The Impacts of Climate Change
on
Traditional and Local Food Consumption
in the Yukon

Prepared by Amanda Sheedy
for the Arctic Institute of Community-Based Research
April 23, 2018

Arctic Institute of
Community-Based Research
For Northern Health and Well-Being

Executive Summary

Climate change has and will continue to have significant impacts on northern diets, food security, culture and health. Most people in the Yukon have a mixed diet, consuming a combination of wild, or traditional foods – largely meat or fish - and market foods. Both food systems will be impacted by climate change and it is important to plan for the future in order to take advantage of opportunities and mitigate, where possible, the threats to health and wellbeing.

Climate change compounds (will make worse) already existing inequities in society, as it hits marginalized and vulnerable communities the hardest (IPCC, 2014), namely Indigenous peoples as well as those who are currently suffering from food insecurity. Food insecurity rates in Yukon were the third highest amongst the provinces and territories in Canada in 2011 at 16.8%, affecting 1 in 5 children in the territory (PROOF, 2017). The First Nations Regional Health Survey (First Nations Information Governance Centre, 2018) found that 54.2% of First Nations households across Canada were moderately to severely food insecure, demonstrating a stark inequity. In the age of reconciliation, we have a collective responsibility to ensure that our efforts lead to reducing the gap in equity and health between Indigenous and non-Indigenous people. Thus, climate change adaptation efforts in the Yukon, where a quarter of the population is Indigenous, must strongly support Indigenous peoples and their traditional ways of life.

This scoping review represents the first phase in a three-year project to support climate change adaptation in the Yukon to ensure that food security and traditional food security improves and supports the health and wellbeing of all Yukon residents. It will contribute to the development of the project by identifying: the current state of knowledge regarding food and climate change in Yukon, gaps in knowledge/understanding, existing baseline data and methodologies of interest and recommendations. The Arctic Institute of Community-Based Research (AICBR) in collaboration with the Government of Yukon (YG) and other steering committee members will then shape, plan and carry out this project between 2018-21.

Numerous research gaps are identified in the report, however given the small scope of the project going forward, it is recommended to focus on the information gap regarding community based, food-related climate change adaptation initiatives in the north. Communities could benefit from hearing about what others are doing to adapt to climate change so that they might preserve their tradition and improve food security. In light of this focus, the following recommendations are offered.

Recommendations to the Yukon Government:

1. Participate in the Household Food Security Survey component of the Canadian Community Health Survey (CCHS) at least every other year (2018, 2020, 2022, etc.) in order to monitor Yukon food insecurity rates at the community and territorial level. Further, adopt food insecurity monitoring as an indicator of climate change in the territory.
2. Advocate for the inclusion of questions in the CCHS related to traditional food security or identify other measures of gathering this data.
3. Share updates, monitoring or evaluation reports regarding local food strategy and climate change monitoring with the public.
4. Make food insecurity, inequity and Reconciliation a priority.

Recommendations related to this project in phase II:

1. Compile an inventory of food related climate change adaptation projects in the Yukon and elsewhere in the North.
2. Identify and further document promising practices in food related climate change adaptation projects.

3. Share the inventory and promising practices with communities in an accessible way and so that they might be inspired to take action. Celebrate the success of some initiatives by promoting them to the media.
4. Identify possible adaptation projects that might be of interest to communities and support them in taking first steps to fund and develop the initiatives.
5. Explore the field of citizen science to determine opportunities for a future community-based climate change monitoring project. Obtain preliminary feedback from communities about indicators that may be of interest to them.

Table of Contents

Glossary of Terms

Local Food: Any agricultural foods produced and consumed in the Yukon (animal and plant).

Traditional Food (TF): Food harvested from the local environment as part of First Nations culture (animal and plant). For the purpose of this report, traditional food also refers to food harvested in this way by non-First Nations.

Market Food (MF): Food obtained through the market economy and requiring money to obtain, such as food bought at a grocery store.

Food Security: "Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life". (World Food Summit, 1996) Most consider food security to also include sustainably produced food.

Traditional Food Security - Traditional food security is a term that is still not widely used and as such does not have a shared definition. In this paper it refers to the availability and access to traditional foods by Indigenous peoples. In Aboriginal Food Security in Northern Canada it states that, "traditional food security depends on the protected right to access lands, the right to harvest, and intact relationships between community, land, and harvest. These rights and relationships are shaped and constrained by past and present governance," (Council of Canadian Academies, 2014).

Food Insecurity - A situation that exists when people lack secure access to sufficient amounts of safe and nutritious food for normal growth and development and an active and healthy life.

Food Sovereignty - Food sovereignty is the right of peoples to healthy and culturally appropriate food produced through ecologically sound and sustainable methods, and their right to define their own food and agriculture systems.

Arctic - The region lying north of the Arctic Circle or of the northernmost limit of tree growth; the polar area north of the tree line.

Sub-Arctic – The geographic region just south of the Arctic Circle.

About AICBR

The Arctic Institute of Community-Based Research (AICBR) is a unique non-profit organization based in Whitehorse, Yukon, co-founded in 2007 by Norma Kassi, Vuntut Gwich'in from Old Crow and long-time northerner Jody Butler Walker. The mission of AICBR is to facilitate, promote and conduct community-based, Northern-led research aimed at improving the lives of Indigenous and non-Indigenous Northerners and the health of Northern environments. AICBR works in collaborative and participatory ways to bring together multiple groups and sectors to work on issues of common importance and to mobilize knowledge and facilitate community-led action on complex issues.

Our current priorities include Food Security & Food Sovereignty, Climate Change Adaptation, and Healthy Lifestyles & Chronic Disease Prevention. We work with northern Indigenous communities, non-governmental organizations, governments (Indigenous, municipal, territorial, federal), academics, graduate students, research organizations, and the private sector. Our approach prioritizes the principles of community-based research, youth engagement and leadership development, collective impact, partnership development, community capacity building, knowledge sharing, inter-sectoral collaboration, and evaluation.

Acknowledgements

The Arctic Institute of Community-Based Research gratefully acknowledges funding from Indigenous and Northern Affairs Canada's Climate Change Preparedness in the North Program. We would also like to thank our project partners, the Government of Yukon's departments of Energy, Mines and Resources (Agriculture Branch) and Environment (Climate Change Secretariat) as well as members of the steering committee, for their valuable contributions and guidance on this scoping review. Members of the steering committee included, Randy Lamb (Government of Yukon), Larissa Lychenko (Government of Yukon), Shaylin Drukis (Council of Yukon First Nations), Alison Perrin (Yukon College), Dr. Treena Delormier (McGill University), Dr. Harriet Kuhnlein (McGill University), and AICBR's Molly Pratt, Lawrence Ignace and Norma Kassi.

The views expressed herein do not necessarily represent the views of the funding agency.

Indigenous and Northern Affairs Canada
Affaires autochtones et du Nord Canada

Introduction

a. Purpose

Climate change has and will continue to have significant impacts on northern diets, food security, culture and health. Most people in the Yukon have a mixed diet, consuming a combination of wild, or traditional foods – largely meat or fish - and market foods. Both food systems will be impacted by climate change and it is important to be able to plan for the future in order to take advantage of opportunities and mitigate, where possible, the threats to health and wellbeing.

On one hand, higher temperatures, already evident in the Yukon, will increase opportunity for northern agricultural production. With proper guidance, this has the potential to increase food security in Yukon. More worrying are the impacts of climate change on the availability of traditional foods such as caribou, moose and fish. Many of these populations are currently in decline across the North due in part to climate change, but also to due to habitat encroachment and decline from farming, forestry, urban and industrial development, invasive species, over harvesting and pollution (World Wildlife Fund, 2017). While the health benefits of foods harvested from the land and water are well documented, it is less clear what short and longer-term effects may arise from limitations in access and/or availability due to climate change. How these changes may be affecting the diets of Yukon residents – both Indigenous and non-Indigenous – is unclear.

This scoping review represents the first phase in a three-year project to identify changes and adaptation measures to climate change in the Yukon Food System. The Arctic Institute of Community-Based Research (AICBR) in collaboration with the Government of Yukon (YG) will carry out a participatory research project to this end with the support of other partners. Existing adaptation strategies in Yukon communities will be briefly described. This work will have a Yukon focus; however, it will be conducted within a Northern context to develop/strengthen partnerships and facilitate information sharing.

This scoping review will contribute to the development of a two to three-year research project regarding climate change and food systems in the Yukon by identifying: the current state of knowledge regarding food and climate change in Yukon, gaps in knowledge/understanding, existing baseline data and methodologies of interest.

b. Context – Food Security in the Yukon

Food insecurity plagues a disproportionate number of people in Canada's North, and even more so amongst Indigenous Peoples. Food and (recently added) nutrition security exists when "all people at all times have physical, social and economic access to food which is safe and consumed in sufficient quantity and quality to meet their dietary needs and food preferences, and is supported by an environment of adequate sanitation, health services and care, allowing for a healthy and active life" (Committee on World Food Security, n.d.)**.** Food insecurity is thus the lack of food security, or the inadequate or uncertainty of access to healthy food of acceptable amounts and quality for an active and healthy life.

Food insecurity rates in Yukon were the third highest amongst the provinces and territories in Canada in 2011 at 16.8%, and rose marginally in 2012 to 17.1%, affecting 1 in 5 children in the territory (PROOF, 2017). Unfortunately, more recent data is not available as the Yukon Government opted out of collecting the information since that time (ibid.). National data will be collected in 2018, so food insecurity rates for the Yukon will be available in the next year.

No recent or comprehensive data could be found for food insecurity rates amongst Yukon First Nations. Across Canada, Indigenous households are more than twice as likely to be food insecure (27%) (Tarasuk, Mitchell, & Dachner, 2014). The First Nations Regional Health Survey (First Nations Information Governance Centre, 2018) found that 54.2% of First Nations households across Canada were moderately to severely food insecure. One study administered Health Canada's Household Food Security Survey Module (HFSSM) in two Yukon communities, which found 48% of Old Crow households suffering from food insecurity and inconclusive results for Teslin (Schuster, Wein, Dickson, & Chan, 2011). The HFSSM does not adequately capture the role of traditional food in food security, (Lambden, Receveur, Marshall, & Kuhnlein, 2006) leading to calls for traditional food to be included in future Canada wide surveys (Lambden, Receveur, & Kuhnlein, 2007). Based on data from the 1990s from the Yukon First Nations Dietary Study (further described below) 40.7% of respondents said they did not have enough equipment to go fishing for the family's food needs, and 30% could not afford to buy all the food needed from the store (Lambden et al., 2006) presumably to replace traditional foods. While this is outdated information, it points to the importance of investigating and documenting traditional food as one of the determinants of food security in northern, remote and/or Indigenous communities.

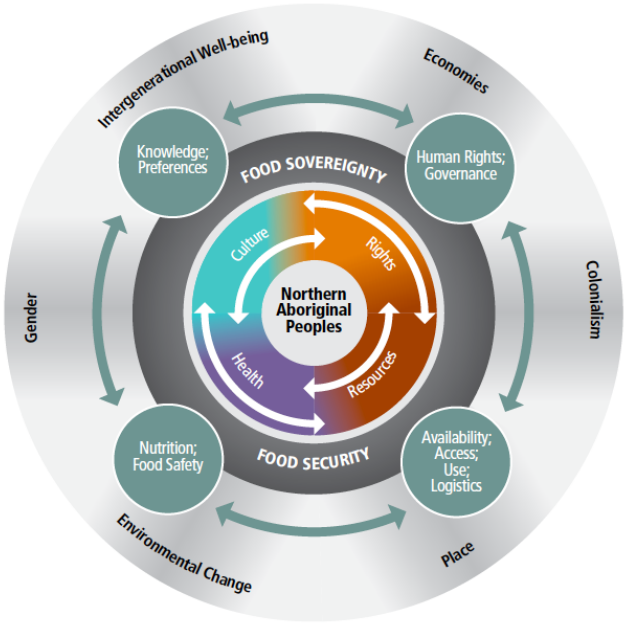
Food sovereignty is defined as "the right of nations and people to control their own food systems, including their own markets, production modes, food cultures and environments" (Wiebe & Wipf, 2011). This concept has gained momentum due to its analysis of power, process and structural barriers to food security that is lacking in the food security framework described below. Indigenous peoples and small-holdings farmers alike have gravitated to this framework, as it points to many of the underlying causes of their food insecurity, namely marginalization in decision-making and economies. This framework poses important questions such as, "How is the state ensuring the right to food?" and "How are people involved in governing their food systems?"

Climate change compounds already existing inequities in society, as it hits marginalized and vulnerable communities the hardest (IPCC, 2014). This being the case, then those who are currently suffering from food insecurity are likely to be hardest hit by climate change. It is our responsibility to ensure that we continue to strive for equity and health for all as we generate responses to climate change.

c. Introducing the framework

There are multiple food security frameworks and models to support understanding of both direct and indirect causes and outcomes. Few have been developed for a northern context. The Canadian Council of Academies (CCA) produced a report on Northern Aboriginal food security in 2014 that will be used to support this scoping literature review. For the purposes of this report, we have applied this framework to all people in the Yukon given that many non-First Nations people in the Yukon live close to the land and in rural or remote northern communities.

Image 1: Northern (Aboriginal) People's Food Security and Food Sovereignty Framework



Copied from (Council of Canadian Academies, 2014)

This framework points to a number of important factors that affect food security in the North and amongst Aboriginal peoples. This shows that food security and food sovereignty are both interrelated and distinct ideas. The ideas of 'place' and 'environmental change' (in the outer circle) give this framework a nod to the importance of these challenges in the Yukon. Interestingly, the ideas found in the outer circle (like gender, colonialism, economies and intergenerational wellbeing) can both cause or get in the way of food security and food sovereignty.

The framework highlights important contributors to food insecurity, including:

- availability (the proximity and quantity of food or food species; the availability of land and tools);
- access (the ability to get food, including transportation, cost of food and hunting material);
- use (the ability to put certain foods, including traditional foods or whole foods, to use);
- food safety (risks associated with consuming unsafe/expired market food or traditional food, including issues such as contaminants or pathogens);
- nutrition (quality of food, including nutrients and the ability to metabolize food);
- knowledge and preferences (understanding how to grow, harvest, preserve or prepare food and the tastes associated with foods);
- human rights and governance (point to the state's responsibility and the manner in which governments approach food insecurity, including involvement of local communities).

Please see the report, Aboriginal Food Security in Northern Canada (Council of Canadian Academies, 2014), for further details on how to interpret this framework.

This framework builds on the concept of food security and combines it with food sovereignty, a rights-based-approach to food, and integrates important factors for a northern or remote context. Given the unique context in the Yukon – a northern territory with many remote communities and a general culture that revolves around 'living on the land' – we will apply this framework to all people of the Yukon, not just Aboriginal peoples.

d. Scope of the report

The purpose of this report is to shape a future study that will identify adaptation strategies and support Yukon communities in adopting those strategies to ensure that they are able to continue to improve their food security and sovereignty in the face of climate change. The scope of this report is informed by this purpose.

The scoping literature review will synthesize knowledge and research related to the impacts of climate change on traditional and local food use in the Yukon. The food use of Indigenous peoples as well as non-indigenous Yukoners will be looked at across all questions. Food use will be broken down into two broad categories: traditional food (specifically caribou, moose, white fish, salmon, ground squirrels, grouse, beaver and berries) and food produced close to communities (hereafter referred to as 'local food', including vegetables and fruits produced in Yukon farms and gardens as well as farmed animals, such as beef, pork, poultry and eggs).

This review will focus exclusively on the consumption and use of traditional and local foods but will not cover other market foods, research on the harvest, distribution or abundance of traditional food; or research regarding production levels in agriculture. It will also not address literature regarding food safety, including contaminant levels in traditional foods, or the assessment of nutrients in traditional or local foods. While the dietary transition at play in Indigenous communities will be acknowledged as a factor in traditional food consumption, this literature will not be explored. Literature regarding the consumption of traditional foods has been limited to those eaten most regularly (caribou, moose, white fish, salmon, ground squirrels, grouse, beaver and berries) to the exclusion of other species.

The following research questions will be used to guide the mapping of key concepts, types of evidence, and gaps in research:

1. How is/has climate change affecting/ed the diet of Yukon First Nation citizens and others living in the Yukon?
    a. What evidence is there that climate change impacts are affecting traditional foods and locally produced food at the community and/or territorial level(s) in the Yukon, and if so, how?
    b. In the NWT & Nunavut? Northern Provinces? In Alaska? Other Northern regions? These jurisdictions include Gwitchin, Dene, First Nations, Métis, Inuit and Inuvialuit peoples in the Canadian North.
2. What evidence exists to characterize Yukon First Nations' traditional food consumption patterns over the past 30 years?
3. What data exists to characterize potential impacts of reduced consumption of caribou, moose, fish, berries and other species traditionally consumed in Northern Canada on nutrition (and health?) status?
4. What adaptation strategies have been developed in Northern regions in response to changes in traditional food access and availability? (For example, the Tr'ondëk Hwëch'in Teaching and Working Farm in Dawson City, Yukon)

Methodology

Scoping reviews are a relatively new methodology that maps the literature available on a topic to identify key concepts, theories, sources of evidence and gaps in the research. Often preliminary to other work, it can determine the extent, range and nature of available research and can help to determine the value of undertaking a full systematic review or other next steps. In other words, a scoping review is a rapid appraisal,

synthesis and analysis of academic and grey literature that covers all the themes but not all of the literature. Scoping reviews can also contextualize knowledge within a policy and practice context (for example – is a research gap identified important or relevant right now?) (Boyd & Bastian, n.d.).

The following outlines the methodology that was employed in this study and is informed by Arksey and O'Malley (2005).

The first step in this review was to identify the research questions and the purpose of the review. The Arctic Institute for Community-Based Research did this in conversations with their partners, Yukon Government Department of Energy, Mines and Resources' Agriculture Branch and Climate Change Secretariat.

Next, the scope was defined, the keywords for searches were identified and some preliminary studies and reports were collected and scanned. This allowed for a table of contents to be generated based on themes. An outline for the review was shared with a nascent project steering committee for comment and feedback. The outline was revised and used as a guideline for further research and writing.

Following this, the step of study selection continued throughout the research and writing phase to help refine the collection of research and studies based on their relevance to the research questions. Then the data was charted and key variables, methodologies were pulled out of the literature. This step happened at the same time as the report writing, which involved collating, summarizing and reporting of results.

Finally, the steering committee was consulted about a draft of the review to determine if any key literature was missing, and to inform the analysis of the literature and the development of the recommendations and the resulting research project.

Climate Change and its Impacts in the Yukon and Northern Canada

It is well understood that climate change – the changes in global or regional climate patterns that are the result of increased greenhouse gases emissions – is occurring at a faster pace in the Arctic and sub-Arctic regions than in other regions of the world – about twice as fast to be precise (Hassol, 2004) (Herman-Mercer, Schuster, & Maracle, 2011). Current projections foresee a further warming in the Arctic of 4-7°C over the next 100 years (Hassol, 2004). In the Yukon, annual temperatures have increased by 2°C over the past 50 years and are expected to increase another 2°C in the coming 50 years (Streicker, 2016). This makes the Arctic, including the Yukon, 'ground zero' or 'the canary in the coal mine' when it comes to climate change, as the region is experiencing the effects of climate change before more southern regions. This has generated a wealth of research data about the Arctic and sub-Arctic, including the three northern territories of Canada.

In the keystone report on the Impacts of a Warming Arctic (Hassol, 2004), 10 impacts of climate change are listed in the summary, nine of which are related to food systems directly (i.e., decline in freshwater fisheries) or indirectly (i.e., disrupted land transportation). Needless to say, climate change will have a multitude of impacts on the Yukon's food systems and food security. The following provides a brief summary of what is known regarding climate change in the Yukon and more generally in Northern Canada.

a. Weather

Northern Canada, including the Yukon, is well known for its cold, long winters and short summers. Precipitation is relatively light and falls predominantly in the warmer months ranging from 400 mm per year in the

southeastern region to over 1000 mm in the southwest (Prowse & Furgal, 2009). The average temperature in Alaska and Western Canada is reported to have increased by 3-4°C in the past 50 years with accelerated change expected in the next 100 years (Joy Hassol, 2004). In the Yukon, temperatures have increased by 2°C over the past 50 years with more than a 2°C increase projected over the coming 50 years (Streicker, 2016).

Numerous models have attempted to predict climate change into the future. Without getting into the debates about the accuracy of any one model, Prowse & Furgal have summarized the means between various models. Based on an analysis of many of these models, which all established a baseline using 1961-1990 data, Prowse and Furgal have determined the mean temperature and precipitation change for eastern and western Arctic, which are summarized in Table 1 below. Specific to the Yukon, annual precipitation increased by 6% over the last 50 years and it is expected to increase by 10-20% over the next 50 years, although this will vary greatly by region (Streicker, 2016).

Table 1: Projected Mean Temperature and Precipitation Change in Northern Canada

Year	Mean Temperature Change	Mean Precipitation Change
2020s	+2 °C	+ 5-8%
2050s	+3.8 °C	+ 5-15%
2080s	+6 °C	+ 15-30%

(Prowse & Furgal, 2009)

These temperature and precipitation changes will be accompanied by greater fluctuations, storms and general 'chaos' in weather patterns. Seasons are also shifting, with spring coming earlier and winter coming later – see details below.

Community members are also noting changes in weather and seasons. In Deh Gah Got'ie (NT) and White River (YK) First Nations, people have noted bizarre or out of season fluctuations, such as Chinooks or thunder at the wrong time of year, a shift in the seasons by two months, stronger storms in the summer and in general, greater weather variations (Guyot, Dickson, Paci, Furgal, & Chan, 2006).

b. Water system, snow and ice cover, permafrost

Almost one fifth of Canada's freshwater resources are found north of 60, not including water found in glaciers. Not surprisingly, a fifth of Canada's wetlands are also found here. Rivers and lakes freeze over in the winter and snow and ice provide the run-off that feeds the rivers in the summer, providing a major source of fresh water to the Arctic Ocean, crucial to regulation of global climate through thermohaline circulation (Carmack, 2000). The Yukon is split between two major watersheds – the McKenzie River Basin (Canada's largest), which flows north to the Beaufort Sea, Arctic Ocean and the Yukon River, which flows through Alaska to the Bering Sea. The Beaufort Sea, Arctic Ocean freezes over during the winter, and their movement and freezing has a great influence on the climate in Northern Canada.

Community members have noted changes in the water system, and these observations are quite localized. Community members of the White River First Nations, Beaver Creek YK, observed that rain patterns were quite different between communities, with Beaver Creek experiencing less rain and snow in recent years. Lakes, rivers, creeks and swamps are drying out, despite more rain being noted in Fort Providence (Guyot et al., 2006). In Beaver Creek community members noted that the river no longer freezes over, leaving them with no ice to travel out on (Guyot et al., 2006). Kluane First Nations community members have noted that the water is murkier due to more glacial runoff and silt, the water is warmer and that the lake is freezing later and thawing earlier (Kluane First Nations & Arctic Institute of Community-Based Research, 2016).

Permafrost (earth material that stays frozen for at least 2 summers) covers much of the Yukon, although to varying degrees. Further north there remains some continuous permafrost, but in other regions it is sporadic, isolated or discontinuous (see map of permafrost on p. 61 of Prowse & Furgal, 2009). Permafrost has warmed by 2 °C in recent decades and the depth of the thaw is getting deeper each year. The southern limit of permafrost is gradually moving northward, with estimates predicting a shift of several hundred kilometers during the coming century (Hassol, 2004).

Sea ice is a key indicator and contributor to climate change in the Arctic (Hassol, 2004) whose impacts are felt by humans, other species, the economy and society at large. For climate change scientists, sea ice provides early warning signs for the rest of the globe. Overall, sea ice extent in the Arctic has declined by about 8% in the 30 years previous to 2004, with summer ice loss at 15-20% (ibid), which leads to more solar energy being absorbed by the sea rather than reflected off the earth by sea ice. This translates into a loss of about 90,000 square kilometers per year, with the loss accelerating over the last decade (Streicker, 2016). Estimates of thinning ice are harder to pinpoint.

Snow cover in the Arctic has declined by about 10% before 2005 and is projected to decline another 10-20% by 2100. Spring will be the time of greatest decline, which will shorten the winter season and bring run-off to the oceans earlier in the season. Snow quality is also changing, with greater freeze-thaw cycles leading to more ice cover, making it difficult for animals to reach food, dens and nests (Hassol, 2004).

Glaciers in the Yukon have decreased in their cover area by 22% over the last 50 years, leading to increased glacial runoff in rivers and streams (Streicker, 2016). Combined with permafrost melting, this is leading to changes in groundwater flow patterns and increased pathways for groundwater (Streicker, 2016). Scientists have recently documented stream capture, or river piracy in Yukon due to climate change: the increased meltwater from the Kaskawulsh Glacier has changed the course of the runoff from flowing north down the Slims River and dumping into the Bering Sea, to now flowing south and into the Pacific Ocean, leaving in its wake a dried river bed of silt (Weikle, 2017). This will have a broad but still unknown impact on the ecosystem, including salmon's ability to spawn in Kluane Lake.

There are several other climate change impacts on water systems that are noteworthy. River and lake freeze-ups have been delayed and break-ups are occurring earlier in the season across Canada's North, and specifically on the Mackenzie River by about 5.8 days per century for freeze-ups, and break-up dates have been pushed back 6.3 days per century (Prowse & Furgal, 2009). This rate of change may indeed accelerate in the coming century. River flows in the Arctic have seen an increase in the last years (Hassol, 2004), although those draining into the Arctic Ocean and Bering Strait (Mackenzie and Yukon) diminished by 10% from 1964-2003, with other studies pointing to no change in the Yukon River (Prowse & Furgal, 2009). Projections show that this is likely to change, with projected increases in discharge of 12-20% for the Mackenzie River and 20-30% for the Yukon River by 2050 (Prowse & Furgal, 2009). Melting glaciers contribute to this runoff and also diminish the reflectivity of the sun's energy.

Together, all these changes amount to considerable shifts in the hydrological systems in the Yukon.

c. Impacts on natural systems

Overall, the above changes will have significant impacts on natural ecosystems. The tree line and the Boreal forest will creep northward (Hassol, 2004) and the alpine tree line will move further North (Government of Yukon, n.d.), increasing the forest cover in the Yukon in the coming years. This amounts to more than just

'more trees', and represents a 'moderate' change in the biota of the Yukon (Callaghan et al., 2011). This, in effect, will decrease the tundra to the point that it will likely disappear altogether from the Yukon in the coming century (Hassol, 2004). Species that depend on the tundra and the wetlands they contain will see a marked decline in population, some to the point of extinction (Hassol, 2004).

These shifts in ecosystems will bring with them a shift in species, some moving as much as 1,000km north (Hassol, 2004). According to modeling with minimal greenhouse gas emissions, we can expect to see anywhere from a 10% loss in animal species over much of Canada, up to 90% turnover of species in regions such as the tundra (Lawler Joshua J. et al., 2009). Invasive species will compete with native and current species, contributing to their displacement, decline and/or extinction (Hassol, 2004). In some places, the shifting ecosystem, melting permafrost and changing water system may lead to desertification (Hassol, 2004).

The boreal forest in the Yukon will change in more ways than one. As the boreal forest expands, so will the habitat of species that inhabit the forest. This may have positive effects on forest dwelling species such as wolves, lynx, moose, birds and boreal caribou (Hassol, 2004) in the long-term. Other impacts of climate change on forest ecosystems include: slowed or increased tree growth rates; increased extent of forest fires and insect outbreaks (i.e., spruce bark beetle); changes in permafrost leading to collapse of surfaces and tree loss (Hassol, 2004). Over the last 30 years, western North America has seen the annual area burned by forest fires double and models predict that it will increase by 80% in the coming century (Hassol, 2004).

It should be noted that projected shifts in ecosystems are theoretical, as there are many interacting factors that make up an ecosystem. For example, the establishment of the boreal in current tundra regions will be contingent on many factors that may support or hinder the establishment of trees. It is also possible that new ecosystems with different structures and species composition may emerge as some species may not shift northward due to the limited hours of sunlight, soil composition and other factors (Hassol, 2004).

Warming air temperatures will also warm the waters of lakes and rivers, which will have its own impact on these freshwater ecosystems in the Yukon (McKnight, 2017) (Poesch Mark S., Chavarie Louise, Chu Cindy, Pandit Shubha N., & Tonn William, 2016) (Rolls, Hayden, & Kahilainen, 2017). Due to a lack of previous data on water temperatures, it is impossible to gauge the changes with any scientific accuracy (McKnight, 2017). However, it is clear that like terrestrial ecosystems, freshwater ecosystems, such as those in Lhù'àän Mân (Kluane Lake), are shaped by temperature, and changes to this fundamental aspect of the ecosystem will impact on species' abilities to survive or thrive (ibid.). Increases in temperature combined with erosion from permafrost thawing will lead to increased nutrient availability affecting species behavior, metabolism and growth and timing of spawning. This will lead to changes in species numbers, ultimately affecting the ecosystem structure and composition and making it more vulnerable to invasive species (Rolls et al., 2017).

d. Impacts on human-built systems

Some of the effects of climate change on food systems and security maybe due to indirect impacts through other systems, such as transportation systems. Infrastructure, including roads and airport runways, may suffer greatly due to permafrost melting as well as from extreme weather events (IPCC, 2014). Given that most market food is currently shipped into the Yukon by road, this type of disruption could have devastating effects on the food supply. The Yukon had a recent experience of this in 2012 when a flood took out the Alaska Highway, leaving grocery store shelves bare, without any recourse (CBC News, 2012). On the other hand, we may see the expansion of marine shipping due to reduced ice on the Arctic Ocean, facilitating marine transportation of food, but also potentially an increase in resource exploitation, pollution and tourism.

Impacts of Climate Change on Access, Availability and Quality of Traditional Food

As we have seen above, there are numerous impacts on the environment due to climate change that have already affected and will continue to impact the access to, availability of and quality of traditional food. The following section draws on the literature to identify the impacts of climate change on traditional food, specifically species that are most commonly consumed by people in the Yukon: caribou, moose, white fish, salmon, ground squirrels, grouse, beaver and berries.

Please see Table 2 below for a summary of the following impacts.

a. Availability

The availability of traditional food refers to the numbers, health and wellbeing of populations, as well as the range and location of species that people in the Yukon depend on for food. Availability of traditional food is one of the central pillars of food security for the people of the Yukon, who depend on traditional foods for their sustenance.

i. Change in species, range and migratory patterns

The range and abundance of many traditional food species are shifting and changing (Anisimov et al., 2007) (Downing & Cuerrier, 2011) (Herman-Mercer et al., 2011). A review of 143 studies regarding the range of species showed that out of close to 1,500 species globally, 80% had shifted their range towards the poles over the course of the 20th century as climate change was still in its early days (Root et al., 2003). With an event greater change in temperature predicted for the coming century, we can expect an even greater shift in ranges. Due to these shifts, some species may flourish, others may disappear from a region entirely and new species will advance into regions as their ranges stretch northward. Not only will this impact the food security of communities, but these changes also hold the potential to impact on cultural identity as certain species become inaccessible to certain communities.

Migration routes are changing as are their destinations, moving northward or up in elevation (Downing & Cuerrier, 2011). This can have impacts on the reproductive or breeding cycles of animals as their migration routes change (Berner & Furgal, 2005).

Shrubs and other plant species are also changing their range. Shrubs and trees are growing more per year, which could impact negatively on lichen growth and berries due to increased shading which would impact on caribou and bear/human consumption respectively (ibid.).

Species ability to adapt to changing temperatures and ranges depends very much on their mobility and speed. Trees and other plants cannot move and thus have limited capacity to adapt to large scale changes. Rodents, such as ground squirrels, move slowly and are also less likely to keep up with the change, whereas large mammals like moose and those who fly, like birds and insects, will be able to shift their location quickly, based on new weather patterns (IPCC, 2014).

Community members in Yukon and NWT have noticed this change in species. They have noted the change in bird migratory patterns, an increase in eagles and beavers, and a decline of rabbits and caribou (Guyot et al., 2006). They have also noticed changes in the health or wellness of the species they depend on, such as white spots appearing on beavers and hair-loss in moose (ibid).

Most caribou herds in Canada and globally are in decline, largely due to the deterioration of and encroachment on their vast habitats (Environment and Climate Change Canada, 2017) (Mallory & Boyce, 2017). Caribou were listed as a species at risk when Species at Risk Act (SARA) was put in place in 2002. Of the 51 caribou herds in Canada none have seen population increases, 10 are considered stable and 20 have decreasing populations (ibid.). There are two caribou herds that call the Yukon home. One boreal caribou herd, referred to as NT1, lives in a small northern corner of the Yukon and most of the NWT (Environment and Climate Change Canada, 2017). The Porcupine caribou herd, one of the largest migratory barren ground caribou herds in North America, calls the northern half of the Yukon and Alaska home ("Porcupine Caribou Management Board," n.d.). Thankfully, both herds appear to be stable at this time, but are still considered threatened and at risk of extinction.

There is currently much discussion and debate about caribou conservation in Canada due to the release of a report by the federal government, assessing progress in caribou conservation and populations over the last five years (Environment and Climate Change Canada, 2017). In April 2018, we will hear whether the federal government has found provincial and territorial action sufficient under SARA and whether there will be consequences for those provinces and territories that are lacking in efforts and results.

There is some debate about the impact of climate change on caribou (Anisimov et al., 2007). Mallory and Boyce (2017) examined the literature to determine if and how caribou could be affected by climate change and concluded that caribou responses to climate change will be varied due to their broad distribution. They summarize that climate change impacts on caribou may include: changing forage quality and quantity in summer and winter; increased icing in winter; change in spring timing and weather; increased wildfire impacts on winter ranges; increased summer insect harassment; and finally changes to migratory patterns and distribution (Mallory & Boyce, 2017). The season that provides good conditions for summer insects is increasing in length due to climate change and it is expected that this has led to (and will lead to more) 'harassment' of caribou by these insects which affect their health by exhausting them as they run from the insects, instead of eating (Mallory & Boyce, 2017). Parasites, including protozoans and helminthes, are also expected to move north due to climate change, and increase the number and severity of infections in caribou (ibid.). Due to the longer warm season, there is also expected to be more food available for caribou, which may counter-balance some of the above named negative effects.

Specifically, in Northern Canada, according to the cumulative effects modeling and decision-support tool being developed by the Sahtu Renewable Resources Board (SRRB) in NWT, Boreal Caribou will experience much higher levels of disturbances under a climate change scenario (Environment and Climate Change Canada, 2017). In other regions of Canada, such as in Ontario, biologists are predicting that caribou will be extirpated from the region by 2070 (Masood, Zuiden, Rodgers, & Sharma, 2017). The Porcupine herd is currently under threat by development plans in Alaska, so their fate also remains precarious.

The **moose** population in the Yukon is stable, unlike other populations in North America at about 100 – 250 moose for every 1,000 km2 of moose habitat in the territory in 2015 (Environment Yukon, 2018). This is considered to be a low density of moose, but generally high enough for controlled harvesting. Environment Yukon monitors the population every 5 years and determines harvesting rates to maintain the population based on these density rates (Yukon Environment, 2016). First Nation allocation priority is covered by the Umbrella Final Agreement and sharing and allocation formulas are outlined in land claim agreements, thus are not bound by government harvest quotas (ibid.). Moose may become affected by climate change by the increase number of winter ticks, which scientists believe to be moving further north and may be responsible for moose population decline in the US and BC (CBC News, 2013). The increased forest fires that result from climate change may in the end support the moose population. In Alaska they have experimented with

controlled burns to increase moose habitat, as species of plants that moose rely on grow in burned areas (Juneau Empire, 2009).

In 1998 the Chinook **salmon** fishery on the Yukon River dropped by 50% and has not recovered since, with only small catches since then in Dawson's commercial salmon fishery (Yukon Salmon Sub-Committee, n.d.). In 2009, the salmon fishery on the Yukon River was closed by the US Department of Fisheries. Touted as a success by conservation communities, it had devastating effects on the food security of First Nations and other communities who depend on salmon for their food security in Alaska (Loring & Gerlach, 2010) and in the Yukon as well. While overfishing accounts for some of the decline, climate change is responsible for changing the hydrology of the Yukon Delta Basin, largely due to melting permafrost and resulting erosion that can block channels and dam lakes making it impossible for salmon to travel (Loring & Gerlach, 2010). The rising temperature of the Yukon River is also hypothesized to have an effect on salmon (Poesch Mark S. et al., 2016)(Loring & Gerlach, 2010). In the summer of 2017, the Department of Fisheries and Oceans allowed First Nations Governments to determine whether to allow fishing due to only moderate population numbers (zone 'yellow)(Government of Canada, 2017). There appears to be some debate about whether the Chinook salmon spawn in Canada or Alaska (Loring & Gerlach, 2010), but regardless, this is a case requiring cross-border collaboration to ensure the conservation of the salmon and the food security of people who depend on them.

Ground squirrel populations in the Yukon appear to be stable for now. Because they hibernate, the onset of spring has been shown to influence their fitness, or population growth rate, with later spring melts leading to a decrease in population growth, as seen in Alberta, potentially impacting population viability (Lane, Kruuk, Charmantier, Murie, & Dobson, 2012). So, the earlier arrival of spring due to climate change may lead to a greater ground squirrel population.

Lake **whitefish** will be reviewed in 2018 by Committee on the Status of Endangered Wildlife in Canada (COSEWIC) to determine the health of the population in the Yukon and if it might be endangered, threatened or of special concern ("Yukon Species At Risk," 2017). Members of the Kluane First Nation have noticed changes in the location of several fish species, including whitefish (Kluane First Nations & Arctic Institute of Community-Based Research, 2016). Overall, they have also noticed a decrease in the abundance of most fish species, including whitefish, trout, lingcod and inconnu. Pike appear to be plentiful and some think that grayling may be increasing in number (ibid.).

Grouse are another important food for some First Nations and are currently not threatened in the Yukon. Scientists recommend monitoring the grouse populations, however, as the populations cycle up and down naturally and they live in unique ecosystems and locations that isolate populations from each other (Life, 2018).

The **beaver** population is plentiful and appears to be increasing in numbers as their range stretches north to the Arctic coastline (Montgomery, 2017). The arrival of the beaver in the tundra of northern Yukon may be due to the 'shrubification' of the tundra due to higher temperatures (Jung, Frandsen, Gordon, & Mossop, 2017). The impact of beavers on ecosystems is well known – they build dams, altering river and lake systems. This alters the habitat of birds and fish that inhabit the regions where beaver have not previously inhabited, and can make it difficult for salmon and char to travel up river to spawn (Malison Rachel L., Lorang Mark S., Whited Diane C., & Stanford Jack A., 2014). Another unfortunate trait of the beaver is that they carry giardia, an intestinal parasite that can spread to humans, making water where beavers live non-potable (Montgomery, 2017). The silver lining is that beaver provide a new source of traditional food for those in the region.

Berries abound in the Yukon, with about 15 different species of edible berries found in the territory (bearberry, black current, black huckleberry, blueberry, bunchberry, cloudberry, cranberry, crowberry, gooseberry, hawthorn, raspberry, red current, Saskatoon berry, strawberry and twisted stalk) (Northern Bushcraft, n.d.). Crop yields of berries vary significantly from year to year and the causes of these variations appear to be hard to pinpoint, as they vary between species and locations considerably (Krebs, Boonstra, Cowcill, & Kenney, 2009). Because of a longer growing season and higher temperatures, berries are ripening earlier and rotting on the plants faster than before (Downing & Cuerrier, 2011).

A few examples of community based climate change monitoring projects using berries were found in both Alaska (IARPC Collaborations, 2018) and Nunavut (Nunavut Climate Change Centre, n.d.), which may be of interest for future climate change monitoring projects in the Yukon.

ii. Invasive species and impacts on plant and animal relations

Invasive species are non-native plant, animal or other species that establish themselves in an ecosystem where they were not previously present, to the point of dominating the structure and function of the ecosystem (Lane, Kruuk, Charmantier, Murie, & Dobson, 2012) and posing the second greatest threat to biodiversity after habitat loss. While this can be a normal part of ecosystem evolution, the problem is the rate at which this change is taking place due to climate change (Szyniszewska, n.d.). Climate change, including increased temperature and precipitation, which are key to determining the range of species, put stress on native species currently residing in ecosystems, making them vulnerable to invasive species that compete for scarce resources, which in some cases eliminates the native species while threatening biodiversity (ibid.).

Environment Yukon has documented over 154 introduced plant, animal and aquatic species in the Yukon, 20 of which are categorized as invasive (Environment Yukon, n.d.). None of the 20 species listed are animals. Efforts are currently underway to develop an aquatic invasive species (AIS) framework to prevent, monitor and manage AIS (Leung, 2016). Sixteen AIS are listed for Yukon, with Didyo, Zebra mussels, New Zealand Mud Snails and waterweed listed as the top five in terms of their risk (Leung, 2016). Clearly these species will have consequences for the ecosystems they invade, although the report does not assess the consequence to traditional food species specifically.

The people of Yukon have also noticed new species in and around their communities. While these species may not be invasive by definition, they will nonetheless have impacts on ecosystems. In Beaver Creek, deer, cougar and lynx have appeared along with new unfamiliar plant species (Guyot et al., 2006). In NWT, the Deh Gah Got'ie community members have noticed new bird species and cougars (ibid.). Beavers have made their way to the Arctic coast and can have a large impact on an ecosystem by changing waterways or altering fish habitat (Berner & Furgal, 2005).

Changes in in the availability of species can alter the nutrients available to Yukon First Nations and others who depend on them for their food source both, negatively and positively (Guyot et al., 2006). For example, nutrients from geese may decrease as the goose hunt period shortens due to climate change, but people begin hunting deer, which were not previously available. This will require adaptive strategies that prevent people from turning to less nutrient-dense market food – further discussed below.

b. Access

Accessing traditional food sources has much to do with the ability of hunters and gatherers to get out on the land. Weather, ice conditions, water levels and much more could create conditions that affect accessibility of traditional food. Further, the ability to predict and adapt to these conditions is paramount to accessibility.

Traditional knowledge passed down through the generations regarding seasons, weather, safety when on the land, has ensured Indigenous peoples' success for many generations. However, a general consensus has emerged amongst Indigenous elders that the reliability of this knowledge has decreased with the advent of climate change (Downing & Cuerrier, 2011).

i. Traditional knowledge of seasons and weather patterns

Getting out on the land has always been contingent on the season and the weather. Elders are well known in their communities for being able to read the weather, horizon, and more to determine if the next day might be conducive to hunting, fishing or gathering. With the abrupt transformations from climate change, elders' ability to predict the weather has diminished, making it increasingly dangerous to go out on the land. While technology has attempted to replace this knowledge, it is not always as effective or location specific as traditional knowledge. Some communities have seen a reduction in the hunting season, due in part to the inability to travel on the land or ice (Downing & Cuerrier, 2011) (Kluane First Nations & Arctic Institute of Community-Based Research, 2016).

ii. Changes in hunting, fishing and gathering season due to weather patterns changing

Indigenous peoples have observed many of these changes, especially with regards to the shifting hunting and gathering seasons (Downing & Cuerrier, 2011) (Kluane First Nations & Arctic Institute of Community-Based Research, 2016). Goose hunting season has shortened (Guyot et al., 2006), caribou migration routes have changed and bird species formerly unseen have appeared. As hunters learn the new migration routes and timing, they may have less success, impacting food security. Some migration routes, as already seen with caribou, may move out of the range of certain communities, making it impossible to hunt them despite availability in other regions. Berry ranges are also shifting.

iii. Safety while hunting, fishing and gathering

Due to changing weather patterns and conditions, for example rain occurring earlier in the winter causing slush to form under the snow; safety is being compromised when out on the land hunting, fishing and gathering (Guyot et al., 2006, p. 411). The same applies to ice quality and thickness, which can delay typical fishing, harvesting, and trapping seasons (ibid) (Archer et al., 2017). Wind, especially in coastal regions, is also a safety factor (Archer et al., 2017). The irregularity of weather patterns with climate change and may compromise the capacity of elders to predict weather thus decreasing the safety of hunting.

Longitudinal studies in the Arctic have demonstrated that these changes and their impacts on hunting are accelerating (Archer et al., 2017). This has led to a 3 x higher rate of accidental injury in regions such as Nunavut (Clark, Ford, Pearce, & Berrang-Ford, 2016), leading to calls for improved search and rescue services, amongst other measures. It has also shortened hunting seasons, as travel on established routes, often on ice or permafrost, is only possible for shorter periods of time (Downing & Cuerrier, 2011).

c. Quality of Traditional Food Sources

i. Climate change induced stress and disease

Climate change can increase stress in humans just the same as it does for plants and animals. This stress leaves animals and plants more susceptible to disease from viruses, bacteria and parasites, which can lead to

widespread die-offs in some cases (Berner & Furgal, 2005). When this happens, as was seen during El Nino, die-offs leave space in the ecosystem for new or invasive species. Some already existing diseases will increase in prevalence as they may benefit from warmer temperatures. It is expected that climate change will bring about greater disease and epidemic occurrences for all species (ibid.).

As we have already seen, the impact of climate change on the availability or accessibility (ex: due to ice) of food for animals (such as caribou) can lead to reduced health and population numbers (Berner & Furgal, 2005).

ii. Food safety and zoonotic diseases

It is expected that higher temperatures due to climate change will increase the prevalence of parasites in traditional food sources and introduce new zoonotic infections from more southern ranges. Zoonotic diseases are infections that can pass from animals to humans directly or indirectly through the environment (Prowse & Furgal, 2009). While many zoonotic diseases already exist in the Arctic, stress from climate change may increase the prevalence of the disease and thus increase the threat to human health. Some zoonotic diseases of concern include: tularemia, rabies, brucellosis (Malta fever or Bang's disease), echinococcus (tapeworm), and cryptosporidium (Berner & Furgal, 2005).

Warmer weather and permafrost melting present food safety problems for communities. Due to warmer weather, meat or fish may go bad before arriving home (Downing & Cuerrier, 2011). Caches or traditional cellars – holes cut in the permafrost and covered with rocks or other items – provided a safe way to store meat through the winter, which is no longer the case where permafrost has melted (Downing & Cuerrier, 2011).

As new and invasive species move north they will also bring their diseases with them. With the increased northern range of the beaver bringing the parasite Giardia, water in the wilderness has become unfit for human consumption as well as impacting other animals (Berner & Furgal, 2005). Giardia also affects caribou, who travel great distances bringing the parasite with them. Introducing new infectious agents to species that have not been previously exposed to them holds the potential for devastating effects.

iii. Nutrient value and taste of food

About 38% of women across Canada's Arctic agree that the quality of traditional food has changed recently, including decreasing availability and physical change (Lambden et al., 2007). Berries, according to some, have changed in abundance and quality, stating that they no longer taste the same (Downing & Cuerrier, 2011). Members of the Kluane First Nations have noticed that their fish is duller in colour, has more parasites, are smaller in size, have softer texture and less taste (Kluane First Nations & Arctic Institute of Community-Based Research, 2016). Assessments of the nutrient content of foods due to climate change were not found.

Impacts of Climate Change on Access, Availability and Quality of Local Agricultural Food

The overall consensus is that the capacity of northern regions to grow food, including crops and animals, will increase in the coming decades due to climate change (Hassol, 2004). This is largely due to the higher temperatures, longer growing seasons and greater precipitation (in some regions) that will make the ecosystem more conducive to a wider range of domesticated species. Land suitable to agriculture is also likely to expand as permafrost melts; however, the quality of soil and its suitability to agriculture remain the limiting factor.

Other non-climate related limiting factors for agriculture and local food production in Yukon include: lack of infrastructure, small population base, remoteness from markets and land ownership (Hassol, 2004).

Greater production of food locally does not necessarily result in greater consumption of local foods. Food systems are currently designed to get the cheapest food possible shipped to consumer retail centers. They are not designed to support local economies, local farmers or the health and food security of local/regional populations.

The Yukon Government released its Local Food Strategy 2016-2021 (Yukon Energy, Mines and Resources, 2016), which contains over 50 recommendations that address many of the issues raised below. The Yukon Food Security Roundtable will oversee and coordinate actions to advance this strategy. No progress report was found. It is also unclear if any baseline data was established for this strategy.

It should be noted that the following does not include a review of agricultural production data for the Yukon due to the scope of this review, but it attempts to stay focused on literature related to consumption.

Please see Table 2 below for a summary of the following impacts.

a. Availability of Local Food

The impacts of climate change on the availability of local food have several dimensions that will be explored below.

i. Crop yield

Average annual yield of agricultural production is expected to increase across the arctic and sub-arctic in the decades ahead (Hassol, 2004). Due to warmer temperatures, growing degree days (GDD) have already increased by about 20% in Alaska (Anisimov et al., 2007).

The Yukon Government and Environment Canada monitor the climate in the four regions where agriculture takes place. It was reported in 2012 that the Effective Growing Degree Days (EGDD) was close to the ten year average with Haines Junction having received 100 mm more precipitation than normal that year (Matthew Ball & Reaume, 2012). Data is also used to define agroclimatic capabilities based on GDD, which is calculated based on the average daily temperature minus 5 C (considered the minimum temperature required for cool season crop growth). Based on this and numerous other considerations (length of day, number of frosts during growing season, etc.) soil in different regions is given a 'class' categorization that indicates the types of crops that the soil can sustain. Without an in-depth analysis, the numbers reported in Ball & Reaume (2012) provide no indication that the GDD is increasing at the research farm and thus the land capability class also appears to be stable. However, they do report that central Yukon provides better conditions, with four of the past 10 years categorized as Class 2, which only slightly restricts the range of crops.

There are some limiting factors to the increase of crop yields. The availability of cropland is a factor in the production of local food, and currently less than 2 percent of Yukon's surface is suitable for agriculture due to climate, soil quality and geography. While this may expand, much of the land suitable for agriculture is deficient in key nutrients required for agriculture (Matt Ball, Hill, & Whelan, 2012). Water will also be a limiting factor in the increase of crop yields, as it is expected that the increase in precipitation predicted in boreal forest regions will be countered by higher temperatures and increased evaporation (Hassol, 2004). To counter this, irrigation is recommended.

ii. Crop range and diversity

The class of a soil determines its ability to support agricultural activities, ranging from Class 1 soils that have no significant limitations on the production of common Canadian crops to Class 6 soils that have severe limitations so that cropping is not feasible. These classifications are based on GDD, discussed above and further described in Ball & Reaume (2012). The range and diversity of agricultural species is thus directly dependent on the GDD, which themselves are dependent on temperature. As GDD increases in the Yukon due to rising temperatures, so too will the range and diversity of crops that can be grown.

iii. Domestic animals

No information specific to climate change impacts on agricultural animals in Canada's north was found.

b. Access to Local Food

If a Yukon citizen decided today that he wanted to buy local food, would he be able to find it? And how might that ability to access local food be impacted by climate change? The following outlines some key factors. Again, the Yukon Local Food Strategy addresses many of these issues.

i. Distribution infrastructure

Local food distribution systems in Yukon rely largely on direct marketing and direct farmer to consumer relationships. The Yukon Government's Local Food Strategy (Yukon Energy, Mines and Resources, 2016) identifies processing, transportation and storage as one of many priorities that need to be addressed in order to increase the availability of local food that is safe and high quality and accessible at Yukon grocery stores.

Infrastructure for distribution of food, such as roads, runways and stores, is at risk due largely to permafrost melting and extreme weather events (IPCC 2014) (Anisimov et al., 2007). Thus, any infrastructure plans will require climate change readiness planning.

ii. Cost

Due in part to increased difficulties with distribution, it is predicted that the cost of food in northern Canada will increase. Already, there is great variability between the cost of food in different communities in the Yukon ranging from $274.78 / week for a family of four in Whitehorse to $500.24 / week in Old Crow (based on Health Canada's Revised Northern Food Basket) (Hammond, 2017). In general, local food costs more than 'imported' market food due largely to the lack of infrastructure to make it efficient, and this is also the case in the Yukon (Yukon Energy, Mines and Resources, 2016). We can expect that climate change will lead to some disturbances in crop production and distribution and that this might drive the cost of local food up. However, as production increases and the infrastructure is put in place to support the local food economy, the Yukon may see prices drop. It goes without saying that growing your own food in a garden provides significant savings.

c. Quality of Local Food

Food produced locally can generally provide greater freshness due to the proximity and lesser time required to get from field to plate. That said, the majority of local food is harvested or slaughtered at the same time of year in the Yukon. For foods that might be sold in a different season than produced (potatoes, meat, etc.) storage becomes an important factor in ensuring ongoing quality (Yukon Energy, Mines and Resources, 2016). Yukon's Local Food Strategy has led to greater investment in food storage infrastructure so that Yukoners are now able to get some local food through winter.

Climate change will lead to greater levels of CO2 in the air, which has been found to increase the growth of plants that livestock eat. However it has also been found to reduce the quality of these foraging plants, such as alfalfa, by decreasing the protein content and thus impacting on livestock wellbeing (US EPA, 2015).

Table 2: Summary of Climate Change Impacts on Traditional and Local Food Consumption

Result of CC	**Impact on Ecosystems**	**Impact on Traditional Food Species, Local Food and capacity to consume them**
↑ temperature	Shift northward of ecological and vegetation zones ↑ evaporation, leading to dryer land ↑ Boreal forest ecosystem ↓ tundra habitat, 'shrubification' ↑ beavers numbers and range, altering water systems	↑ length of growing season, more food for TF species to forage ↑ capacity for agriculture Change in migratory patterns and ranges occupied by different species Potential for new invasive species to displace TF species Possible extirpation ↑ capacity for forest foods Difficult to dry meat, more spoilage Less gear needed on the land = more space for TF on skidoo Ease of travel on the land in warm months ↓ birds and fish that rely on tundra habitat ↑ prevalence of zoonotic parasite giardia
	↑ forest fires	↑ forest habitat disturbance ↑ moose foraging plants and thus # moose (possible) ↑ displacement of communities and hunting sites (possible)
	↓ permafrost	↑ potential area for agriculture ↑ disruption of transportation infrastructure and other infrastructure
	↑ Parasites and insects in summer	↑ Stress/motion leading to less foraging ↓ health of affected species (i.e., caribou)
	↑ temperature of water	Soggy fish flesh (not eaten) ↑ water borne parasites
	↑ Extreme weather events	↑ disruption of transportation infrastructure ↑ disruption of agriculture
↑ precipitation	Shift in ecological and vegetation zones (see impacts on food above) ↑ forest habitat	↑ capacity for agriculture ↓ population bird, fish and grazing species Possible extirpation Smaller berries
↓ Sea ice extent and thickness ↓ quality and thickness of	↓ salinity of ocean surface ↑ coastal erosion	↑ Marine transport access for food ↑ tourism and resource development ↓ Ability to travel on lakes and rivers in winter ↓ days on the land/ice for harvest ↑ accidents while out on the land ↓ harvest amount

river and lake ice		
↓ Snow cover and length of winter	↑ Terrestrial ice ↓Access of animals to food/nests ↓ Insulation for plants Earlier spring run-off	↓ food access for animals ↓ Current and known plant and animal species required for food security ↓ amount of berries
↑ river flow, earlier Changes to glacial runoff	↑ Sea levels ↓ Ocean salinity Shift in hydrological system	Disruption of river ecosystems, including species that depend on them

The format and some of the content is from Guyot et al. 2006

Traditional and Local Food Consumption – Patterns, Factors and Links to Climate Change

We cannot say with any certainty whether traditional or local food consumption is increasing or decreasing in Yukon due to a lack of comparative studies. There are, however, a number of studies that assessed consumption patterns at one point, which could thus act as baseline data for the current study being scoped. In order to support this contemplation of next steps, these studies are summarized here in some detail.

a. Traditional Food Consumption and Diet – Review of Studies

The Centre for Indigenous Peoples' Nutrition and Environment (CINE) at McGill University undertook a study entitled **'Yukon First Nations' Assessment of Dietary Benefits/Risks'** (Olivier Receveur, Kassi, Chan, Berti, & Kuhnlein, 1998) between 1995-98 in collaboration with Yukon First Nations, primarily driven by a concern over environmental contaminants in traditional food sources. Similar studies were completed in Northwest Territories and amongst Inuit in Nunavut, but these are not discussed here. There were several research objectives, but the ones of relevance to this study were to determine quantitative estimates of traditional and market food consumption in Yukon First Nations, and to establish baseline dietary intake data. Researchers trained and worked with community researchers to collect a wealth of information about the traditional food diets of Yukon First Nations.

Methodology: This was a participatory research project, with clear collaborative agreements with YFN communities, CYFN and YCC, and consultation about methods, results, etc. Offers to participate were extended to all YFN communities, and 10 accepted (Dawson City, Mayo, Carmacks, Ross River, Watson Lake, Lower Post, Atlin, Carcross, Burwash Landing and Beaver Creek). Random samples of 25 households or 10% of households (whichever was larger) with one man and one woman identified from each household were chosen to participate. Individual data was collected with trained community researchers through an interview, which included:

- Food frequency questionnaire of traditional food: to determine frequency with which 107 traditional food species (for list see Appendix B of Receveur, et al 1998) were consumed in previous 3 months (< 1x/week; 1-2 x/week; every other day; every day or so).
- 24-hour dietary recall: a detailed recall of food eaten the previous day, including portion sizes, repeated when data was questionable.
- self-reported height and weight, or measured when participant agreed

- sociocultural questionnaire: a series of 27 questions collected data related to perceptions, preferences and household demography

Interviews were conducted twice, with 409 individuals in the late winter 1995 and with 444 individuals in the fall of the same year.

Nutrient analyses of dietary data were done using two food composition databases. This will not be discussed in detail as nutrient analysis is outside the scope of this report. Community data were also collected including: a food price list; a harvest calendar; food sample collection, which underwent nutrient analysis, proximate analysis, mineral analysis, and contaminant analyses.

Results: The food intake research found that 70% of households reporting hunting or fishing in the last 3 months, 58% collected plants and 18% planted a garden. Traditional food was consumed on average 57% of the days, and included more than seventy species of plants and animals (Olivier Receveur et al., 1998). Summer consumption was highest (80%) and winter the lowest (40%). Thirty-nine percent (39%) of respondents said they would not be able to afford the store-bought food that would be needed to replace their traditional food consumption. Young adults were found to consume less traditional food. Traditional food provided between 9 – 38% of total dietary energy, depending on the community.

A detailed analysis of the nutritional content and environmental contaminants was conducted to assess the risks and benefits of food use. Overall, they found that traditional food diets were healthier than market diets based on an assessment of fats, vitamins and minerals and recommended the promotion of traditional food diets for improved health and overall wellbeing (Receveur et al., 1998). They also found that the risks due to contaminants were relatively low, with the exception of trout and salmon if consumed at high levels.

See Table 6 and 7 of Receveur et al. 1998 for details of the percentage of the population consuming each traditional food species and the frequency with which they consume it. Table 10 lists the average daily serving for all traditional food items reported in the recall study. Researchers used data from 24-hour recall by age/gender with average daily servings, along with food frequency data, to calculate daily intake estimates for summer and winter and estimates for yearly consumption per capita, listed in Table 11. The researchers suggest that this data could be used to estimate population level consumption to cross-check harvest study estimates.

This same data was later analyzed by Batal et al. (Batal, Gray-Donald, Kuhnlein, & Receveur, 2005) who estimated the average daily intake of different traditional food species (see Table 3), by category (e.g., land animal meat) and the per capita food use. These findings are presented alongside findings from the same study that was conducted with the Denendeh in the Northwest Territories. The methodology used in this study draws on both the food frequency and the 24-hour recall data to calculate median daily intakes by food categories (land animal meat, dried land animal meat, fish flesh, fish organ and bird meat). These median daily intakes were used to quantify findings from the food frequency questionnaire. These numbers were then used to calculate per capita food use (see Table 5). The authors state that 'no other daily intake figures available in the literature would have been as appropriate for this exercise' (Batal et al., 2005a, p. 53).

Some of the findings from Batal et al. (2005) are presented in the tables that follow for the sake of clarity. The data presented in this paper was for the most common foods consumed during the 1990s, stating that a complete list of all traditional foods consumed is available upon request. Food items identified as a priority for this scoping review for which data is not available in this paper, but could be obtained in the future, are written in red (Table 3).

Table 3: Median daily intakes, by sex, for Yukon First Nations consumers in grams of traditional food

Food	Female (n=401) Median Daily Intake (g)	Male (n=347) Median Daily Intake (g)
Land Animals		
Caribou Barrenland meat, baked	281 (n=6)	338 (n=1)
Caribou meat, dried	36 (n=1)	47 (n=1)
Caribou woodland meat, baked	113 (n=15)	197 (n=12)
Moose meat, baked	225 (n=137)	245 (n=139)
Moose meat, smoked/dried	120 (n=15)	170 (n=17)
Rabbit meat, baked/boiled	189 (n=12)	214 (n=14)
Ground squirrel		
Beaver		
Fish		
Trout flesh, baked	225 (n=7)	337 (n=4)
Whitefish flesh, baked	225 (n=1)	225 (n=2)
Salmon		
Birds		
Black duck flesh, baked	113 (n=1)	225 (n=1)
Grouse		
Plants		
Berries		

Reproduced from Table 1 of (Batal et al., 2005)

Table 4: Median weights of daily servings

Food Category	Female (n=401) Median (g/day)	Males (n=347) Median (g/day)
Land animal meat	225 (n=194)	263 (n=188)
Land animal meat, dried	113 (n=17)	145 (n=18)
Land animal organs	169 (n=8)	86 (n=6)
Fish meat	184 (n=26)	225 (n=19)
Fish meat dried	--	--
Fish organ	363 (n=2)	338 (n=2)
Bird meat	113 (n=1)	225 (n=1)
Plants	40 (n=9)	28 (n=5)

Reproduced from Table 2 of (Batal et al., 2005)

Table 5: Per Capita Food Use by Season and Sex (grams / person / day)

Food	Summer		Winter	
	Female mean	Male mean	Female mean	Male mean
Land animal meat	158	179	103	118
Land animal meat, dried	28	30	13	13

*Total Land Animal (with conversion)**	*230*	*256*	*136*	*150*
Fish meat	98	99	24	29
Fish meat dried	12	15	3	3
*Total fish (with conversion)**	137	156	36	42
Total Bird meat	9	14	3	4
Total Plants	19	13	8	4
Total Wet Traditional Food	281	305	139	154
Total Dried Traditional Food	40	45	16	16
Total Traditional Food (with conversion)*	**396**	**439**	**183**	**199**

Reproduced from Table 3 of (Batal et al., 2005)

* Conversion of dry weight to wet/fresh weight

Numerous studies also used this data to conduct further analysis of Yukon First Nations diets (as well as Denendeh and Inuit). The study did not analyze the variation between communities.

Studies of children during the same time period demonstrate the dietary transition that is taking place in First Nation communities in Yukon and elsewhere. Most studies show that children are consuming less traditional food (TF) than their parents or elders and that children from more northern communities are consuming more TF then their southern counterparts (Nakano, Fediuk, Kassi, & Kuhnlein, 2005) (O. Receveur, Boulay, & Kuhnlein, 1997) (Harriet V. Kuhnlein & Receveur, 2007) (Morrison et al., 1995). In one study of Yukon First Nations and Denendeh children using 24 hour recalls, only 4.5% of total energy from food was derived from TF, although this went up to 10.7% in Old Crow and down to 0.4% in Carcross. Children who had eaten more TF had also consumed more micronutrients of interest (Nakano, Fediuk, Kassi, Egeland, & Kuhnlein, 2005) (Harriet V. Kuhnlein & Receveur, 2007), much like the YFN Dietary Study found for adults (Olivier Receveur et al., 1998). Of health concern is that Dene/Métis and Yukon First Nations children are getting more than 90% of their total daily energy from grains and 'other foods' (snack foods that don't fit into other categories of foods, such as sweets, chips, etc.) which constitutes high risk for chronic disease development (Kuhnlein & Receveur, 2007). On days when TF is consumed, dietary quality is higher, making TF an important part of health and wellbeing in more ways than one (ibid.).

Factors, aside from climate change, that have an influence on the amount of TF consumed include: TF availability; availability of affordable MF; prevalence of hunting and fishing; and population size (Nakano, Fediuk, Kassi, & Kuhnlein, 2005). Other factors include access to harvesting equipment and availability of time to go out on the land (Schuster et al., 2011).

Without weighing into the literature about contaminants, we can draw on the conclusions of literature, which conclude that the benefits of consuming TF outweigh the risks (H. V. Kuhnlein, Receveur, & Chan, 2001). Benefits cited include: health benefits, both from consuming food rich in micronutrients and low in fat and

sodium; increased physical activity that comes with hunting, gathering or fishing; taste and cultural preferences; children's education; and savings on the cost of market food (H. V. Kuhnlein et al., 2001).

Studies that pre-date the YFN Dietary Study came to similar conclusions – that YFN households use TF on average 400 times in the year, with moose being consumed on average 95 times per year, caribou 71 times, salmon 22 times, berries between 11-14 times per year depending on the berry (Wein & Freeman, 1995). This study also found that the further north or remote the community, the more frequently TF was consumed (Wein & Freeman, 1995).

Shuster et al (2011) conducted research on TF and food security in 2007-2008 by repeating food frequency questionnaires originally administered by Wein and Freeman in Old Crow (Vuntut Gwitchin First Nation) and Teslin (Teslin Tlingit First Nation). In addition, they administered questions from the Household Food Security Survey Module (HFSSM). Their findings show that in the 15 years between the two studies, at least in these two communities, the frequency of TF consumption had not changed significantly. The Vuntut Gwich'in of Old Crow reported that they ate TF 582 times per year, compared to 443 in 1992, with a median consumption of 259 g/day or mean consumption of 367 g/day (Schuster et al., 2011). Data shows that consumption of salmon, other fish, berries and TF plants all increased since 1992, with caribou, Labrador tea, Chinook salmon, blueberry and salmonberry being consumed the most often in 2008 (Schuster et al., 2011). The results for the Teslin Tlingit in Teslin were similar, with consumption of moose, trout, blackberries, raspberries and cranberries being the most frequent. TF was consumed an overall median of 386 times per year in 2008, with median consumption of 182 g/day and mean average of 185 g/day. In 1992, they consumed TF 498 times per year. Twenty-six percent of households in both communities reported not getting as much TF as they would like, possibly indicating traditional food insecurity. According the HFSSM results, 48% of Vuntut Gwich'in households were food insecure, with data from Teslin being hard to interpret due to refusal of a large number of participants to answer questions from the HFSSM.

b. Rates and patterns of traditional and local food consumption in Yukon

According to Schuster et al., rates of traditional food consumption in the Yukon did not change significantly between 1992 and 2007-8. This does not tell the entire story, however, since it is obvious that TF consumption increased in Old Crow and decreased in Teslin, pointing to the need for community-by-community analysis. If we look at a species by species analysis, consumption of some species has increased while others have decreased. This data is now 10 years old and begs the question why – why did consumption of some species increase while others decreased? Could this be due to lack of species availability, possibly linked to climate change? Why did TF consumption go up in one community and down in the other? This study also attempted to combine food frequency data with food security assessment, although this was not possible due to incomplete data.

No studies were found that attempted to quantify the consumption of local food in Yukon like the studies on traditional food above, so no rate or pattern can be discerned at this time.

c. Determining causation: Nutrition transition and climate change

Even if dietary change and consumption of traditional or local food could be detected through a food frequency or 24-hour recall, this would not tell us why these changes were taking place. It is well known and documented that Indigenous Peoples globally are undergoing significant nutritional transitions, and the same is true in Yukon, as demonstrated by younger generations consuming significantly less traditional food than older generations within the same community. This might require a different set of questions, much like those that

accompanied the studies described above, that would inquire into the reason for changes in traditional food consumption.

The question then becomes – is repeating the 24-hour recall or food frequency research the right way to get at this question regarding the impact of climate change on diets? Does the change in diets need to be quantified in order to inform future actions?

Food Related Adaptation Strategies to Climate Change

> *"If we work together and build off of our current initiatives with our strengths in mind, we can ensure our children and our children's children will be able to walk this land as our ancestors did before us."*
> (Selkirk First Nation & AICBR, 2016, p. 11)

Northern and Indigenous communities have coped and adapted to changing and harsh climates for thousands of years, and there is no reason to think that this can't continue. The major challenge will be to ensure that traditional ways continue to persist in the face of change. Many fear that the loss of traditional food species will lead to a greater reliance on market food, leading to greater chronic disease (Berner & Furgal, 2005). When Indigenous people lose traditional foods, they also lose a significant part of their culture, language and identity.

The Intergovernmental Panel on Climate Change defines adaptation as: "The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects" (IPCC, 2014). It is important to understand that climate change is only one of the big waves of change in the Artic and sub-Arctic, with globalization, increased demand for natural resources and increased tourism all driving more interest and traffic to the North (AMAP, 2017).

There is no 'one size fits all' when it comes to adaptation due to the diversity of communities in the North (AMAP, 2017), which means that community engagement, collaborative partnerships, and community-based research that integrates traditional and scientific knowledge, effective communication and learning about others' success, and local coordination become tantamount to the success of adaptation (AMAP, 2017). These processes allow for communities to develop their own modes of adaptation and make important decisions about their future. Local adaptation is key to assembling the building blocks of wider territorial or national strategies. It is at the community/local level, where climate effects are felt, thus it must be at the community/local level where solutions must be made. Comprehensive policy, frameworks and strategies will not impact change if they do not have mechanisms, funding and other supports to implement recommendations, include inter-jurisdictional and interdisciplinary partners in the process, harness innovation and sustainability, promote sovereignty and local governance, and monitor progress on all fronts (ibid.).

In communities that are still dependent on traditional food in both Indigenous and non-Indigenous populations, food security can be an indicator of climate change (AMAP, 2017). Although, as agriculture is a major contributor to climate change, building sustainable food systems can also be a mechanism for mitigating climate change and adapting to its effects. Because traditional diets are so deeply affected by climate change, governments must support community strategies through policies and funding that support traditional food security as part of their climate change adaptation strategies (AMAP, 2017).

In a recent project between the Selkirk First Nation and AICBR, community strategies were developed to both adapt to climate change while sustaining and strengthening tradition (Selkirk First Nation & AICBR, 2016). They identified six themes to guide their work which could be guidelines for this work moving forward:

- Keep our tradition
- Connect youth to the land
- Raise our voice locally, regionally and internationally
- Think outside the box
- Decision making is key
- These can all be accomplished through a community-based food security strategy

Conditions required for adaptation to be successful

Local coordination, community decision making and governance

Climate change is currently displacing millions of people and this number is expected to rise to 200 million by 2050. Due to the fact that Indigenous peoples throughout the world are amongst the poorest peoples, it is expected that climate change will affect them disproportionately, threatening their existence and presenting a major human rights and equity issue (Division for Social Policy and Development Indigenous Peoples, n.d.). In order to ensure that the mistakes of the past are not repeated, where Indigenous people were displaced during the course of colonization, Indigenous people need to be at the decision making table regarding climate change adaptation strategies (Downing & Cuerrier, 2011). Not only is this vital to advancing Reconciliation, but Indigenous knowledge can both inform and strengthen community and government adaptation strategies (Lynn et al., 2013).

Governance mechanisms need to be improved in order for adaptation strategies to be most effective (AMAP, 2017). Some of the key factors to governance that works to support adaptation include: adaptability, ability to respond quickly, flexibility, multi-scalar relationships to allow for coordinated action across different levels of government, co-management structures, action on short-term and long-term goals, a recognition of the context (AMAP, 2017). In a review of the literature on food insecurity in the North, Loring & Gerlach (2015) recommend a renewal in participatory research methods and food security interventions that support the right of communities to make decisions about their own food systems (especially in the context of climate change and increasing interest in the North). Food sovereignty is a key issue for Northerners, and for Indigenous populations in particular.

Policy change and advocacy

Policy change and coordinated multi-stakeholder strategies will be required to advance work to adapt the Yukon food system to climate changes. In a recent study of Nunavut climate change adaptation, researchers found that despite 700 discrete adaptation initiatives, few actions for planned adaptation such as changes to policies, climate adapted bylaws for building codes or plans for emergency preparedness (Labbé, Ford, Araos, & Flynn, 2017). The authors point to the need for monitoring and evaluation of adaptation strategies to ensure that talks, strategies and policies turn to concrete action. Ultimately, civil society will need to hold governments accountable to their commitments to support climate change adaptation. Non-governmental organizations and community champions play a vital role in advancing change on the ground and can be important allies and resources to achieving government mandates; a coordinated response to the complex issues facing today is paramount. There needs to be adequate support and recognition of this relationship and the important role civil society takes in climate change adaptation and advancing food security, among other environmental, social and health issues.

Monitoring climate change, health indicators and adaptation strategies

It's hard to adapt to something if you can't see it, and the impacts of climate change on health, food security and the environment require more than just two eyes to see them. Integrating science and traditional knowledge to counteract and adapt to climate change effects has great potential. This is often referred to as "two-eyed seeing".

One way that communities can empower themselves to adapt to climate change is by identifying, selecting and monitoring indicators of climate change and/or the impacts on the health of the community (Berner & Furgal, 2005). This knowledge can be strengthened by Traditional Knowledge of the land and weather patterns; not only does this tell community members about what change is taking place and how fast these changes are happening, but it can also help them project into the future and plan for those eventualities, using the wisdom of the past as keys to future adaptation. For example, a community might decide to monitor ice thickness and the date of break-up on their river. After a few years, this could provide them with useful information including: trends in break-up dates; providing points of reference for current conditions; enhancing the ability to anticipate hazardous conditions; and allowing communities to identify cause and effects so people can be warned, eventually reducing injury. Where once Elders knew the rhythms of the seasons, these rhythms are changing so this type of information could help communities to make important decisions related to community members' safety (Berner & Furgal, 2005). Humans, like all species have always adapted to their surroundings. Indigenous communities in particular, with their strong knowledge of the land, have much to teach the rest of the world in future adaptations.

A research project called the Yukon-Kuskokwim Delta Berry Outlook: Identifying berry vulnerabilities to climate and landscape change using traditional and scientific knowledge (IARPC Collaborations, 2018) (that does not appear to have been published yet) poses an interesting and potentially low budget participatory research methodology linking traditional food, climate change and adaptation. They used a combination of cultural consensus surveys (to identify if there is shared knowledge about drivers of berry resources), participatory mapping (to determine if berry locations are changing) and ecological data collection (existing data from weather stations and permafrost monitoring).

Berner et al. (2005) provide some useful guidelines for developing these indicators as well as some examples of direct impact mechanism indicators (e.g., rates of unintentional injury or cold injuries, highest and lowest seasonal temperatures) and indirect impact mechanisms indicators (e.g., the arrival and departure dates of migratory species).

While these could be established community by community, they could be even more powerful if communities across the Yukon were monitoring the same indicators in collaboration with the Yukon government, in order to establish a collective understanding of phenomenon and to share adaptation strategies.

The Yukon Government through its Climate Change Action Plan is currently monitoring the following indicators to build territorial understanding of climate change impacts (Yukon Government & Climate Change Secretariat, 2016). The Action plan includes research for innovation and monitoring as well as outreach through curriculum for K-12 students. Some research of interest to food systems include the monitoring of:

- Impact of climate change on snowshoe hare survival
- Keystone boreal species trends
- Permafrost temperatures

Numerous other initiatives are listed in the Yukon Government's Climate Change Action Plan Progress report (Yukon Government & Climate Change Secretariat, 2016). The Yukon Water Strategy and Action Plan might also contain some points of interest but was not explored.

No concise listing and description of climate change adaptation initiatives could be found for the Yukon, nor could any evaluations of these initiatives be found.

Adaptation strategies currently underway

Increased reliance on market food

As food becomes scarce in the bush, people will have no choice but to find it elsewhere, and the easiest place to find it will be the store. As discussed above, this is currently a strong trend in Indigenous populations. This presents a host of challenges, as the cheaper, more affordable foods are also the highly processed, high fat, high sodium, high sugar foods that are responsible for increased rates of chronic diseases including diabetes, heart disease and cancers. Given this reality, the above-mentioned in-store healthy food promotion activities may very well be an important component of adjusting to climate change.

More concerning still is the impact that this will have on food security, as many who rely on traditional foods may not be able to afford to buy the equivalent protein at stores. As the cost of food goes up so too will the reach and impact of food insecurity.

Increased Local Food Production

Governments, businesses and other actors throughout Canada are supporting the reorientation of food systems to become more localized. This not only helps achieve greenhouse gas emissions objectives but also supports the local economy and sustainable development goals. As mentioned above, the Local Food Strategy for Yukon presents an exciting opportunity to further develop the local food system in the Yukon. However, it should be executed with a clear analysis of both food security and traditional food security so that it does not exclude low-income and First Nations peoples from the benefits of the local food economy.

The Yukon Government funded a number of Community Climate Change Adaptation Projects (2006-2012), some of which resulted in community greenhouses and farmers' markets. The Effects of Melting Permafrost on Agricultural Capacity Project (2012-16) was aiming to help current and future farmers adapt to changes in permafrost (Yukon Government & Climate Change Secretariat, 2016) although it could not be found online.

Changes in hunting, fishing and gathering practices

> "There are many spots that we used to fish that are no longer safely accessible due to changing environment and thin ice."
> (Kluane First Nations & Arctic Institute of Community-Based Research, 2016, p. 28)

Community members report having adapted to changing climate and weather by changing when, where and what they hunt, fish or gather. "The change is so gradual that we adapt without even noticing, our ability to adapt kind of makes it easier, we change without even knowing, we do what we have to do" (community member interviewed by Guyot et al., 2006, p. 411). In Selkirk First Nations, people report changing their fishing

habits by eating different fish, cutting back on fishing and releasing females (Selkirk First Nation & AICBR, 2016).

Due to changes in weather and seasons, migratory animals such as geese and ducks are coming earlier, changing the timing of when people need to be out on the land. According to Deh Gah Got'ïe First Nations members, the goose hunting season had already shortened by approximately one week, twelve years ago when the study was conducted (Guyot et al., 2006). The increase in severe storms makes it more dangerous to be out on the land, decreasing the number of days people can be out. Some people have reported decreased travel on water, but dryer weather means travel on land is easier, enabling hunters to travel longer distances and haul greater amounts of food home. Likewise, wetter seasons may lead to a decrease in hunting capacity (Guyot et al., 2006).

In the face of declining caribou, some Indigenous communities have increased their consumption of muskox (Downing & Cuerrier, 2011). Muskox is considered a lower-quality meat and this also implies a shift in cultural identity. New species are also reported to have moved into the Yukon, such as deer, which may provide a new traditional food option for some communities. However, there is also concern over the new introduction of diseases that these animals bring and their potential encroachment on the caribou habitat.

Teaching and adapting with youth

Teaching the next generation about the land and how to hunt, fish and gather is paramount to the continuation of Indigenous identity, ways of life and food security. The sense of urgency amongst Elders and the older generation about this teaching is palpable. As things change quickly on the land due to climate change, the teaching/learning cycle also needs to adapt to the fast pace of change (Archer et al., 2017).

Many of AICBR's projects train and teach youth and empower them to take leadership roles in their communities. For AICBR, this as an integral mechanism of sustainability. In many former research projects, including Keeping Our Traditions at the Fish Camps, youth are trained as researchers. As part of the current YIC4 Training project, AICBR is training Indigenous youth to be climate change champions (AICBR, 2018). This capacity and experience represents an asset that should be leveraged for the upcoming project.

Community-based and government-supported initiatives

The following briefly outlines some of the projects, initiatives and programs from the Yukon and elsewhere that are supporting traditional and local food consumption, or addressing food insecurity through access and education. Only a few were found to specifically be addressing climate change adaptation in their current forms. However, a number of these approaches could be changed to include climate change adaptation strategies. For example, collective kitchens and school food programs have an educational component that could be used to support the development of the taste for new country foods (like muskox or deer) and how to prepare them.

It should be noted that much of the information below is based on knowledge of the author and conversations with steering committee members. Very little information exists about food and climate change adaptation projects online in an accessible format.

First Nations owned/run farms and teaching farms

There has been an increase the number of farms set up in the North with the intention of teaching or that are owned and run by First Nations. Here is a brief overview of some of them:

- In Yukon, the Tr'ondëk Hwëch'in Teaching and Working Farm has made its mark as the only Canadian First nations teaching and working farm school north of the 60th parallel. A collaboration between the Tr'ondëk Hwëch'in (TH) First Nation and Yukon College, it started with a modest vegetable patch in 2015 and had its first students in 2016. They have a bold vision to supply TH families and the surrounding communities with fresh produce, meat and eggs. They plan to establish an abattoir and a food processing facility in the future (" Tr'ondëk Hwëch'in Teaching & Working Farm," 2018).
- In the Hay River, Northwest Territories, the Northern Farm Training Institute (NFTI) was established in 2013 to provide immersive farm training to people committed to improving local food systems, with a majority of trainees being First Nations Inuit Métis ("Northern Farm Training Institute," 2018).
- In Northern Manitoba, Aki Energy is a social enterprise that works with First Nations to start green businesses in their communities, including food businesses. They recently established Meechim Farm in collaboration with Garden Hill First Nation in Northern Manitoba to employ local people, grow affordable food for the local community and overall regain some control over the local economy ("Aki Energy," 2018).
- Greenhouses have multiplied by leaps and bounds in the North, due in part to great interest in greenhouses by funders but also communities. Greenhouses come in many shapes and sizes, with diverse purposes, from individually owned small-scale greenhouses to community greenhouses to industrial greenhouses. The Yukon government produced a report to support the establishment of greenhouses in the North (Rudge, 2013). It is unclear if any northern greenhouses have been established with the goal of growing traditional plants.

Supporting the Adaptation of Traditional Food Species Populations

The Kluane Salmon project is in the early stages of developing an adaptation strategy. As a result of the Slims River (A'ay Chü) drying up, groundwater discharge areas may no longer be accessible for salmon to spawn. The project is working to identify areas of groundwater discharge, identify current spawning areas, and locate potential future spawning areas for egg incubation as lake levels continue to lower.

There are other ideas that emerged from the Selkirk First Nations that may only still be ideas, but are worth mentioning: starting a fish hatchery, clearing creeks, building channels (so fish can pass when levels are low), creating a salmon management plan (Selkirk First Nation & AICBR, 2016). These types of adaptation strategies that emerge from communities require adequate support to enable communities to carry them out.

These projects/ideas fall into a category of projects yet unexplored here that seek to support the adaptation of wild traditional food populations. It would be interesting to see if others exist across the North.

Land Based Initiatives and cultural activities for teaching youth and for healing

A number of programs exist across Canada to support FNIM to get out on the land, many of them focused on healing. There is an array of different program models, but many include a component related to culture, identity and wellbeing rooted in the land that is passed on through teaching about hunting, fishing and gathering. In the Yukon, the Kwanlin Dün First Nation has been running health and wellness programs for many years and received funding in 2014 to expand its land-based healing program at the Jackson Lake Healing Centre. In Nunavut, a number of programs exist including summer healing and cultural retreats, country food programs, men's groups, father and son programs, as well as the Makimautiksat youth camp, all hosted by the Ilisaqsivik Society (Brascoupé, 2015). Health Centres, including the Cree Board of Health and Social Services, are integrating land based activities in health care to improve mental health and healing from substance abuse, trauma and the effects of residential schools (Brascoupé, 2015).

First Nations, Inuit and Métis across Canada are calling for more of these land-based healing centres as they see the interconnection between healing from colonialism and its many effects (ill health, addiction, violence, etc.), and being on the land and learning about traditional food.

In Selkirk First Nations, their first recommendation regarding traditional food and climate change adaptation is to support cultural activities, demonstrating how central this issue is at the grassroots (Selkirk First Nation & AICBR, 2016). Some of the activities they identified included: May gatherings to fish and learn from each other; taking time off to go out on the land; practicing the First Fish Ceremony; practicing story telling; and participating in fish camps.

Yukon Government's Local Food Strategy

In 2015 the Yukon Government conducted a consultation with the public, industry and First Nations regarding the development of a Local Food Strategy for Yukon, which was then launched in 2016. It ambitiously outlines 14 strategies to improve the local food system, from policy changes to improve the accessibility of land to establishing a seed library (Yukon Energy, Mines and Resources, 2016). It is unclear if an action plan and timeline were developed and who is tracking progress on these 14 strategies.

Community Kitchens

Community kitchens are a popular way in the North and the South to support both the social and food needs of people living with food insecurity and poverty. People come together to learn to cook a healthy meal, sometimes eat together and sometimes bring portions home. In some communities, community kitchens have integrated traditional food preparation into their repertoire. It appears that several community kitchens exist in the Yukon, including in Watson Lake.

Food Sharing Networks

There still exists a strong culture of sharing in the North, and many believe that traditional food should not be sold, but shared in keeping with tradition. There is a strong desire to bring back "old ways" such as having kids eating first or re-establishing trade networks, etc. The Yukon Food Security Roundtable meeting heard participants recommend support for food sharing networks and it also emerged through the Selkirk First Nations planning process. It is unclear if efforts or initiatives have been started to strengthen sharing in Yukon or in other Northern regions. Community freezers are one initiative that has become popular in northern communities that support sharing.

Community Freezers

Community freezers have re-emerged all over the North as a culturally informed response to food insecurity in First Nations, Métis and Inuit communities. Hunters contribute some of their catch to the community freezer and some hunters are paid by the land-claims organization through the hunter support program. The freezer acts as a kind of food bank for the local community by providing traditional food to those in need. Much like food banks, community freezers are not always stocked, providing an unreliable solution to those suffering from food insecurity. Also because deep freezes are becoming more popular in households across the territory, shared, community freezers are utilized less (Kluane First Nations & Arctic Institute of Community-Based Research, 2016).

Hunter Support Programs

There are a variety of programs that support hunters by providing funding for equipment, fuel or their catch (to stock community freezers), particularly in Inuit land-claim regions (and also amongst James Bay Cree). Reducing the cost of going out on the land can provide important incentives to continue hunting, trapping and fishing (Duncan & Bailey, 2017). It appears that no such program exists in Yukon.

School Food Programs
School Food Programs (SFP) can provide an important source of nutrients to children who might otherwise not have access to healthy food at home. Some First Nations communities have developed SFP that provide traditional food to children at school ("Transformations - OCIC Transformations Stories," 2018). This creates an important opportunity to not only feed kids and drive down the risk of chronic disease, but also develop their taste for traditional food. Some reserve schools have even integrated hunting, fishing, gathering and transforming of traditional foods into their curriculum, ensuring that kids grow up with at least some skills for living on the land. Some food being is being served in Yukon schools, but there is no widespread program.

Local and Traditional Food Processing and Markets
Processing of local or traditional foods can provide a business opportunity within local communities, keeping dollars and jobs within the community while also promoting and providing local and/or traditional food to the local economy. Inuvialuit is currently developing a traditional food abattoir. Iqaluit has a well-known traditional food market modelled on markets in Greenland that has had mixed success (MacDonald, Huet, Ford, Statham, & MacRury, n.d.).

Herding of Traditional Animals and Commercial Hunts
The Sami of Norway have traditionally herded Reindeer to provide for their people. Likely inspired by this, the federal government introduced 3,000 Reindeer to Inuvialuit Settlement Region (ISR) in response to a decline in the caribou herd in 1935. The herd remains today and the meat is shared amongst families in a similar way to caribou, despite the fact that it must be purchased from the families who herd the animals (Duncan & Bailey, 2017). Also in ISR, a commercial muskox hunt is held where animals are inspected and slaughtered for sale.

Agroforestry community gardens
In Northern Ontario there appears to be some forest-based gardens in remote First Nations communities that cultivate both forest plants and animals. This model has had some success in developing countries in addressing food insecurity (Spiegelaar, 2011).

Food Security Initiatives without a specific climate change, local food or traditional food angle

Soup Kitchens and Food Banks
Soup kitchens provide a hot meal to those in need. Food Banks provide food, which is often donated by individuals or companies, to those in need. Offered alone, these initiatives provide much needed but temporary relief from hunger but do little to address any of the roots of the problem. There is a desire in the Yukon to focus on systems-level change and move towards food hub/food centre/co-op/Good Food Bucks programs and models of provisioning food for those in need.

In-store healthy food promotion activities
There are an increasing number of in-store initiatives to support people to make healthy and affordable choices, due in part to funding from Nutrition North Canada for these initiatives. Evidence shows that they can have an effect on people's awareness, understanding and purchasing of healthy foods in low-income neighbourhoods (Gamburzew et al., 2016).

Implementation of the Good Food Bucks Program was one recommendation to come out of the Anti-Poverty Coalition.

Discussion

"First Nations peoples have always lived off the land, therefore we can adapt to the challenges we face with climate change. Our people are knowledgeable and resilient and will continue to protect our homelands for future generations."

Selkirk First Nation Community Member
(Selkirk First Nation & AICBR, 2016)

The research going forward

In order to clarify the research going forward, it is important to be clear about the purpose of this project. Ultimately, **this project will support climate change adaption in the Yukon to ensure that food security and traditional food security improves and supports the health and wellbeing of all Yukon residents**. Health and wellbeing considered mental, physical, emotional and spiritual wellbeing, which emerges from a strong sense of cultural identity that is closely tied to the land and to traditional food.

This current scoping review is written with the intention of supporting Phase II of the project funded by Indigenous and Northern Affairs' Climate Change Preparedness in the North Program. Funding is for $50,000 per year for 2018/19 and 2019/20, with $30,000 for 2020/21 and is meant to fund the emerging project in its entirety, without matching or additional funds. It should be noted that since AICBR is a non-profit organization, these funds must also cover staff time, rent and other administrative costs associated with running a project. Therefore, the scope of the research project and its methodology needs to be limited to what can be done within the confines of this budget.

The questions posed for this scoping review are big questions that have not been completely answered by this scoping review. A small research project cannot hope to answer all these questions either. Focusing on one of the four questions for the upcoming research project might be a more appropriate course of action.

Based on the review it is safe to say that climate change is affecting the access, availability and quality of traditional food that Yukon First Nations and others who depend on traditional food for their food security. How climate change is affecting traditional food is summarized in Table 2, and this applies to other northern regions as well. Research does not exist which quantifies climate change's effect on diet, but we can assume that it does affect diet based on qualitative accounts.

The story is more complex for local food. From firsthand accounts, efforts have been made to make local food more available to Yukoners, but we have no sense of whether people are consuming more. Literature specific to the Yukon was hard to obtain and the scope of the study excluded local food production and market data, which may be more appropriate measures for local food. Researchers have not yet established a methodology for assessing consumption of local food. It would be interesting to know how the Yukon Local Food Strategies, and other Local Food Strategies have decided to measure success.

There exists some baseline data to characterize Yukon First Nations' traditional food consumption patterns between 1990 and 2007, but nothing more recently. Food frequency and 24 hour recall research would need to be conducted to update this understanding and provide comparative data. While this would be great data to collect, it is unclear if it would be helpful to Yukon communities who require support to adapt to climate change in order to maintain or improve their food security. Overall, traditional food consumption is declining.

The review found that the nutrient intake of First Nations is better overall when traditional food is consumed in a day. This affirms the fact traditional food is an important contributor to food security and health amongst First Nations and those who rely on traditional food for their food security. The fact that traditional food consumption is declining thus poses an important and concerning trend to public health in the Yukon.

Food related adaptation strategies were identified with some difficulty, as many of them are buried in reports, government or First Nations files, or simply not documented at all. Much work remains to be done to support communities in telling their stories about how they are adapting to climate change and in so doing preserving their culture and traditional food practices.

Methodologies for phase II

It is tempting to build on the great work of AICBR and academics who have done traditional food diet studies using food frequency questionnaires and 24-hour recalls. Reproducing these studies in order to quantify the change in traditional food consumption over the last 30 years would not only exceed the budgetary allowance for this project but it is not clear if this research would achieve the goals of supporting climate change adaptation. As discussed, no baseline data exists for local food.

Through this scoping review, it became clear that while many communities are already adapting to climate change in their own ways, there remains nowhere for northern communities to turn to for inspiration, to find out what other communities are doing and what is working well. Compiling this information and presenting it in a manner that could support communities to adopt new adaptation strategies is an interesting opportunity for this project.

While this is outside the scope of the current project being developed, it is worth mentioning that there is a growing community of people across the globe engaged in citizen science to monitor climate change that presents a great opportunity for the future. This allows for local communities to monitor data of relevance to them and their community while contributing to larger, in some cases global, monitoring projects ("Citizen Science to track weather and climate change," 2017). Funding worth $31.4 million over 5 years was announced by the Canadian government for the Indigenous Community-Based Climate Monitoring Program (Canada, 2017), so it may be worth thinking about this approach in more detail (although this year's deadline has already passed). Climate change monitoring at a community level, for example, might be an interesting opportunity for the Yukon Government to gather more data on climate change, while also providing communities with vital information for their health and safety. While this is outside the scope of phase II of this project, it may be a consideration for future research projects.

It should be noted that this year's Canadian Community Health Survey (conducted by Statistics Canada) will include the Household Food Security Survey Module (HFSSM), which will provide updated statistics on food insecurity in the Yukon. There remains the need for complimentary information that can be compiled with other regions regarding the role of traditional food in food security.

Research Gaps

Food security data for the Yukon is currently six years old. Data for the Yukon by community is not available, making it impossible to target efforts or measure progress due to local, community-based interventions.

Current measures of food security do not consider traditional food and its role in northern, remote and Indigenous communities' food security.

There exists no centralized place in Canada (or elsewhere that could be found) that describes climate change adaptation initiatives underway at a community level specific to northern or Indigenous communities. Findings that are presented in this paper about food related climate change adaption initiatives are pieced together from conversations, former knowledge and from digging into reports that were often shared directly with the author, but did not appear in web searches. It appears that innovation is underway but under the radar.

Further, no evaluation of northern food and climate change adaptation strategies, initiatives or projects could be found. Evaluations are notoriously hard to find, but provide important and useful information for learning at a local, regional and territorial level about what works and what doesn't work so that adaptation can be responsive.

It is unclear how the Yukon Government will measure the success of its Local Food Strategy. How are other provinces, territories or regions measuring success for local food system development? What methodologies have been developed for assessing/measuring local food consumption? These questions were not pursued as part of this review.

It became clear through numerous Yukon Government reports that many indicators of potential interest to future research and to communities are currently being gathered. It was beyond the scope of this report to gather and assess these indicators and their potential to support adaptation to climate change initiatives.

Other research gaps identified by papers referenced in this scoping review are outlined below.

Berner & Furgal (2005):

- There is a need to monitor and document environmental change through community and regional strategies.
- More coordinated efforts to capture and use Indigenous Knowledge regarding climate change are required.
- There is a gap in data regarding the impacts of climate change on traditional food diets.
- There is a lack of systematic monitoring of safety factors related to ice and snow conditions that impact on food gathering.
- There is a lack of data regarding regional impacts of climate change on plants and animal species, including the diseases they carry and how they interact with humans.

The Canadian Council of Academies in their report: Aboriginal Food Security in Northern Canada identify the following knowledge and research gaps which are important when considering the need for evidence-based policy making:

- Climate change, the environment and traditional food systems;
- Monitoring and research methodologies;
- Health, wellness and nutrition transition;
- Food security and knowledge translation.

Recommendations

Recommendations to the Yukon Government
Governments have access to big data that are often unavailable to communities and organizations seeking to address societal problems. During the course of research for this report, it became clear that while the Yukon Government has many research and monitoring initiatives underway, much of this data is unavailable to the public. In the age of increased government transparency and in an effort to support collaboration with other partners in the Yukon, the following recommendations are offered directly to the Yukon Government.

1. **Participate in the Household Food Security Survey component of the Canadian Community Health Survey (CCHS) at least every other year (2018, 2020, 2022, etc.) in order to monitor Yukon food insecurity rates at the community and territorial level. Further, adopt food insecurity monitoring as an indicator of climate change in the territory.**

It is unclear if food insecurity rates have improved or not in the past six years due to the fact that the Yukon government has not participated in the CCHS since 2012. This information is vital for communities and those working to address food insecurity, in order for them to have a sense of whether their efforts are having any impact. This survey is also designed to enable community-by-community assessment, which will also be important going forward given how localized food insecurity rates can be.

Further, the Arctic Monitoring and Assessment Programme, a working group of the Arctic Council, recommends that governments closely monitor food insecurity rates as part of their climate change adaptation strategies, as these rates may indicate success or failure in climate change adaptation strategies (AMAP, 2017).

2. **Advocate for the inclusion of questions in the CCHS related to traditional food security or identify other measures of gathering this data.**

Traditional food security (including access, availability and quality) is an important component of food security in the Yukon and other northern regions. The questions posed by the CCHS do not address traditional food security. It is likely that efforts are already underway to influence the CCHS to be more inclusive of Indigenous health and concerns.

First Nations Regional Health Survey has released its phase III report in March 2018 based on data gathered between 2015-2016. This survey may provide an interesting source of data, as they have gathered survey data on food security, traditional foods, foods and nutrition over three times over the last 20 years. Housed by the First Nations Information Governance Centre, the 2018 report presents only national data. The Council of Yukon First Nations are the regional partners for this study and should be able to provide data gathered on these questions, which may or may not be available on a community by community basis (First Nations Information Governance Centre, 2018).

3. **Share updates, monitoring or evaluation reports regarding the local food strategy and climate change monitoring with the public.**

Given local food's capacity to contribute to the reduction of greenhouse gases and to be part of climate change adaptation strategies, it is important for many stakeholders to better understand what is being done, how they can contribute and what the results are.

4. **Make food insecurity, inequity and Reconciliation a priority.**

There is a food security crisis in First Nations communities in the Yukon. Based on food insecurity rates for Yukon and First Nations communities, a great inequity exists within the Yukon between First Nations and non-First Nations. While inequity is created at many scales (local, regional, territorial, federal, international), the Yukon government plays an important role in maintaining and perpetuating this inequity. As we advance our efforts for Reconciliation in Canada, we must all play our part in actively addressing the history of colonialism and the inequity it has produced. The Yukon Government should consider reviewing programs and policies related to food (including agriculture, wildlife management, health programs) to remove barriers to access and to create new supports for First Nations communities, in order that they might increase First Nations capacity and drive down food insecurity and inequity.

Recommendations related to this project

According to members of the steering committee who work closely with Yukon First Nations, community members have had enough of research and are anxious for action and support for this action. This corresponds with findings of Labé et al. who found that despite 700 unique climate change initiatives in Nunavut, few 'action items' or 'action plans' have been developed, funded or executed. Given this reality, the findings of this review as well as the limited scope of phase II of this project, the following recommendations are offered.

1. **Compile an inventory of food related climate change adaptation projects in the Yukon and elsewhere in the North.**

As described above, no listing, website or report exists that comprehensively describes what communities are doing at a grassroots level to adapt to climate change in the North. Building on the above list of community-based initiatives, research could be conducted through phone interviews with funders and community members to first identify projects and then describe them in enough detail that communities might be inspired by them. Pictures, videos, reports, newspaper articles, etc. about the project could be gathered to support telling a brief story about the initiative.

2. **Identify and further document promising practices in food related climate change adaptation projects.**

It is likely that through the process of compiling the inventory, a few projects will stand out. For 2-3 initiatives, others involved in the project (participants, community members, staff, etc.) might be interviewed to further develop a sense of the impact of the project, factors of success and first steps required to establish the project. These results could be used to develop a more in-depth review of these promising practices with attention to supporting others to adopt these strategies.

3. **Share the inventory and promising practices with communities in an accessible way and so that they might be inspired to take action. Celebrate the success of some initiatives by promoting them to the media.**

In conversation with community members and based on their experience, AICBR should determine the best tool(s) to reach diverse communities in the Yukon with the inventory. Options include: an online map, a spiral bound booklet, a power point presentation, a workshop or series of workshops, radio interviews, etc. At least one face-to-face option (such as a workshop) is recommended. Options for delivering the workshop might include a train-the-trainer approach so that AICBR could train youth (for example, building on their previous experience) to deliver workshops throughout the Yukon.

The radio is an important way that information is shared and it might be interesting to promote the promising practices' stories to the media to further share their success in the Yukon.

4. **Identify possible adaptation projects that might be of interest to communities and support them in taking first steps to fund and develop the initiatives.**

Through conversations with communities about the inventory, such as workshops, initiatives of interest might be identified. If this is the case, AICBR could work with community members to further develop their project and identify possible funding sources to support their work.

5. **Explore the field of citizen science to determine opportunities for a future community-based climate change monitoring project. Obtain preliminary feedback from communities about indicators that may be of interest to them.**

As discussed above, there are a number of large citizen science initiatives underway specific to climate change, as well as funding to support them. This approach fits well with participatory research approach of AICBR, since community members would be involved in gathering data themselves that could be used to assess their situation locally, but also contribute to larger findings that the Yukon Government, the Canadian Government and others might benefit from as well. Berner et al. (2005) provide an excellent set of guidelines and possible indicators for monitoring and action on community based health and climate change. Through the above mentioned workshops, communities could be asked to give light feedback on the types of food-related climate change indicator they might be interested in monitoring in the future, such as freeze-up dates on their rivers, arrival of migratory species, etc. This would allow AICBR to shape a territory-wide monitoring project that several communities might participate in.

Appendix A

Possible Indicators for Future Studies

The results of interest that emerged from these studies that may prove valuable indicators of consumption are:

Food Frequency

- Percentage of population consuming individual foods or species (i.e., 90% of people ate moose in the last 3 months)
- Frequency of consumption measured by percentage of population consuming individual food or species and average numbers of days/week foods are consumed (i.e., 20% ate moose approximately 3 days/week)
- Most frequently consumed traditional food species
- Number of different species consumed by food category – can be broken down by age group (i.e., people 20-40 years of age consumed 1.9 different species of fish, 2 different species of land animals, 0.4 different species of birds and 2.1 different plant species)
- Frequency of traditional food use per year (i.e., 400 times/year, or about 1 time/day)

24-hour recall (some of these may require food frequency data as well)

- Daily intake of different species/day broken down by age category (i.e., for people 20-40 years of age, people who consumed moose meat consumed on average 245 g/day)
- Average weight of daily serving (g/day)
- Average yearly consumption by food category (fish) or species (salmon) (kg/person/year)
- Total energy provided per day by traditional food (i.e., one third of total energy is derived from traditional foods)
- Per capita traditional food use (grams/day by sex, age and season – this combines data from consumers of traditional food with non-consumers to give population wide averages)

Possible local food indicators

- Number of households that produce some of their own food (garden, chickens, etc.) and the amount of that food, or approximate savings at the grocery store
- Number of households that seek out and buy local food when possible – what foods do they seek out, how often are they consumed

Bibliography

AICBR. (2018). Youth. Retrieved April 19, 2018, from https://www.aicbr.ca/youth/

Aki Energy. (2018). Retrieved April 9, 2018, from http://www.akienergy.com/

AMAP. (2017). *Adaptation Actions for a Changing Arctic (AACA) - Bering/Chukchi/Beaufort Region Overview report | AMAP*. Oslo, Norway: Arctic Council. Retrieved from https://www.amap.no/documents/doc/adaptation-actions-for-a-changing-arctic-aaca-beringchukchibeaufort-region-overview-report/1531

Anisimov, O. A., Vaughan, D. G., Callaghan, T. V., Furgal, C., Marchant, H., Prowse, T. D., … Walsh, J. E. (2007). Polar regions (arctic and antarctic). *Climate Change*, *15*, 653–685.

Archer, L., Ford, J. D., Pearce, T., Kowal, S., Gough, W. A., & Allurut, M. (2017). Longitudinal assessment of climate vulnerability: a case study from the Canadian Arctic. *Sustainability Science*, *12*(1), 15–29. https://doi.org/10.1007/s11625-016-0401-5

Arksey, H., & O'Malley, L. (2005). Scoping studies: towards a methodological framework. *International Journal of Social Research Methodology*, *8*(1), 19–32.

Ball, Matt, Hill, T., & Whelan, V. (2012). *Yukon Agriculture - State of the Industry Report 2010-2011-2012*. Yukon Energy, Mines and Resources. Retrieved from http://www.emr.gov.yk.ca/agriculture/pdf/20102012_agriculture_stateofindustry_interimreport.pdf

Ball, Matthew, & Reaume, K. (2012). *Yukon Agriculture - Research and Demonstration 2012 Progress Report*. Yukon Energy, Mines and Resources. Retrieved from http://www.emr.gov.yk.ca/agriculture/pdf/2012_Research_Report.pdf

Batal, M., Gray-Donald, K., Kuhnlein, H. V., & Receveur, O. (2005). Estimation of traditional food intake in indigenous communities in Denendeh and the Yukon. *International Journal of Circumpolar Health*, *64*(1), 46–54. https://doi.org/10.3402/ijch.v64i1.17953

Berner, J., & Furgal, C. (2005). Human Health, Chapter 15 of ACIA. In *Arctic Climate Impact Assessment* (p. 44).

Boyd, A., & Bastian, M. (n.d.). *What is a scoping study?* Retrieved from https://www.youtube.com/watch?v=kt2dQk3eIMg

Brascoupé, S. (2015). *FIRST NATIONS LAND BASED HEALING*.

Callaghan, T. V., Tweedie, C. E., Åkerman, J., Andrews, C., Bergstedt, J., Butler, M. G., … Zemtsov, V. A. (2011). Multi-Decadal Changes in Tundra Environments and Ecosystems: Synthesis of the International Polar Year-Back to the Future Project (IPY-BTF). *AMBIO: A Journal of the Human Environment*, *40*(6), 705–716. https://doi.org/10.1007/s13280-011-0179-8

Canada, G. of C. I. and N. A. (2017, November 3). Indigenous Community-Based Climate Monitoring Program [promotional material]. Retrieved April 11, 2018, from https://www.aadnc-aandc.gc.ca/eng/1509728370447/1509728402247

Carmack, E. C. (2000). The Arctic Ocean's Freshwater Budget: Sources, Storage and Export. In *The Freshwater Budget of the Arctic Ocean* (pp. 91–126). Springer, Dordrecht. https://doi.org/10.1007/978-94-011-4132-1_5

CBC News. (2012, June 16). Highway closure sparks questions about food security | CBC News. *CBC*. Retrieved from http://www.cbc.ca/news/canada/north/highway-closure-sparks-questions-about-food-security-1.1132731

CBC News. (2013, October 16). Yukon moose population hearty, despite overall U.S. decline | CBC News. *CBC*. Retrieved from http://www.cbc.ca/news/canada/north/moose-die-off-not-seen-in-yukon-where-populations-stable-1.2055719

Citizen Science to track weather and climate change. (2017, March 2). Retrieved April 11, 2018, from http://blogs.discovermagazine.com/citizen-science-salon/2017/03/02/citizen-science-to-track-weather-and-climate-change/

Clark, D. G., Ford, J. D., Pearce, T., & Berrang-Ford, L. (2016). Vulnerability to unintentional injuries associated with land-use activities and search and rescue in Nunavut, Canada. *Social Science & Medicine*, *169*, 18–26. https://doi.org/10.1016/j.socscimed.2016.09.026

Committee on World Food Security, F. (n.d.). Committee on World Food Security. Retrieved March 22, 2018, from http://www.fao.org/cfs/en/

Council of Canadian Academies. (2014). *Aboriginal Food Security in Northern Canada: An Assessment of the State of Knowledge*. Ottawa, ON. Retrieved from http://www.scienceadvice.ca/en/assessments/completed/food-security.aspx

Division for Social Policy and Development Indigenous Peoples, U. (n.d.). Environment | United Nations For Indigenous Peoples. Retrieved April 23, 2018, from https://www.un.org/development/desa/indigenouspeoples/mandated-areas1/environment.html

Downing, A., & Cuerrier, A. (2011). A synthesis of the impacts of climate change on the First Nations and Inuit of Canada. *IJTK Vol.10(1) [January 2011]*. Retrieved from http://nopr.niscair.res.in/handle/123456789/11066

Duncan, J., & Bailey, M. (2017). *Sustainable Food Futures: Multidisciplinary Solutions*. Routledge.

Environment and Climate Change Canada. (2017). *Progress of Recovery Strategy Implementation for the Woodland Caribou (Rangifer tarandus caribou), Boreal population in Canada for the Period 2012 to 2017*. Retrieved from http://registrelep-sararegistry.gc.ca/document/default_e.cfm?documentID=3199

Environment Yukon. (2018). Yukon Big Game Species. Retrieved April 19, 2018, from http://www.env.gov.yk.ca/hunting-fishing-trapping/biggame.php#moose

Environment Yukon. (n.d.). Invasive Plants. Retrieved March 21, 2018, from http://www.env.gov.yk.ca/animals-habitat/invasiveplants.php

First Nations Information Governance Centre. (2018). *The National Report of the First Nations Regional Health Survey: Phase 3: Volume 1* (p. 200). First Nations Information Governance Centre. Retrieved from http://fnigc.ca/sites/default/files/docs/fnigc_rhs_phase_3_national_report_vol_1_en_final_web.pdf

Gamburzew, A., Darcel, N., Gazan, R., Dubois, C., Maillot, M., Tomé, D., … Darmon, N. (2016). In-store marketing of inexpensive foods with good nutritional quality in disadvantaged neighborhoods: increased awareness, understanding, and purchasing. *The International Journal of Behavioral Nutrition and Physical Activity*, *13*. https://doi.org/10.1186/s12966-016-0427-1

Government of Canada, F. and O. C. (2017, July 14). Yukon River salmon update 2017 | Pacific Region | Fisheries and Oceans Canad. Retrieved March 21, 2018, from http://www.pac.dfo-mpo.gc.ca/yukon/docs/2017/2017-07-13-eng.html?wbdisable=true

Government of Yukon. (n.d.). Climate Change brochures. Retrieved March 8, 2018, from http://www.env.gov.yk.ca/publications-maps/brochures.php#climatechange

Guyot, M., Dickson, C., Paci, C., Furgal, C., & Chan, H. M. (2006). Local observations of climate change and impacts on traditional food security in two northern Aboriginal communities. *International Journal of Circumpolar Health*, *65*(5), 403–415. https://doi.org/10.3402/ijch.v65i5.18135

Hammond, K. (2017). *The Cost of Healthy Eating in the Yukon*. Whitehorse, Yukon: Yukon Anti-Poverty Coalition. Retrieved from http://yapc.ca/news/entry/167

Hassol, S. J. (2004). Impacts of a Warming Arctic: Arctic Climate Impact Assessment. Cambridge University Press.

Herman-Mercer, N., Schuster, P., & Maracle, K. (2011). Indigenous Observations of Climate Change in the Lower Yukon River Basin, Alaska. *Human Organization*, *70*(3), 244–252. https://doi.org/10.17730/humo.70.3.v88841235897071m

IARPC Collaborations. (2018). *Different Ways of Knowing: Successful Examples of Co-production of Knowledge in Arctic Research*. Retrieved from https://www.youtube.com/watch?v=GVCrUMMxoAI&feature=youtu.be&t=1272

IPCC. (2014). *Climate Change 2014: Synthesis Report. Contributions of Working Groups I, II, and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Geneva, Switzerland. Retrieved from http://www.ipcc.ch/report/ar5/syr/

Juneau Empire. (2009, May 14). Controlled burn considered to boost moose habitat near Fairbanks. *Juneau Empire*. Retrieved from http://juneauempire.com/stories/051409/sta_439783201.shtml#.Wtilx9PwbOQ

Jung, T. S., Frandsen, J., Gordon, D. C., & Mossop, D. H. (2017). Colonization of the Beaufort Coastal Plain by Beaver (Castor canadensis): A Response to Shrubification of the Tundra? *The Canadian Field-Naturalist*, *130*(4), 332–335. https://doi.org/10.22621/cfn.v130i4.1927

Kluane First Nations, & Arctic Institute of Community-Based Research. (2016). *Nourishing Our Future: Building on Kluane First Nations Community Food Security Strategy & Youth Engagement in Traditions Related to Fisheries and Fish Health in Kluane Lake*. Yukon: AICBR and Kluane First Nation. Retrieved from https://static1.squarespace.com/static/56afc7218259b53bd8383cb8/t/581bca0eebbd1a9e3ab911c3/1478216258678/FINALKFNNourishingOurFutureReportPhase2_Aug2016_FINAL%255b2%255d.compressed.pdf

Krebs, C. J., Boonstra, R., Cowcill, K., & Kenney, A. J. (2009). Climatic determinants of berry crops in the boreal forest of the southwestern Yukon. *Botany*, *87*(4), 401–408. https://doi.org/10.1139/B09-013

Kuhnlein, H. V., Receveur, O., & Chan, H. M. (2001). Traditional food systems research with Canadian Indigenous Peoples. *International Journal of Circumpolar Health*, *60*, 112–122.

Kuhnlein, Harriet V., & Receveur, O. (2007). Local Cultural Animal Food Contributes High Levels of Nutrients for Arctic Canadian Indigenous Adults and Children. *The Journal of Nutrition*, *137*(4), 1110–1114. https://doi.org/10.1093/jn/137.4.1110

Labbé, J., Ford, J. D., Araos, M., & Flynn, M. (2017). The government-led climate change adaptation landscape in Nunavut, Canada. *Environmental Reviews*, *25*(1), 12–25. https://doi.org/10.1139/er-2016-0032

Lambden, J., Receveur, O., & Kuhnlein, H. V. (2007). Traditional food attributes must be included in studies of food security in the Canadian Arctic. *International Journal of Circumpolar Health*, *66*(4), 308–319. https://doi.org/10.3402/ijch.v66i4.18272

Lambden, J., Receveur, O., Marshall, J., & Kuhnlein, H. (2006). Traditional and market food access in Arctic Canada is affected by economic factors. *International Journal of Circumpolar Health*, *65*(4), 331–340. https://doi.org/10.3402/ijch.v65i4.18117

Lane, J. E., Kruuk, L. E. B., Charmantier, A., Murie, J. O., & Dobson, F. S. (2012). Delayed phenology and reduced fitness associated with climate change in a wild hibernator. *Nature*, *489*(7417), 554–557. https://doi.org/10.1038/nature11335

Lawler Joshua J., Shafer Sarah L., White Denis, Kareiva Peter, Maurer Edwin P., Blaustein Andrew R., & Bartlein Patrick J. (2009). Projected climate-induced faunal change in the Western Hemisphere. *Ecology*, *90*(3), 588–597. https://doi.org/10.1890/08-0823.1

Leung, M. (2016). *DEVELOPMENT OF A FRAMEWORK FOR MANAGEMENT OF AQUATIC INVASIVE SPECIES OF CONCERN FOR YUKON: LITERATURE REVIEW, RISK ASSESSMENT AND RECOMMENDATIONS* (p. 96). Yukon Department of Environment.

Life. (2018, February 22). Short-tailed grouse are the singing, dancing lotharios of the avian world. Retrieved April 19, 2018, from https://www.yukon-news.com/life/short-tailed-grouse-are-the-singing-dancing-lotharios-of-the-avian-world/

Loring, P. A., & Gerlach, C. (2010). Food Security and Conservation of Yukon River Salmon: Are We Asking Too Much of the Yukon River? *Sustainability*, *2*(9), 2965–2987. https://doi.org/10.3390/su2092965

Loring, P. A., & Gerlach, S. C. (2015). Searching for Progress on Food Security in the North American North: A Research Synthesis and Meta-analysis of the Peer-Reviewed Literature. *Arctic*, *68*(3), 380–392.

Lynn, K., Daigle, J., Hoffman, J., Lake, F., Michelle, N., Ranco, D., … Williams, P. (2013). The impacts of climate change on tribal traditional foods. *Climatic Change*, *120*(3), 545–556. https://doi.org/10.1007/s10584-013-0736-1

MacDonald, J. P., Huet, C., Ford, J., Statham, S., & MacRury, A. (n.d.). THE COMMERCIALIZATION OF COUNTRY FOOD AND FOOD SECURITY: THE CASE OF GREENLAND AND CONSIDERATIONS FOR NUNAVUT IN MOVING FORWARD, 5.

Malison Rachel L., Lorang Mark S., Whited Diane C., & Stanford Jack A. (2014). Beavers (Castor canadensis) influence habitat for juvenile salmon in a large Alaskan river floodplain. *Freshwater Biology*, *59*(6), 1229–1246. https://doi.org/10.1111/fwb.12343

Mallory, C. D., & Boyce, M. S. (2017). Observed and predicted effects of climate change on Arctic caribou and reindeer. *Environmental Reviews*, *26*(1), 13–25. https://doi.org/10.1139/er-2017-0032

Masood, S., Zuiden, T. M. V., Rodgers, A. R., & Sharma, S. (2017). An uncertain future for woodland caribou (Rangifer tarandus caribou): The impact of climate change on winter distribution in Ontario. *Rangifer*, *37*(1), 11–30. https://doi.org/10.7557/2.37.1.4103

McKnight, E. (2017). Characterizing and Monitoring the Water Properties and Dynamics of Lhù'ààn Mān̄ (Kluane Lake), Yukon, in the Face of Climate Change. *ARCTIC*, *70*(4), 435–440.

Montgomery, M. (2017, June 9). Climate change: beavers on the move north. *RCI | English*. Retrieved from http://www.rcinet.ca/en/2017/06/09/climate-change-beavers-on-the-move-north/

Morrison, N. E., Receveur, O., Kuhnlein, H. V., Appavoo, D. M., Soueida, R., & Pierrot, P. (1995). Contemporary Sahtú Dene/Métis use of traditional and market food. *Ecology of Food and Nutrition*, *34*(3), 197–210. https://doi.org/10.1080/03670244.1995.9991460

Nakano, T., Fediuk, K., Kassi, N., & Kuhnlein, H. V. (2005). Food use of Dene/Métis and Yukon children. *International Journal of Circumpolar Health*, *64*(2), 137–146. https://doi.org/10.3402/ijch.v64i2.17966

Northern Bushcraft. (n.d.). Edible Berries of Yukon. Retrieved April 19, 2018, from http://northernbushcraft.com/guide.php?ctgy=edible_berries&region=yt

Northern Farm Training Institute. (2018). Retrieved February 21, 2018, from http://nftinwt.com/

Nunavut Climate Change Centre. (n.d.). Assessing Berries to Monitor Ecological Change: a collaboration with Nunavut Arctic College's Environmental Technology Program | Nunavut Climate Change Centre. Retrieved April 19, 2018, from https://www.climatechangenunavut.ca/en/project/assessing-berries-monitor-ecological-change-collaboration-nunavut-arctic-colleges

Poesch Mark S., Chavarie Louise, Chu Cindy, Pandit Shubha N., & Tonn William. (2016). Climate Change Impacts on Freshwater Fishes: A Canadian Perspective. *Fisheries*, *41*(7), 385–391. https://doi.org/10.1080/03632415.2016.1180285

Porcupine Caribou Management Board. (n.d.). Retrieved April 18, 2018, from http://www.pcmb.ca/

PROOF, F. I. P. R. (2017, May 25). Provinces and Territories Opting Out of Measuring Household Food Insecurity. Retrieved March 20, 2018, from http://proof.utoronto.ca/provinces-and-territories-opting-out-of-measuring-household-food-insecurity/

Prowse, T. D., & Furgal, C. (2009). Northern Canada in a changing climate: major findings and conclusions. *AMBIO: A Journal of the Human Environment*, *38*(5), 290–292.

Receveur, O., Boulay, M., & Kuhnlein, H. V. (1997). Decreasing Traditional Food Use Affects Diet Quality for Adult Dene/Métis in 16 Communities of the Canadian Northwest Territories. *The Journal of Nutrition*, *127*(11), 2179–2186. https://doi.org/10.1093/jn/127.11.2179

Receveur, Olivier, Kassi, N., Chan, H. M., Berti, P. R., & Kuhnlein, H. V. (1998). *Yukon First Nations' assessment of dietary benefit/risk*. Ste-Anne-de-Bellevue: CINE.

Rolls, R. J., Hayden, B., & Kahilainen, K. K. (2017). Conceptualising the interactive effects of climate change and biological invasions on subarctic freshwater fish. *Ecology and Evolution*, *7*(12), 4109–4128. https://doi.org/10.1002/ece3.2982

Root, T. L., Price, J. T., Hall, K. R., Schneider, S. H., Rosenzweig, C., & Pounds, J. A. (2003). Fingerprints of global warming on wild animals and plants. *Nature*, *421*(6918), 57–60. https://doi.org/10.1038/nature01333

Rudge, S. (2013). *Greenhouses_for_the_Northern_Climate.pdf*. Retrieved from http://www.emr.gov.yk.ca/agriculture/pdf/Greenhouses_for_the_Northern_Climate.pdf

Schuster, R. C., Wein, E. E., Dickson, C., & Chan, H. M. (2011). Importance of traditional foods for the food security of two First Nations communities in the Yukon, Canada. *International Journal of Circumpolar Health*, *70*(3), 286–300. https://doi.org/10.3402/ijch.v70i3.17833

Selkirk First Nation, & AICBR. (2016). *Adapting to Climate Change and Keeping our Traditions*. Yukon: Selkirk First Nations and Arctic Institute of Community Based Research. Retrieved from https://static1.squarespace.com/static/56afc7218259b53bd8383cb8/t/57ab923e59cc68307527742f/1470861914849/Selkirk+Climate+Change+Adaptation+Plan_CommunityReport_final%5B2%5D.compressed.pdf

Spiegelaar, N. (2011). Agroforestry Community Gardens as a Sustainable Import-Substitution Strategy for Enhancing Food Security in Remote First Nations of Subarctic Ontario, Canada, 136.

Streicker, J. (2016). *Yukon Climate Change Indicators and Key Findings 2015*. Yukon College: Northern Climate ExChange, Yukon Research Centre. Retrieved from https://www.yukoncollege.yk.ca/sites/default/files/inline-files/Indicator_Report_Final_web.pdf

Szyniszewska, A. (n.d.). Invasive Species and Climate Change. Retrieved March 21, 2018, from http://climate.org/archive/topics/ecosystems/invasivespecies.html

Tarasuk, V., Mitchell, A., & Dachner, N. (2014). FOOD INSECURITY POLICY RESEARCH, 30.

Transformations - OCIC Transformations Stories. (2018). Retrieved April 9, 2018, from https://www.transformationstories.ca/transformations-4

Tr'ondek Hwech'in Teaching & Working Farm. (2018). Retrieved April 9, 2018, from http://trondekfarm.ca/

US EPA, O. (2015). Climate Impacts on Agriculture and Food Supply [Overviews and Factsheets]. Retrieved April 19, 2018, from /climate-impacts/climate-impacts-agriculture-and-food-supply

Weikle, B. (2017, April 17). Climate change causees glacial river in yukon to change direction. *CBC*. Retrieved from http://www.cbc.ca/news/technology/climate-change-yukon-river-piracy-1.4070153

Wein, E. E., & Freeman, M. M. R. (1995). Frequency of Traditional Food Use by Three Yukon First Nations Living in Four Communities. *Arctic*, *48*(2), 161–171.

Wiebe, N., & Wipf, K. (2011). Nurturing Food Sovereignty in Canada. In A. Desmarais, N. Weib, & H. Wittman (Eds.), *Food Sovereignty in Canada: Creating Just and Sustainable Food Systems* (pp. 1–12). Fernwood Publishing.

World Wildlife Fund. (2017). Living Planet Report Canada | WWF-Canada. Retrieved March 8, 2018, from http://www.wwf.ca/newsroom/reports/lprc.cfm

Yukon Energy, Mines and Resources. (2016). *Local food strategy for Yukon*. Government of Yukon. Retrieved from http://www.emr.gov.yk.ca/agriculture/yukon-local-food-strategy.html

Yukon Environment. (2016). *Science-based guidelines for management of moose in Yukon*. Yukon Department of Environment, Fish and Wildlife Branch. Retrieved from http://www.env.gov.yk.ca/publications-maps/documents/moose-guidelines-2016.pdf

Yukon Government, & Climate Change Secretariat. (2016). *Yukon government climate change action plan: progress report.* Retrieved from http://www.deslibris.ca/ID/10049428

Yukon Salmon Sub-Committee. (n.d.). Commercial Fishing Along the Yukon River. Retrieved March 21, 2018, from http://yssc.ca/issues/item/commercial-fishing-along-the-yukon-river

Yukon Species At Risk. (2017). Retrieved April 19, 2018, from http://www.env.gov.yk.ca/animals-habitat/speciesrisk.php