62 papers used participatory methods (Loring & Gerlach, 2015). Despite the availability of data related to food security in the North, these studies (theoretical and empirical) are based on definitions of food security made by practitioners (researchers and/or organizations) (Loring, 2017; Loring & Gerlach, 2015).

The *Alaskan Inuit Food Security Conceptual Framework: How to Assess The Arctic from an Inuit Perspective* is a document that reflects how the Inuit have experienced and defined food security (Inuit Circumpolar Council-Alaska, 2015). It is a technical report that identified the causes of food [in] security and provided a framework from the Inuit perspective (Inuit Circumpolar Council-Alaska, 2015).

Food [in]security in the North has complexities that go beyond the definitions and dimensions included in the frameworks. Socio-economic transformations in northern indigenous societies,

for example, the transition from being nomads to being set up in permanent settlements is an important consideration to understand changes in lifestyle and food systems (Loring & Gerlach, 2015). With the changing context of the North, food security must be assessed as a dynamic process in which people interact with different needs, preferences and vulnerabilities (Loring & Gerlach, 2015).

Colonialism, federal-claim settlements and resource development (environmental dispossession) have affected how Indigenous communities in the North relate the land (Loring, 2017). As a result, they have changed the dependency on the land as the principal provider of their food systems and rather have begun to rely on store-bought foods to meet their basic needs (Loring, 2017; Loring & Gerlach, 2015).

2.5 Nutrition transition and socio-cultural barriers in food preferences

The nutrition transition experienced by Northern Indigenous communities has determined the consumption of different types of food and how these are perceived. According to Halseth (2015), the literature has presented different approaches on how the nutrition transition has been included in the lifestyle of northern communities of Canada. On one side, the consumption of traditional foods has remained stable in different communities, but there are differences in the quantity and type of store-bought foods consumed; according to this perspective, the transition entails the inclusion of new foods in the regular diets rather than the substitution of country foods (Halseth, 2015). The other perspective of nutrition transition indicates that the consumption of country food has been decreasing in quantity and diversity; therefore, the intake of market-base food has increased (Halseth, 2015).

Cultural barriers are present when it comes to food preferences. For instance, Northern Indigenous communities are not used to buying in large quantities (buy in bulk) and do not have regular patterns for buying food (e.g. weekly); their identity is based on taking only what is necessary from the land for sustaining their livelihoods (Mercier, Mondor, Villeneuve, & Marcos, 2018).

Other social barriers have been identified related to the changes in consumption patterns and the utilization of market food. Store-bought food, market-based food or 'southern food' is preferred by young Inuit (Ford, 2009). The consumption of non-nutritional food has been promoted in nutrition education programs and advertisements; the adoption of western lifestyle

behaviours has undermined the cultural and nutritional value of traditional foods, limiting the knowledge of their quality and preparation specially among young northerners (Halseth, 2015; Kenny, Wesche, Fillion, MacLean, & Chan, 2018). However, public health messages about the nutritional value of traditional species can influence positively traditional food intake (Halseth, 2015).

Halseth (2015) identified a large body of literature that mentioned how the engagement in traditional subsistence practices has been diminishing among local populations in Northern Canada. Changes in populations of plant and animal species, contamination of food sources, the transfer of traditional knowledge from elders to youth, difficulties in spending time on the land because of employment activities, resource development projects are among stressors affecting the consumption of traditional food sources (Halseth, 2015). Similarly, socio-cultural changes like the establishment of stationary communities and the residential school system affected the culture regarding traditional harvesting practices (Halseth, 2015). Despite the obstacles to access it, traditional food has cultural, social and spiritual significance (Halseth, 2015).

3 RESEARCH QUESTION AND OBJECTIVE

The research question to address in this study is the following:

How is grey literature (government and non-government sources) addressing access, availability and quality topics about food [in] security in North Canada (country food, market-based food and locally produced food)?

Objective

Identify information and examples of food [in] security drivers influencing the territories of Yukon, NWT and Nunavut, using supplementary scientific literature as support.

4 METHODOLOGY: SECONDARY DATA AND INTERPRETIVE RESEARCH

The type of data collected is secondary data (qualitative). This data was previously gathered by different sources and purposes, that might not be related with the research that will use it (Bhattacherjee, 2012). The use of secondary data in research has some limitations. Data collection processes might not have employed scientific and systematic methods and therefore it could be inappropriate for scientific research (Bhattacherjee, 2012).

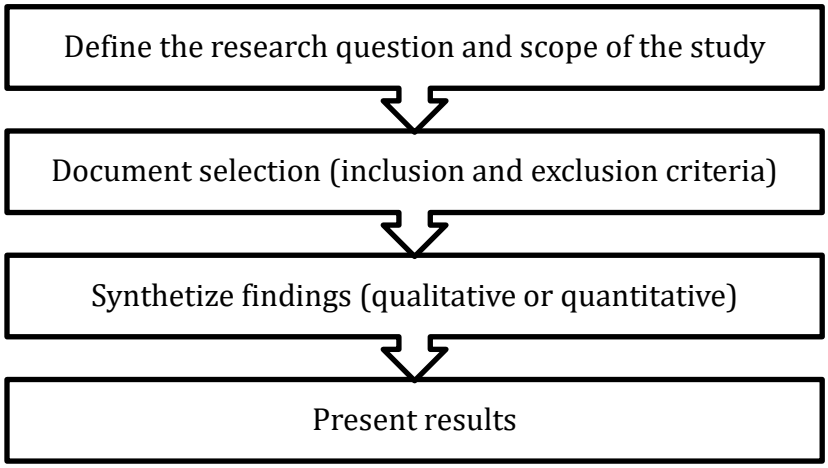
The inductive approach to exploring the literature enabled the analysis and synthesis of emerging patterns and concepts with the objective of generating new explanations or complement current theories (Bhattacherjee, 2012). Similarly, an interpretive approach, which is appropriate for "studying context-specific, unique, or idiosyncratic events or processes" (Bhattacherjee, 2012, p. 105) was taken for this research.

Interpretive research has some challenges; reliance on insufficient data can result in premature or inaccurate assumptions, whereas a surplus of data may not be processed accurately by the researcher (Bhattacherjee, 2012). The outcomes from interpretive research are mainly based on context-specific events; for that reason, the outcomes and conclusions may not be generalizable or replicable. The different data sources used for this research could be biased or could hide political agendas. The idea is to generate new questions and highlight relevant issues for further research (Bhattacherjee, 2012).

4.1 Process to identify and analyze secondary data

A literature review is a changing and adjustable process that is able to adapt to different research questions (Berrang-Ford, Pearce, & Ford, 2015). The methodological approach for this study was adapted from these authors. The following steps were taken in order to have a clear picture of the selection process (Figure 1).

Figure 1. Methodological steps conducted in the study



Source: Adapted from Berrang-Ford et al. (2015)

4.1.1 Research question and scope of the study

The theoretical framework was the guide to establish the research question and scope of the search. Documents from scientific literature and grey literature presented an overview of food [in]security in Northern Canada and were key in the conceptual approach used in this study**.** The first step was to establish the geographic range of the research, which includes the territories of Yukon, Northwest Territories and Nunavut.

4.1.2 Document selection (inclusion and exclusion criteria)

An initial search was conducted in Google and Google Scholar using the term food [in]security in Northern Canada. This search resulted in a broad body of both scientific and grey literature. Considering the time frame for developing the study and the diversity of scientific literature in existence, it was decided to focus on non-peer review literature. This type of sources could provide explanatory information or data and, depending on its author, the information may reflect specific interests and opinions; all these documents are considered to have quality, relevance and significance in providing an in-depth perspective (Berrang-Ford et al., 2015).

- **Inclusion criteria**

This study used grey literature published during the years 2014-2018. It focused on a specific sample of research available in international, local and national reports and documents from government and non-government sources; some exceptions were included, considering the relevance of the information. Supplementary peer-review literature sources were included to provide specific examples applicable to the conceptual framework. Additional techniques such as forward and backward citation tracking were integrated into the search. The information was collected principally using two security dimensions mentioned in the framework for this study: access and availability. Relevant information of the quality dimension specifically related to the presence of contaminants in traditional food was included.

Usually, in-depth reviews use between 30-40 articles/documents and in-depth qualitative systematic analysis can use as few as 15-20 articles (Berrang-Ford et al., 2015). A total of 58 sources were used in this study: ten (10) are peer-review literature and 48 are from non-peer review literature. Twenty-two (22) of the grey literature sources were from different reports and statistics from the Government of Canada and the Governments of Yukon, NWT and Nunavut. Some examples of these sources are reports from the Northern Contaminants Program (NCP) and climate change in Canada. The other 26 non-peer review literature documents are from non-government sources. Some of them are from national (e.g. The Conference Board of Canada) and the others are international reports (e.g. The Arctic Monitoring and Assessment Programme).

Table 1 indicates the number of sources found during the search. They were classified per food type; the final category 'food security' included documents about the topic in general or that combined information about northern food systems. Country food (15) and locally produced food (18) were predominant in the grey literature. Documents addressing environmental drivers such as climate change and its influence in traditional food were common during the search. Similarly, government and non-government sources have produced reports about locally produced food initiatives.

Table 1. Number of sources used in the study

	Grey literature	Scientific literature	Total
Traditional food	15	3	18
Market-based food	5	3	8
Locally produced food	18	1	19
Food security	10	3	13
Total	**48**	**10**	**58**

The following topics were only covered selectively in this study:

Traditional food: This food encompasses a diversity of species in northern food systems with specificities in each territory. This study presented only examples from key species such as caribou, in the subsistence species section.

Food Quality: For this study, some information regarding contamination in northern foods is discussed; however, an extensive scientific literature on the diet profile (consumption levels, nutritional intake, health implications) of northern food systems (traditional, store-based and locally produced food) was not included.

5 NORTHERN CANADA

The following section presents a brief description of the area of study, including biophysical aspects and general information such as population, education, employment, income levels and economy. Northern Canada is known for being a diverse territory with unique features. Three territories are part of the north coast region: Yukon, Northwest Territories and Nunavut; also the provinces of Labrador, Ontario, Quebec and Manitoba have northern coastlines (Lemmen, Warren, & Mercer Clarke, 2016). Together, the northern coast has 176 000 km of coastline, supporting 70 000 people and 58 communities. The majority of them are Aboriginal (Inuit, First Nations or Métis). Twenty four (24) communities of Nunavut are located on the coast (Ford, Trevor, et al., 2016; Lemmen et al., 2016) (See Figure 2). An important feature of the northern climate system is that terrestrial, water and ocean areas are characterized for being temporally or continually frozen (snow, glaciers, permafrost, lake, river, sea ice) (Pendakur, 2016). Climate change impacts in the North are associated with these systems (Pendakur, 2016).

Figure 2. Northern Canada provinces and territories (Area of study: Yukon, NWT and Nunavut)

Source: (Ford, Trevor, et al., 2016, p. 157)

5.1 Climate change in Northern Canada

In Canada, ice and snow are predominant in different parts of the country during most of the year; their presence and dynamics throughout the seasons influence climate locally and globally (Bush, Loder, James, Mortsh, & Cohen, 2014). Climate change could have significant consequences on Northern Canada, specially on Aboriginal populations (Halseth, 2015). The modification of temperature and precipitation trends, sea-ice conditions and season variations could be the most common impacts; climate models have indicated bigger changes compared to any other regions in the world (Ford, Trevor, et al., 2016).

Projections have indicated that the vulnerability of the Artic to climate change is the greatest; Arctic warming process is faster than any other region of the world; this phenomenon is known as Arctic Amplification (Lemmen, Johnston, Ste-Marie, & Pearce, 2014; Pendakur, 2016). The loss of artic sea ice could influence resident's livelihoods and simultaneously, could bring more access to trans-artic shipping, with environmental, economic and social outcomes (Bush et al., 2014).

From 1948 to 2014 the Northwest Territories in the Mackenzie District experienced a significant warming of 2.6ºC; other regions of Northern Canada, like the arctic tundra had a warming of 2ºC, and 1.6ºC for the arctic tundra and Fjords region of Nunavut (Ford, Trevor, et al., 2016; Pendakur, 2016). Canada had a warming trend of 1.6ºC over the same period, 50% less than the rate of warming registered in the Mackenzie District (Ford, Trevor, et al., 2016; Pendakur, 2016). There was an increase in annual precipitation in the period 1950 to 2010 (Ford, Trevor, et al., 2016). It was expected an increase in rain with predominance in fall and winter (Ford, Trevor, et al., 2016; Pendakur, 2016).

According to Pendakur (2016), climate projections suggested that warming of the North could continue more intensely compared to Canada as a total area, and the warmest seasons might be winter and fall. Climate change models also suggested that the greenhouse effect could alter the warming pattern of the region; if the emissions were high the temperature would rise up to 10ºC, if the emissions were low it would be more than 5ºC (Pendakur, 2016).

Anomalies were also reported regarding sea ice extent. The September monthly average has been decreasing 13.3 % per decade and in March the decrease is 2.6 % per decade. This data was reported using the mean values of the period 1981-2010 (Ford, Trevor, et al., 2016). With the sea ice cover decreasing, the open water season was increasing in Northern Canada, with an average of 3.2-1.2 days per decade; it was expected that storms might be more frequent and intense (Ford, Trevor, et al., 2016).

5.2 Demographics

Demographic aspects related to Northern Canada population and the Indigenous population will be presented in this section. Considering that non-Aboriginal and Aboriginal peoples are part of the region, it is important to present data related to both of them.

The main cities of the three provinces of Northern Canada (Whitehorse, Yellowknife and Iqaluit) have populations exceeding 7000 inhabitants (Pendakur, 2016). Other communities have small populations with long distances from one to another and are only accessible by air or water (Pendakur, 2016). The socio-economic dynamics in the North are different compared with the South part of the country, which is more urbanized and agricultural (Holen et al., 2017). Approximately two-thirds of northern communities are located along coastlines and have less than 500 inhabitants (Holen et al., 2017).

According to the 2016 Census, the population of Canada was 35 151 728 million people. The growth of the population from 2011 to 2016 was +5.0 % (Statistics Canada, 2017c). Table 2 presents the population general data of Northern Canada in 2016. NWT had the largest population with 41 876 inhabitants and also the highest number of communities.

Table 2. Demographic information of Yukon, NWT and Nunavut (2016)

	Yukon	Northwest Territories	Nunavut	Total
Population (1000)	35 874	41 876	35 944	113 694
Area (km2)	474 713	1 143 793	1 877 778	3 022 046
Population Density/km2	0.1	0.04	0.03	0.17
Number of Communities	19	33	25	77

Source: (Statistics Canada, 2017b)

Table 3 indicates that Nunavut is the territory of Northern Canada that experienced a significant growth of their population from 2011 to 2016 (12.70 %). Yukon was the second with 5.80 %, and NWT had a growth of 0.8 %, lower than the national growth. According to Holen et al. (2017), the non-Indigenous population growth is due to resource development and government and public administration increase; the urban centres have experienced more arrivals of immigrants.

Table 3. Population growth by provinces and territories from 2011 to 2016

Province and territories	Population growth
Yukon	5. 80 %
Northwest Territories	0.80 %
Nunavut	12. 70 %

Source**:** (Statistics Canada, 2017c)

Northern territories are constantly under different dynamics, influencing population growth. *The Territorial Outlook Economy Forecast: Spring 2018*, presented some projections related to demographic changes in this area:

- **Nunavut:**

The Conference Board of Canada (2018) indicated that this area has the youngest and fastest growing population of all the territories in Canada, which will grow at an average of 1.4 % per year, doubling the national one; in approximately 5 years it is expected a population of 51 938. In Iqaluit, the capital, there has been an 8.3 % increase of population between 2006 and 2011 according to Statistics Canada, and it might continue growing as a result of development projects (AMAP, 2018).

With the highest fertility rate in Canada, 3 children per woman (the national average is 1.6), it is estimated that in around 10 years, 35 % of the population will be 14 years old or below, 10 % more than NWT and Yukon. Nunavut will be the only region in Canada where youth population will be higher than seniors (The Conference Board of Canada, 2018).

- Northwest Territories

According to the Conference Board of Canada (2018), by 2035, 1300 local workers who rely on the mining industry will lose their positions. As a consequence, outmigration levels of youth and working-age people will be higher, and the number of seniors will increase; by 2040, more than 5468 people in the territory will be 65 year old and over; in NWT women have 1.9 live births compared to 1.6 births of Canada in total (The Conference Board of Canada, 2018).

- **Yukon**

The Yukon population is anticipated to age faster and immigration will contribute to population growth; by 2027, it is expected that Yukon population will have 45 000 people, compared to the 38 459 from today; these figures indicate a steady growth over the years (The Conference Board of Canada, 2018).

Women will have 1.6 live births in their lifetime and it is expected that annually 334 people will move into the region between 2018 and 2030; after that year outmigration will increase due to limited employment opportunities (The Conference Board of Canada, 2018). Between 2018 and

2040, the Yukon population aged 65 and older will represent 22.5 % of the total population; almost the double of the 12.4 % of today (The Conference Board of Canada, 2018).

5.2.1 Aboriginal People

Aboriginal people (First Nations, Inuit, Métis) in Northern Canada make up an important part of the population. As table 4 indicates, half of the population of NWT are Aboriginal and only 14 % of the population in Nunavut are non-Aboriginal.

Table 4. Demographic overview of Aboriginal population (First Nations, Inuit, Métis) in Yukon, NWT and Nunavut (2016)

	Population (1000)	% Of the total population in the territory
Yukon	8195	23 %
Northwest Territories	20 860	50.70 %
Nunavut	30 550	85.90 %

Source: (Statistics Canada, 2017b)

Recent data from Statistics Canada indicate an increase of First Nation, Métis and Inuit population from 2006 to 2016. The First Nation population had a growth of 39.3 %, Métis population of 51.2 % and Inuit Population of 29.1 % (Statistics Canada, 2018).

By 2036 it is expected that the Aboriginal population might be between 1 965 000 and 2 633 000 people (Statistics Canada, 2015). The proportion of Aboriginal people within the total of Canadian population would increase from 4.4 % in 2011 to between 4.6 % to 6.1 % in 2036 with a higher annual growth in Aboriginal population (Statistics Canada, 2015).

In 2011 the median age of Aboriginal people was 27.7 years and in 2036 it would be between 34.7 years and 36.6 years; according to this projections, the Indigenous population would be younger than the non-Indigenous population; however, they might age more rapidly (Statistics Canada, 2015). Among the three groups, Inuit are the youngest population with an average age of 27.7 years, followed by First Nation people with an average of 30.6 years and Métis with 34.7 years (Statistics Canada, 2018).

5.3 Education

Aboriginal peoples in general have experienced few increases in education levels according to Statistics Canada. By 2016 almost 70 % Indigenous people (ages 25 to 64) had earned a high school diploma or an equivalent certificate. In contrast, by 2006, 60 % obtained the same education level (Statistics Canada, 2017a).

In postsecondary education data also confirmed the improvement in its access. In 2006, 7.7 % of Aboriginal people aged 25 to 64 gained a bachelor's degree or higher, in 2016 an increase of 10.9 % was registered (Statistics Canada, 2017a). Over the same period, Aboriginal people who obtained a college diploma went up from 18.7 % to 23.0 % (Statistics Canada, 2017a).

The differences between First Nations living on and off reserves are important to consider in terms of education levels. People living on reserves have more constraints in education opportunities; in many cases they have to leave their communities in order to attend educational institutions (Statistics Canada, 2017a). Alternatively, people living off reserve are more likely to complete postsecondary education; the figures in 2016 showed that 11.4 % of First Nation people (age 25 to 64) living off reserve had completed a bachelor degree or higher, compared to 5.4 % of the same people living on reserve (Statistics Canada, 2017a).

Education levels can enable or constraint the ability to access and maintain employments (Holen et al., 2017). Many Aboriginal community members maintain their unemployment or under-employment status because the lack of education and skills to advance in the resource development industry (Holen et al., 2017). A significant number of workers from Southern Canada receive the benefits of the resource development industry in Northern Canada (Holen et al., 2017). Yukon had the highest levels of education completion (high school, college, apprenticeship and university, followed by NWT and Nunavut (Jeffrey, Fiser, Brender, & Dowdall, 2015).

5.4 Employment levels

Table 5 indicates the rates of employment and unemployment levels in the territories of Yukon, Nunavut and NWT. In 2016, Nunavut had the highest unemployment level (21.5 %), almost twice as Yukon and NWT (Holen et al., 2017). In many regions of Northern Canada unemployment levels surpass 50 % in some communities and labour-force involvement is lower than the rest of the country (Ford, Trevor, et al., 2016).

Table 5. Employment and unemployment rates in Yukon, NWT and Nunavut (2016)

	Employment rate (%)	Unemployment rate (%)
Yukon	68.5	9.2
NWT	66.2	10.6
Nunavut	53.6	21.5

Source: (Statistics Canada, 2017b)

Information from *The Territorial Outlook Economy Forecast: Spring 2018* presented possible dynamics in employment levels:

Nunavut

Resource extraction activities will increase immigration (temporary and permanent) trends in Nunavut; between 2018 and 2023, 2000 new jobs will be available in the mining sector (AMAP, 2018). Both mining and construction industries in Nunavut rely principally on workers coming from southern Canada, and it is expected that in this period of time (2018 to 2023) Nunavummiut workers will only represent 25 % of the workforce (The Conference Board of Canada, 2018).

By 2040, unemployment levels will drop to 11.7 % in Nunavut, however this territory will still have the highest unemployment level of any province or territory of Canada and wages and salaries per person will increase at a annual rate of 2.2 % (The Conference Board of Canada, 2018).

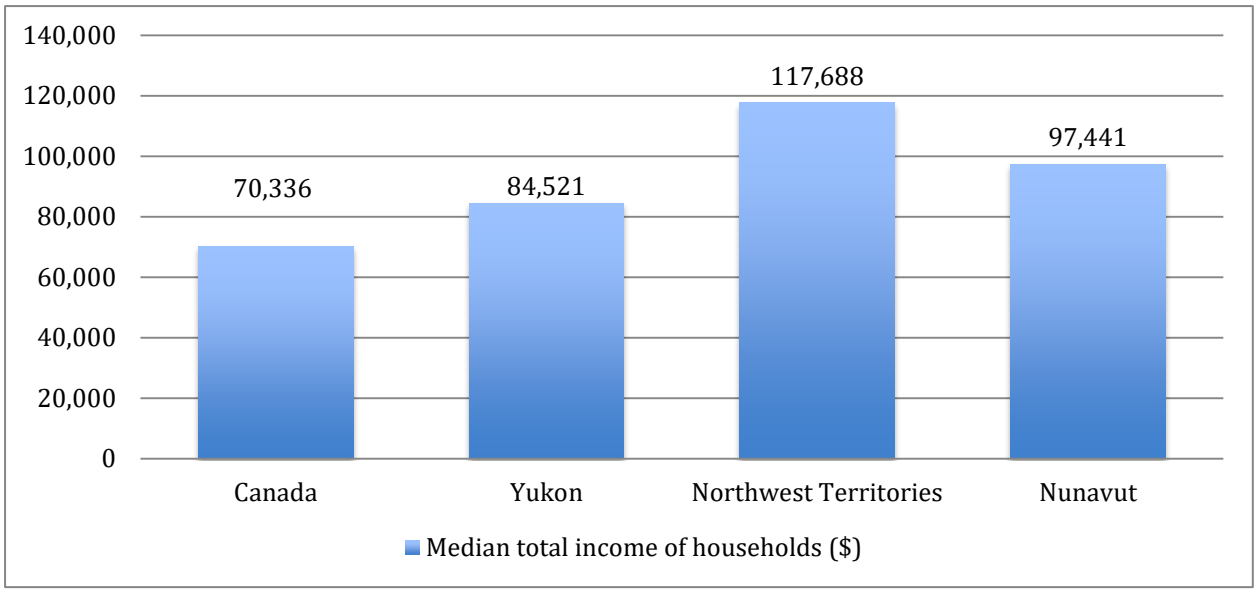
Yukon

Temporary workers coming from South Canada fill a significant amount of mining and construction jobs in Yukon; the service sector has the opposite trend, with more jobs filled by local people; local population (Yukoners) will still have limited job opportunities in the mining and construction industries over the years 2020 and 2040 (The Conference Board of Canada, 2018). Unemployment levels will remain relatively low at around 4 %; but in 2026 after the mining industry starts to reduce production, unemployment will begin to rise; the opposite will happen in the public sector, in which employment opportunities will emerge due to the health care required for the aging population (The Conference Board of Canada, 2018).

5.5 Income levels

The following data shows the median total income of NWT, Yukon and Nunavut, compared to the median total income of Canada in 2015. NWT has the highest income compare to Yukon and Nunavut (Figure 3).

Figure 3. Median total income of Northern Canada territories (2015)



Source: (Statistics Canada, 2017b)

According to Statistics Canada (2017b), the distribution (%) of household total income in Canada, Yukon, NWT and Nunavut in 2015 is the following:

Table 6. Distribution of household total income in Canada, Yukon, NWT and Nunavut 2015 (%)

Location	Under $30 000	$30 000 to $59 999	$60 000 to $89 999	$90 000 to $124 999	$125 000 to $199 999	$200 000 or more
Canada	17.8	24.7	19.7	15.7	15.2	6.8
Yukon	15.6	19	18.8	17	21.4	8.2
Northwest Territories	12.8	13.1	12.3	14.9	25.2	21.6
Nunavut	14.3	18.7	13.9	15.1	21.1	16.8

Source: (Statistics Canada, 2017b)

According to the information in table 6, between 20-55 % of the households from Yukon, NWT and Nunavut received an income between $125 000 to $199 999 in 2015. Meanwhile, in the same period, 24.7 % of the households of Canada received an income in the range from $30 000 to $59 999**.**

Adjusting Northern Canada income and comparing it to the South in terms of acquiring capacity could be difficult because the same amount of money will not buy the same households goods in the North and South (Daley, Burton, & Phipps, 2015). In this region, the prices of most of the basic needs are double or triple than in Southern Canada (Daley et al., 2015).

Daley et. al (2015) found that a northern household has a cost of living 1.46 times higher than the same-sized family in the South; the levels of poverty for northern households with children according to this estimation increase to 31.1 %. The northern equivalence scale used by these authors included the high cost of subsistence activities (Daley et al., 2015).

Complete information about poverty and inequality in Canada has been difficult to obtain, given the challenges to collect data in isolated northern communities; for that reason, these populations have been usually excluded from studies of poverty, although nowadays some practitioners have started to include this part of the population (Daley et al., 2015).

5.6 Economy

The economy in Northern Canada is a combination of different sources of income: waged employment and subsistence activities. These two components are interacting permanently and depend on each other (AMAP, 2018; CCA, 2014; Holen et al., 2017; Kenny, Wesche, et al., 2018).

Waged economy is based on public administration, resource extraction, arts and crafts and tourism; subsistence activities are hunting, fishing and trapping (Fast & Berkes, 1998; Ford, Trevor, et al., 2016). Northern communities depend on both cash economy and subsistence activities. To make visible in the statistics the economic value of subsistence activities, further reliable data is required on the real cost of hunting and harvesting practices (Holen et al., 2017).

5.6.1 Formal economy

The formal economy generates part-time, full-time, seasonal and rotational employment; these job dynamics and the season of the year in which they happen influence the subsistence economies of the communities (Jeffrey et al., 2015). Part-time jobs allow flexibility to spend time on the land to practice subsistence activities, whereas full-time employment provides the necessary income for all the equipment and supplies required for hunting traditional foods (Jeffrey et al., 2015). Full-time jobs reduce the amount of time available for spending time on the land; more participation in wage employment might indicate the weakening of sharing networks and reciprocity of northern communities (Jeffrey et al., 2015; Kenny, Wesche, et al., 2018).

Resource development makes up approximately 25 % of the GDF (Growth Differentiation Factor) for the three northern territories, compared to 8 % for Canada as a total (Ford, Trevor, et al., 2016). Another source of income is public administration, a major employer in the area. This activity makes up 18 % of GDP (Gross Domestic Product), compared to the 7 % for Canada as a total. Public administration accounts for 23 % of the total labour force in the northern territories (Ford, Trevor, et al., 2016). Resource development and public administration make up more than 40 % of the GDP in Northern Canada (Ford, Trevor, et al., 2016).

During recent decades there has been an expansion of mining development: gold, nickel, lead, zinc, iron, uranium, copper, silver, platinum, palladium and cobalt are among them (Ford, Trevor, et al., 2016). In Nunavut for instance, it is expected the rise of gold production, reaching a peak in 2020. After that, the mining industry will have an annual decrease of 5.6 %; Nunavut also has resource-rich areas that are isolated, constraining exploration and operation activities, especially due to transportation issues; for example, the MMG's Izoc Corridor has the potential to produce copper, lead, zinc and silver (The Conference Board of Canada, 2018).

In NWT, the diamond industry has likely reached its peak; despite the opening of two metal mines in the 2020s, there still will be a decline in diamond, oil and gas production; as a result,

the territory's economy will have some drawbacks, although there are some ongoing gold and other metals exploration projects in process (The Conference Board of Canada, 2018).

In Yukon, during the last few years the mining industry has had some difficulties due to downturns in the metal markets; however, three new mines are expected to open over the next 10 years (The Conference Board of Canada, 2018). Between the years 2018 and 2025, projections indicate that the mining industry production will grow 17 % annually over the years 2018-2040 (The Conference Board of Canada, 2018).

The three territories will have different patterns in resource development; however, the common trend is that people from the South of the country will retain most of the employment. This might accentuate unemployment levels and low income for the population. Youth population, which will lead population growth in Nunavut, will have to overcome the difficulties related to lack of income and employment opportunities. NWT, on the other hand, will have a growing senior population that will need support to meet their basic needs.

Climate change impacts (thawing permafrost, warming temperatures, and increasing extreme weather events) could have both negative and positive implications for northern mixed economies (Fast & Berkes, 1998; Holen et al., 2017). On one side, industrial activities such as oil and gas development would be more expensive with melting permafrost; on the other side, offshore hydrocarbon developments might take advantage of more moderate conditions and sea transport would increase its activity annually for more than six to eight weeks (Fast & Berkes, 1998). Reduction in permafrost and sea ice might reduce shipping costs, creating opportunities for the mining industry, with extended benefits to the tourism and recreation sectors; however, there might be downsides at the environmental and social levels (Fast & Berkes, 1998; Lemmen et al., 2014).

5.6.2 Informal economy

The informal economy encompasses all harvesting activities such as hunting, fishing, trapping and gathering; some by-products result from subsistence activities too, for example walrus *(Odobenus rosmarus)* and narwhal *(Monodon monoceros)* tusks; artistic activities (carving and sewing) are also included in this economy (AMAP, 2018). Likewise, the commercialization of sealskins and other furs has generated income for hunters and trappers, improving their means

to buy food for the households and acquire the necessary equipment for hunting and fishing (AMAP, 2018; Holen et al., 2017).

Sealing is considered an important alternative for communities with limited income and could generate from 25 % to 35 % of the sealer's total income (Holen et al., 2017). Every year sealing represents between CAD $4 million to CAD $6 million of food value; before the European Union seal ban, the revenues from seal pelts could generate up to CAD $1 million annually (Holen et al., 2017).

Trapping also represents economic value in Northern Canada; in Yukon it is an important activity that can provide revenue, especially in winter when unemployment levels are high. "Yukon's fur harvest has fluctuated in value between CAD $250 000 to over CAD $1.5 million annually, with economic spin-offs worth two to three times that amount" (Holen et al., 2017, p. 102). In 2015 the government of Nunavut created a subsidy of pelts, recognizing that this activity represents cultural and traditional values within the communities, and a contribution to food security (Holen et al., 2017).

6 NORTHERN FOOD SYSTEMS

The aim of this chapter is to highlight aspects influencing food [in]security in the area of study, as determined by the literature review. Examples of how the access and availability to traditional and market-based food have been limited will be presented; the quality of traditional food might be affected by the presence of contaminants, as some studies indicate. Finally, this section includes a description of how locally produced food initiatives might be seen as an opportunity to improve self-sufficiency.

6.1 Food [in]security levels

The data on food [in]security in Canada is collected using the Canadian Community Health Survey (CCHS) and is conducted under the administration of Statistics Canada; approximately 60 000 Canadian households per year participate in the survey (Tarasuk et al., 2016). Despite the fact that the sample is built to be representative, some groups are excluded: people in prisons, Indigenous peoples living in reserves –First Nation, Crown Lands, Région du Nunavik

and Région des Terres-Cries-de-la-Baie-James - and people in health care facilities (Tarasuk et al., 2016).

The high vulnerability of individuals living on First Nations reserves and the fact that they are not included in the sample indicate that somehow the real preponderance of food [in]security is not accurately represented in the final data (Tarasuk et al., 2016). The answers provided for the survey classified the households as food secure or marginally, moderately or severely food insecure (Tarasuk et al., 2016). The original reports of food [in]security presented by Statistics Canada considered individuals of 12 years and older and counted only moderate and severe food insecure households (Tarasuk et al., 2016).

In their *PROOF (Food Insecurity, Policy Research)* report Tarasuk et. al (2014) used an alternative method of calculation in which all members of the households are taken into account. Considering the inclusive approach of food [in]security calculated by these authors, their statistics will be included.

For the provinces and territories of Canada, being included in the CCHS module has always been optional. In 2013 and 2014, British Columbia, Manitoba, Newfoundland and Labrador decided not to take part of the survey (Tarasuk et al., 2016). In table 7 the authors presented the total of food [in]security levels (marginal, moderate and severe) in Canada from 2005 to 2014. The blank spaces in some years indicate provinces and territories that did not take part in the survey (Tarasuk et al., 2016)

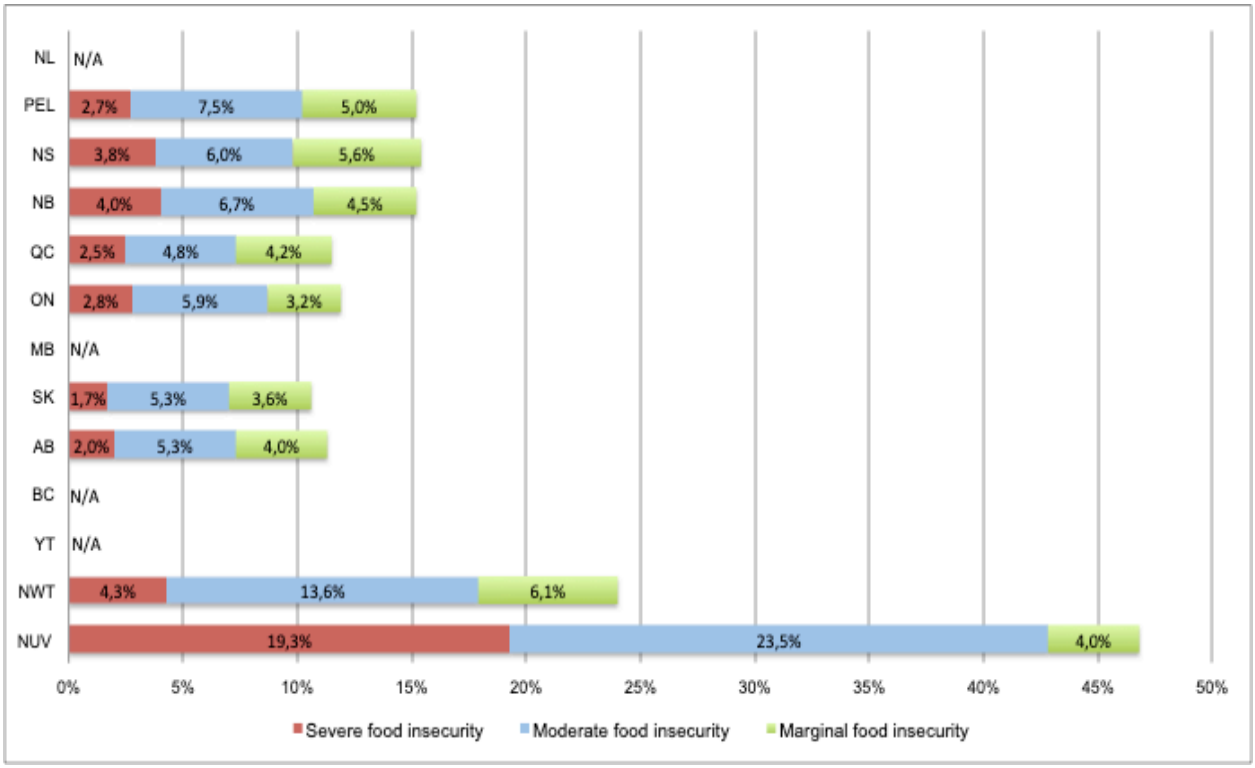
Table 7. Household food [in]security in Canada (2005-2014)

	2005	2007	2008	2009	2010	2011	2012	2013	2014
Newfoundland and Labrador		15.7%	14.3%	11.8%	11.5%	10.6%	13.4%		
Prince Edward Island	12.9%	14.9%	15.3%			15.4%	16.2%	16.7%	15.1%
Nova Scotia	16.1%	14.4%	13.5%	15.9%	14.9%	17.1%	17.5%	18.5%	15.4%
New Brunswick		13.8%	15.1%			16.5%	15.6%	16.0%	15.2%
Quebec	11.3%	10.9%	9.4%	11.3%	9.7%	12.5%	13.5%	11.8%	11.6%
Ontario	11.6%	11.8%	12.1%	12.5%	11.3%	11.9%	11.7%	12.5%	11.9%
Manitoba		12.4%	12.9%	10.8%	10.0%	12.4%	12.1%		
Saskatchewan		9.5%	9.7%	8.2%	9.2%	11.8%	12.5%	12.2%	10.6%
Alberta	10.4%	9.1%	10.0%	10.8%	10.9%	12.3%	11.5%	11.3%	11.4%
British Columbia	11.0%	10.8%	11.5%	11.9%	11.1%	11-0%	12.7%		
Yukon		17.8%	13.0%	13.9%	12.6%	16.7%	17.1%		
Northwest Territories	14.2%	16.5%	17.8%	9.8%	12.0%	15.2%	20.4%	20.4%	24.1%
Nunavut	38.0%	35.4%	34.6%	31.0%	31.0%	36.4%	45.2%	45.0%	46.8%

Source: (Tarasuk et al., 2016, p. 16)
Canadian Community Health Survey (CCHS), 2005, 2007, 2008, 2009, 2010, 2011, 2012, 2013 and 2014

The CCHS has been reporting data since 2005. During these years, food [in] security levels (in table 7 marginal, moderate and severe) have had a high prevalence in Northwest Territories and Nunavut, with an increase in 2014. The data in Yukon varies from year to year, with their highest percentages in 2007 and 2012. Nunavut and Northwest territories had the highest prevalence in 2014 with 46.8 % and 24.1 % respectively.

Figure 4. Household food [in] security in Canada by province and territory, 2014



Source: (Tarasuk et al., 2016, p. 10)
Statistics Canada, Canadian Community Health Survey (CCHS), 2014

Figure 4 indicates the levels of household food [in]security in Canada. In 2014, Nunavut had the highest prevalence of severe and moderate household food [in]security (19.3 % and 23.5 % respectively). Northwest territories presented a level of moderate household food [in] security of 13.6 %. In 2014, Yukon opted out from the survey and no data is available for that year.

6.2 Market-based food

This section explains how the program Nutrition North Canada (NNC) works as an initiative designed to improve access to store-bought food in isolated northern communities, followed by some examples that indicate how the affordability of market-based food remains limited due to high prices and, finally, some logistic aspects that impede its regular distribution.

6.2.1 Nutrition North Canada

Nutrition North Canada (NNC) is a market-based food subsidy program of the Government of Canada, designed to provide nutritious food to remote Northern Communities where high costs of food storage and transportation constrain the availability and access to perishable healthy food (Nutrition North Canada, 2018b). Recent data from NNC indicated that 121 communities are beneficiaries of the subsidies; 90 % of the people living in these communities are Indigenous People (Nutrition North Canada, 2018e).

This program was implemented in 2011 and the food subsidized is selected considering the Revised Northern Food Basket (RNFB), a guide used by Indigenous and Northern Affairs Canada to monitor the prices of healthy food in remote northern communities eligible for the program (Hammond, 2017). This guide was elaborated to include the real food consumption patterns of northern communities; for instance, meat and non-perishable foods have a larger percentage, whereas fruit and vegetables have a smaller proportion in the basket (Skinner et al., 2016).

As of May 2016, the eligibility of communities includes conditions such as the absence of permanent roads or difficulties for marine access, being part of a northern community and access to infrastructure such as an airport, post-office or grocery store for food delivery; environmental conditions (freeze up or break up) that occur less than four weeks at a time are excluded. (Nutrition North Canada, 2018d, 2018c).

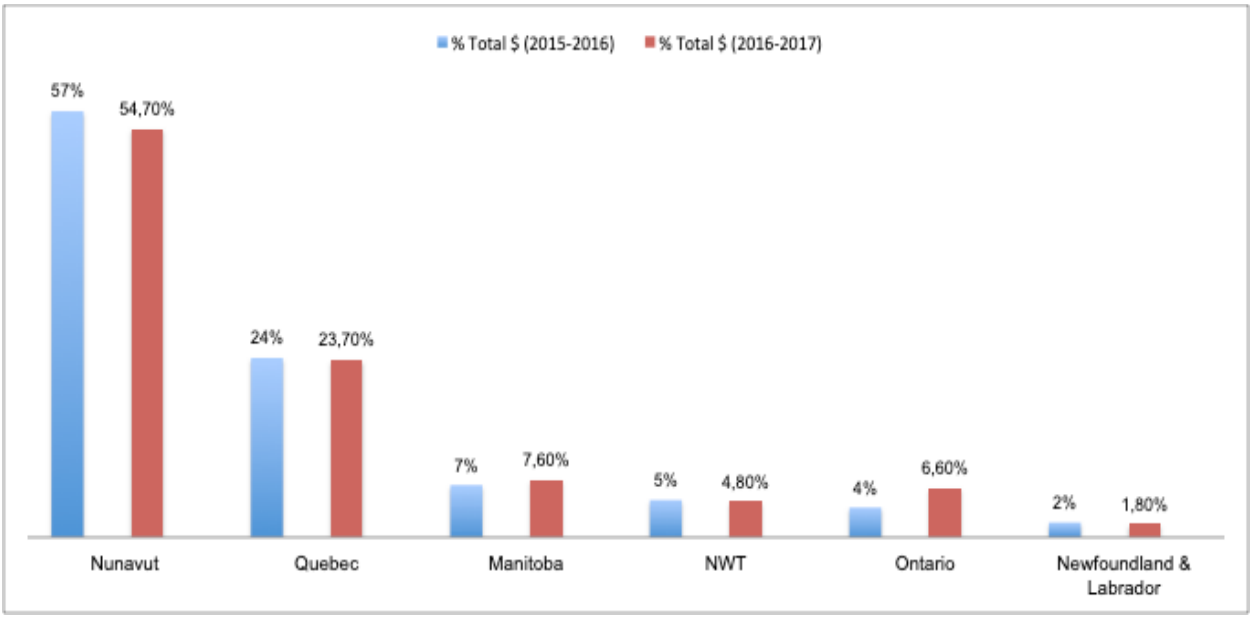
Retailers and suppliers eligible for the program have the responsibility to transfer the entire value of the subsidy to consumers (Nutrition North Canada, 2018d). Two types of food are taken into consideration for the NNC: perishable and nutritious food items such as fruit, milk, vegetables, eggs, meats and cheese and traditional food (e.g. Caribou) that are commercially processed in the North (Nutrition North Canada, 2018d).

Beneficiaries of subsidized food are individuals, local businesses (e.g. restaurants) and schools and daycares. Social institutions can buy eligible food directly from southern suppliers (Nutrition North Canada, 2018d). NNC also has education initiatives performed by Health Canada under the subprogram “Healthy Living” (Nutrition North Canada, 2018e). These education programs seek to improve knowledge regarding healthy eating habits and provide training in the selection and preparation of both store-bought and traditional foods (Nutrition North Canada, 2018e).

The results of the NNC indicate that in the period of April 2011 to March 2015, the affordability of a food basket (based on the Revised Northern Food Basket) for a family of four had a standard cost that was 5 % or CAD$94 per month lower than in March 2011 (Nutrition North Canada, 2018a).

Between 2011 and 2015, the weight of the products brought into northern communities raised 25 % approximately (Nutrition North Canada, 2018d); in the same period, about 127.8 Kg of eligible items were subsidized, with an average increase of 5.5 kilograms per year (Nutrition North Canada, 2018a). Figure 5 indicates how the subsidy has been distributed recently. It provides data regarding Nunavut and NWT, areas of study of this research.

Figure 5. Distribution of NNC subsidy (% Total $)

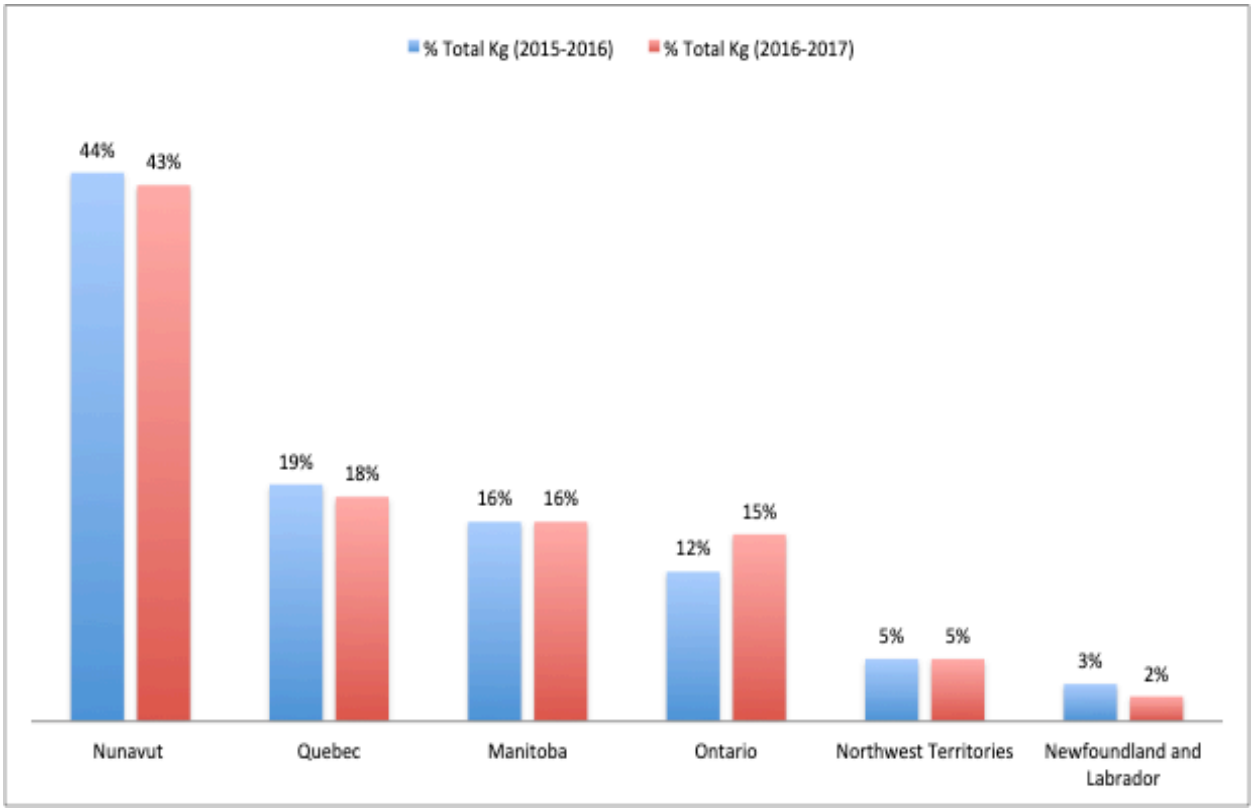


Source: (Nutrition North Canada, 2018a, 2018b)

During the period of April 1 2015 to March 31 2016, the region of Nunavut received 57 % of the annual NNC subsidy (more than half of the annual subsidy amount), followed by the Region of Northern Quebec with 24 % (Figure 4); one-hundred and thirty one (131) communities were eligible to receive the full subsidy (Nutrition North Canada, 2018a). In the period of 2016-2017, Nunavut and Quebec received 54.7 % and 23.7 % respectively, the biggest amount of NNC subsidy (Figure 4). In the fiscal year of 2016-2017, some regions in the Province of Alberta were included in the list of eligible communities (not included in the graphic).

Figure 6 also shows the distribution of the food (in Kg) delivered by NNC during the same periods. Nunavut received the highest percentage of food in both years.

Figure 6. Distribution of NNC subsidy (% Total Kg)



Source: (Nutrition North Canada, 2018a, 2018b)
Note: Numbers may not add up due to rounding

Table 8 indicates the type of food delivered for the program during the periods 2015-2016 and 2016-2017. Fruit and vegetables were mostly distributed, followed by meat, poultry and fish. At the end, country food represents a small portion of the food subsidized.

Table 8. Data by product category ($ subsidy)

Product category	2015-2016	2016-2017
	$ Subsidy	$ Subsidy
Fruit and vegetables (fresh and frozen)	21 263 049	22 505 921
Meat, poultry and fish (fresh and frozen)	11 508 265	12 041 182
Milk (fresh, UHT and canned evaporated)	11 288 915	11 591 139
Bread and bread products, cereals, crackers, flour and plain fresh and frozen pasta.	7 795 319	8 060 925
Cheese, yogurt and other dairy products	5 360 366	5 506 346
Unsweetened juice	3 278 378	3 398 589
Eggs and egg substitutes	2 745 181	3 064 144
Combination foods (fresh and frozen)	1 622 349	1 502 541
Infant formula and foods prepared specifically for infants	955 345	942 450
Cooking oils, margarine, lard, shortening, butter, mayonnaise and salad dressing	819 446	706 008
Nuts, seeds, peanut butter and other nut butters, tofu and other meat alternatives	373 959	324 756
Non-prescription drugs	42 264	16 608
Country Food	2406	868
Total	**67 055 242**	**69 661 477**

Source: (Nutrition North Canada, 2018a, 2018b)

Table 9 indicates the amount (Kg) of food delivered for the program during the periods 2015-2016 and 2016-2017. Fruit and vegetables and meat, poultry and fish have the highest quantities. Country food had the less kilograms delivered with a small variation during the two periods.

Table 9. Data by product category (Kg food subsidized)

Product category	2015-2016	2016-2017
	Kg of food	Kg of food
Fruit and vegetables (fresh and frozen)	7 444 653	7 978 967
Meat, poultry and fish (fresh and frozen)	4 367 478	4 629 191
Milk (fresh, UHT and canned evaporated)	4 307 265	4 448 810
Bread and bread products, cereals, crackers, flour and plain fresh and frozen pasta.	3 185 109	3 278 409
Cheese, yogurt and other dairy products	2 259 998	2 368 406
Unsweetened juice	1 436 170	1 501 847
Eggs and egg substitutes	1 136 187	1 253 121
Combination foods (fresh and frozen)	1 090 294	1 045 552
Infant formula and foods prepared specifically for infants	366 152	357 857
Cooking oils, margarine, lard, shortening, butter, mayonnaise and salad dressing	703 667	668 715
Nuts, seeds, peanut butter and other nut butters, tofu and other meat alternatives	129 136	111 072
Non-prescription drugs	41 397	16 730
Country Food	1268	1348
Total	**26 468 774**	**27 660 025**

Source: (Nutrition North Canada, 2018a, 2018b)

A total of 53 communities benefit from set rates for country food subsidies; 24 communities are located in Nunavut, 15 in Northwest Territories, 14 in Northern Quebec and 1 in Yukon; there are only two country food distributors registered, located in Nunavut, Cambridge Bay and Rankin Inlet (Nutrition North Canada, 2018c, 2018d).

6.2.2 Examples of market-based food prices

6.2.2.1 Yukon: Cost of market-based food

Even though compared to Nunavut and NWT, the food [in]security experienced by Yukon is moderate, the following example indicates the affordability of store-bought food for isolated communities. The research was conducted to enhance the understanding of the income levels and food security levels (Hammond, 2017). Monitoring food costs help evaluate access and availability of market-based food.

The Cost of Healthy Eating in Yukon (Hammond, 2017) is a report designed to show the approximate weekly cost of a basic, healthy diet for Yukoners using a standardized survey methodology (Hammond, 2017). The data was collected in June 2017 at grocery stores across Yukon (Hammond, 2017). This study indicated the cost of a healthy diet of Yukoners from different communities. The cost of food and how the prices changed compared to the capital Whitehorse is also shown.

Researchers used the Revised Northern Food Basket (RNFB) as a survey tool to measure the cost of healthy eating in both remote fly-in communities and northern communities connected by road. "The RNFB consists of 67 items intended to reflect the dietary preferences and food consumption patterns of those living in northern communities, based on the findings of food consumption surveys among Indigenous Peoples as well as nutrition surveys administered in isolated, northern communities" (Hammond, 2017, p. 7).

Table 10. Weekly cost of the RNFB for a reference family of four by community in Yukon

Community	Weekly cost	Difference from Whitehorse
Carcross	$426.33	+43.23
Carmacks	$326.11	+17.08
Dawson	$303.56	+9.95
Faro	$379.20	+31.93
Haines Junction	$380.80	+32.34
Mayo	$367.60	+28.90
Old Crow	$500.24	+58.18
Pelly Crossing	$346.40	+23.06
Ross River	$346.55	+23.10
Teslin	$355.75	+25.68
Watson Lake	$348.86	+23.76
Whitehorse	$274.78	—

Source: (Hammond, 2017, p. 13)

Table 10 indicates how the weekly cost of market-based food varies in different communities in Yukon. Families in Carcross and Old Crow spent the highest amount on their weekly groceries, compared to the capital Whitehorse. Old Crow is the only community that is under the benefits of the NNC program.

Table 11. Availability of food items listed in the RNFB by community in Yukon

Community	Availability
Carcross	80.6 %
Carmacks	86.6 %
Dawson	94.8 %
Faro	82.1 %
Haines Junction	82.1 %
Mayo	97.0 %
Old Crow	86.6 %
Pelly Crossing	76.1 %
Ross River	88.1 %
Teslin	91.0 %
Watson Lake	97.0%
Whitehorse	98.5%

Source: (Hammond, 2017, p. 14)

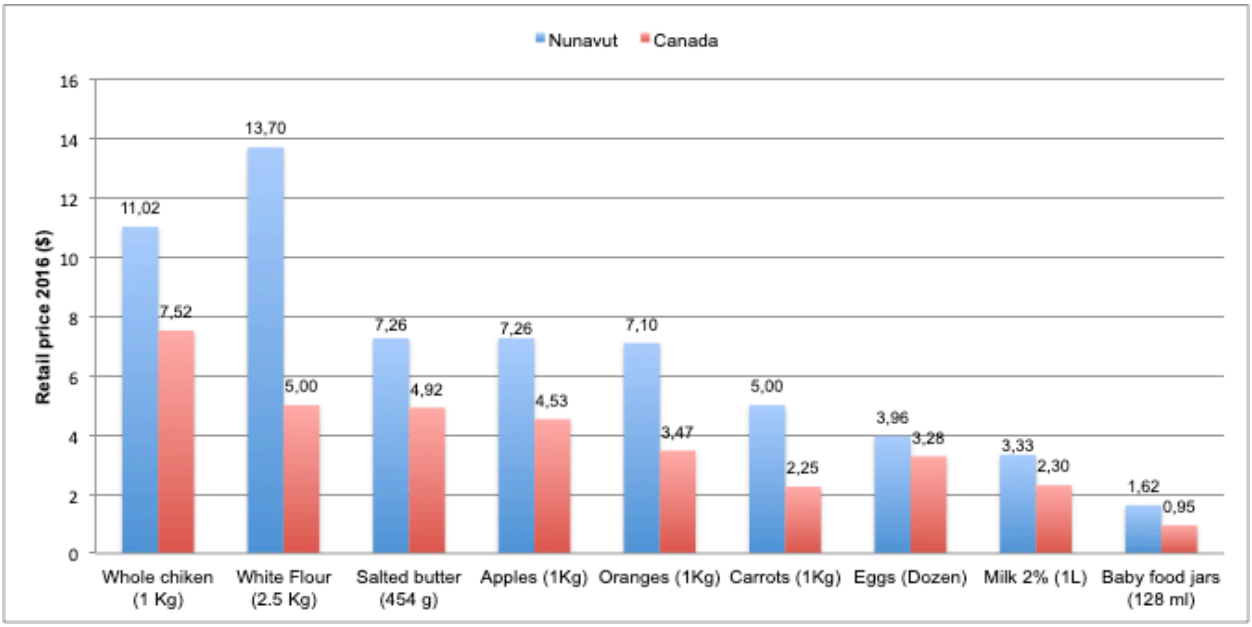
Regarding market-based food availability, the study presents the percentage of availability per community based on the Revised Northern Food Basket (RNFB). Table 11 indicates variations in communities such as Pelly Crossing compared to Whitehorse. The case study sets an example about cost and availability of market-based food in northern communities. Hammond (2017) indicates that despite this attempt, the research does not include seasonal changes and modifications in the market food system (e.g. the introduction of new retailers). The study did not account for the food that was acquired by other means such as community gardens, food sharing networks and traditional practices.

6.2.2.2 Nunavut: Food items comparison 2016-2017

The Nunavut Bureau of Statistics has conducted in 2016 and 2017 the *Nunavut Price Food Survey* in 25 communities of the territory. The data from the survey is compared with the *Consumer Price Index Food Price Basket* produced by Statistics Canada (Nunavut Bureau of Statistics, 2016, 2017). In both years the food items included in the survey indicated that all the items had a higher price ratio difference compared to the average price of Canada.

In 2016, as figure 7 indicates, some items such as white flour (2.5 Kg) and whole chicken (1 Kg) had a higher difference of price compared to the average price of the country. Likewise apples, oranges and carrots that are considered nutritious food have also a higher price difference.

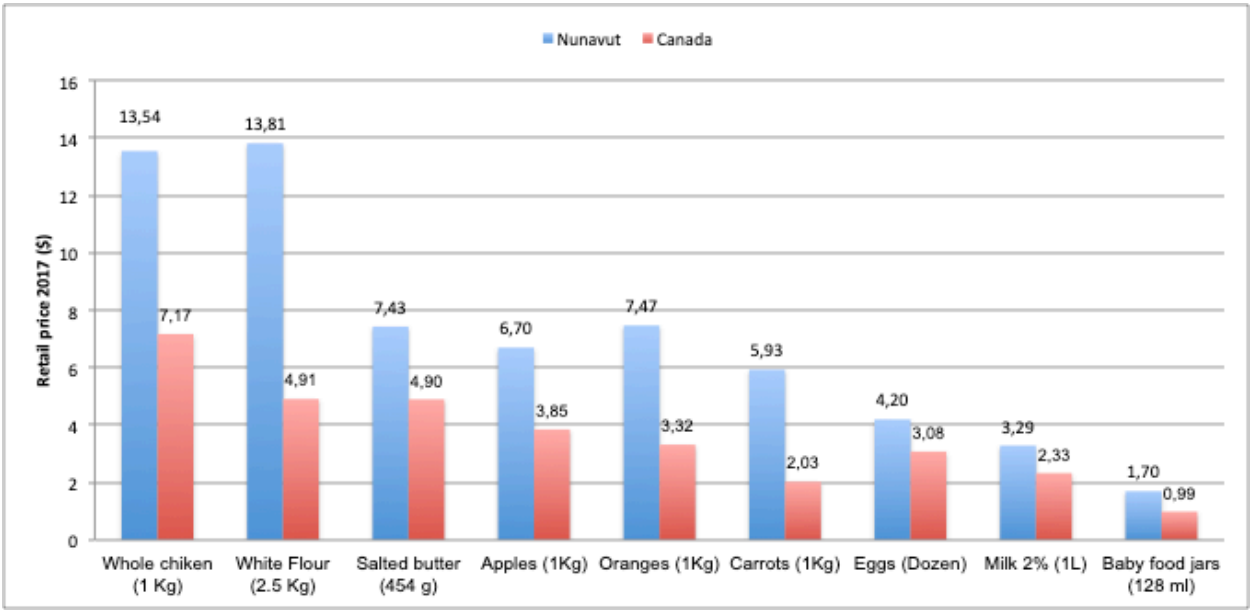
Figure 7. Food items cost comparison: Nunavut and Canada 2016



Source**:** (Nunavut Bureau of Statistics, 2016, p. 1)

In 2017, the survey indicates the same patterns in food prices (Figure 8). All the items have higher prices and there are greater differences compared to the average price of Canada.

Figure 8. Food items comparison Nunavut and Canada (2017)



Source**:** (Nunavut Bureau of Statistics, 2017, p. 1)

6.2.2.3 Inuvialuit Settlement Region (ISR) study: Retail food prices compared to the Canada average

The ISR is located in the western Canadian Arctic with a total population of 5800; six communities with populations from 132 to 3265 inhabitants are part of the region (Kenny, Fillion, MacLean, Wesche, & Chan, 2018). Inuvik, the managerial center, has road-access, whereas Aklavik, Paulatuk, Sachs Harbour, Tuktoyaktuk and Ulukhaktok, the other communities, have not road-access; the isolated communities of ISR have access to Nutrition North Canada (Kenny, Fillion, MacLean, et al., 2018).

Between 2014 and 2016 a food costing study with a participatory approach was conducted in the region (Kenny, Fillion, MacLean, et al., 2018). For the study period, ISR food prices were compared with Canadian averaged food prices; the results showed large differences for perishable and non-perishable foods; fresh produce products such as apples and celery were 52 % and 303 % higher respectively in relation to the Canadian standard (Kenny, Fillion, MacLean, et al., 2018). Other types of products also showed the same tendency compared to the national average: milk (41 %), butter (42 %), bread (51 %), pasta (179 %), potatoes (256 %) and cola (470 %). The authors stated that food prices are still high despite the support provided for NNC and also remarked that the standard annual income (except Inuvik) for 40 % of the tax-filers of five ISR communities included in the research was less than CAD $15 000 pear year and from this

annual earnings, CAD $4500 (30 %) represent the price of meeting health's Canada food guidelines (Kenny, Fillion, MacLean, et al., 2018).

6.2.3 Food Distribution

The transportation system in Northern Canada is complex and unique to each territory. Transportation is fundamental in the distribution of market-based food. Its efficacy and safety are crucial for guaranteeing the availability and access to healthy food. Geographic characteristics make access difficult in northern communities; some of them can only be reached by air or water and other isolated communities have a winter road access for about eight weeks annually (Jeffrey et al., 2015). Northern residents face obstacles related to the transportation system and these are reflected in the high cost of food, fuel and other goods (Pendakur, 2016).

Halseth (2015) states that communities closer to food distribution networks likely consume more store-bought food. Consumption of country food is variable depending of the distance of the communities from food distribution centers. In some studies included in a literature review provided by Halseth (2015), communities living in larger towns are more likely to include more store-bought food in their diets, compared to isolated communities.

Transportation in the North depends on the season. In winter, the movement of goods and people is facilitated by the frozen roads across lakes and rivers, but mobility is limited to short periods of time (Pendakur, 2016). In summer, the navigability of the water is an advantage for isolated areas. Permafrost is also related to the stability of all winter roads and airports; finally, air transportation is indispensable during the whole year, especially for medical and evacuation services (Pendakur, 2016).

Yukon and the Northwest Territories are reliant on road transportation (all weather and winter roads) for the development of mining activities and oil production (Pendakur, 2016). The province of Yukon has a land-based all-weather transportation system that maintains all the communities connected with the exception of Old Crow (Jeffrey et al., 2015; Pendakur, 2016). In contrast, only half of the Northwest Territories communities have connection with the national highway system (Jeffrey et al., 2015; Pendakur, 2016). The Peel and Mackenzie rivers have ferry services; the Northwest Territories also have a network of river transportation (Pendakur, 2016).

In Nunavut there are no roads and food delivery is only dependent on air and sea-based transportation (Jeffrey et al., 2015). Marine transportation is the main driver of the economic activities in the territory and is considered more cost-effective despite the lack of adequate infrastructure and difficult water conditions (Pendakur, 2016). In some places in Northwest Territories and Nunavut air-based transportation guarantees community re-supply all year round. Runways are paved but most of them are made with gravel with different degrees of vulnerability to ground conditions caused by climate change impacts (Pendakur, 2016).

The vulnerability of Northern transportation infrastructure used for food distribution has increased due to changes in sea ice, permafrost (permanent frozen ground) and waterways ice cover; Pendakur (2016) presented examples of how climate change is altering transportation systems:

- The thawing of permafrost is causing failures in roads railways and airport taxiways: mass-movements problems, vertical movement of the ground, drainage damages and other forms of deterioration.
- Winter roads have been affected by changes in the duration and thickness of ice; these variations have shortened their times of operations and load capacities, particularly in some roads of NWT.
- Air transportation can be affected by the intensification of fog, freezing rain, heavy precipitation, high winds and blowing snow.
- The increase of sea-ice movement, wind variations, modification in water levels and coastal erosion are influencing marine shipping. Some areas of Northern Canada will experience low sea levels, experiencing navigation problems and affecting delivering times. As an opposite trend, the areas of Tuktoyaktuk and Sachs Harbour (NWT) will experience higher sea levels.

The expansion of resource development has coincided with the development of several infrastructure projects. For instance in November 2017, the all-season Inuvik Tuktoyaktuk Highway (140 km long) was opened; it is a CAD $300 million project that took over 4 years to complete (Strong, 2017). The road is considered a monument to civil engineering, taking into account that it was built over tundra and permafrost; the scientific community is eager to investigate how a warming climate will impact construction over time (Strong, 2017). The opening of new roads might gain accessibility for the communities, but at the same time disrupts the ecosystems, altering the mobility, distribution and availability of species.

The high cost of market food, caused by significant costs in distribution and energy consumption is considered an important issue that limits both access and availability to a variety of market based quality food (Kenny, Wesche, et al., 2018; Mercier et al., 2018). In northern communities, for instance, electricity is likely to be five to ten times more expensive compared to the south, with a significant contribution in operational costs in retail contexts (Enrg Research Group, 2016).

In the North, retailers have to assume the cost of transportation of the products to their stores, whereas in the South the supplier is responsible for the transportation of the products to the retailers (Enrg Research Group, 2016). Some retail stores in northern communities indicate food loss percentages varying from 5 % to 20 %; two reasons have caused this situation: product deterioration or spoilage, and diminution in inventories due to stealing in the stores by customers or employees, or accounting errors (Enrg Research Group, 2016).

The risks of spoilage in northern communities are associated with travel distances, delays caused by weather conditions (strong winds, foggy conditions, snow storms) and intense temperatures (−50 °C during winter to 20 °C during summer) (Enrg Research Group, 2016; Ford, 2009; Mercier et al., 2018). The exposure of fruits and vegetables to extreme temperatures during transport and long travel times decrease the quality of fresh food (Kenny, Wesche, et al., 2018; Mercier et al., 2018).

6.3 Traditional or Country Food

Country food is the most important source of nutrition of for northern peoples. It represents a foundation for physical, spiritual and mental well-being. The cohesion and culture of the community depends on eating traditional foods, practicing subsistence activities and sharing networks. Among Indigenous communities traditional foods are considered to have more nutritional properties, being less expensive, free from any contaminants and having better taste (Halseth, 2015).

One of the main features of Northern Canada is sea ice, which is key in providing habitats to representative marine species in the traditions of Indigenous communities (Ford, Trevor, et al., 2016). According to Holen et al. (2017), in NWT fresh-water fish and mammals such as caribou, moose *(Alces alces)* and hare *(Lepus)* are representative; also birds such as duck *(Anas platyrhynchos),* geese *(Anserini)* and ptarmigan *(Lagopus muta)* are common sources of

traditional food; in Inuit communities seal *(Phocidae)*, narwhal, walrus, whale *(Cetacea)* and caribou are the most representative. Berries *(Cyanococcus)* are also considered traditional food. In northern populations of Canada women have had less consumption of country food than men, and adults have a higher intake of country food than children (Halseth, 2015). The consumption of wild species is much higher than plant species; caribou and moose are the most popular across communities (Halseth, 2015).

Fishing is also a significant activity for both subsistence and recreational purposes; lake trout *(Salvelinus namaycush)*, char *(Salvelinus alpinus),* inconnu (*Stenodus leucichthys)*, white fish *(Coregonus clupeaformis)*, pike *(Esox lucius)*, burbot *(Lota lota)*, and salmon *(Salmo salar)* are some examples of the species frequently consumed in Northern Canada. Land claims agreements in NWT, Yukon and Nunavut protect indigenous fishing rights with special emphasis to access to country or traditional foods (Holen et al., 2017).

The difficulties of practicing subsistence harvesting activities have contributed to declines in the intake of traditional food. For example, the Nunavut Harvesters Support Program indicated that for a weekend hunting trip it is necessary to have CAD $200, which is an amount difficult to obtain for low-income families (Holen et al., 2017).

Resource development is likely to compromise the accessibility to harvest traditional species for subsistence and in general influence negatively the livelihoods of northern communities in the Arctic (AMAP, 2018). For instance, a popular fishing spot in in Tuktoyaktuk, NT was obstructed when an oil company built its dock, constraining the access to local resources (Ford, Trevor, et al., 2016).

The access to traditional food has also been limited by social and political systems in which these foods are embedded. For instance, the Vuntut Gwitchin First Nation (Old Crow, Yukon) has faced challenges when it comes to harvesting and sharing networks of traditional food; their traditional territory is part of international and regional borders with territorial, state and federal government laws, which have usually disregarded the land's rights and needs of the community (Jeans, Tetlichi, Kassi, & Natcher, 2014).

When a Vuntut Gwitchin community member seeks to transport or share traditional foods with friends or relatives in Alaska, they must provide an export permit before crossing the Alaska-Yukon border; obtaining this permit could be complex and people are hesitant to approach the

government staff for the permit; there are modifications in this law that are expected to be made but this situation has generated uncertainty and anxiety in community members who want to share country foods and fear that their hunting equipment might be confiscated (Jeans et al., 2014). There are around 30 Northern American and Canadian Tribes and First Nations that are affected by this situation, but the level of isolation of Vuntut Gwitchin (no road or marine access) exacerbates the risk to experience food [in] security (Jeans et al., 2014).

6.3.1 Climate change and subsistence activities

Northerners have developed adaptation and resiliency in terms of the unpredictability of environmental conditions and the fluctuations of natural resources (Fast & Berkes, 1998). Climate change has contributed to nutrition changes for northern communities because it influences the access, availability and quality of traditional species (Halseth, 2015).

According to Fast et al. (1998), there were three anticipated impacts of climate change on northern subsistence economies:

- The distribution of natural resources (e.g. animals, plants) relevant for northern subsistence economies may be altered by the unpredictability of events related to climate change
- Local and traditional knowledge may be altered by climate change
- Impacts on the health of northern populations caused by nutritional constraints may be caused by climate change

Climate change in Northern Canada is influencing the access and availability of plant and animal species used for subsistence in the communities (Fast & Berkes, 1998; Hansen et al., 2018). Later ice freeze up, earlier ice break-up, changes in snowfall patterns are among the factors increasing the risks for harvesters when accessing the semi permanent ice and snow-based trails used for hunting and fishing (Halseth, 2015; Hansen et al., 2018). Some opportunities have emerged: the increase of the open water season during the summer has facilitated commercial and subsistence fishing (Hansen et al., 2018).

According to Fast & Berkes (1998), significant areas of permafrost were likely to disappear considering the warming climate trends; similarly, some movements in the tree line were expected (200 to 300 kilometres northward), compromising the amount of snow cover. The

increase of snowfall could bring wetter and cooler springs, a reduction in the annual frost-free period and delays in the flowering of vegetation (Fast & Berkes, 1998). The alteration of the permafrost (thawing) could influence severely ecosystems, wildlife, fish species and forest resources critical for subsistence harvesting (Fast & Berkes, 1998).

Warmer water temperature, circulation patterns changes and increased acidity, are consequences of climate change that are affecting fish and marine mammals reproduction and distribution (Fast & Berkes, 1998; Lemmen et al., 2016).

Fast & Berkes (1998) provided some examples related to how climate change will affect northern species: Barren-ground caribou *(Rangifer tarandus groenlandicus)* and Woodland caribou *(Rangifer tarandus caribou)* could experience habitat fragmentation, caused by fires and thicker snow conditions; longer periods of open water could reduce the movement of species such as caribou, moose, arctic fox *(Vulpes lagopus)* and wolves *(Canis lupus)*. The decline of the sea ice might impact the populations of polar bear *(Ursus maritimus),* ringed *(Pusa hispida)* and bearded seal *(Erignathus barbatus)* (Fast & Berkes, 1998; Halseth, 2015). Climate change is not the only factor that affects access and availability of species for subsistence. Other cumulative events such as natural resource exploitation and an increase in contamination levels are contributing to food [in] security levels in Northern Canada.

6.3.2 Traditional knowledge and climate change

Food systems in Northern Canada are related to traditional uses of the land, aboriginal rights and access to resources for subsistence and cultural practices (CCA, 2014; Kenny, Wesche, et al., 2018). Traditional knowledge of the land and the abilities for hunting, harvesting, traveling, and food preparation processes are part of food security and food sovereignty (CCA, 2014). Nevertheless, changes in the transmission of traditional knowledge from elders to younger generations have reduced their skills and experience in subsistence practices (CCA, 2014; Kenny et al., 2018).

Table 12 presents observations based on traditional knowledge from different northern communities and how climate change is affecting their traditional territories. The table was adapted from Ford et al. (2016); it shows how these environmental changes have affected food systems in the communities.

Table 12. Environmental changes observed by Northerners and their implications on food systems

Implications for food security systems	Environmental Change	Observations based on TK
Limitations to resource harvesting: changes in hunting routes, constraint access to hunting grounds and trails, difficulties and risks when traveling on the land/ice	Weather/Temperature	Changes in wind velocity, direction and frequency
		Snow changes: decrease in winter, increase in summer (some cases); late arrive in fall or winter
		Increased coastal erosion
		Increased rain
		Warmer or cooler summers (differences across communities)
		Warmer winter; fewer cold days; winter starting later
Implications for aging processes of traditional foods		Increased frequency of extreme weather events (e.g. storms)
Limitations to resource harvesting: changes in hunting routes, constraint access to hunting grounds and trails, difficulties and risks when traveling on the land/ice	Ice Dynamics	Earlier/slower sea-ice break-up
		Thinning of ice
		Less or no multiyear ice in the summer; more open water and rougher water in some areas; changes in floe-edge location
Damage of transportation infrastructure	Geomorphological processes	Increases in coastal erosion
		Land subsiding in some areas
		More mud on the land and drainage issues
		Changes in water levels of lakes and rivers
Changes in availability of country food for subsistence	Wildlife	Changing migration behaviour and population numbers
		Decline in animal health in some species or changes in species body composition (i.e., thinner fur, skin or hides)

Source: Adapted from Ford et al. (2016)

6.3.3 Subsistence species examples

There is availability of data of the demographic status of subsistence species generated in government reports. These sources have presented quantitative information of population trends and documented possible causes of changes. It is acknowledged that traditional food encompasses a variety of species across Northern Canada. This section presents information

about caribou, as a concrete example to indicate the dynamics of key subsistence species; data about specific herds will be mentioned. Only recent reports from NWT and Yukon were found that align with the search criteria indicated in the methodology section.

6.3.3.1 Caribou: NWT Examples

- Porcupine caribou (*Rangifer tarandus granti)*

An assessment on ecological change of Porcupine caribou herd in 1972, estimated a population of around 102 000, with a grew of approximately 5 % every year until 1989, when they reached a number of 178 000 (Porcupine Caribou Technical Committee, 2016). From 1989 to 1998 the herd began to decline by 3 to 4 % annually, and from 1998 to 2001 the decline was 1.5 % annually (Porcupine Caribou Technical Committee, 2016). In 2001 the census indicated 123 000 caribou in the Porcupine herd (Porcupine Caribou Technical Committee, 2016).

The census in 2010 showed that the Porcupine caribou herd had an estimated population of 169 000, indicating a recovery from the 12-year decline between 1989 and 2001 (Porcupine Caribou Technical Committee, 2016). In 2013, a new census showed an increment in the Porcupine Caribou herd with an estimated population of 197 228 (Porcupine Caribou Technical Committee, 2016).

- **Barren-ground caribou** (*Rangifer tarandus groenlandicus*)

Barren-ground caribou populations have been decreasing more than 70 % in Northern Canada in the last 20 years; the Bathurst herd is the only herd of Barren-ground caribou that has experienced a significant decrease in its population, with a change in the last two decades from approximately 475 000 (high) to less than 20 000 (Parlee et al., 2018). One of the explanations provided is that the Bathurst caribou range has been subjected to environmental impacts caused by resource development activities such as mining compared to others Barren-ground caribou herds (Parlee et al., 2018). Table 13 shows Bathurst caribou herd declining numbers since 2003.

Table 13. Bathurst caribou herd numbers (2003-2018)

Year	Number of animals
2003	186 000
2006	128 000
2009	32 000
2012	35 000
2015	20 000
2018	8200

Source: (Northwest Territories Environment and Natural Resources, 2018, para. 18)

6.3.3.2 Caribou: Yukon Examples

In this section two of the 26 herds of the northern mountain caribou (*Rangifer tarandus caribou*) recognized in Yukon are mentioned as punctual examples. According to oral history, there were thousands of Carcross caribou in the Southern Lakes region before the Klondike Gold Rush (Francis & Nishi, 2015). The most recent data, obtained between 1997 and 2008, indicated that Carcross caribou herd populations doubled from 400 to 800 animals; nowadays the population has approximately 775 animals and still is considered lower than older accounts (Francis & Nishi, 2015).

Francis & Nishi (2015) indicated that since 1992, the Carcross caribou has not been harvested; the Southern Lakes Caribou Recovery Program implemented seasonal closure for license Yukon hunters and First Nations decided to stop harvesting voluntarily. These authors mention that despite the harvests limitations, the herd remains vulnerable to human-caused cumulative effects such as habitat loss caused by residential, agricultural and industrial projects and the potential of severe wildfire events.

In 2012, the Klaza woodland herd had an estimated population of 1180 caribou (Francis & Nishi, 2016). An assessment conducted of the population status in the Dawson Range of west-central Yukon, pointed out that mineral activity during the years 2009-2011 did not have significant long-term impacts. However, the authors indicated that potential mineral development in the Dawson Range area could increase habitat disturbance; a 25 years scenario projected that 4 mines might be operating in the Klaza herd range; natural disturbances such as wildfire were also considered (Francis & Nishi, 2016).

6.3.4 Environmental contamination of traditional food

During recent decades, there has been increasing concern related to the contamination of country food, and the growing risks to human health; the presence of pesticides, heavy metals, and the use of lead bullets during harvesting might have accumulated dangerous contaminants in the different species used for subsistence (Gibson, Adlard, Olafsdottrir, & Sandanger, 2015; Halseth, 2015). This section provides examples of research projects that have studied the presence of contaminants in traditional food in Northern Canada.

Aboriginal people have expressed their concerns about the presence of contaminants in traditional foods (Halseth, 2015; Sonne et al., 2018). Diet behaviour and traditional lifestyles might be affected when there is a perception about the presence of levels of contaminants in traditional foods and communities may develop anxiety about the type of food they should consume (Ford, Trevor, et al., 2016). This section also mentions some aspects related to risk communication and food perception.

Arctic Indigenous people have observed biological effects related to mercury (Hg) and persistent organic pollutants (POPs); the livers of some species of freshwater fish and freshwater mammals have been found malformed: swollen, shrunken or even inflamed; therefore they can not be consumed (Letcher & Rune, 2018). Similarly, some changes have been identified in birds, like eggshell thinning, difficulties for chick survival during incubation and smaller clutches (Letcher & Rune, 2018).

The Northern Contaminant Program (NCP) has been working since 1991 to conduct research related to long-range contaminants in the Canadian Arctic; the results obtained are used to evaluate ecosystems and human health, indicate the safety of country foods and inform the federal government to improve its decision-making processes regarding policy and regulatory actions; the collaboration of communities and the incorporation of traditional knowledge are frequent in research conducted by the NCP (AMAP, 2018).

The NCP have been annually assessing the levels of contaminants in landlocked Arctic char, a representative source of traditional food for Indigenous populations in Northern Canada; since 2005 the level of mercury (Hg) has been decreasing in this species, however the highest concentrations of this element are related to warmer temperatures in summer (Sonne et al., 2018). Further research is required to evaluate the effect of the temperature in cold-adapted fish species (Sonne et al., 2018).

Contaminants such as mercury (Hg) and persistent organic pollutants (POPs) have a high level of absorption in the base of the food chain, bioaccumulating and biomagnifying in every organism; high concentrations of mercury (Hg) have been found in top predators in marine environments, whereas concentrations of persistent organic pollutants (POPs) in arctic biota have been decreasing over time (AMAP, 2018). The future release of new compounds to the environment is expected, affecting food chains in general (AMAP, 2018).

Blood mercury (Hg) levels surpassing health standards have been found in Inuit population, whose diet include the consumption of significant amounts of marine mammals (AMAP, 2018). Likewise, higher persistent organic pollutants (POPs) concentrations have been found in Nunavut and Nunavik communities (eastern Arctic) with a traditional diet based on marine mammals (Gibson et al., 2015). To reduce exposure, public health authorities have advised Inuit communities that the safest measure is to limit the amount of certain traditional foods in their diets (AMAP, 2018). For instance in Nunavut, pregnant and childbearing age women have been advised to reduce the intake of ringed seal *(Pusa hispida)* liver (AMAP, 2018).

Long-dietary transitions and short-dietary transitions are related to exposure levels to food contaminants (Wania & Curren, 2015). The synopsis of 2014-2015 research projects conducted by the NCP suggested that changes in diet might be correlated with the decrease of persistent organic pollutants (POPs) levels among northerners; for instance, persistent organic pollutants (POPs) exposure can be reduced during short-term nutritional transitions in vulnerable populations such as pregnant women (Wania & Curren, 2015).

Laird (2015) indicated that in some lakes of the Dehcho Region (NWT), high levels of mercury (Hg) have been found in certain predatory fish species: walleye *(Sander vitreus)*, pike and lake trout; as a consequence, people in this region have been advised to reduce its consumption; significant concentrations of Cadmium (Cd) have been also found in the organs (e.g., kidneys) of moose in some parts of the region. The real exposure of these contaminants in the Dehcho Region (NWT) has not been fully assessed (Laird, 2015).

To reduce exposure to contaminants in the Dehcho Region (NWT) and increase traditional food consumption, some researchers of the NCP have been attempting to find fishing lakes with mercury concentrations below 0.5 mg/g (Low, 2015). Some non-predatory fish species have been suggested as an alternative to include in a healthy diet: lake whitefish *(Coregonus clupeaformis)*, suckers *(Catostomidae)* and grayling *(Thymallus thymallus);* examples of water bodies

identified as low risk are Great Slave Lake and the Mackenzie River (Low, 2015).

According to a desktop review conducted by Montgomery (2015) in the Sahtú Region (NWT), the levels of mercury (Hg) in fish (e.g. walleye, pike, lake trout) are low and do not represent concerns for the human health. In the case of caribou, some studies indicated that the levels of mercury (Hg) and cadmium (Cd) are low with few risks for consumption; nevertheless, some consumption advisories have been issued in this region (Montgomery, 2015).

There are some ongoing studies in Inuit communities to understand what factors are influencing food choices. In Arviat (Nunavut) for example, beluga whales *(Delphinapterus leucas)* are an important source of traditional food and researchers want to explore perceptions and misperceptions related to safety in its consumption (Tagalik, Furgal, & Boyd, 2015). Beluga whales can be a source of contaminants and at the same time provide nutritional benefits because of the presence of selenium (Se) and protein (Tagalik et al., 2015).

Mercury (Hg) levels in fish species used for subsistence purposes were also evaluated by the Northern Contaminants Program in the area of Old Crow (Yukon); researchers sought to determine whether fish was a healthy choice (Josie, 2016). The findings indicated that species such as chinook *(Oncorhynchus tshawytscha)*, chum *(Oncorhynchus keta)*, coho *(Oncorhynchus kisutch)*, whitefish and pike had low mercury (Hg) levels and did not represent any concern for consumers; on the other hand, species such as inconnu *(Stenodus leucichthys)* had high mercury (Hg) levels (Josie, 2016).

In the Kluane Lake Area (Yukon), the community of Burwash Landing can access market-food in a grocery store located 300 km away; Kluane Lake is an important source for subsistence fishing in the area (Alatini, 2016). A small-scale study was conducted to assess mercury (Hg) levels in two fish species: lake trout and lake whitefish. The findings revealed that "Lake Trout had higher mean mercury concentrations than Lake Whitefish (0.086 +- 0.091 ppm and 0.022 +- 0.008 ppm, respectively), however, only Lake Trout greater than 800 cm fork length exceeded the Subsistence Consumption Guideline for mercury (0.2 ppm)" (Alatini, 2016, p. 46). Further research is ongoing for this project with the NCP.

Inuit and First Nations have differences in the type of traditional food consumed; this factor might affect the intake of traditional food exposed to contaminants in both; the Inuit diet is based principally on marine mammals, birds, fish and terrestrial animals (Hansen et al., 2018).

Ringed seal, caribou, Arctic char and belugas are the most common species of the traditional diet in Nunavut, which comprise approximately 300 species (Hansen et al., 2018). It's likely that the consumption of traditional food exposed to contaminants is higher in the Inuit rather than other First Nations or Métis populations (Halseth, 2015).

According to Halseth (2015), the literature suggests that First Nations and people in NWT are not frequently consuming traditional foods with high levels of contaminants and they might not stop consuming them only for fear of chemical contamination. The same author suggests gaps in the research on the health consequences due to the presence of contaminants in traditional food systems and how to communicate effectively the risks for humans.

Risk communication requires more attention from researchers and governments in order to provide valid information about the quality of food, which is part of the many food security concerns faced by Inuit communities (Tagalik et al., 2015). Krümel et. al (2015) indicated that there are still gaps in how to develop and assess risk communication in Arctic communities; in the scientific literature, recommendations and discussions about the topic are very common, but there is a lack of empirical evidence in Arctic regions. Montgomery (2015) also mentioned some deficiencies in validating these advisories, pointing out the importance to improve risks communication processes and therefore food choices within the community.

The report *AMAP Assessment 2018: Biological Effects of Contaminants on Arctic Wildlife and Fish* mentioned the influence of development activities such as exploration, extraction, tourism and transportation in the contamination of fresh and seawater, and therefore the transmission of contaminants to the food chain. Letcher et al. (2018) indicated some research needs expressed by indigenous communities regarding the effects of mercury (Hg) and persistent organic pollutants (POPs): 1) Pollution generated by the discharges from ships, which might be sources of these contaminants and 2) The effects of the extraction industry in the health on animals and environment in general.

6.4 Locally produced food

Locally produced food in northern communities remains an interesting issue to further explore, and is an opportunity to contribute to food needs, considering the high cost of market-based items; however it is frequently questioned and does not have a significant background (Kenny, Wesche, et al., 2018; Simba & Spring, 2017). Greenhouses could reduce the cost of vegetables in

half and it could be an important relief for communities that experience high rates of food [in] security (Sparks, 2017). There are several initiatives across Northern Canada to improve food security and food sovereignty through locally produced food that will be mentioned below.

There are unique features that might restrict local food production (e.g. extreme weather, permafrost) in Northern Canada; for example in Nunavut despite of 24 hours of sun in the summer season, the lack of topsoil and extreme temperatures (below freezing) constraint the development of community gardens and greenhouses (McGwin, 2017). Yukon has also identified that the growing season is short and at its end there is a lot of fresh produce available, but during the rest of the year there is a lack of local products (Government of Yukon, 2016).

Another interesting question concerning locally produced food in northern communities is related to its sustainability in economic terms. A research with the question "*Can healthy food be produced in remote northern communities in an economically sustainable way using a greenhouse?*" (Allen, 2014, p. 58) was conducted. The study included two approaches: the first one inquired about the financial benefits of the greenhouses and the second one explored other non-quantified opportunities that extend beyond economic sustainability (Allen, 2014).

For the financial feasibility of a community greenhouse in Northern Canada, Allen (2014) used as a model the typical size of a small northern community in Saskatchewan: 1000 people with a CAD $200 000, 600 square meter greenhouse; it would be able to produce an 8 to 10 month harvest season with reduced heat and light. It was expected that the model used in the research might generate minimal earnings as a result of the production and sale of locally greenhouse produce vegetables; however, the financial assessment suggested that it would be difficult to operate a greenhouse at a commercially sustainable level in a community of 1000 people (Allen, 2014).

The amount of consumers in a northern settlement is not sufficient to generate economic profit, which would not be enough to cover the operational and labour costs; in 2013 Agriculture and Agri-food Canada estimated that operating a small greenhouse would cost CAD $43 994 per year, without including labour costs and management returns (Allen, 2014). Another factor that constrains the economic profitability of a community greenhouse is the low level of vegetable consumption in a typical northern community; for instance, in a small community in Northern Saskatchewan more than 66.6 % of the respondents of a survey indicated that they include

vegetables in their diets; this percentage is below the level of intake of the average Canadians (Allen, 2014).

There are other non-quantified benefits of community greenhouses that go beyond income that usually are underestimated when it comes to evaluating alternatives to improve food [in]security; some of these include the contribution to community healthy lifestyles, the improvement of mental health levels and learning opportunities (Allen, 2014).

Some literature suggests that global warming may foster an increase in local yields and expand growing seasons in high latitude countries such as Canada, Russia and Northern Europe; however, the yields may be low because of lack of soil fertility and water scarcity in some regions (Porter & Xie, 2014). Nonetheless, the development of local agriculture in the North will require significant financial investment, the development of new skills in community members and training (Kenny et al., 2018).

The Government of Canada has made financial contributions to different local food initiatives in Northern Canada thorough the programs Growing Forward (GF) and Growing Forward II (GF2). From 2013 to 2018, GF2 provided $3 billion dollar cost-shared funding by federal, provincial and territorial government in national, regional and local agriculture (Government of Northwest Territories & Government of Canada, 2017). The Small Scale Food Program is part of GF and it focuses on community initiatives to locally produced foods to further the skills necessaries to produce food in peripheral regions (Government of Northwest Territories & Government of Canada, 2017).

In an inventory of community gardens and greenhouses across Northern Canada, Chen & Natcher (2019) identified a total of 53 initiatives (36 community gardens and 17 greenhouses): 36 are in Northwest Territories, 10 in Yukon, 2 in Labrador and 2 in Nunavik; sixty-four percent of these initiatives were located in communities with less than 1000 people. In terms of size, the Gameti Community Garden in NWT (21 600 ft^2), the Tr'ondek Hwech'in Teaching and Working Farm in Dawson City, Yukon (35 ha.), and the Inuvik Community Greenhouse in the Northwest Territories (4,000 ft^2) were the largest (Chen & Natcher, 2019).

According to this research, community gardens and greenhouses are looking for additional forms of local and vegetable production; for example, some communities in NWT and Nunavik have included poultry operations for producing organic fertilizers and meat for consumption; the

contributions of these initiatives go beyond local food production: education opportunities about food preparation, food storage, healthy nutrition, among other topics are among the benefits (Chen & Natcher, 2019).

6.4.1 Initiatives of locally produced food at the regional and community levels

The following initiatives in each region indicate the growing interest in developing systems of locally produced food in northern communities. The contributions for the development of these community projects usually are provided by government subsidies and/or volunteer work and usually do not have long-term continuity (Allen, 2014).

6.4.1.1 NWT

NWT has had initiatives in developing locally harvested vegetables in arctic conditions for some years now; the University of Toronto conducted horticultural tests in three locations in NWT: Keewatin Gardens in Rankin Inlet (summer 1972 to 1982), Pond Inlet Gardens on Baffin Island (1985-1986) and Green Igloos Farm in Alexandra Fiord, Ellesmere Island (1982-1984) (Svoboda, Bergsma, McCurdy, Romer, & Cummins W.R., 2014). One of the objectives for the experiments was to explore the possibility of practicing low-cost and locally scale gardening in artic communities; the experiments conducted demonstrated some opportunities for small gardening in Arctic communities (Svoboda et al., 2014).

In the Beaufort Delta Area (NWT) the Small Scale Food Program has provided support to the small communities of Inuvik, Fort McPherson, Tuktoyaktuk, Aklavik, Tsiigehtchic, Paulatuk, Ulukhaktok and Sachs Harbour by encouraging gardening initiatives and promoting healthy nutrition habits (Solotki, 2016).

In the summer of 2016, the Inuvik community greenhouse, the largest and oldest in the Beaufort Delta Area, started the Community Supported Agriculture (CSA) Veggie Box program, whose purpose was to provide to members of the community a box of mixed vegetables (6-8 items) at a cost between CAD $25 and CAD $35 weekly; in 2017, 8 people had already signed up in advance for the boxes and the goal was to increase from 10-12 to 20 people weekly (Solotki, 2016). The Inuvik community greenhouse has set an example for others regions in the circumpolar area such as Nunavut, Iceland and Russia (Government of Northwest Territories & Government of Canada, 2014).

In 2016 the communities of Aklavik and Fort McPherson built their community greenhouses with the support of the Small Scale Food Program; each community established their own garden societies: the Peel River Garden Society in Aklavik and the Gwich'in Green Thumb Gardeners in Fort McPherson (Solotki, 2016). Paulatuk and Sachs Harbour also received support in 2016 from the program in different aspects related to the operation of a community greenhouse (Solotki, 2016).

In the Dehcho Region (NWT), the communities of Fort Liard, Fort Simpson, Jean Marie River, Nahanni Butte, Sambaa K'e and Wrigley, the Growing Forward Program 2 has provided support and encouragement to different community gardens and community garden societies (Government of Northwest Territories & Government of Canada, 2016).

The Northern Farm Training Institute (NFTI) in Hay River, NWT, is a non-profit society established in 2013 by local Métis and northern farming expert Jackie Milne (NFTI, 2019). It has received financial support from the Federal Government thorough the programs Growing Forward and Growing Forward II (Chen & Natcher, 2019). The NTFI teaches and promotes methodologies for practicing sustainable agriculture in a 260-acre farm campus (NFTI, 2019). These techniques are adapted to northern systems and include gardening, greenhouses, permaculture and food storage, among others (NFTI, 2019).

Another initiative in NWT is from Ka'a'gee Tu First Nation (KTFN), a small community with the nearest store located 100 km away. In 2015, with the whole community involved and assistance from outside partners, KTFN decided to begin with gardening initiatives; in two garden boxes some fast-growing vegetables were grown, producing a small quantity of food (Simba & Spring, 2017). In 2016, the gardening project had a boost with four more garden boxes installed and the growing of potatoes in the land (Simba & Spring, 2017).

The Yellowknife Farmers Market is another initiative in NWT to purchase locally produced food (baked, cooked, processed and harvested) from June to September; is a non-profit society, which began in 2013 and has had an important impact on the city's economy with revenues close to $1 million annually (Yellowknife Farmers Market, 2018). The market promotes both gardening programs and community programs that encourage community participation. The Yellowknife Food Charter Coalition, also supports the development of a local food strategy with the aim of addressing social and political action regarding food security (Artic Institute of Community-Based Research, 2018; Yellowknife Farmers Market, 2018).

6.4.1.2 Yukon

The Local Food Strategy launched by the Yukon Government in 2016 emphasized the importance of local food production and consumption; there is an increasing demand for local products that reduce packaging and distance to transport, and Yukon residents and visitors have been modifying their attitudes towards locally grown foods (Government of Yukon, 2017). The strategy promotes the development of the commercial agriculture sector, but additionally supports small-scale backyard food production such as non-commercial gardens, greenhouses and community/urban gardens (Government of Yukon, 2016).

Several of the 14 Yukon's First Nations communities have created a community garden or have been working in developing one (Government of Yukon, 2017). Harvesting levels varies year to year and there is still no data indicating how each community has improved self-reliance and food security levels (Government of Yukon, 2017).

Little Salmon Carmacks First Nation has been a pioneer in Yukon with their community greenhouse and garden established in 2000 (Government of Yukon, 2017). The Tr'ondek Hwech'in Teaching and Working Farm was established in 2014 with a partnership between the Tr'ondek Hwech'in First Nation and Yukon College (Chen & Natcher, 2019; Government of Yukon, 2017). It is located 15 Km from Dawson City and provides food for community members; the excess is sold in Dawson city (Chen & Natcher, 2019).

Some initiatives related to locally produced food came from individuals interested in the topic. For instance, Suzanne Crocker a filmmaker and retired family doctor began a project called "*First We Eat. Food Security North of 60"* in which she and her family spent a year only feeding from local food from Dawson City, Yukon (Canada Media Fund et al., 2017). This initiative aims at contributing to the public conversation around food security, exploring the food options available and becoming a guide to northern food solutions; it included the expertise of local producers and traditional knowledge (Canada Media Fund et al., 2017). The experience will be registered in a documentary that will be completed in 2019.

The full year started mid summer 2017 and the family (5 people) only ate local products (grown, raised, harvested, hunted, trapped and fished) in and near Dawson. Crocker expressed that she wants to extrapolate her own experience to her whole community (500 people), monitoring

quantity, price and health in order to determine whether the project is both feasible and sustainable at the community scale (Artic Institute of Community-Based Research, 2018).

6.4.1.3 Nunavut

The Nunavut Food Security Coalition provides guidelines to improve food security in the territory; one of its objectives is to explore and promote the potential for local food production (Nunavut Food Security Coalition, 2014). This approach indicates an interest in the region for pursuing food sovereignty.

In Nunavut, a non-profit initiative, The Iqaluit Community Greenhouse Society was established in 2001 to build and operate a community greenhouse; it requires approximately CAD $4000 a year to operate and has some research projects for the future related to invasive species, outdoor composting and growing (Iqaluit Community Greenhouse Society, 2017). McGwin (2017) states that in spite of the fact that this society started in 2001, the 100 square-meter greenhouse was only built in 2007, indicating that this type of initiaves requiere time and patience.

In 2016, Growing North, a non-profit organization, provided the funding to build a greenhouse (a geodesic dome rising four meters above the ground) in Naujaat (Nunavut); the greenhouse had a cost of CAD $160 000 for purchasing and shipping and its operation costs CAD $17 000 annually (McGwin, 2017; Sparks, 2017). The daily produce of the greenhouse was enough to feed half of the community (1000 persons) with vegetables and the harvesting included potatoes, kale, lettuce, spinach, chard, tomatoes, beets, peas, beans, radish, herbs, cauliflower and broccoli; all this produce can be found in vegetable gardens in southern Canada (Sparks, 2017). The produce of this greenhouse was sold at a farmers market (McGwin, 2017).

One of the main challenges in Naujaat (Nunavut) has been related to the lack of experience with gardening and growing vegetables; it was very difficult at the beginning. Similarly, because of the difficult climate conditions of the North, the greenhouse only grow produce six months of the year; the community and Growing North are working on to design alternatives to expand the food production during the year and also reduce the costs to CAD $95 000 for the new version (Sparks, 2017). In the summer of 2017, Growing North was setting up a second greenhouse (two domes) in Arviat (Nunavut); the greenhouse could provide daily locally produced food for half of the community (total around 2600 people) (McGwin, 2017; Sparks, 2017).

In Qikiqtarjuaq, another small community in Nunavut, the local teacher Adam Malcolm raised CAD $19 425 for a greenhouse and equipment. The initial goal for the campaign was CAD $4500 (CTV News, 2017; McGwin, 2017) . At this moment the greenhouse is only a school project, but it is expected to expand as a source of community supply (McGwin, 2017).

7 DISCUSSION

The objective of this thesis was to identify information and examples of food [in]security drivers influencing the territories of Yukon, NWT and Nunavut using a specific sample of grey literature sources. With this idea in mind, the findings of this study provide insight about sustainability of food systems in Northern Canada. Based on this review, [in]security appears to be increasing, especially in isolated communities in the area of study, where the access and availability to both traditional and nutritional market-based food is very limited. Some information showed that locally produced food might be an alternative to alleviate food insecurity levels; however, it requires a large body of research and consistent work in a long-term basis.

Environmental and non-environmental stressors simultaneously affect food systems and it might be difficult to determine which one has more influence. Ford (2009) stated that the interaction between climate-related conditions and socio-economic variables has exacerbated food insecurity conditions and, most importantly, these interactions have occurred in the context of historical changes in the livelihoods of northern communities.

7.1 Market-Based Food

7.1.1 Access and Availability

In Canada, the efforts of retailer subsidies have centered on compensating the high transportation costs (Kenny, Fillion, MacLean, et al., 2018). Programs such a Nutrition North Canada (NNC) provide access to store-bought food to isolated communities. Nunavut and Quebec are the territories that have received the biggest support of this program during the periods 2015-2016 and 2016-2017. In an assessment of the NNC program, Galloway (2017) identified inconsistencies in food prices between regions and communities; these inequities do not align with the objective of the program, which is to alleviate the logistics and transportation costs of perishable food to remote northern communities. As a conclusion, Galloway (2017) stated that the NNC retail subsidy does not assure the access to nutritious food with equitability across regions and communities.

Despite the attempts to reduce high food prices, they are still above the Canadian median according to different examples in the regions of Yukon, Nunavut and the ISR (Inuvialuit Settlement Region) in the Northwest Territories. In Yukon, for instance, an study comparing the

costs of weekly groceries in different communities and the capital Whitehorse, showed how access can be limited by high prices (Hammond, 2017). The families of Carcross and Old Crow spend the highest amount of money in their weekly groceries (CAD $426.33 and CAD $500.24 respectively), compared to the capital Whitehorse, where families spend CAD $274.78 weekly. Old Crow is the only community in Yukon that is under the benefits of the NNC program.

There are specific differences in each territory that reflect the degree of difficulty when delivering store-bought food to northern communities. Yukon and NWT have systems of road transportation, but in NWT only half of the communities are connected with the national highway system (Jeffrey et al., 2015; Pendakur, 2016). Nunavut is the most isolated region, and there is high reliance on air and sea-based transportation (Jeffrey et al., 2015). This region has received a significant support from the NNC program but the food prices are still high, according to some examples presented in this study. Food insecurity levels are significant in Nunavut compared to other northern territories; in 2012, 2013 and 2014 the household food insecurity levels in Nunavut were 45.2 %, 45.0 % and 46.8 % respectively (Tarasuk et al., 2016).

New resource development projects will require the building of new roads across Northern Canada and could create more opportunities for the distribution of market-based food. For instance, the new all season road Inuvik Tuktoyaktuk Highway (140 km long) will have a permanent impact on Tuktoyaktuk, Nunavut population, which will gain accessibility (Strong, 2017). Although these new resource development projects might generate new infrastructure in northern communities, but there is the downside that such projects may also compromise the integrity of ecosystems and the availability and access to subsistence species, which will be discussed below in the traditional food section.

Logistics difficulties in the transportation and distribution networks affect the arrival of food in time and therefore the quality of some perishable food items like fruits and vegetables. Travel distances, and delays caused by extreme temperatures decrease the quality of fresh food, influencing food choices among people. The NNC has received critiques regarding its real contributions in providing nutritious and healthy foods (Kenny, Fillion, MacLean, et al., 2018). Likewise, the promotion of nutritional and healthy diets, which is part of the program too, remains ambiguous; the intake of low nutrient density food in northern Aboriginal people have increased over time (CCA, 2014).

Despite this situation, market-based foods are less exposed to environmental changes in local conditions, and for that reason could provide more space to depend less on country foods (Ford, 2009). Although market-based food may be less vulnerable to environmental changes, there are still issues with its accessibility; the income received must guarantee the capacity to buy enough food for all household members. And most importantly, market-based food must provide the quality and nutritional benefits to guarantee consumer's health.

7.2 Traditional or Country Food

For Aboriginal people, traditional foods are not replaceable and have nutritional, cultural and spiritual meaning (Loring, 2017). Some mental-health issues reported among Inuit hunters are associated with climate-related changes (e.g. change in ice conditions); not only their ability to provide food for their households has been diminished, but also a weakness of their cultural identity and traditions (Ford, Trevor, et al., 2016). There are several factors that, isolated or together, are interfering with the access, availability and quality of traditional food.

7.2.1 Access and Availability

Climate change, resource development and socio-economic factors are interacting continuously and influencing northern food systems. Despite the fact that climate change is affecting access and availability to country food, there is another relevant factor that might disturb it even more: the economic interest in Northern Canada, considering its potential for resource development industries. Upcoming projects will make the region highly vulnerable to drastic changes in regional ecosystems and therefore threats to subsistence harvesting activities and other aspects of community wellbeing, which are linked directly to the land. A large body of literature indicates that arctic and subarctic regions are likely to experience climate change faster than other regions in the world. Biophysical modifications related to climate change are affecting the access to wildlife for subsistence activities; for instance, changing ice conditions and the difficulty to use traditional knowledge for going to the land, reflect how climate change is impacting country food access(Holen et al., 2017).

Nevertheless, Northern Indigenous peoples have had the ability to adapt and develop skills and practices to survive the challenging and changing conditions in their traditional territories. For centuries, northerners have been adapting to diverse short or long term climate variations; changing is part of their regular lifestyle and flexibility is embedded in their behaviour (Fast & Berkes, 1998; Loring, 2017). Communities are responding to climate change by adopting

strategies to maintain access to harvesting areas with variability in their success; new hunting/fishing equipment, changes in harvesting areas, new transportation routes, variations in the timing for harvesting some species and improve food sharing networks are among them (Hansen et al., 2018).

Northern communities are aware that fluctuations in species populations occur as a natural process in ecosystems and have managed to adapt to these fluctuations by utilizing a wide diversity of traditional food sources. For instance, when caribou harvest was not enough to feed community members, moose and fish have been used as replacements (Northwest Territories Environment and Natural Resources, 2011). This shows how flexible their capacity of adaptation to different circumstances can be.

Caribou has been largely studied across Northern Canada and some reports, included as example in this study, have evidenced an alarming decline of some caribou herds such as Barrenground caribou. Climate change and unsustainable harvesting levels have been brought to attention when it comes to changes in species patterns and declining populations. Parlee et al. (2018) used 13 years of harvest data from NWT and Yukon and qualitative data, concluding that subsistence harvest is not a threat to the barren-ground caribou population; stressors caused by resource development activities are by far the strongest. For example, over the last two decades key areas of the caribou habitat (Bathurst caribou herd) have been disrupted by mining exploration, causing loss and degradation of ecosystems and therefore affecting population numbers (Parlee et al., 2018). Mineral and oil developments constrain traditional subsistence activities, raising uncertainties related to where, when and how people can hunt or harvest (Philip Loring, 2017).

Economic aspects related to income and employment activities also interfere with traditional food access. The high cost of subsistence activities (e.g. equipment) is considered one of the main constraints for access to country food (Holen et al., 2017). Harvesting and hunting activities must be combined with wage-related activities, creating conflicts with the availability of time; childcare and school attendance also conflict with time availability (Holen et al., 2017).

Despite the fact that the effects of climate change and socio-economic conditions (e.g. elevated prices of food and fuel) have received a significant amount of attention about food [in]security in Northern Canada, there are some political issues that may influence even more the access to and availability of traditional food; top-down government policies related to land use and resource management are setting aside the culture and realities of indigenous communities (Loring &

Gerlach, 2015). This situation will continue unless colonial practices and inequalities in the distribution of power are addressed (Loring, 2017; Loring & Gerlach, 2015).

For instance, the Total Allowable Catch (TAC) is considered by local communities a limitation imposed by central governments and international organizations and the scientific criteria used as a baseline for establish TAC is frequently contested (AMAP, 2018). Indigenous communities have raised concerns regarding quota allocations, expressing that the population estimates upon which these measures are based do not align with traditional knowledge on wildlife stocks (Ford, Trevor, et al., 2016).

NNC subsidizes country food produced and shipped from federally-authorized processing facilities, however, statistics indicate that less than 0.1 % of the expenses are for this type of food, suggesting that there are some weaknesses of the program in promoting availability and access to traditional food (Galloway, 2017). The government has not responded to requirements to modify regulatory laws regarding transportation of harvested foods at the regional level (provinces and territories) and to requests to provide subsidies in the acquisition and repairs of hunting equipment (Galloway, 2017). Further assessments are needed in order to gain knowledge about how the country food distribution network can improve within the program.

7.2.2 Quality

The presence of contaminants in local sources of food affects their quality and nutritional benefits. Indigenous communities have expressed their concerns and have observed changes in traditional food. The Northern Contaminants Program has conducted assessments to determine the level of contaminants across Northern Canada, with different findings regarding contaminant levels.

When there is uncertainty about the presence of some contaminants, the authorities have advised to reduce the intake of some traditional species; although this is a measure to prevent health issues, it generates a shift in the perception of traditional food as a nutritional alternative and disrupts traditions and cultural practices. Not having enough information about the quality of traditional food might lead to other alternatives in the market-based food, which may not be affordable and may have low nutritional benefits. Risk communication is an issue that is been explored by researchers and governments.

7.3 Locally Produced Foods

Loring et al. (2015) suggest that discussions and initiatives around food [in]security should reinforce self-governance. Thus, it is important to consider food sovereignty or the capacity of people to manage their own food supply in northern environments instead of relying only on programs that usually do not reflect adequately their unique context. Locally produced food is an alternative that can be further explored.

There are several initiatives of locally produced food across Northern Canada, as some examples provided in this study indicated. According to an inventory of community gardens and greenhouses from the 53 initiatives identified, 36 are located in NWT, 10 in Yukon, 2 in Labrador and 2 in Nunavik (Chen & Natcher, 2019). There is an increased awareness in northern communities that locally produced food is an alternative to address some issues with market-based food, which has high prices, could be unhealthy and has logistics problems related to transportation.

Some northern communities have started with community gardens and greenhouse projects with the idea to become self-sufficient and build sustainable food systems (Chen & Natcher, 2019). The Government of Canada with the program Growing Forward has supported alternatives to locally produced foods; similarly, territorial policies such as the Local Food Strategy in Yukon and The Nunavut Food Security Coalition identify local food production as an important opportunity.

The research project conducted by Chen et. al (2019) highlights that participants in community garden projects are likely to double the consumption of vegetables and decrease the intake of store-bought foods. However, there is further work required when it comes to establishing the real impact of locally produced food initiatives on food security levels (Chen & Natcher, 2019).

More research is needed to consolidate locally produced food within a long-term framework. Greenhouses and community gardens have the risk of becoming short-term projects if the necessary support is not provided. Education and training need to be ongoing processes in order to deliver all required knowledge. It is crucial to understand how northern communities perceive local food production and whether it is considered a priority. Locally produced food might be a complement to country food, which is a subsistence activity part of the culture of communities.

8 CONCLUSIONS

Food [in]security is a widely discussed topic across disciplines and among stakeholders; this research has documented some key specific findings emerging from this body of work. The main purpose of this research was to capture concrete information and examples of food [in]security drivers in the territories of Yukon, Northwest Territories and Nunavut, using a sample of grey literature (government and non-government) and supplementary scientific literature sources. The focus of the study was to explore how these sources were addressing access, availability and quality aspects in northern food systems. This section focuses on highlighting and summarizing the key results from the literature used; the limitations from this study are also mentioned.

A total of 58 sources were included; grey literature documents (48) were the main focus, and some scientific literature sources (10) were used as supplementary material. Eighteen (18) documents had aspects of traditional food as a main topic, 19 addressed locally produced food issues, 13 contained information about food [in] security in general (this documents included information of two or all types of food or combined food [in] security dimensions) and finally, eight (8) documents addressed market-based food themes. It is acknowledged that the amount of sources included is not sufficient to obtain a general picture of food [in] security in the area of study; instead it captured information and examples of some drivers influencing northern food systems.

The first section of this thesis provided a general description of the populations of Northern Canada, indicating socio-economic variables in the area of study; this information is key in understanding vulnerability to food insecurity. Demographic data, income levels and information related to the mixed economy in Northern Canada provided context and indicated how these variables are interacting permanently with northern food systems.

The second part of the study presented information and examples related to market-based food, traditional food and locally produced food. In relation to market-based food, three aspects were mentioned in the findings: Nutrition North Canada (NNC), examples of food prices across the three regions of study and food distribution issues. NNC is a subsidy program aiming to improve access and availability to store-bought food in isolated communities; despite the efforts to reduce food prices, some examples found in the literature indicated that in northern communities buying food is expensive. Finally, distribution networks, key in food distribution, vary in each region; Nunavut is the most isolated region, relying principally on air transportation. Climate

change is altering transportation infrastructure, affecting both access and availability of store-bought food.

Nutrition North Canada (NNC) is an example of a top-down initiative that has not been sufficient to accommodate the high price of market-based food in northern communities. Several critiques have pointed out the drawbacks of the model. The program is expected to facilitate and promote the consumption of traditional food. Complex issues, as northern food systems, and high food insecurity levels require reinforcing bottom-up initiatives and maximizing local involvement.

With respect to country food, the findings reflected different issues concerning this type of food; examples of the economic implications of hunting and political issues affecting the access to traditional territories indicated the complexity of food [in]security in Northern Canada. In the literature review it was noted that access and availability to subsistence species is being influenced by climate change; according to some examples, the availability of country food is also affected by resource development. Studies about contamination of traditional food showed mixed results; some traditional species have been found with high levels of contaminants, whereas others did not represent any concern for consumption; this has created confusion among traditional food intake in northern communities. Risk communication is a topic that needs to be addressed in further research.

Locally produced food has not been fully explored yet. Grey literature from both government and non-government sources, presented relevant information that revealed the growing interest to initiate a path towards food sovereignty. The government has provided financial and technical support, but it is not clear the continuity of these initiatives. Although the interest in this topic is increasing, further work is needed to explore how important is locally produced food and what is its relevance for remote northern communities.

There were limitations while conducting this research project. The area of study included only the regions of Yukon, Nunavut and Northwest Territories; it includes only concrete information and examples regarding the topic of study in these specific areas. The findings do not necessarily reflect the specific reality at a local and regional level. Nonetheless, the findings could be used as a reference for other communities in Northern Canada, given some similarities related to food [in]security issues.

Another challenge of this research was related to type of data. The use of secondary data from different sources made it difficult to carry out comparisons because it came from different methods of collection and responded to a variety of purposes. To bring together all the relevant sources, I used the contextual framework established in the literature review section. Likewise, I structured a secondary data collection process indicating the type of literature included, document selection and inclusion and exclusion criteria.

Although this study contained information regarding the current situation, there is a need to develop a broader and deeper understanding of food systems and food [in]security focusing on the reality of all northern communities, with their own specificities. This aspect was highlighted by Halselth (2015) who mentions that research has to take into consideration the diversity of Aboriginal sub-populations (e.g. urban and rural populations, First Nations and Métis communities, migrants, etc.) with the idea to assess food choices and food consumption patterns and have a clearer picture of food systems in the North. To sum up, it is important to point out that this document is not a comprehensive analysis of all the issues influencing food [in]security in Northern Canada; it is acknowledged that food [in]security is a multi-dimensional topic with dimensions of access, availability and quality overlapping and interacting continuously.

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