Climate Change Impacts on Dietary Nutrient Status of Inuit in Nunavut, Canada

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Abstract

This thesis characterizes the nutritional implications of climate change impacts on the traditional food system of Inuit in Nunavut, Canada. Both focus groups and food frequency questionnaires were used in collaboration with two communities to describe current climate change impacts on traditional food and define nutrient intake. Currently, both communities experience climate-related changes to important species which provide high levels of key nutrients. If climate changes continue to impact traditional food species, serious nutritional losses may occur unless healthy alternatives can be found. Policy should support Inuit communities to maintain optimal nutrition in the face of climate change.

Résumé

Ce mémoire démontre les implications nutritionnelles du changement climatique sur le système alimentaire traditionnel des Inuits à Nunavut au Canada. En collaboration avec deux communautés Inuits des entretiens en groupe ainsi que des questionnaires sur l'alimentation personnelle furent utilisés pour montrer comment le changement climatique affecte la nourriture traditionnelle ainsi que de déterminer la prise de nutriment des sujets d'expérience respectivement. Présentement les deux communautés observent des changements de population causés par le changement climatique parmi les espèces clés qui fournissent les nutriments importants aux deux communautés. Si le changement climatique continue d'influencer la population de ces espèces des manques alimentaires graves pourraient se produire à moins que des alternatives saines soient trouvées. La pratique politique devait être d'aider les communautés Inuit à garder une alimentation optimale malgré le changement climatique.

Contribution of Authors

For Manuscript 1, Tanya Nancarrow, Master of Science candidate, worked under the supervision and guidance of Dr. Hing Man Chan, Principal Investigator for the overall project. Together they developed research questions, solidified community research agreements and organized and carried out community meetings. The candidate carried out the analyses of the data and wrote the initial draft of the manuscript. Dr. Hing Man Chan provided direction and academic insight throughout.

Research agreements and research questions for Manuscript 2 were completed by the candidate and Dr. Hing Man Chan. The field questionnaire for Manuscript 2 was modified from a previous study, by the candidate. Training of the interviewers and preparation for the survey was carried out by the candidate with support from a fellow student. The supervision of the survey, data analysis and interpretation, and the writing of the draft manuscript were by the candidate. Amy Ing was essential in carrying out the data analysis and editing. Dr. Hing Man Chan provided constant supervision of the research activities. Co-supervisor, Dr. Harriet V. Kuhnlein's expertise in the field of nutrition, as well as her careful editing, were imperative to the success of the project.

Table of Contents

List of Tables

List of Figures

1 Introduction

"There is a growing demand to anticipate the future responses of plant and animal populations to ongoing environmental change"
~(Ludwig *et al.*, 2001) in (*2*).

Country food is locally derived plant, animal, and fish foods, which are harvested from the surrounding environment. It is a well documented source of nutritional, cultural, physical, social, and economic strength for Inuit communities across the Arctic (*3-7*). The heavy reliance by Inuit on the exceptional nutritional value provided by country food may be jeopardized by climate change. The purpose of this thesis is to determine the affects of climate change on Inuit nutrition.

Country food makes important nutrient contributions to Inuit communities, despite seemingly low energy intake. A Health Canada study in Repulse Bay showed that country food was the major source of protein, iron, zinc, phosphorus, thiamine, riboflavin, niacin, vitamin B6 and vitamin B12, even though it provided only 16% of total energy intake at the time of the survey (*8*). Country food in Kugaaruk, although only 10% of food energy intake, was found to be the major source of protein, niacin, vitamin B6, vitamin B12 and cholesterol and an important source of vitamin A, thiamine, riboflavin, iron and zinc (*9*).

It is likely that decreased intake of country food and increased intake of high-energy, low nutrient market food will put Inuit communities at risk for micronutrient deficiencies (*10*). Decreasing intake of country food also increases the risk of obesity, which is associated with increased risk of chronic disease (*7*).

As numerous studies suggest, Indigenous populations of the Arctic, including Inuit, have already experienced climate change and its impacts (*11-17*). Some of these climate changes observed in the regions studied, include unpredictable weather, earlier break up and later freeze up of ice, thinning ice, melting glaciers, decreasing lake and stream levels, and changes in animal populations and travel conditions (*11, 12, 14*). These changes can affect the access and availability of country food in both positive and negative ways.

Most scientists agree that increasing temperatures and other climate changes over the last fifty years are caused by human industrial activity (*18*). Although the majority of greenhouse gases do not come from the Arctic region, climate change is occurring there at an increased rate compared to other parts of the world (*18*). Over the next century, the level of atmospheric CO_2 compared to the pre-industry level is expected to double (*19*) and overall temperatures in the Arctic are expected to increase by 2.5°C by mid century, to 5 to 7°C by the end of the century (*20*). Will rapid environmental change impact Inuit's ability to harvest country food? If so, in light of country food's champion nutritional value, what will be the consequences for the Inuit population? In collaboration with Repulse Bay and Kugaaruk, Nunavut, these questions will be addressed in the following two manuscripts and thesis summary.

1.1 Rationale

This is the second study to obtain diet and climate change data in an Indigenous community in order to examine links between climate change and dietary nutrient status. A similar study was carried out in G'we Gah Hoe and Beaver Creek by Guyot et al (2007). However this study is the first of its kind, set in an Inuit community, which looks quantitatively at nutrient status in order to examine impacts caused by future climate changes.

Little has been published about the impacts that climate change may have on Inuit nutrition. What will this change of key food species do to their nutritional profile? The following two manuscripts lay the foundation to explore this question. The first manuscript describes qualitative field work that recorded observations of climate change impacts on harvested animals for both Repulse Bay and Kugaaruk. This manuscript explores the observed changes, the response of the community, and the potential nutrients that are impacted by the change. The results of a nutritional survey, a snapshot of food consumption in Repulse Bay are presented in Manuscript 2. Co-author permission forms can be found in Appendix 1. The thesis summary explores links between country food's extreme nutritional importance and impacts from climate change. Nutrient losses and gains will be examined in future projects, in order to inform community adaptation plans.

1.2 Study Objectives

This study aims to:

1) identify current perceived climate change affecting traditional food species in two communities;
2) identify current traditional food intake in Repulse Bay only; and
3) explore the link between country food's nutritional importance and observed climate changes.

1.3 Communities

Kugaaruk and Repulse Bay community members were participants in this study due to their extensive country food use and as their concern over climate change impacts in their communities.

Kugaaruk (Latitude 68.5327, Longitude 89.807495)

English translation of Kugaaruk: *river flowing through the community* or *used as a water supply and for fishing.*

The predominantly Inuit community of Kugaaruk (formerly known as Pelly Bay) is located along the east coast of the Kitikmeot region of Nunavut (Figure 1.1). Although it had long been a meeting place for semi-nomadic families, it was not until 1968 that Kugaaruk became a permanent settlement (*21*). Today the community consists of 688 people living in 137 dwellings (*22*). The main sources of income are subsistence harvesting, government jobs, selling of handicrafts, and government assistance (*9*). In 2001, the yearly income for a family of four in Kugaaruk was $37,000 (*22*), compared to the provincial average of $48,100 (*9*). Most frequently consumed country food in the Kitikmeot region are caribou, Arctic char, muskox, trout, eider duck, ringed seal, and beluga (*5*).

Repulse Bay/Naujaat (Latitude 66.56057, Longitude 86.24727)

English translation of Naujaat: *Seagull nesting place*

Repulse Bay, or Naujaat is in the Kivalliq region of Nunavut (Figure 1.1). It is a coastal town with 153 dwellings and 748 people (*23*). In the Kivalliq region, the most frequently consumed country food is caribou, char, beluga, trout, ringed seal, walrus and narwhal (*5*). The main sources of income are government or community jobs, government assistance, fishing, trapping, hunting, and the sale of handicrafts (*8*). Yearly income for full time workers in 2001 was recorded to be $34,300 (*22*) compared to the provincial average of $48,100 for that time.

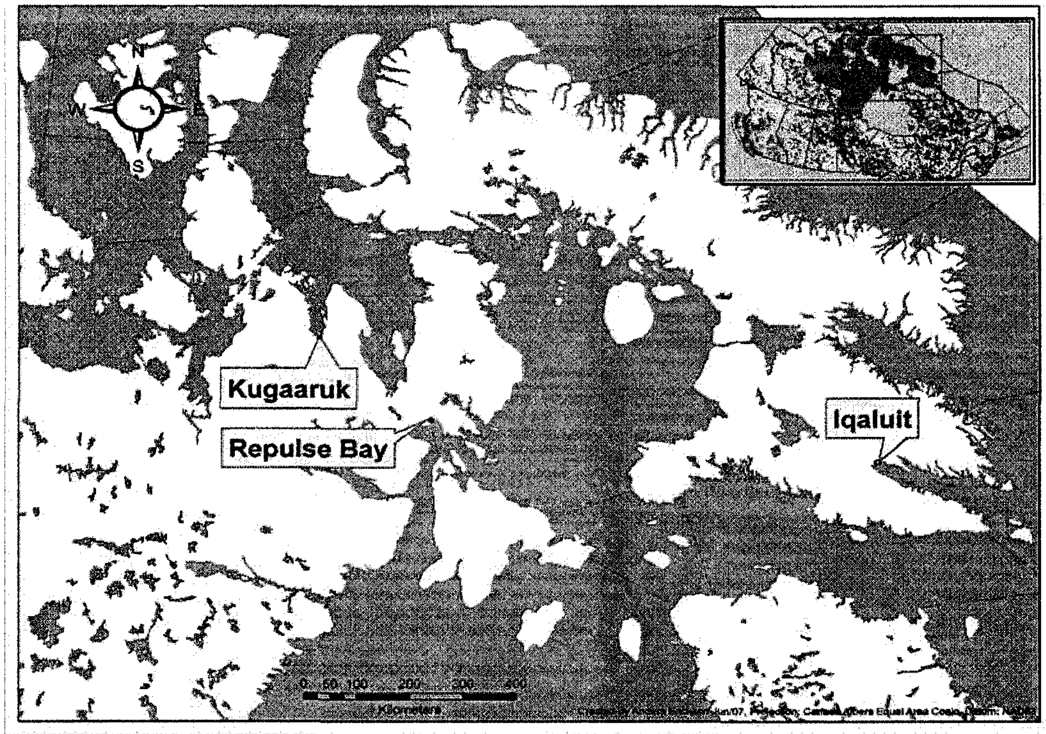

Figure 1.1 Map of Nunavut, Canada, with locations of Kugaaruk and Repulse Bay.

2 Literature Review

2.1 Inuit and Environment

In order to discuss the nutritional implications of climate-related changes to harvesting of country food, we must emphasize the breadth of knowledge, ability to adapt, and connection of Inuit peoples with all aspects of the environment, including the animals. Inuit culture recognizes the seasonality of ecological events, such as changing weather patterns, birth, moulting, migration, and ice floe patterns (*24*). Successful hunting is directly related to knowledge of the ecology of the animal and the environment. Inuit hunters tend to possess expertise on the physical environment, seasons, weather patterns, effects of temperature, and the habitat and location of animals. Health of an animal is instantly assessed by different indicators such as thickness of seasonal fat, condition of the liver, colour and taste of the meat, condition of the fur, and behavior (*24*). The relationship between Inuit peoples and the animals with whom they share the land, remains strong and intricately woven, via cultural, social and kinship lines.

2.2 Nutrient Content of Country Food

Currently, Inuit communities draw on a fusion of store-bought and country or traditional food for nourishment. Store-bought or market food provides the majority of the energy intake for Inuit communities across the Arctic, however, country food makes up anywhere from 8 to 38% of food energy (*5*). As well, even with a lower contribution to total energy, country food is frequently a major contributor of key nutrients. A Health Canada study in Repulse Bay showed that country food was the major source of protein, iron, zinc, phosphorus, thiamine, riboflavin, niacin, vitamin B6 and vitamin B12, even though they made up only 16% of total energy intake at the time of the survey (*8*). Country food in Kugaaruk, although only 10% of food energy intake, was found to be the major source of protein (40%), niacin (44%), vitamin B6 (39%), vitamin B12 (83%) and cholesterol (35%), and an important source of vitamin A (23%), thiamine (29%), riboflavin (38%), iron (23%) and zinc (27%) (*9*). A study in the Baffin Island community of Qikiqtarjuaq, found that country food contributed more protein, phosphorus, iron, zinc, copper, magnesium and vitamin A to the diet than did market food (*25*).

Environment Canada reports that seal meat has an iron content six to ten times higher than that of beef (*26*). Furthermore, Wenzel describes that protein, calcium, thiamine, and riboflavin levels are all significantly higher in seals than in beef, and that fat content is significantly lower (*24*). Similarly, a modeling study by Borre (1986), cited within Wenzel (*24*), found that a man on a diet of 3000 calories per day could eat one seal every six days and not starve. Marine mammal blubber is a major source of omega (ω)-3 fatty acids (*27*). It is possible that decreased intake of country food and increased intake of high-energy, low nutrient market food may put Inuit communities at risk for micronutrient deficiencies (*10*).

Micronutrients are needed for optimum bodily function. Table 2.1 displays some principle micronutrients and their role in human health. For example, magnesium is required for calcium absorption. Iron is important for women of childbearing age, pregnant, and lactating women. Zinc is important in pregnancy for a healthy birth outcome, and in childhood to support growth and normal immune function. Vitamin A is required for normal growth, development, vision, reproduction and immune function. Omega-3 fatty acids (especially eicosapentanoic acid [EPA] and docosahexanoic acid [DHA]) are thought to be protective against some cancers through cancer cell apoptosis, inhibition of cell proliferation and angiogenesis (*28*). Furthermore, these ω-3 fatty acids have been shown to reduce the risk of cardiovascular diseases by a multitude of functions.

Table 2.1 Major functions of key nutrients. Source: (*28-30*).

Nutrient	Main function
Calcium	Bone health
Folate	Cell maintenance, growth, DNA replication, anemia
Iron	Oxygen transport
Magnesium	Calcium absorption, metabolism of energy, protein synthesis, RNA and DNA
Omega 3	Cancer, CVD protection
Riboflavin	Coenzyme
SE	Antioxidant, regulation of growth and development
Vitamin A	Vision, growth and development, immune function, reproduction
Vitamin B6	Coenzyme
Vitamin C	Electron donor to enzymes, antioxidant
Vitamin D	Skin conditions, bone resorption, needed for calcium and phosphate absorption
Vitamin E	Major antioxidant
Zinc	Essential for growth, sexual and bone development, immune system

2.3 Lifestyle and Health

Besides having superior nutritional value, the harvesting, processing, and consumption of country food is associated with a more active lifestyle, and an increase in cultural morale, food diversity, and participation in culturally-specific activities (*31*). Inuit respondents in a 2000 survey cited that country food contributed to physical fitness and good health, encouraged community sharing, saved money, and was an essential part of the culture (*5*). Consumption of marine mammals, coupled with increased physical activity is associated with a lower incidence of ischaemic heart disease in Greenland Inuit (*32*). In many Inuit communities in Arctic Canada, a trend towards obesity and chronic diseases is becoming apparent. Substituting market food for country food, coupled with decreased physical activity is likely leading to obesity (*10, 31, 33*), and is associated with increased risks of cardiovascular disease, cancer, and diabetes in Baffin Island Inuit (*33*).

2.4 Food Security

Country food consumption is associated with greater food security (*8, 9*). Food security, according to the World Health Organization, is defined as "physical and economic access to sufficient, safe and nutritious food to meet … dietary needs and food preferences for an active and healthy life" (*34*). By this definition, food security for Inuit peoples includes access to country food for their contribution to nutrition, culture, health, and physical fitness.

Many Inuit communities are considered food insecure. An analysis of a larger study (*5*) by Lambden and coauthors (*35*) showed that 60% of the 838 Inuit women surveyed across Arctic Canada could not afford to buy all the food they needed from the local store. This was due to the high cost of food, paired with low incomes. Thus country food is a necessary companion of market food for increased food security. However, approximately 45% of the women reported that their households did not own enough equipment to go fishing or hunting for the family's food needs (*35*).

Food security in the study communities, Kugaaruk and Repulse Bay, is similarly compromised. In 2003, 5 out of 6 households in Kugaaruk were classified as food insecure (*9*). Likewise in Repulse Bay, half of the survey's respondents felt that the majority of the people in their community did not have the financial ability to purchase enough food for their families (*8*). The reasons for food insecurity in these two communities include lack of jobs, low income opportunities, high food prices (*8, 9*) and a large number (roughly 45%) of the community being under the age of 15 (*22, 23*). The number of families on government assistance in Repulse Bay is over half (*8*), whereas in Kugaaruk, 1/3 of the community is receiving financial support (*9*). The cost of the Northern Food Basket in Kugaaruk, estimated to feed a family of four for one week, costs 91% of the total social assistance income after paying for housing (*9*).

The poverty and food insecurity of many Inuit communities is decreased by access to country food. Country food is a way to supplement the diet with nutrient-dense low cost food. Thus threats to harvesting ability may further decrease food security.

2.5 Human-Induced Climate Change

The European Project for Ice Coring in Antarctica (EPICA) recently procured an ice core over 3 kilometers long, detailing climate history of up to 740,000 years. Among the eight glacial cycles that were recorded, there was a period climatically similar to present day, which lasted 28,000 years (*36*). EPICA conjectures that this period could be a potential model for our own climate, due to the nearly identical orbit of the earth during the two time periods. Without human intervention our climatic period, which thus far is 12,000 years old, should extend well into the future with stable temperatures. However, the authors agree that humans have and are altering the earth's climate trajectory (*36*).

Most scientists agree that warming temperatures over the last fifty years have been caused by human activities, namely industrial activity (*18*). Chemical gases (carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons) are trapped in the atmosphere and are associated with warming temperatures, which has ignited a host of other climate changes (*19*). Since the industrial revolution, CO_2 levels have risen by 35% and are rising steadily as more unclean industrial growth occurs (*18*). Over the next century, levels of CO_2 compared to pre-industry are expected to double (*19*) and temperatures are expected to increase worldwide by 1.4° to 3.5°C (*20*).

2.6 Current and Predicted Arctic Climate Change and its Impacts

This section will explore the impacts of a warming environment on the Arctic's abiotic systems. The following section covers impacts on biotic systems, including human communities. Wherever possible, specific information for the Repulse Bay and Kugaaruk areas are given. Much of the climate change data in this review comes from the 2004 ACIA report (*18*) that is heralded as the general consensus of the Arctic scientific community. Where appropriate, chapters are referenced directly. The regional-specific climate change data and impacts are based on sub-region IV, as defined by the 2004 ACIA Executive Summary (*18*) and the Arctic Coast climate region (*19*) as defined by Ferguson, which include the study communities.

Predicting impacts of climate change on biotic and abiotic systems, as well as on ecosystems using computer generated models comes with a high degree of uncertainty due to the complex interaction between the earth's spheres (*37*). Thus, this report will follow as much as possible the method to interpret predictions developed by the ACIA. This is namely a lexicon of likelihood with the parameters: "Very Unlikely, Unlikely, Possible, Likely, and Very Likely". This confidence scale is based on expert assessment of multiple facets of scientific study.

The line between *predictions* and events that are *already* happening is blurred. The majority of Inuit communities are observing some form of climate change. Thus, it is important to think about the scale upon which some of these events are occurring, rather than if they are occurring at all.

2.6.1 Arctic Climate Change

Temperature Rising

Although the majority of greenhouse gases do not come from the Arctic region, climate change is occurring there at an increased rate compared to other parts of the world (*18*). Over the past few decades, temperatures in the Arctic have been rising, although with large inter-Arctic variability.

Observations in the Western Arctic have demonstrated a marked warming trend. The past five decades have seen a rise in winter temperatures of 2 to 4°C for most of the Canadian Arctic *(38)*. The community of Sach's Harbour in the Western Arctic has experienced extreme environmental changes first hand in the form of erosion, melting permafrost, thinning ice, invasion of southern species, lack of incoming summer ice and reduction in the number of ringed seals (*16*).

The Eastern Arctic around the Labrador Sea (including Repulse Bay and Kugaaruk) experienced a cooling trend since 1950 (*38*), however currently, scientists agree that this area is now warming as well (*39*). Inuit observations from Igloolik, Clyde River and Iqaluit speak of unpredictable weather, sudden winds, stronger sun, and loss of areas once reliable for hunting (*13*).

The ACIA prediction for average temperature increase in the Arctic over the next century is between 5 and 7°C (*20*). One source predicts that Arctic winter temperatures may increase by 6 to 10°C, while summer temperatures will increase up to 2°C (*19*). Projections of winter temperature increases specifically for the study area range from 3-5°C by 2050 (Natural Resources Canada (*40*)) to 8 to over 10°C over the next century (*18*).

Warming temperatures are expected to bring major change to abiotic spheres. Table 2.2 shows a summary of climate changes in the Arctic ecosystem according to the ACIA. A number of these observations will be discussed in greater detail.

Sea Ice

Sea ice in the Arctic is dynamic and has many faces. Fast ice extends out from land to sea and is attached or "fastened" to the shore. This type of ice is integral to land and sea mammals for survival. Pack ice is formed when loose floating ice is packed together (*18*). The Arctic's central ice pack refers to the consolidated ice mass covering the Arctic Ocean and covers approximately 7% of the earth's surface (*41*). All the forms of ice are interconnected and are hugely important to the earth's climate for two reasons: regulation of heat transfer between the ocean and atmosphere and solar reflection (*41*). Arctic sea ice reflects up to 90% of the solar radiation that hits it (*37*) and thus positively affects the earth's albedo and climate (*41*). Arctic sea ice as well affects the thermohaline circulation of the North Atlantic.(*42*)

Sea ice is extremely sensitive to temperature changes. From 1978 to 1996, overall Arctic sea ice extent has decreased by 2.9% per decade (*43*) and it has also thinned. Future sea ice declines of 10-50% of annual average sea ice extent are projected by 2100 (*18*). Fast ice is expected to decrease considerably from its present thickness of one or two meters (*18*). Glacier melt and warming temperatures will cause sea levels to rise 0.5 to 1.4 m above the 1990 level by 2100 (*44*).

Since 1979, *summer* sea ice extent has retreated by 7.7% per decade (*45*). This decline is projected to accelerate as temperatures warm. Summer ice currently retreats north to a maximum of 150 to 200 kilometers in Repulse Bay and

Table 2.2 Present Arctic climate change observations (*18*).

Increasing	Declining
Temperature	Snow cover
Precipitation	Permafrost
Sea level	Sea ice extent
Forest fires	Sea ice thickness
Insects	Glacier ice
Southern species	Ocean salinity
UV radiation	

Kugaaruk. This ice, important to seals, polar bears, and thus humans, is projected to retreat 500 to 800 kilometers over the next century in the area (*19*). Additionally, there are presently more melt days in the summer (*46*). As ice melts, more open water is revealed, which has the capacity to absorb a greater amount of heat, thus raising the temperature of the water and melting more ice. The positive feedback loop created is known as the albedo effect. The albedo effect has important implications for Arctic sea ice and thus the Arctic climate.

Some ice experts project that the Arctic's colossal central ice pack will completely melt each summer within 30 to 50 years (*47*). They report data on seven different simulations using different CCSM3 climate models used by the Intergovernmental Panel on Climate Change (IPCC). One simulation predicts a stable period from 2003-2024 where over 60% of present multi-year summer ice remains. This abruptly changes in 2024 when summer ice extent retreats rapidly from six million km^2 to two million km^2 in one decade. After this abrupt drop, it is projected that summer sea ice extent over the Arctic Ocean will continue to shrink, with 100% loss occurring sometime around 2050 (*47*). Six other simulations similarly anticipate abrupt decreases in sea ice within the suggested times. The authors suspect that the sudden drop in sea ice extent is due in part to the dynamics between thinning and melting, in part to the albedo effect, and to pulse-like injections of warm ocean currents from the south (ocean heat transport). As illustrated later in this thesis, this has major implications for Inuit and the food they harvest.

Snow and Rain

Over the past thirty years, snow cover has decreased by 10% and precipitation has increased over the Arctic. These parameters are projected to continue on their trajectories. By the year 2070, general Arctic snow cover is projected to decrease by a further 10-20% and precipitation is set to increase by 30% in the winter and autumn seasons (*18*). Maps specifically detailing precipitation changes for the study areas were accessed on the Natural Resources Canada website. These maps are a simulated projection to the year 2040 to 2060. True to the ACIA projections, they show a 10-20% increase in summer precipitation (*48*) and a 10% decrease in winter snow cover (*49*) for both communities. Repulse Bay however, borders an area where increase in snow cover of 0-10% is projected (*40*). These projected events will have major impacts on access to country food and thus nutrition.

Other Impacts

Other possible consequences of environmental change include encroachment and competition from non-native species (*2*), increased storms and floods, and melting permafrost causing infrastructural damage. The opening of new trade and shipping routes will be facilitated from disappearing sea ice, bringing along with it economic opportunity, as well as the consequential pollution and environmental degradation (*18*). Ultraviolet radiation is estimated to be 30% higher now than in the former generation. Increased UV has consequences for humans (sun burns, skin cancer), plants (disruption of photosynthesis), and on developing fish and amphibians. Furthermore, increases of UV generally occur in the spring where species are most susceptible (*18*).

2.6.2 Case Study: Climate Change Observations in Kugaaruk

The Inuit Tapiriit Kanatami (ITK), Nasivvik Centre for Inuit Health and Changing Environments, and the National Aboriginal Health Organization (NAHO), recently released the results of their study, "Unikkaaqatigiit – Putting the Human Face on Climate Change". A series of workshops were held across the North representing the areas of Nunavik, Inuvialuit, Labrador, and Nunavut. The aim of this study was "to collect and make available local knowledge of environmental change…and to bring a "human face" to the issue of environmental change in the Arctic." (*11*) Workshops were held in both Kugaaruk and Repulse Bay.

Kugaaruk residents had much to say about the environmental changes they have witnessed (*11*). Unusual fluctuations in temperatures were reported; weather, once consistently predictable, was now unpredictable. Temperatures stayed warmer longer into the autumn. The sun was reported as hotter, and it, along with the moon and stars have changed positions in the sky. Kugaaruk residents also noticed that ice was getting thinner and darker and there were fewer glaciers. It was reported that the ice broke up earlier and faster and froze up later and slower. Snow came earlier in the fall (before freeze up) and wind direction was unpredictable. Lakes and river levels have dropped. Plants and animals (caribou) were regarded as being less healthy. Population changes of birds and insects were noted. Clearly the residents are observing climate change in their community.

2.6.3 Case Study: Climate Change Observations in Repulse Bay

Repulse Bay's community workshop also revealed many climate change observations (*12*). In general, community environmental experts have noticed that both the summer and winters were warmer now. Furthermore, the winters were shorter and spring and summer were longer. The temperature was more variable and fluctuates rapidly over the season, day-to day, even within a matter of hours. The floe edge was reportedly closer to the community. People of Repulse Bay are finding they cannot predict the weather as they once could. The sun was described as being hotter and more intense, and the sky as white rather than clear blue. A change in the pathway of the moon was observed. Strong fluctuating winds were noted. As well, since the 1990s, the intensity of the rain has been increasing.

The community pointed out that snow and ice were melting faster and earlier than before. Travel was hindered due to early ice melt in the first week of June, 2004. Ice was much thinner and less rough. Also noted was that glaciers and icebergs were much less frequent today than in the past, and that fresh and sea water levels were dropping (*12*).

Berries in Repulse Bay were reported to be less numerous. Increases have been seen in algae and seaweed growth in the last ten years. Caribou were reported as in poorer health, their fat levels varying year to year. Some residents described the caribou as starving, and some having parasites. Marine mammal populations next to Repulse are reportedly in flux. There were less beluga and more orca whales and polar bears, and ringed seals had less fat and thus sink more easily when shot. New species of birds and insects have been observed in the community (*12*).

2.6.4 The Impacts of Climate Change on Animals and People

Climate change will affect the entire Arctic ecosystem. Changes in the breadth and thickness of sea ice are very likely to affect ice-dependant species such as seals, polar bears and walrus (*18*). These species rely on different types of ice (fast ice, pack ice, floe edge) for survival. Changes in the ice may affect seasonal distributions, ranges, migration, nutrition, and reproductive success (*42*). Ringed seal, bearded seal, narwhal, beluga and walrus habitat may not extend as far south (*50*). Caribou may be affected by habitat loss, change to migration routes, and change in access to main food forage. Arctic char are likely to be threatened by encroachment from southern species (*18*). A reduction or loss in the access of these species would impact Inuit communities nutritionally, culturally, and economically. Country food harvesting habits are already being affected (*4*). Changing migrations patterns, thinning ice, altered timing of spring break up and fall freeze up of ice are all contributing to observed changes to access and availability of animals (*4*).

2.6.4.1 Impacts on Country Food

When ecosystems have a simple structure (such that is seen in the Arctic), cascade-type changes in communities may occur (*50*). For example, if there is a small change affecting one member of the food web, it will cause a ripple effect and disturb the other members of the community. This section will introduce general impacts of climate change on the Arctic ecosystem, and then focus on important food species.

Bioenergetic models, such as temperature gradients, are compatible with predicting climate impacts on animals (*2*). Kerr and Packer have shown that species richness (number of species per region) is positively linearly related to mean annual temperature (R^2 =0.736) (*1*). Under this premise, they provide a model of projected species richness in Canada under an IPCC 75 year warming temperature projection scenario based on a 1% increase in CO_2 per year (Figure 2.1). They conclude that Canada's wildlife will need to migrate in order to stay within their climatically suitable areas. According to the map (Figure 2.1), Repulse Bay and Kugaaruk are anticipated to have gains in species richness by 60 and 80% respectively (*1*). The article relayed its concern for 25 animals whose northern ranges were blocked by the Arctic Ocean and thus could not migrate further north. Of these, the caribou and the polar bear are part of the Inuit diet. What will these animals do if migration is not an option? Will they be able to adapt to higher temperatures and an influx of new species (*2*)?

A longer open water season will increase overall production in high trophic levels of marine environments due to an increase in phytoplankton. Biodiversity at higher latitudes may increase, although current marine species occupying these areas may suffer, especially along their southern ranges (*50*). Land mammals such as lemmings, voles, Arctic fox, and snowy owls may be in danger (*37*).

Summer warmth is directly and potently related to regional flora (*50*). Warming temperatures will mean shrinking of the tundra and its unique flora of lichens, forbes and mosses. Increases in geese populations have begun degrading marsh areas of the Hudson Bay coastal area. As a result of the cooling trend in the Eastern Arctic, the plants are still in the dormant phase when the geese come to feed. In a positive feedback loop involving less vegetation, evaporation, and increased salinity, the marsh plants are destroyed, impacting the rest of the ecosystem (*50*).

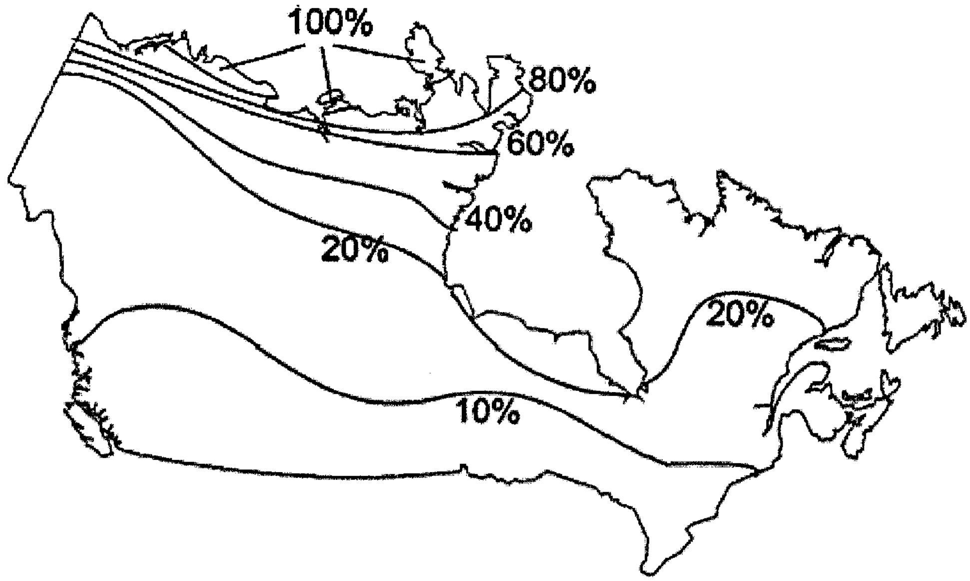

Figure 2.1 Anticipated increases in species richness according to projected temperature warming (from Kerr and Packer (*1*)).

Some would argue that Arctic plants are predisposed to survive the potential rapid changes that a warming climate may bring. The Arctic is a high stress, extreme environment with a short growing season, low resources, and periods of intense grazing, which all helps to improve their long-term fitness (*51*). However, an experiment simulating greenhouse gas-driven warming showed that forbes, lichens, and mosses (important forage food for caribou) rapidly declined as more aggressive deciduous species took over (*50*).

Caribou, Arctic char, ringed seal and polar bear are all important species to the diet and culture of the Inuit. All of these species are under threat from climate change.

Caribou (*Rangifer tarandus):* Caribou is an extremely important food species in Nunavut (*5*). Unfortunately, many characteristics of the caribou and its relationship with the environment make it vulnerable to projected climate change. Normal large fluctuations in caribou numbers occur every few decades, but impending climate change stands to abnormally decrease herd size over the next century (*52*). Energy models relating caribou with climate change events and their associated energetic costs predict that caribou reproductive rates could fall by 40% to 100% (*50*). Several factors are at play including decreased access to and availability of food, increased exposure to insect harassment, and parasite infestation, which in turn affects reproductive rates and calf survival.

The ability of caribou to access their food is intimately linked to climate. As temperatures increase, some undesirable weather events are beginning to occur, including freezing rain, late autumn rain, which freezes before the snow fall, and poor summer growing conditions (*50*). Freeze-thaw events create ice layers, which restrict caribou's access to their food. Digging through ice crusts formed by the freezing of a late autumn rain, coupled with less lichen, puts caribou in a nutritionally disadvantaged situation. This was seen with the Peary caribou herd when numbers dropped from 3000 to 75 between 1994 and 1997 due to record heavy snowfalls and/or icing events (*18*). Furthermore, Inuit communities of Nunavut have observed that caribou numbers decline in years where numerous freeze-thaw events occur (*18*).

Increased snow depth will increase the energy required by caribou to access winter forage. This is reflected in body condition of adult, and thus affects calf survival (*52*). However, the ACIA predicts that snow cover will decrease (*18*), which will allow caribou to expend less energy when digging. Energy expenditure will increase with the rise of insect harassment. Caribou need to run to avoid biting insects, such as warble flies and mosquitoes, and thus lose valuable forage time. Warmer temperatures will result in a linear increase in insect harassment, and thus caribou adults and calves will be thinner at the end of the summer, and ill-prepared for challenging winter conditions (*52*).

Earlier spring timing events (such as vegetation bloom) and delays in freeze up may affect the acceptability of migration routes and breeding grounds. Herds may be pushed closer to industry and infrastructure (*50*), leading to habitat fragmentation, reproductive disruption, and/or encounters with polluted areas. Other climate change-associated events that may affect caribou, include unsafe travel conditions over ice and increased wolf predation (*52*). On the contrary, earlier spring melt would allow caribou to have earlier access to forage, and could reduce energy expenditure of springtime migration (*52*). Furthermore, a longer, warmer summer could mean increased availability of forage for caribou if they are able to adapt to new plant species.

Arctic Char *(Salvelinus alpinus):* Traditionally harvested Arctic char, as well as broad whitefish (*Coregonus nasus*), and Arctic cisco (*Coregonus autumnalis*) will likely be under threat due to competition from incoming southern species, such as salmon and brook trout (*18*). This could lead to population decline or local extinctions.

Ringed Seal *(Phoca hispida):* Ringed seal are inextricably dependant on sea ice. They prefer areas with annual ice break-ups and freeze-ups (*53*). Networks of breathing holes are maintained throughout the winter, which double as fishing holes for their predators. In the latter part of the winter, the seals form snow caves, on the ice to prepare for breeding. Pups are born in mid-April in the fast ice snow caves where they remain during the 30-day lactation period. In mid-May, the pups haul out on the sea ice and moulting begins until the ice breaks up and they begin self-feeding. Their main source of food is Arctic cod along with invertebrates such as mysids (*Mysis oculata*) and amphipods (*53*).

The extent of the Arctic's central ice pack has steadily been shrinking over the past few decades and is projected to continue at a greater speed (*47*). For ringed seals, changing sea ice conditions, as well as decreased snow cover is linked to failure to breed, increased predation, and decreased pup survival rate (*18, 53*). First year seal survival is connected to the break up time of ice. Stirling conducted a comparative study in Hudson Bay from 1992 to 2000, looking at pregnancy, ovulation, and Young-of-the-Year (YOY) ringed seals (*54*). They found normal ovulations rates, but below average pregnancy and YOY rates in the 2000 samples as compared to the 1992 samples. This led to the conclusion that ecological factors were causing the pups not to survive and the pregnancy rates to drop. Sea ice in the Hudson Bay breaks up 2 to 2.5 weeks earlier than it did 20 to 25 years ago (*54*).

In a study conducted in Prince Albert Sound, NWT in 2001, it was observed that earlier ice break-up could shorten lactation or moulting time (*55*). Ice in that area broke up a month earlier than usual and noticeable affects on ringed seals were observed. After sampling, 30% of the pups were not fully moulted. This phenomenon had never been previously recorded. Non-moulted pups were in poorer body condition, shorter, and smaller. Furthermore, the non-moulted pups ate less Arctic cod and more invertebrates, indicating less ability to hunt for preferred food. Authors blamed lack of good ice leading to overcrowded conditions, shortened lactation, delayed pupping, and reduced resources due to unfavourable ice conditions (*55*). It is clear that a reduction and eventually loss in sea ice would have major consequences for the survival of the species in their current ranges.

Ringed seals are especially vulnerable to climate change because of their small birth size, slow growth rate, and their long lactation period (36-41 days) (*55*). Out of all the seals, ringed seals are likely to be most highly affected if ice free conditions prevail in the Arctic. Lack of summer ice means that ringed seals are unlikely to survive (*18*).

Polar Bears (*Ursus maritimus):* Polar bears hibernate for eight months of the year, during which time they give birth and nurse their young (*56*). When they emerge in the spring, hungry from the long fasting period, polar bears use sea ice platforms to feed on fat ringed seal pups. This crucial feeding period lasts only until ice break-up occurs (*57*).

Rising temperatures are causing ice to break up earlier in the spring. Long term studies on polar bears have concluded that earlier ice break ups due to higher temperatures are causing polar bears to emerge from hibernation skinnier (*54*) and in poorer condition (*56*). This phenomenon affects polar bear reproduction, lactation and survival in general (*57*). Furthermore, polar bear dependence on ringed seal is so great, that its range and abundance depends on that of the ringed seal (*50*).

Another impact of climate change is the newly observed polar bear drownings. This has been observed at an increased rate in 2004 and is predicted to increase due to shrinking ice pack and a longer open water season (*58*).

2.6.4.2 Impacts on Inuit

The ACIA concludes that for Arctic Indigenous Peoples, "(Climate) changes present serious challenges to human health and food security" [(*18*), pp. 11]. Inuit communities rely on animal and plant species harvested from the land, including caribou, seal, narwhal, fish, walrus, polar bear, birds, and berries. Since animal quantity and quality and plant health are very likely to be altered, the lifestyles of the people that rely in part or in whole on these species will be threatened.

The previous section explained the likely and possible impacts of climate change on key food species. Loss of access and availability of country food leads directly to loss of food security, culture and important nutritional value. "For Inuit, warming is likely to disrupt or even destroy their hunting and food-sharing culture as reduced sea ice causes the animals on which they depend to decline, becoming less accessible, and possibly become extinct" [(*18*), pp.16]. Climate change will effect the distribution and the quality of hunted animals, fish and plants (*18*).

Inuit travel is affected by increasingly unpredictable ice conditions. As we have seen, both study communities are experiencing thinning and unpredictable ice. This leads to potentially dangerous travel conditions while they are out on the land hunting and fishing (*14, 18*).

Several lifestyle changes among the Inuit have made them more vulnerable to climate change. Firstly, communities are no longer nomadic and thus cannot follow the changing migration patterns of key food animals (*18, 59*). Also, the snowmobile, despite its many benefits, is not equipped to sense thin ice conditions like dogs can (*18*), making travel more dangerous.

Scientists agree that the possibility of polar bear extinction due to ice melt is very real. Polar bear sport hunting is a $2.9 million annual business for Nunavut, $1.5 million of that going directly to Inuit guides. Most tourist hunters come from the United Sates, which is poised to put polar bears on their threatened list, perhaps leading to a ban on polar bear importations into the country (*60*). This action would have devastating consequences for Nunavut's economy and hunter livelihood.

Inuit communities will potentially benefit from climate change in some ways. Home and industry heating and operation costs may decrease (*61*). With the anticipated opening of the North-West passage, increased shipping, resource extraction, and tourism will provide new economic opportunities for the Arctic (*18, 61*). However, this will be coupled with environmental degradation and habitat fragmentation.

The Inuit have had a long tradition of adaptation to climate change. One potent example of this is the so-called Neo-Atlantic Optimum period (*37, 62*). This climatic period, that started in 1000 A.D. in the Eastern Canadian Arctic, was characterized by summer temperatures 2°C higher than present, which caused summer sea ice to retreat, longer summers with more open water, and allowed more access to marine mammals, the most important of which was the bowhead whale (*Balaena mysticetus*). This spurred a change from the 2000 year old Dorset culture to the Thule whaling culture. These present day ancestors laid the foundation for Inuit culture (*37, 62*).

Climate change may change access to favoured animal species and thus bring about a change in hunting technique and lifestyle. Extinctions are possible as well as influx of new species. Thus hunting practices may continue, albeit with necessary adaptations. A situation where all summer ice is gone may lead the Inuit to hunt the species found on land and in the water. There are many scientists in Canada working on adaptation management in Canada (*14, 63*). Furthermore, the results of the present study will inform adaptation plans for the two communities and the surrounding areas.

3 Manuscript 1

Observations of Environmental Change and Impacts on Diet in Two Nunavut Communities

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3.1 Abstract

Introduction: Inuit from communities across the Arctic are describing how climate change is impacting their traditional food systems. Here, we report observed climate change impacts, affecting the country food harvest from Repulse Bay and Kugaaruk, and discuss the nutritional implications of these changes.

Methods: Two-day focus groups were held in each community with knowledgeable community members.

Results: Participants from both communities found that climate change was affecting the country food harvest in both positive and negative ways. Key nutrients that could be affected are protein, iron, zinc, ω-3 fatty acids, selenium and vitamins D and A.

Conclusion: Community members from Repulse Bay and Kugaaruk have confirmed that climate change is affecting their traditional food system.

3.2 Introduction

Most scientists agree that increasing temperatures and other climate changes over the last fifty years are caused by human industrial activity (*18*). Although the majority of greenhouse gases do not come from the Arctic region, climate change is occurring there at an increased rate compared to other parts of the world (*18*). Over the next century, the level of atmospheric CO_2 compared to the pre-industry level is expected to double (*19*) and winter temperatures in the Arctic are expected to increase 4 to 7 degrees Celsius (*18*). As numerous studies suggest, Indigenous populations of the Arctic, including Inuit, have already experienced climate change and its impacts (*11-17*). Some of these climate changes observed in the regions studied include unpredictable weather, earlier break-up and later freeze-up of ice, thinning ice, melting glaciers, decreasing water levels, and changes in animal populations (*11, 12*). These changes can affect the access and availability of country food in both positive and negative ways.

Currently country food is a major contributor of key nutrients to Inuit populations across the Arctic, even though they make up only 8 to 38% of food energy (*5*). In Repulse Bay, country food is the major source of protein, iron, zinc, phosphorus, thiamine, riboflavin, niacin, vitamin B6 and vitamin B12, even though it makes up a mere 16% of total energy intake (*8*). Country food in Kugaaruk, although only 10% of food energy intake, was found to be the major source of protein, niacin, vitamin B6, vitamin B12 and cholesterol and an important source of vitamin A, thiamine, riboflavin, iron and zinc (*9*). Furthermore, marine mammal blubber is a major source omega (ω)-3 fatty acids (*27*). Besides having superior nutritional value, the harvesting, processing, and consumption of country food is associated with a more active lifestyle, an increase in cultural morale and food diversity, and participation in culturally-specific activities (*31*). Decreased intake of country food and increased intake of high-energy, low nutrient market food may put Inuit communities at risk for micronutrient deficiencies (*5*), obesity, cardiovascular disease, cancer, and diabetes (*10, 31, 33*). Furthermore, consumption of country food is associated with greater food security (*8, 9*).

Environmental changes may impact the harvest of plants and animals which are nutritionally, culturally, and economically important to Inuit. This study reports climate change observations from two Inuit communities and makes direct links to key species and nutrients that may be affected in the Inuit diet.

3.3 Rationale

Recent studies report Inuit observations of climate change in Repulse Bay and Kugaaruk, however, this is the first known study to look specifically at how climate change impacts country food.

3.4 Methodology

3.4.1 Ethics and Research Agreements

Ethical approval was obtained from the McGill's Faculty of Agriculture and Environmental Sciences Human Ethics Review Committee (Appendix 2). Preliminary meetings with leaders of Kugaaruk and Repulse Bay, Nunavut took place in February 2005. In these meetings, the project proposal was presented and approved by the Hamlet Councils. A research license was obtained from the Nunavut Research Institute. Research agreements with the Centre for Indigenous Peoples' Nutrition and Environment (CINE) were signed in both communities (Appendix 3). A participant consent form (written in both Inuktitut and English) was used in order to bring greater clarity to the collaborative relationship and to define participant and researcher rights and responsibilities (Appendix 4).

3.4.2 Focus Groups

Two-day bilingual focus groups were held in each community to discuss perceived climate changes related to the access and availability of key species. The Kugaaruk meeting was held in March, 2005 and the Repulse Bay meeting was held in April 2005. Participants were selected using purposeful sampling methods *(64)* picking the most knowledgeable community members for the study. Inuit elders, hunters, processors of the animals, and other community members above the age of 18 years were selected for their knowledge of harvesting and the environment. A representative of the Hamlet council organized the selection process, which included radio advertising and word of mouth. The community wildlife officer and the Mayor were present in the Repulse Bay focus groups.

Key topics of focus included ice, snow, weather, marine mammals, land mammals, fish, species ranges, migration patterns, and quality and quantity of animal populations. Maps, on a scale of 1:250,000 and 1:50,000, were used to pinpoint harvesting locations. Focus groups were conducted using semi-directed, unstructured questions (*13, 14, 16, 17*). Meetings started with general observations of environmental change, and subsequently each harvested species was discussed in detail (i.e. caribou, ringed seal, Arctic char). Observations were recorded pertaining to changes in animals or the community's ability to harvest the animals. On site translation was done by community translators and audio tapes were made of each meeting to ensure full understanding of the data.

3.4.3 Data Analysis

Qualitative data collected from focus groups were analyzed with the objective of understanding the current perceptions on how environmental change is affecting access and availability of country food. The meeting tapes were transcribed into English with the help of community translators. Data were checked with community members for accuracy. A qualitative analysis categorizing strategy was used for analysis (described in Maxwell (*64*) and used in Guyot et al., 2006 (*15*)). This strategy involves coding data in order to form themes and to allow for cross comparison analysis between communities. Each major animal represented a category; other categories included land, sea, and weather.

3.4.4 Validity

A possible source of error is participant bias, saying what the researcher wants to hear, or reactivity (*64*). Thus to minimize this bias, focus groups were conducted in a semi-directed unstructured manner (*13, 14, 16, 17*). Specific, directed questions such as *'How is climate change impacting your country food?'* were avoided, so as not to imply the intended goal of the researcher. Rather, questions were asked such as, '*Have you noticed any changes in how or when you harvest food?* These types of questions allowed participants to draw their own conclusions and tell their own truths.

3.5 Results

"I've seen a lot of changes in the land, sea and sky. Weather and temperature changed as well."

~Repulse Bay elder

A total of ten community members participated in the focus groups in Repulse Bay, three women and seven men. In Kugaaruk, seven people participated, including one woman.

A multitude of climate observations relating to changes in harvesting were given by members of each community. Three themes emerged from the observations: 1) ice/snow/water 2) weather and 3) changes in species. Table 3.1 displays the observed environmental changes affecting the food harvest in both Repulse Bay and Kugaaruk. Table 3.2 shows the observed changes in species.

3.5.1 Ice, Snow and Water

All observations about ice, snow or water can be referred to in Table 3.1. Respondents in both Repulse Bay and Kugaaruk observed that ice was thinner and that it melted earlier in the spring. Repulse Bay participants noted that this was an asset to hunting ringed seal, caribou and fish,

"we like it when the ice melts earlier…we get to use the boat earlier and give meat or fish to our children for them to grow up healthy".

~Repulse Bay community member

However, Kugaaruk respondents reported an increase in "rotten ice", or ice in an advanced stage of disintegration (*65*). While hunting seals in the spring, rotten ice prevented hunters from moving freely between ringed seal breathing holes, which made harvesting more difficult and dangerous.

When the floe edge was closer to the community, harvesting seals and walrus was reported to be easier. Repulse Bay participants reported that presently, the floe

Table 3.1 Environmental changes observed by Kugaaruk and Repulse Bay residents affecting the ability to harvest wildlife.

Theme	Repulse Bay	Kugaaruk
Ice/Snow/ Water	▶ ice thinner now	▶ ice thinner now, increase in rotten ice
	▶ lower water table	▶ lower water table
	▶ variable snow fall	▶ more snow this year
	▶ snow and ice on hills and mountains melts now in the summer, whereas in the past it stayed all year	▶ tea water darker, dirty
	▶ water current stronger in spring	
	▶ proximity of floe edge varies each year	
Weather	▶ late autumn rain, then quick freeze-up	▶ increase in freezing rain
	▶ unpredictable now	▶ unpredictable now
	▶ wind quicker to change and stronger	▶ more rain in summer
	▶ summer sun is hotter, more intense	▶ sun much hotter
	▶ warmer winters	▶ no more ice fog
	▶ position of stars have changed	▶ sun rises straight up, before shallow

edge proximity varied slightly year to year. Snowfall had increased in both communities and had become more variable in Repulse Bay. Hunters and elders in both communities stated that caribou like to be where there is less snow in order to access vegetation. In Repulse Bay, where snow and ice once remained throughout the summer on hills and mountains and in some places in the community, it reportedly currently melted during the summer, increasing the albedo of the area. Kugaaruk elders noted that in the spring, soft snow that before would harden at night, now remained soft.

Participants from both communities reported that the water table was lower in lakes and the ocean. New reefs have appeared in Kugaaruk, and Repulse Bay residents now accessed islands at low tide which previously had been inaccessible. A river in Kugaaruk was said to have nearly dried up, making fishing for lake trout and Arctic char in that area impossible. Tea water in Kugaaruk was reported as now dark, dirty, and brown; sediments were seen in the water. In Repulse Bay, the water current in the spring was said to be stronger now.

3.5.2 Weather

Weather observations are listed in Table 3.1. The weather was reported to be unpredictable now in both communities. Wind changed quickly and was stronger, as reported in Repulse Bay. Respondents from both communities reported that increased summer rain boosted vegetation growth, translating to healthier, fatter caribou. Also, it was described that more rain let hunters stalk caribou more quietly. Increase in summer rain was reported to be akin to increased berry harvest.

Kugaaruk community members reported increased freezing rain. In 2004, a freeze-thaw event occurred in Repulse Bay that changed the migration pattern of caribou making access more difficult:

"This year was exceptional because we had a late rainfall in the autumn which caused a coating of ice on the ground, which caused the caribou to migrate even further south to the Saskatchewan border or N.W.T. border. It is unusual. That's why it was harder to get a caribou this winter."

~ Repulse Bay hunter and elder.

Another important environmental change, as told by participants in both communities, was the increased intensity and heat of the summer sun. This was reported to cause problems when drying fish or meat; the meat either spoiled, or dried too quickly and became soft.

Repulse Bay participants reported warmer winters and that the position of the stars have changed. Kugaaruk community members described that there was no more "ice fog" and that the sun rose more steeply in the sky.

3.5.3 Changes in Species

Respondents from both communities gave a multitude of very specific changes they have noticed happening in the species upon which they rely. Table 3.2 documents these observations. Generally, participants from both communities reported that the health of the animals has decreased, and the taste and texture of caribou and fish was different. Participants from Kugaaruk cited the reason as being pollution from exploration, or using wooden storage containers for the fish instead of using ice.

3.5.3.1 Caribou

Both Kugaaruk and Repulse Bay community members stated that presently the caribou population was close to the community and that caribou were tamer and easier to harvest. However, respondents from both communities suggested that because of an increased population, the meat did not look as healthy and was infested with more parasites and warble flies than before. Repulse Bay participants reported that caribou hide was thinner, easier to tear, and Kugaaruk participants says the fur was not as healthy. Repulse Bay community

Table 3.2 Direct changes in species affecting the ability to harvest wildlife.

Theme	Repulse Bay	Kugaaruk
Wildlife	▶ seal, caribou meat darker in colour	▶ animals not as healthy, more illness ▶ ↓ quality meat
Caribou	▶ ↑ caribou close to the community ▶ meat does not look as healthy ▶ ↑ in parasites in meat ▶ tamer now ▶ hide easier to tear, thinner ▶ easier to harvest ▶ migratory route varies, no longer on the sea ice ▶ caribou are skinnier ▶ sandy material found between skin and meat	▶ ↑ caribou close to the community ▶ meat does not look as healthy ▶ ↑ in parasites in meat ▶ tamer now ▶ fur not as healthy
Marine Mammals	▶ ringed seal population size/proximity, fat content fluctuates according to floe edge distance, orca whale and polar bear populations ▶ hunt more seals when floe edge is closer ▶ 5 years ago, there were more seals ▶ fat abundance varies each year ▶ seals are skinnier this year ▶ ↑ narwhal, orca whale populations ▶ beluga population not close	▶ seal population is abundant now ▶ seal population is cyclical ▶ illness in seals ▶↑ narwhal ▶ ↑ bowhead whale ▶ ↑ polar bear
Fish/ Sea Life	▶ abundant Arctic char and lake trout populations ▶ fish flesh is whiter than before	▶ fish eat pollution left by exploration companies ▶↓ in shrimp, jellyfish, and seaweed
Birds	▶ ↑ in non-native species ▶ ↓ in native bird species	▶ ↑ in non-native species ▶ ↓ in native bird species
Plants	▶ more rain equals more berries ▶ berries eaten by geese ▶ berry leaves broken by caribou	▶ vegetation getting bad ▶ berries eaten by geese
Insects	▶↑ parasites ▶↑ warble flies	▶ ↑ parasites

members described that caribou were skinnier and sometimes there was sandy material between the skin and the meat. Furthermore, they said that caribou no longer migrated over the sea ice; their migration patterns varied.

3.5.3.2 Marine Mammals

Kugaaruk respondents noted that the ringed seal population was abundant. Repulse Bay, reported that there were more ringed seals 5 years ago, but the proximity of the population was close this year. Residents described that the size and proximity of the ringed seal population and their fat content fluctuated according to floe edge distance, as well as the orca whale and polar bear populations. When their predators were close or numerous, the ringed seal population decreased as did their fat content. However, the seals tended to congregate closer to the shore when predators were near, which made them easier prey for Inuit. Presently, community members said, the orca whale population was resurging. As well, ringed seals this year had less fat, which presented a problem when hunting. It was reported that less fat equaled less buoyancy when shot in the water, and therefore hunters lost more seals. Furthermore, it was mentioned that fatter ringed seals had tastier livers. Kugaaruk participants reported that sometimes now ringed seals had bad livers. Beluga populations reportedly did not come close anymore to the community of Repulse Bay. Kugaaruk's polar bear, narwhal and bowhead whale populations are said to have increased.

3.5.3.3 Fish and Sea Life

Participants in Repulse Bay noticed a decrease in two types of shrimp, as well as jellyfish and seaweed. The Arctic char and lake trout population in Repulse Bay was reported to be abundant, however, the flesh was paler than before. According to participants in Kugaaruk, the fish ate the pollution left behind from mining and exploration operations, and this causes concern for human health.

3.5.3.4 Birds

Members of both communities have seen a decrease in native bird species and an increase in non-native bird species. Ptarmigan population and body size have reportedly decreased. Kugaaruk residents confirmed decreased eider duck, Arctic tern, other shorebird, and song bird populations. Geese and swan were reported to have increased in both communities, and ravens increased in Repulse Bay. Some people in the communities hunted more geese as a result.

3.5.3.5 Plants

Berries in Repulse Bay generally were reported as not abundant, but blueberry, blackberry, and cranberry populations that are present were being diminished by migrating geese and caribou populations. Participants in Kugaaruk reported that the "vegetation is getting bad" and caused the caribou to migrate elsewhere to find healthy forage.

3.6 Discussion

"I have seen both positive and negative impacts from climate change"

~Kugaaruk elder and hunter

The observed climate changes have both positive and negative consequences on the Arctic ecosystem and have the potential to affect the amount of food harvested and eaten in Inuit communities. Tables 3.3-3.5 show which nutrients would possibly be affected by projected changes in country food consumption as a result of observed environmental changes in Repulse Bay and Kugaaruk.

Changing ice, snow and water conditions will impact the animals that are harvested by Inuit (Table 3.3). On one hand, using the boat to harvest seals earlier may increase ringed seal consumption. However, increased rotten ice may translate to harvesting less seals in the spring which would decrease valuable nutrient intake. Early break up of ice, an Arctic-wide symptom of climate change (*18*), may reduce ringed seal numbers by decreasing pregnancy rates and pup survival (*54*) and by shortening lactation and moulting times (*18*). Ringed seal flesh is extremely high in protein, iron, and zinc (*66*). The blubber is an excellent source of ω-3 fatty acids (*27*), and vitamin E (*67*), while intestines are a good source of vitamin E (*67*). Zinc can be found in very high levels in ringed seal eyes (*66*), which are traditionally eaten by women.

Earlier boating may increase access to caribou (shot from the boat) and fish (Table 3.3). Like most country food, caribou boasts a whole host of micro and macronutrients, including protein, iron, zinc and phosphorous from the flesh (*66*), and vitamins A and D from the liver (*66, 67*). Vitamin E is found in the flesh, liver, and fat (*67*). Caribou stomach and stomach contents are good sources of manganese and magnesium respectively (*66*). Arctic char and lake trout are an excellent source of vitamin D, which is important for Inuit due to low consumption of fortified milk beverages (*66*) and limited sun exposure during the

Table 3.3 Nutrients possibly affected by changes in country food as a result of observed climate changes in ice, snow and water.

Observation	Consequence	Country Food	Major Nutrients Affected
► thin ice	use boat earlier	↑ fish	vitamin D, protein, ω-3 fatty acids
		↑ caribou	iron, zinc, protein
		↑ seal	iron, protein, ω-3 fatty acids
► rotten ice	travel dangerous	↓ seal	iron, protein, ω-3 fatty acids
► lower water table	local streams dried up	↓ fish	vitamin D, protein, ω-3 fatty acids
	access to new islands	↑ caribou	iron, zinc, protein
► ↑ snow	↓ access to vegetation for animals	↓ caribou	iron, zinc, protein
► variable floe edge proximity	shift in proximity of animal populations	↑↓ seal	iron, protein, ω-3 fatty acids
		↑↓ walrus	vitamin A, ω-3 fatty acids
		↑↓ polar bear	vitamin A

winter. Arctic fish are also excellent sources of protein (*66*) and ω-3 fatty acids (*27*). Thus more access to caribou and Arctic fish by earlier boating could increase consumption of these valuable foods and their nutrients.

Participants in both communities observed that the water table, including rivers and fishing spots, is lower now (Table 3.3). This observation is supported by scientific evidence in the Arctic from Queen's University and the University of Alberta (*68*). Since 1983, a series of limnological records show a lower water table, summer drying of substantial bodies of water and ponds, and changes in water chemistry; elements which, in the Arctic, have been stable for millennia. The authors cite an increased evaporation/precipitation ratio due to warmer temperatures and a longer ice-free season as the cause of these changes (*68*). The drying of these bodies of water is changing the health and the structure of invertebrate populations, which is likely to cause a cascading effect on the food chain. Wildlife are losing valuable watering holes, waterfowl are losing essential habitat (*68*), and ultimately, this will effect the access to country food in both communities. On the contrary, a lower water table has increased access at low tide to small islands, thus giving greater access to caribou hunting areas.

Presently, Repulse Bay has reported annual variability of the proximity of the floe edge (Table 3.3). The ACIA predicts that the summer floe edge will retreat, changing the habitat, feeding, and breeding conditions for ringed seal, walrus, and polar bear (*18*) (Table 3.3). Ringed seal are very unlikely to survive in regions where there is no summer ice. Polar bear survival depends namely on their primary prey, the ringed seal (*18*). Vitamin A would be affected if polar bear consumption decreases (*66*) and adequate alternative foods were not consumed.. Bottom feeding walrus' would lose access to productive coastal areas if the floe edge retreats and would lose an important mode of transportation if floating sea ice is reduced (*18*). The main nutrients affected from change in walrus consumption are vitamin A and ω-3 fatty acids (*66*).

Caribou are heavily influenced by weather conditions. Both increased snow cover and freeze-thaw ice layers drive caribou further south (Table 3.4). Access by Inuit to the nutrients provided by caribou may be diminished as these weather patterns continue. However, increased rain and wind may benefit the status of caribou by increasing summer vegetation and providing relief from insect harassment respectively (Table 3.4).

="*When there is more rain in the summer time, the caribou are better, healthier, fatter, because vegetation grows, they eat more.*"

~Kugaaruk community member.

Furthermore, if caribou are easier to stalk in rainier conditions, Inuit may gain more access to caribou's beneficial nutrients (Table 3.4).

Nutrients in meats (whale, caribou) and fish are concentrated and become up to three times higher when dried (*66*), a traditional practice in both communities. Residents of both Kugaaruk and Repulse Bay assert that the sun's heat, which is now more intense and hotter, at times spoils the fish or meat before it is dry, making it soft and inedible (Table 3.4). If drying practices are affected by climate change, an old tradition may be at stake, as well as valuable nutrients (Table 3.4). However, it is possible that Inuit people will adapt to the situation.

"*We will not stop drying fish as long as we live. It is a cultural thing.*"

~Repulse Bay elder.

Decline in quality of meat and fish and increase in parasites may have a negative effect on consumption of nutrients from caribou, ringed seal, and fish (Table 3.5), especially for attracting the younger generation to eat country food.

It is assumed that the increase and decrease of animal populations will translate to a relative increase or decrease in consumption for Inuit (Table 3.5). Reported decreases in ringed seal, ptarmigan, and king eider duck and ptarmigan body size, may have negative consequences for Inuit relying on those nutrients. Ptarmigan and King Eider are both high sources of iron and protein, and contain a variety of

Table 3.4 Nutrients possibly affected by changes in country food as a result of observed climate changes in weather.

Observation	Consequence	Country Food	Major Nutrients Affected
► freeze-thaw events	icy layer covering vegetation	↓ caribou	iron, zinc, protein
► hotter sun	affects drying quality	↓ fish	vitamin D, protein, ω-3 fatty acids
		↓ caribou	iron, zinc, protein
► ↑ rain	easier to hunt caribou	↑ caribou	iron, zinc, protein
	↑ vegetation	↑ berries	vitamin C, phytochemicals
► ↑ wind	↓ insect harassment	↑ caribou	iron, zinc, protein

Table 3.5 Nutrients possibly affected by changes in country food as a result of observed changes in species.

Observation	Consequence	Country Food	Major Nutrients Affected
► ↓ quality of meat, ↑ parasites	more effort needed to hunt good meat	↓ caribou	iron, zinc, protein
		↓ seal	iron, protein, ω-3 fatty acids
		↓ fish	vitamin D, protein, ω-3 fatty acids
► ↓ animal population	harvest less	↓ seal	iron, protein, ω-3 fatty acids
		↓ ptarmigan	protein, iron
		↓ king eider	protein, iron
► ↑ animal population	harvest more	↑ fish	vitamin D, protein, ω-3 fatty acids
		↑ narwhal	vitamin A, E, D, ω-3 fatty acids
		↑ bowhead	vitamin A, E, D, ω-3 fatty acids
		↑ goose	protein, iron, zinc, copper
		↑ swan	protein, iron, zinc, copper
► loss of fat	seals: sink faster	↓ seal	iron, protein, ω-3 fatty acids
	caribou: less healthy	↓ caribou	iron, zinc, protein
► ↑ orca whale	↓ seal population	↓ seal	iron, protein, ω-3 fatty acids
► ↑ goose	destroy vegetation	↓ berries	vitamin C, phytochemicals
► ↓ bird body size	less meat	↓ ptarmigan	protein, iron
► caribou break leaves	less berries	↓ berries	vitamin C, phytochemicals
► vegetation getting bad	affect caribou migration	↓ caribou	iron, zinc, protein
► ↑ parasites, warbles flies	caribou harassment	↓ caribou	iron, zinc, protein

other micronutrients (CINE nutrient database ~ http://cine.mcgill.ca/nutrients/searchpage.php).

Repulse Bay reports that Arctic char and lake trout populations are abundant which adds important nutrients to Inuit diets. The Arctic Climate Impact Assessment (ACIA) reports that under a warming scenario, warmer water temperatures are likely to increase body size in Arctic char but it has also been shown to increase respiration, and therefore accumulation of heavy metals. Lake trout are projected to be gravely stressed by lower oxygen levels and food supply (*18*). Thus, future Arctic fish consumption and the nutrients they provide (Table 3.5) could be at risk.

Assuming that increased population means greater consumption, growth in narwhal, bowhead whale, goose and swan populations will provide greater access to some valuable nutrients. Sea mammal fats are very high in ω-3 fatty acids including the very healthy eicosapentanoic acid (20:5ω3) and docosahexanoic acid (22:6ω3) (*27*), as well they are excellent sources of vitamins A, E, and D (*67*). Dried narwhal meat is extremely high in phosphorus and sea mammal skin is a high source of protein (*66*). Geese and swan are harvested by both communities in small numbers, and if the harvest increases, this will contribute to protein, iron, zinc and copper levels (*69*).

Respondents from both Repulse Bay and Kugaaruk have noticed however, that higher numbers of geese consume more berries thereby decreasing their availability to Inuit. Caribou, it was noted by Repulse Bay community members, trample and destroy the berry leaves during their migration. Arctic berries, such as blueberries, blackberries, and cranberries contain phytochemicals (*70*), carbohydrates (*66*) and vitamin C (CINE nutrient database ~ http://cine.mcgill.ca/nutrients/searchpage.php). Due to poorer quality vegetation, caribou are skinnier and have to migrate further, thus decreasing access to caribou's superior nutrients.

The increase in orca whales in Repulse Bay may alter the amount of ringed seals available to the community. Repulse Bay participants noted that when the orca whale population is close, the seals are skinnier and they stay closer to the shore. This may translate to increased access for Inuit. However, since skinnier seals sink more easily when shot, hunters have less access to valuable nutrients from seals.

3.7 Conclusion

3.7.1 Limitations

The information gathered for this thesis could have been richer if community visits were longer. Furthermore, the communities were visited in later winter only. It would perhaps have been more effective to visit the communities during the summer season as well, in order to glean more information about that time. However, this study was reasonably limited by time and financial constraints. Lastly, the saturation point for the number of community members participating in the focus groups was not reached.

3.7.2 Conclusion

It is evident that climate change is having a perceived impact on the way the communities of Repulse Bay and Kugaaruk are able to harvest their regional species. However, no general trend is easily discernable after examination of the influence that climate change has on access and availability of key harvested species. In fact, both positive and negative harvesting outcomes have been reported. Changes in weather and landscape, as well as changes in the animals, have both diminished and given greater access to country food, depending on the species. Inuit have historically adapted to changes in climate and species distribution (*37, 62*). However, current climate change is happening at record speed (*18*). This, together with encroaching global culture, increasing contaminant deposition (*18*) and imminent natural resource exploitation, creates a multi-faceted scenario, to which Inuit hunting culture must respond.

Besides the great cultural and economic significance, the nutritional value of the food that Inuit harvest from the land and sea is unparalleled. Government support is needed to increase social and financial support for hunters and communities harvesting wildlife. Initiatives may include funding for community harvests, hunting equipment and community freezers, and meaningful environmental assessments to protect Arctic species from exploitation. On a global scale, policy must support green technologies in order to curb fossil fuel emissions and hinder climate warming in the Arctic. Country food is extremely important to Inuit communities across the Arctic, the access of which must be encouraged and supported.

"*When you stop to think, your vision tells you that if we are not looking after the care of the environment, what does the future hold for our upcoming generations.*"

~ Kugaaruk community member

3.8 Connecting Paragraph

Manuscript 1 provides clear evidence on how climate change is impacting key harvested species in Kugaaruk and Repulse Bay, Nunavut. What is the nutritional impact of these changes? In order to examine this question and makes links between observed climate change and Inuit dietary nutrient status, a clear picture of the current nutritional situation is needed. Manuscript 2 focuses directly on the nutrient content of country food and how this enhances nutrient intake for Repulse Bay residents.

4 Manuscript 2

Consumption of Country Food and Nutrient Intake in Repulse Bay

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4.1 Abstract

Introduction: Inuit receive essential nutrients through the consumption of country food. This study characterizes nutrient intake from country food in Repulse Bay.

Methods: Twenty-five percent of the community of Repulse Bay, Nunavut, Canada participated in a country food frequency questionnaire. Median daily intake (g/day) of the total population was used to compare intake of 22 nutrients to daily required values.

Results: A total of 43 men and 40 women aged 18 and over participated in the survey. Median daily intake of country food was 367 g/day for the whole population. Country food provided 100% of the Dietary Reference Intakes (DRI) for protein, omega 3 fatty acids, vitamins A and B6, riboflavin, phosphorus, iron, copper, zinc and selenium, thus when total diet is taken into account, it is likely that participants consume levels over DRI recommendations. Caribou was the most consumed country food (by weight and frequency). The top contributing species to each nutrient are also reported.

Conclusion: Country food is extremely important to Inuit dietary nutrient status, considering its reported low energy intake by Inuit communities.

4.2 Introduction

Country food, also called traditional food, is food that has been traditionally and is presently gathered and hunted from the land and sea by Inuit communities. Inuit populations have been living off the land for thousands of years. Despite a move to consumption of mostly store-bought or market food, the Inuit diet still comprises 8 to 38% country food (*5*).

Country food provides important nutrient contributions to Inuit communities, despite seemingly low energy intake. A Health Canada study in Repulse Bay showed that country food was the major source of protein, iron, zinc, phosphorus, thiamine, riboflavin, niacin, vitamin B6 and vitamin B12, even though they made up only 16% of total energy intake at the time of the survey (*8*). Country food in Kugaaruk, although only 10% of food energy intake, was found to be the major source of protein, niacin, vitamin B6, vitamin B12 and cholesterol and an important source of vitamin A, thiamine, riboflavin, iron and zinc (*9*).

Each species contributes a variety of nutrients. Environment Canada reports that the iron content of seal meat is six to ten times higher than that of beef (*26*). Protein, calcium, thiamine, and riboflavin levels are all significantly higher in seal meat than in beef, and fat content is significantly lower (*24*). Marine mammal blubber is a major source of ω-3 fatty acids (*27*), while Arctic fish are rich in vitamin D.

Country food intake in Inuit communities has declined due a nutrition transition (*71*), greater access to market foods and other social factors. It is likely that decreased intake of country food and increased intake of high-energy, low nutrient market food will put Inuit communities at risk for micronutrient deficiencies (*10*). Decreasing intake of country food also increases the risk of obesity, which is associated with an increased risk in chronic diseases (*33*).

Country food is associated with a more active lifestyle, and an increase in cultural morale, food diversity, and participation in culturally-specific activities (*31*). Inuit respondents in a 2000 survey cited that country food contributed to physical fitness and good health, encouraged community sharing, saved money, and was an essential part of the culture (*5*). Furthermore, country food is associated with greater food security (*8, 9*).

The collaborating community, Repulse Bay is located in the Kivalliq region of Nunavut (Latitude 66.56057, Longitude 86.24727). It is a coastal town with 153 dwellings and 748 people (*23*). In the Kivalliq region, the most frequently consumed country food is caribou, char, beluga, trout, ringed seal, walrus and narwhal (*5*). The main sources of income are government or community jobs, government assistance, fishing, trapping, hunting, and the sale of handicrafts (*8*). Yearly income for full time workers in 2001 was recorded to be $34,300 (*22*) compared to the provincial average of $48,100 for that time.

4.3 Rationale

This study gathers baseline nutritional data about country food in Repulse Bay. It is important to collect this information to understand country food's contribution to nutrients in the diet. The most recent data collected on diet in Repulse Bay were completed in 1997 (*8*). Also, a study in 2000 reports similar nutritional data for the Kivalliq region, but did not specifically include Repulse Bay (*5*). The present study updates that information and combined its results with another unpublished study, which collected data in 2003, to improve accuracy by creating a larger sample size. These data will be instrumental in future research which requires nutritional data on country food. Specifically, these data will be used in other projects, to anticipate the impact of climate change on the dietary nutrient status of Repulse Bay and other Inuit communities.

4.4 Methodology

4.4.1 Ethics and Research Agreements

Conducting research in Indigenous communities requires cultural awareness and sensitivity. Thus, the study was guided by the principles of Participatory Health Research (PHR) (*72*). PHR involves consultation with the communities through all stages of the research process, including planning, field work, data collection, and review of results before publishing (*72*). Further details can be found at www.cine.mcgill.ca/documents/english.pdf. "Good intentions are not always sufficient for avoiding adverse reactions or effects of research. Mutual respect will develop from meaningful consultation and partnerships…" [(*73*), pp. 5].

Research proposals and data collection tools were peer reviewed before they were introduced to the communities. Identity, background, and prior experiences of the researchers involved, were explained to the communities; a process known as reflexivity (*74*). The research team visited the communities for discussion and approval of the results before publication.

Ethical approval was obtained through the McGill's Faculty of Agriculture and Environmental Sciences Human Ethics Review Committee (Appendix 2). Furthermore, special ethical considerations were followed as outlined in the guidelines *Ethical Principles for the Conduct of Research in the North* (*73*).

Research agreements were signed between Repulse Bay and The Centre for Indigenous Peoples' Nutrition and Environment (CINE) (Appendix 3). A participant consent form (written in both English and Inuktitut) was used in order to bring greater clarity to the collaborative relationship and to define participant and researcher rights and responsibilities (Appendix 4).

4.4.2 Food Frequency Questionnaires

Five trained interviewers from the community administered bilingual (Inuktitut and English) food frequency questionnaires (FFQ) (Appendix 5) asking participants to identify the number of days they had eaten food items over the last week, month, and year. A community harvest calendar, which specifies the seasons for which key species are harvested, was used to aid memory recall (Appendix 6). The 111-item FFQ was completed over a period spanning four days in April, 2005. Questionnaires took approximately 45 minutes to complete. A sub-sample of the participants was asked to estimate average portion sizes using life-like synthetic meats as a memory aid.

Sample size and design of the questionnaire complimented a previous CINE study in Repulse Bay conducted in 2003, led by Patricia Solomon (*75*). The FFQs were identical except that food preparation methods for meat were defined in the present study. The questionnaire was based on key species harvested by Repulse Bay and was validated in 2003 by Solomon (*75*) and by the Repulse Bay community wildlife officer in 2005. The food frequency questionnaires were conducted in participants' homes.

To generate the random sample, a list of adult community members (n=361) was stratified according to gender and age (19-40, 41-60, 61+) categories. Individual names were then randomly drawn from each age and gender category, according to the method used by Solomon (*75*). A combined sample goal of 25% of the adult population was established for the two datasets. The 2003 survey focused mainly on women of child-bearing age, thus the present survey excluded those women and focused more on other groups to achieve a representative community sample. Those under 19 years old were excluded from the study for ethical reasons. Individuals were not interviewed if they were unavailable (working, out on the land, out of town) or chose not to participate.

4.4.3 Data Analysis

A nutrition transition trend over the Arctic has resulted in stratified consumption of country food across age and gender (*10*). Thus, data from food frequency questionnaires were divided according to age and gender for analysis. The questionnaire was set up to take seasonal variations into account, as availability and thus intake of country food varies greatly per season (*25*).

The main variables of interest from the food frequency questionnaire were grams per person per day (g/day) of each food item on the survey and the frequency (days/year) that each food item was consumed by the sample population. These numbers were multiplied by the estimated portion size to get the grams of food/person/year. Further calculation established the grams of food/person/day (personal intake) for each food item across gender and age groups. Participants reporting consumption of over 4000 kcal from country food were excluded as outliers.

4.4.3.1 Combining the Two Datasets

Means, medians and standard deviations of each age and gender group from the 2003 dataset and the 2005 dataset are presented in Table 4.1. The two sets of data were collected to complement each other in terms of gender and age group, using identical methodology. They were thus combined to increase sample size and demographical representation. Combined mean g/day are shown with a similar dietary assessment, which included three communities in the Kivalliq region (*5*) (Table 4.2). Henceforth the combined data will be discussed and analyzed.

4.4.3.2 Nutrient Content of Food Items

The contribution of twenty-two nutrients, including five macronutrients, seven vitamins, and ten minerals, was examined. These nutrients were chosen because the country food values for these nutrients were available. The CINE Arctic Nutrient database (http://www.mcgill.ca/cine/resources/nutrient) was used to obtain the value of all macro and micronutrients per gram of each food item.

Table 4.1 Mean, median and standard deviation g/day and sample size (n) for adults in the 2003 dataset and 2005 dataset.

Gender/Age	2003			2005		
	n	Median	Mean±SD	n	Median	Mean±SD
Women						
19-40	26	442	516±344	8	253	336±310
41-60	3	364	441±249	2	230	230±230
61+	1	582	582±582	-	-	-
Men						
19-40	10	411	528±407	20	295	369±323
41-60	1	555	555±555	9	759	656±379
61+	1	571	571±571	2	975	975±975
Total	**42**	**453**	**518±335**	**41**	**312**	**448±312**

Table 4.2 Combined mean (g/day) of adults in datasets 2003 and 2005 with the mean found for the Kivalliq region in the 2000 CINE survey (*5*).

Gender/Age	Combined mean	CINE mean
Women		
19-40	472	233
41-60	357	523
61+	577	508
Men		
19-40	422	413
41-60	645	686
61+	836	979
Total	**559**	**557**

Hence, the nutrient contribution from each food item was calculated for each age group and gender. When the food item was not available through the CINE database, the United States Department of Agriculture's online Nutrient Data Laboratory (http://www.nal.usda.gov/fnic/foodcomp/search/) was used. In a small number of cases, the nutrient value for the food item was not found in either database. In this case, nutrient values from comparable species were substituted (Appendix 7).

The age-gender stratified macro and micronutrient contribution of each food item, was found by multiplying personal intake of each food item (g/day) by the nutrient value per gram of food item (i.e. mg/g). This was carried out for each micro and macronutrient and each age and gender category. To continue with the example in section 4.4.3: daily ω-3 fatty acids contribution from cooked polar bear meat to men aged 19-40 is:

➔ 2 g/day consumed x $4.25x10^{-3}$ g ω-3 fatty acids per 1 gram cooked polar bear
= 8.5×10^{-3} g ω-3 fatty acids /day
For men age 19-40, cooked polar bear contributes 8.5×10^{-3} g ω-3 fatty acids /day.

4.4.3.3 Comparison of Nutrient Contribution to the Dietary Reference Intake (DRIs)

The Dietary Reference Intake (DRIs) of each nutrient is set as a guideline for optimum nutrition (*29, 30, 76-78*). They include Estimated Average Requirements (EAR), Recommended Dietary Allowance (RDA), Adequate Intake (AI) and the Tolerable Upper Intake Level (UL). According to the Institute of Medicine, the EAR is used to assess the nutrient requirements of groups (*28*), while the RDA is used to assess individual nutrient requirement. When the EAR is not available for a specific nutrient, the Adequate Intake (AI) is used. EARs and RDAs are different between age and gender groups.

In this thesis, estimated daily contributions of each food item to nutrient intake are found. Nutrient content of country food is expressed as a percent of the EAR, so as to show the daily nutrient contribution to the diet of Repulse Bay community members. Individual nutrient intake was expressed as a percentage of the RDA.

4.4.4 Statistical Analysis

SAS (v. 8.0) and Microsoft Excel were used to manipulate all data. General descriptive statistics were compiled using SAS.

4.5 Results

The food frequency questionnaire (FFQ) included 12 species separated into parts and preparations methods for a total of 111 food items (Appendix 5). The following species were included: Arctic char, bearded seal, beluga, caribou, king eider, lake trout, narwhal, polar bear, ptarmigan, ringed seal, swan, and walrus. A total of 52 FFQs were completed in Repulse Bay in 2003 and 51 in 2005 for a total of 103 completed surveys. This covered 29% of the adult community (range of 24% to 33% across age and gender groups) (Table 4.3). After outliers were removed, 83 surveys, (or 24% of women and 25% of men), were used for analysis.

4.5.1 Food Frequency

The frequency of country food consumption (days/year), as well as portion sizes (g/meal) and percent use by the sample population of Repulse Bay are reported in Table 4.4. Caribou was the species eaten most frequently, by the largest percentage of the population (Table 4.4). This was true for all age and gender groups (data not shown).

Median portion size per meal for all food was 193 g/meal. Minimum and maximum portion sizes were 63 g/meal for caribou kidneys, and 333 g/meal for ringed seal intestines (Table 4.4). First and third quartiles were 131 and 239 g/meal respectively.

Table 4.3 Repulse Bay adult population and representative community sample used in food frequency questionnaires in 2003 and 2005.

Gender/Age	Community Total[a]	2003 N[b]	2005 N[c]	Combined N[d]	% Total[e]
Women					
19-40	126	30	8	38	30%
41-60	34	4	4	8	24%
61+	10	3	0	3	30%
Men					
19-40	134	13	23	36	27%
41-60	42	1	12	13	31%
61+	15	1	4	5	33%
Total	**361**	**52**	**51**	**103**	**29%**

[a] total number of communities members per age/gender group.
[b] number of participants in 2003 survey per age/gender group.
[c] number of participants in 2005 survey per age/gender group.
[d] total combined participants from 2003 and 2005 surveys per age/gender group.
[e] combined data's percentage of 'a'.

Table 4.4 Frequency of consumption and serving size of country food for consumers only (n=83).

Food item	Portion Size (g) [a]	Frequency (days/year) [b]	% Use [c]
Caribou - Meat fresh or frozen	270	78	99%
Caribou - Broth/Soup	256	63	78%
Caribou - Meat cooked	199	52	98%
Caribou - Intestines	169	42	14%
Caribou - Tongue	167	31	94%
Narwhal - Muktuk with blubber	149	31	61%
Char - Soup/Broth	213	31	28%
Caribou - Stomach and contents	205	26	20%
Narwhal - Meat cooked	245	26	17%
Caribou - Meat dried	244	21	90%
Caribou - Fat	122	21	83%
Char - Meat fresh or frozen	214	21	83%
Caribou - Bone marrow	117	21	66%
Narwhal - Muktuk without blubber	280	21	64%
Narwhal - Meat fresh or frozen	240	21	28%
Caribou - Cartilage	113	21	13%
Beluga - Muktuk with blubber	166	16	65%
Ringed Seal - Intestines	333	16	53%
Beluga - Meat cooked	193	16	17%
Ringed Seal - Blood	293	16	17%
Ringed Seal - Meat cooked	218	10	93%
Ringed Seal - Meat fresh or frozen	240	10	83%
Char - Meat cooked	184	10	81%
Char - Meat dried	267	10	77%
Beluga - Muktuk without blubber	146	10	63%
Narwhal - Flippers	193	10	60%
Beluga - Flippers	187	10	55%
Ringed Seal - Soup/Broth	266	10	47%
Caribou - Liver	123	10	35%
Caribou - Kidneys	63	10	33%
Char - Eggs/Roe	190	10	33%
Beluga - Meat fresh or frozen	170	10	27%
Ringed Seal - Heart	101	10	16%
Ringed Seal - Flippers	311	10	14%
Trout - Soup/broth	227	10	13%
Polar Bear - Meat cooked	233	5	78%
Ringed Seal - Liver	130	5	66%

Walrus - Meat cooked	149	5	60%
Bearded Seal - Intestines	164	5	54%
Bearded Seal - Meat cooked	245	5	53%
Ringed Seal Fat/Oil	87	5	53%
Trout - Meat cooked	205	5	47%
Caribou - Brain	87	5	46%
Caribou - Heart	91	5	46%
Walrus - Intestines	132	5	45%
Walrus - Meat fresh or frozen	221	5	45%
Ringed Seal - Kidney	74	5	42%
Walrus - Blubber	110	5	34%
Polar Bear - Feet	331	5	33%
Ptarmigan - Meat	192	5	31%
Trout - Meat dried	254	5	31%
Trout - Meat fresh or frozen	192	5	31%
Swan - Meat	197	5	30%
Bearded Seal - Meat fresh or frozen	201	5	28%
Walrus - Liver	147	5	27%
Walrus - Flippers	214	5	23%
King Eider - Meat	199	5	22%
Walrus - Heart	119	5	22%
Walrus - Oil	83	5	20%
Ringed Seal - Cartilage	113	5	14%
Swan - Soup/Broth	245	5	12%
Trout - Eggs/Roe	127	5	11%

[a] Portion sizes were estimated by a sub-sample of Repulse Bay participants using food models and is reported as g/meal.
[b] days per year food item was consumed by 10% of the population and above.
[c] Percentage of sample population reporting consumption.

Over half (32 out of 62) of the food items in Table 4.4 were consumed by over 40% of the population. Over 98% of the population ate uncooked and cooked caribou meat 78 and 52 days/year respectively. Typical portion sizes were 270 and 199 g/meal respectively. Caribou tongue, dried meat and fat were eaten by 94, 90 and 83% of the population 31, 21 and 21 days/year respectively (Table 4.4). Average portion sizes for those three items were 167, 244 and 122 g/meal respectively. Ringed seal meat was eaten cooked 10 days/year by 93% of the population, and uncooked 10 days/year by 83% of the population. A typical serving size was 240 g/meal for uncooked and 218 g/meal for cooked ringed seal meat (Table 4.4).

Arctic char meat was consumed uncooked (214 g/meal), cooked (184 g/meal) and dried (267 g/meal), 21, 10 and 10 days/year by 83, 81 and 77% of the population respectively (Table 4.4). On average, 233 g/meal of cooked polar bear meat was eaten by 78% of the population 5 days/year. Typically, 166 g/meal of beluga muktuk with blubber was eaten 16 days/year by 65% of the population, while 146 g/meal of the muktuk without blubber was eaten 10 days/year by 63% of the population. Narwhal muktuk with blubber was eaten 31 days/year by 61% of the population, while the muktuk without blubber was eaten 21 days/year by 64% of the sample population. Usual portion sizes for those two food items respectively were 149 and 280 g/meal. Many other food items were consumed by the community of Repulse Bay for which the frequency of consumption and the percentage of the population varied (Table 4.4).

4.5.2 Daily Reported Intake of Country Food

Reported daily intake of each food item was calculated for each participant (n=83) and averaged over age and gender groups (data not shown). The estimated median, mean and standard deviation of daily intake (g/day) of the top 80% of country food (by median intake) is shown in Table 4.5. Table 4.5 reports food items consumed by over 10% of the population for the total sample population, women combined, and men combined.

The median intake of all food items combined is 386 g/day for the total population (Table 4.5). Median intake rather than mean was reported due to high individual variation in the data. The three food items with the highest median intake in all gender categories came from caribou and included uncooked meat (men = 60 g/day, women = 59 g/day), cooked meat (men = 39 g/day, women = 34 g/day), and broth/soup (men = 28 g/day, women = 24 g/day).

4.5.3 Dietary Intake of Nutrients

4.5.3.1 Group Intake

Median group intake for all nutrients from country food was compared to Estimated Average Requirement (EAR) for women and men (Table 4.6ab). Several nutrients for both men and women were found to be over 100% of the EAR/AI including protein, ω-3 fatty acids, vitamin A, vitamin B6, iron, copper, zinc, phosphorus, selenium and riboflavin. For women, 1^{st} quartile intakes exceeded the daily requirements of protein, iron, zinc and selenium, while for men, iron and selenium requirements were met by 1^{st} quartile intakes.

Country food contributed moderately (>20% EAR) to vitamins D, C, and E, magnesium, sodium, and potassium for women and men, and to folate for men only (Table 4.6ab). Those nutrients to which country food contributes minimal amounts (<20%) include water, carbohydrates, ω-6 fatty acids, calcium and manganese for women and men, and folate for women only.

Table 4.5 Estimated country food intake from FFQs (g/person/day) in Repulse Bay. Top 80% of all country food is shown.

	Total (n=83)			Men (n=43)			Women (n=40)		
Food Item	**n**	**Med[a]**	**Mean ±SD[a]**	**n**	**Med[a]**	**Mean ±SD[a]**	**n**	**Med[a]**	**Mean ±SD[a]**
Caribou - Meat fresh or frozen	82	60	79±78	42	60	82±75	40	59	75±82
Caribou - Meat cooked	81	36	52±50	42	39	57±52	39	34	47±47
Caribou - Broth/Soup	65	28	63±76	31	28	58±72	34	24	67±80
Narwhal - Muktuk with blubber	51	21	32±38	28	25	39±46	23	21	24±23
Caribou - Tongue	78	19	31±43	41	11	24±37	37	25	38±47
Caribou - Meat dried	75	11	19±22	37	11	23±27	38	12	15±16
Caribou – Cartilage	11	11	19±23	5	7	10±5.3	6	15	27±30
Caribou - Fat	69	10	19±23	33	13	23±26	36	7.4	16±20
Narwhal - Muktuk without blubber	53	10	19±28	28	11	20±26	25	8.1	17±30
Char - Meat fresh or frozen	69	10	19±29	36	12	24±36	33	9.2	13±16
Narwhal - Meat fresh or frozen	23	8.1	21±25	14	7.9	16±20	9	11	28±31
Caribou - Bone Marrow	55	7.4	19±29	28	7.4	19±31	27	7	20±28
Char - Soup/Broth	23	6.7	29±46	10	4.0	23±45	13	13	33±48
Trout - Soup/broth	11	6.7	9.5±8.3	7	5.6	4.9±2.9	n/a	n/a	n/a
Beluga - Muktuk with Blubber	54	5.7	14±25	31	5.2	9.5±13	23	16	21±34
Char - Meat cooked	67	5.6	12±20	33	6.2	16±27	34	4.1	7.8±10
Beluga - Meat cooked	14	5.6	16±20	10	4.4	15±21	n/a	n/a	n/a
Ringed Seal - Intestines	44	4.9	17±35	28	5.6	22±42	n/a	n/a	n/a
Char- Meat dried	64	4.5	12±27	32	5.4	16±36	32	4.3	8.2±11
Beluga - Muktuk without blubber	52	4.0	8.3±13	n/a	n/a	n/a	n/a	n/a	n/a
Narwhal- Meat cooked	14	3.9	25±37	n/a	n/a	n/a	7	8.4	31±35
Char - Eggs/Roe	27	3.9	12±15	n/a	n/a	n/a	13	10	11±11
Ringed Seal - Meat cooked	77	3.7	8.2±14	39	4.7	10±18	n/a	n/a	n/a
Caribou - Stomach and contents	17	3.7	28±51	n/a	n/a	n/a	10	7.4	43±64
Walrus - Oil	17	3.6	3.5±2.9	6	5.4	5.0±1.5	n/a	n/a	n/a
Ringed Seal - Heart	n/a	n/a	n/a	9	11	11±12	n/a	n/a	n/a
Beluga- Meat	n/a	n/a	n/a	15	4.7	12±20	n/a	n/a	n/a

fresh or frozen									
Ringed Seal - Meat fresh or frozen	n/a	n/a	n/a	35	4.2	11±21	n/a	n/a	n/a
Swan - Soup/Broth	n/a	n/a	n/a	n/a	n/a	n/a	5	4.7	3.3
Total [b]		**386**	**483±350**		**386**	**503±374**		**386**	**460±325**

[a] median and mean intake (g/day) of each country food consumed by >10% of the population.
[b] total median and mean intake (g/day), of country food combined, consumed by >10% of the population.
[n/a] food items not found in top 80% of country food.

Table 4.6a Country food contribution to nutrient intake of women from food frequency questionnaires (n=40)

	Mean±SD	Median	1st quartile	3rd quartile	Reference Intake	% Reference Intake [c]
Total g/day	460±325	386	202	691	n/a	n/a
Carbohydrate (g)	9±7	7	2.5	13	100 [b]	7%
Protein (g)	96±66	75	49	141	38 [b]	197%
ω-3 fatty acids (g)	1.8±1.3	1.5	0.9	2.7	1.1 [a]	138%
ω-6 fatty acids (g)	1.4±1.1	1.1	0.6	2.1	12 [a]	9%
Vitamin A (μg)	2068±5234	940	242	1757	500 [b]	188%
Vitamin D (μg)	10±11	6.7	3.1	13	12.5 [a]	53%
Vitamin C (mg)	23±27	14	5.2	31	60 [b]	24%
Vitamin B6 (mg)	2.6±2.0	2.2	1.1	3.5	1.3 [b]	170%
Folate (μg)	93±118	57	25	103	320 [b]	18%
Calcium (mg)	86±144	49	24	76	1200 [a]	4%
Iron (mg)	28±28	18	10	36	8.1 [b]	221%
Copper (μg)	1277±1365	846	437	1916	700 [b]	121%
Zinc (mg)	16±11	13	8.1	21	6.8 [b]	194%
Phosphorus (mg)	816±572	644	373	1211	580 [b]	111%
Magnesium (mg)	101±69	81	50	145	265 [b]	30%
Sodium (mg)	342±254	300	138	450	1500 [a]	20%
Manganese (mg)	0.65±1.7	0.2	0.0	0.4	1.8 [a]	12%
Potassium (mg)	1194±814	958	571	1738	4700 [a]	20%
Selenium (μg)	314±291	228	73	509	45 [b]	506%
Riboflavin (mg)	1.9±1.6	1.6	0.6	2.6	0.90 [b]	176%
Vitamin E (mg)	3.9±5.0	2.6	1.0	5.7	12 [b]	22%

[a] Adequate Intake (AI) used as Reference Intake.
[b] Estimated Average Requirement (EAR) used as Reference Intake.
[c] Median % contribution to AI or EAR.

Table 4.6b Country food contribution to nutrient intake of men from food frequency questionnaires (n=43)

	Mean±SD	Median	1st quartile	3rd quartile	Reference Intake	% Reference Intake [c]
Total g/day	503±374	386	187	759	n/a	n/a
Carbohydrate (g)	7.5±6.2	5	3	12	100 [b]	5%
Protein (g)	113±86	86	42	174	46 [b]	187%
ω-3 fatty acids (g)	2.8±2.6	2	1	5	1.6 [a]	104%
ω-6 fatty acids (g)	1.7±1.2	1	1	2	17 [a]	8%
Vitamin A (μg)	1914±2882	849	383	2349	625 [b]	136%
Vitamin D (μg)	18±29	9	4	22	12.5 [a]	75%
Vitamin C (mg)	25±21	20	8	39	75 [b]	26%
Vitamin B6 (mg)	3.1±2.5	2	1	5	1.4 [b]	157%
Folate (μg)	140±162	89	35	176	320 [b]	28%
Calcium (mg)	89±172	42	19	108	1200 [a]	3%
Iron (mg)	34±38	19	9	44	6 [b]	311%
Copper (μg)	1349±1191	1070	400	1732	700 [b]	153%
Zinc (mg)	17±12	13	9	29	9.4 [b]	135%
Phosphorus (mg)	970±764	726	362	1476	580 [b]	125%
Magnesium (mg)	121±95	95	47	186	350 [b]	27%
Sodium (mg)	392±302	305	137	651	1500 [a]	20%
Manganese (mg)	0.60±2.1	0	0	0	2.3 [a]	8%
Potassium (mg)	1431±1079	1131	535	2218	4700 [a]	24%
Selenium (μg)	383±376	264	111	613	45 [b]	587%
Riboflavin (mg)	2.1±1.7	1.7	0.9	2.6	1.1 [b]	154%
Vitamin E (mg)	4.3±3.8	3.0	1.4	7.4	12 [b]	25%

[a] Adequate Intake (AI) used as Reference Intake.
[b] Estimated Average Requirement (EAR) used as Reference Intake.
[c] Median % contribution to AI or EAR.

4.5.3.2 Individual Intake

Another approach used to consider country food's contribution to nutrient status in Repulse Bay was to compare each participant's intake to Recommended Daily Allowances (RDAs) of each nutrient. The contribution from all food items to each nutrient was totaled per person. Figures 4.1 to 4.3 show the percentage of the population whose intake was found to be more than adequate (over 100% of the RDA) and from 50 to 100% of the RDA, solely from country food. Values for men and women separately were comparable to those for the total population, thus only the data for the total population was presented.

Figure 4.1 shows that 73% of all participants obtained more than their daily needs for protein, just through the consumption of country food (Figure 4.1). A further 14% of the population acquired 50 to 100% of protein's RDA from harvested species (Figure 4.1).

Similarly, consumption of country food offered 59% of Repulse Bay residents over 100% adequacy for daily ω-3 fatty acids consumption, while a further 22% of participants achieved 50 to 100% adequacy (Figure 4.1).

Repulse Bay residents participating in the study did not achieve over 50% of the RDA for carbohydrates or ω-6 fatty acids solely through the consumption of country food (data not shown).

Country food contributed importantly to vitamin intake in Repulse Bay. It provided over 100% of the RDA for vitamin B6, vitamin D, riboflavin, vitamin A, folate, vitamin E and vitamin C for 70%, 59%, 61%, 53%, 6%, 2% and 1% of individuals, respectively (Figure 4.2). Furthermore, 50 to 100% of the RDA was additionally met for vitamin B6 , vitamin D , riboflavin , vitamin A , folate, vitamin E and vitamin C for 17%, 21%, 19%, 18%, 10%, 15% and 16% of individuals, respectively (Figure 4.2).

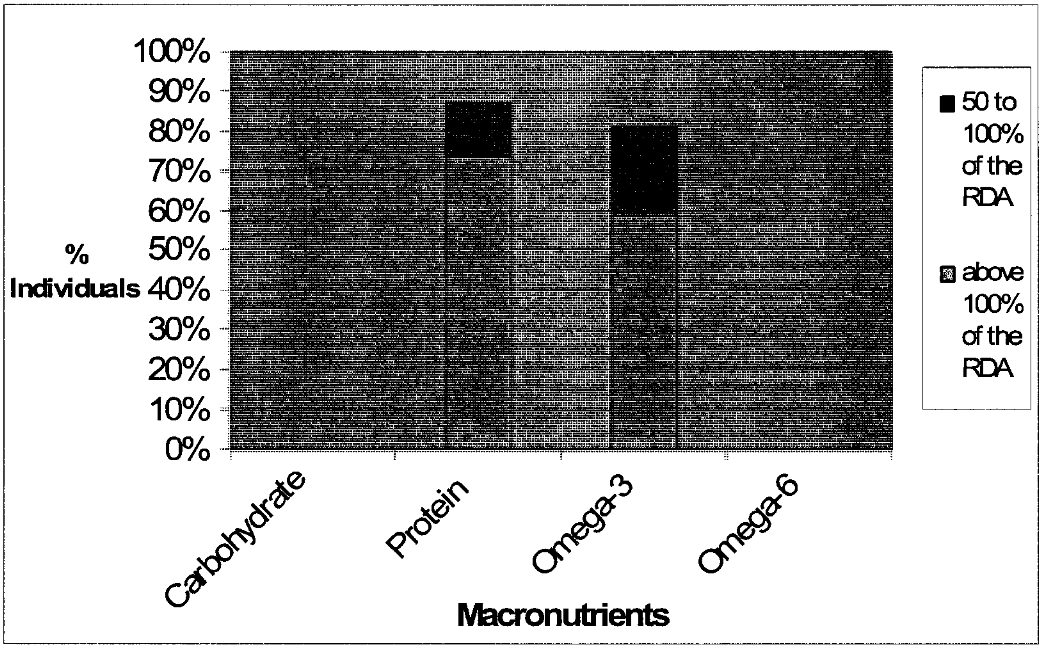


Figure 4.1 Percent of individuals in Repulse Bay meeting 50 to 100% or 100% or more of the RDA of selected macronutrients through consumption of country food.

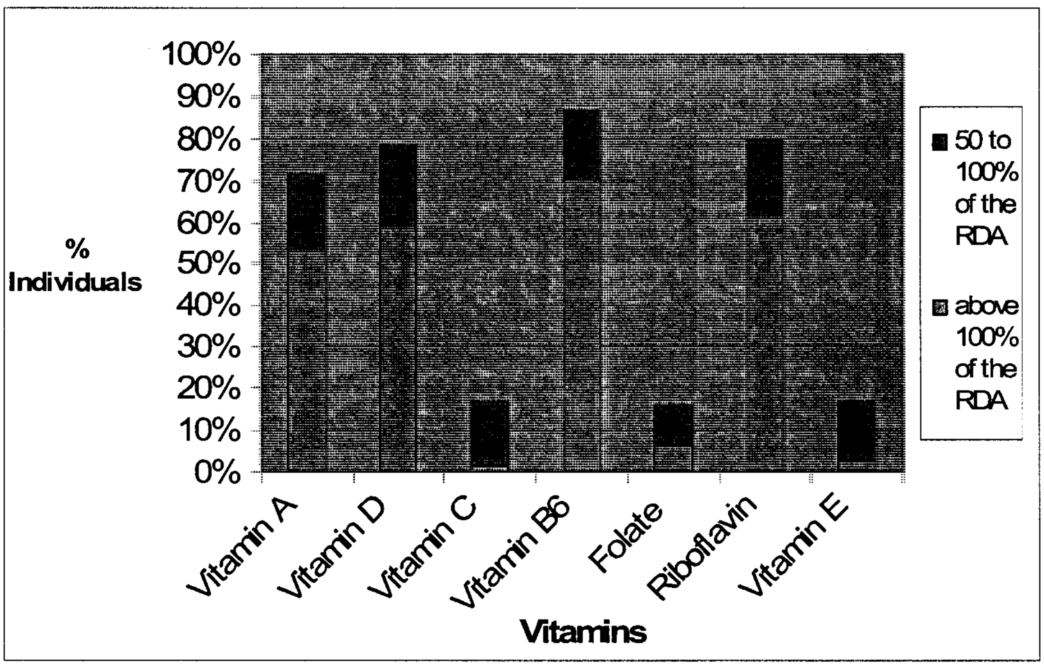


Figure 4.2 Percent of individuals in Repulse Bay meeting 50 to 100% or 100% or more of the RDA of selected vitamins through consumption of country food.

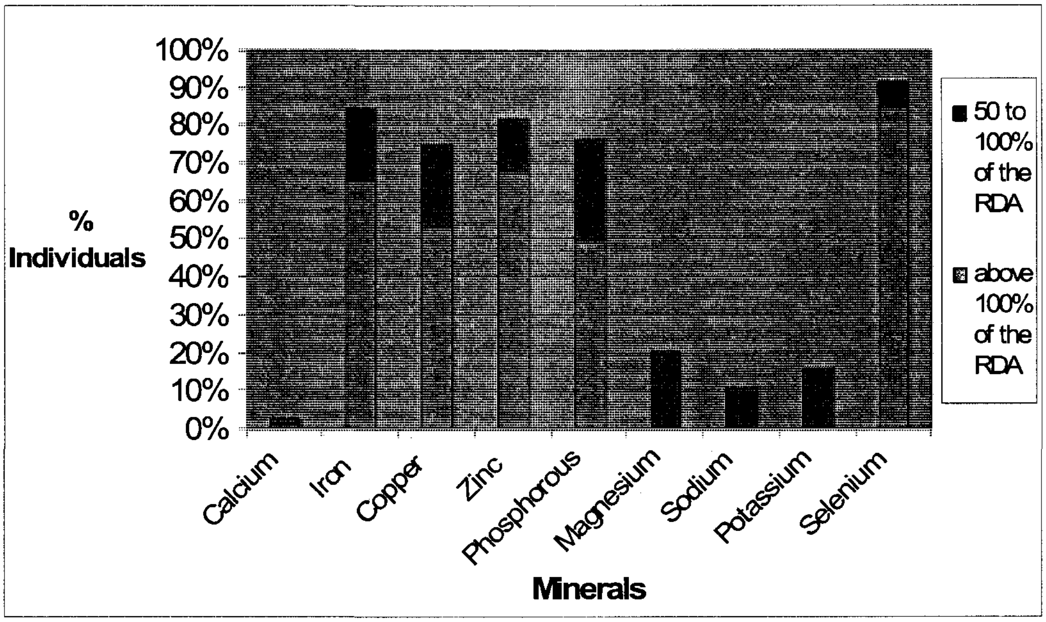


Figure 4.3 Percent of individuals in Repulse Bay meeting 50 to 100% or 100% or more of the RDA of selected minerals through consumption of country food.

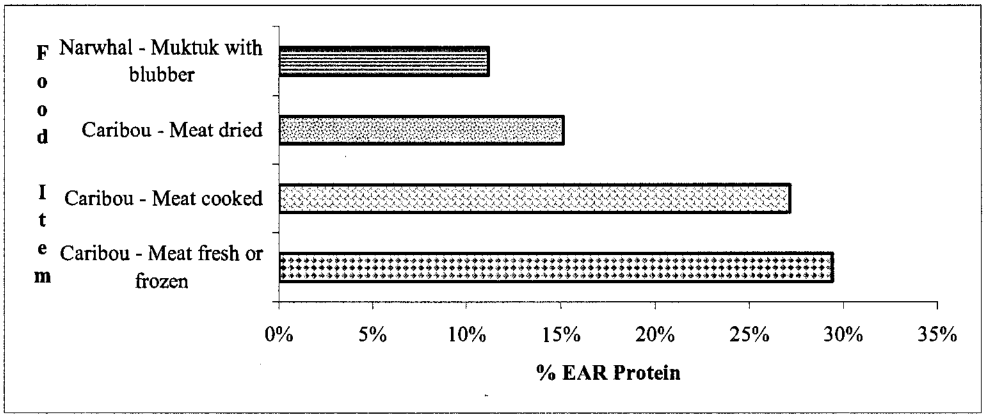
Repulse Bay participants' mineral status was also boosted considerably by the consumption of country food. Over 100% of the RDA for selenium, zinc, iron, copper, phosphorus and calcium was met by 84%, 67%, 65%, 53%, 49% and 1% of the population, respectively, just through consumption of country food (Figure 4.3). While 50 to 100% of the RDA for those same nutrients were achieved by a further 8%, 15%, 19%, 22%, 27%, and 1% of the participants respectively (Figure 4.3). Country food contributed 50 to 100% of the RDA of magnesium, potassium, and sodium for 20%, 16% and 11% of the population, respectively (Figure 4.3). Participants did not exceed 50% of the daily amount required for manganese through consumption of country food (data not shown).

4.5.4 Nutrient Contribution of Country Food

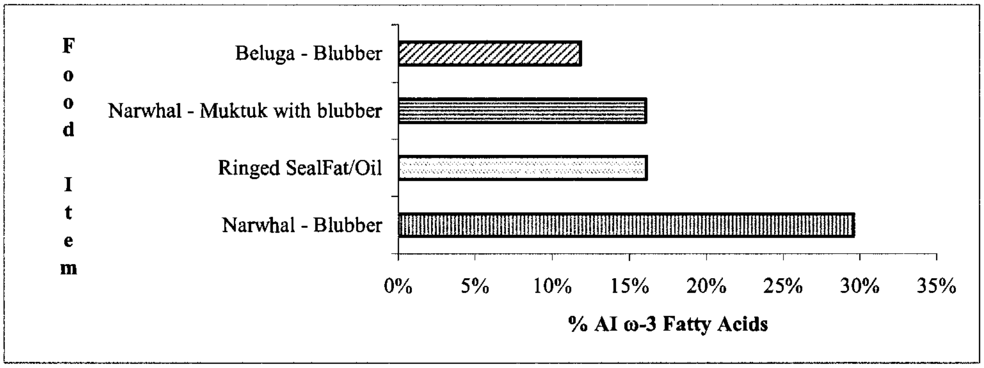
The following section presents the top contributing food items to important nutrients for residents of Repulse Bay. This thesis defines an important nutrient as one which provides over 100% of the RDA to 50% or more of the total population (Figures 4.1-4.3). Top contributing food items were obtained by ranking the median grams of each food item consumed by the total population. Nutrient contribution by these foods was then obtained by calculating the percent contribution of each food item to the EAR or the AI for each nutrient of interest.

4.5.4.1 Macronutrients

Country food contributed importantly to two major macronutrients; protein and ω-3 fatty acids. Out of 39 species that contributed to protein intake in Repulse Bay, caribou was the top provider. The top food items contributing to daily protein intake were caribou meat (uncooked, cooked and dried), and narwhal muktuk with blubber (Figure 4.4a). Thirty-five food items contributed ω-3 fatty acids to the diet of Repulse Bay residents, mostly from marine mammal fats and fish. Top contributors for total population included narwhal blubber, ringed seal fat or oil, narwhal muktuk with blubber and beluga blubber (Figure 4.4b).



a)



b)

Figure 4.4 Top country food items contributing to macronutrient intake in Repulse Bay: a) protein b) ω-3 fatty acids.

4.5.4.2 Vitamins

Daily intake of vitamin A came from 15 food items in the country food diet of Repulse Bay, mostly from organ meats and marine mammal skin and fat. The biggest contributors to vitamin A status from country food for the total population are caribou liver, bearded seal liver, narwhal blubber, ringed seal liver, narwhal muktuk with blubber and caribou broth or soup (Figure 4.5a). Seventeen food items supply vitamin D to residents. The overwhelming majority of this came from Arctic char meat (uncooked, dried, cooked) (Figure 4.5b).

Thirty-five food items contained vitamin B6, each one adding to the diet of Repulse Bay residents. The main contributor to vitamin B6 was caribou meat (cooked, uncooked, dried) and narwhal muktuk with blubber (Figure 4.5c).

Although riboflavin's presence in the diet came from 25 different food items, 70% of the EAR for riboflavin of the total population came from uncooked caribou meat (Figure 4.5d). Other top contributors included cooked and dried caribou meat and ringed seal lungs (Figure 4.5d).

4.5.4.3 Minerals

Thirty-three food items combined to make country food an important source of iron. Caribou, ringed seal, bearded seal and narwhal were all top contributors. Parts of these animals central to iron intake were caribou blood, ringed seal blood, uncooked and cooked caribou meat, bearded seal liver and uncooked narwhal meat (Figure 4.6a).

Although 27 food items contributed to daily copper requirements, a full 100% of the EAR came from caribou (uncooked, cooked and dried meat, tongue, liver and cartilage) (Figure 4.6b). Zinc was another important mineral, which was mostly provided to Repulse Bay residents in the form of caribou meat (uncooked, cooked and dried) and narwhal muktuk with blubber (Figure 4.6c). Twenty-five food items in total contributed to zinc status in Repulse Bay residents.

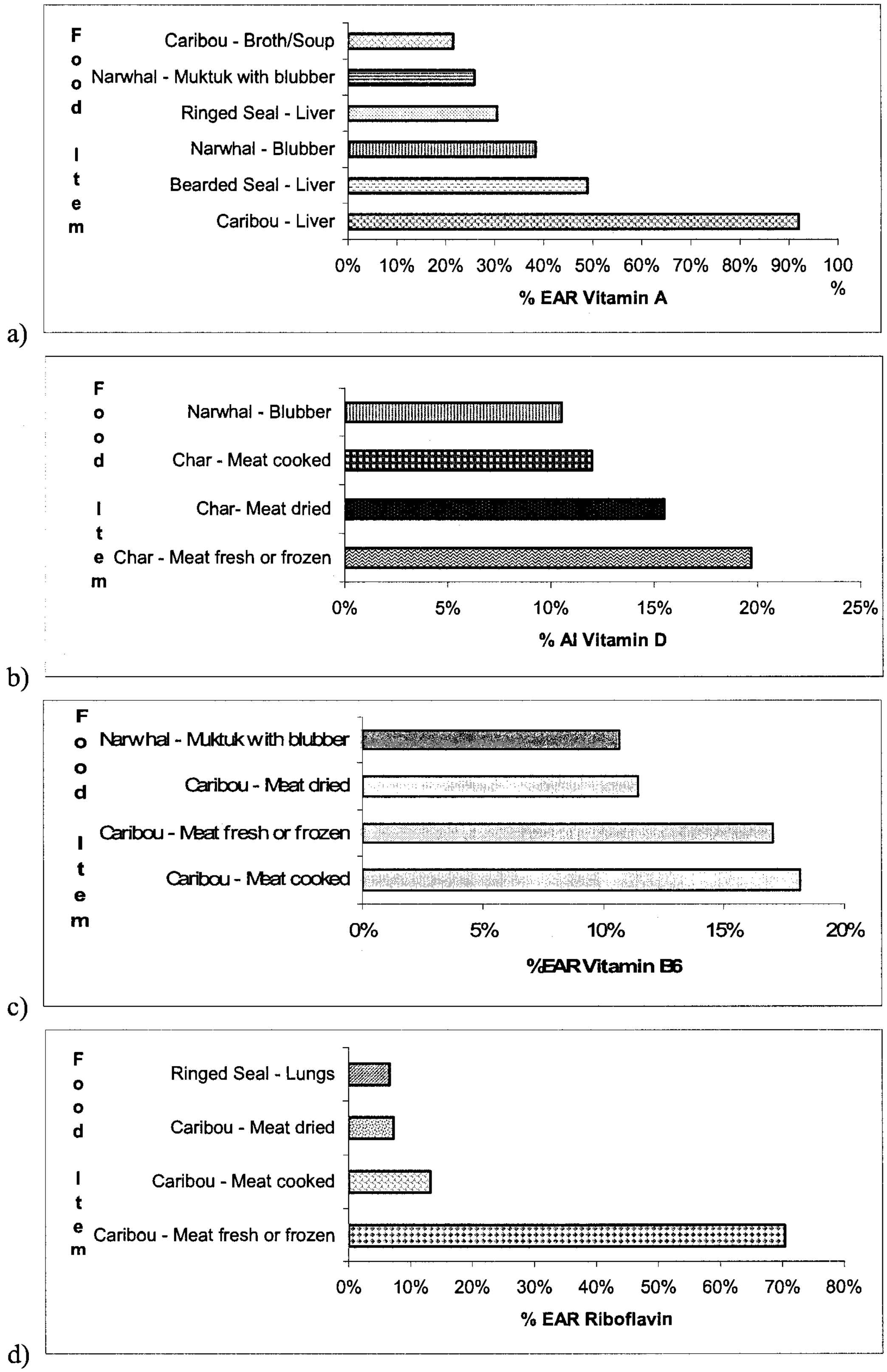


Figure 4.5 Top country food items contributing to vitamin intake in Repulse Bay: a) vitamin A b) vitamin D c) vitamin B6 d) riboflavin.

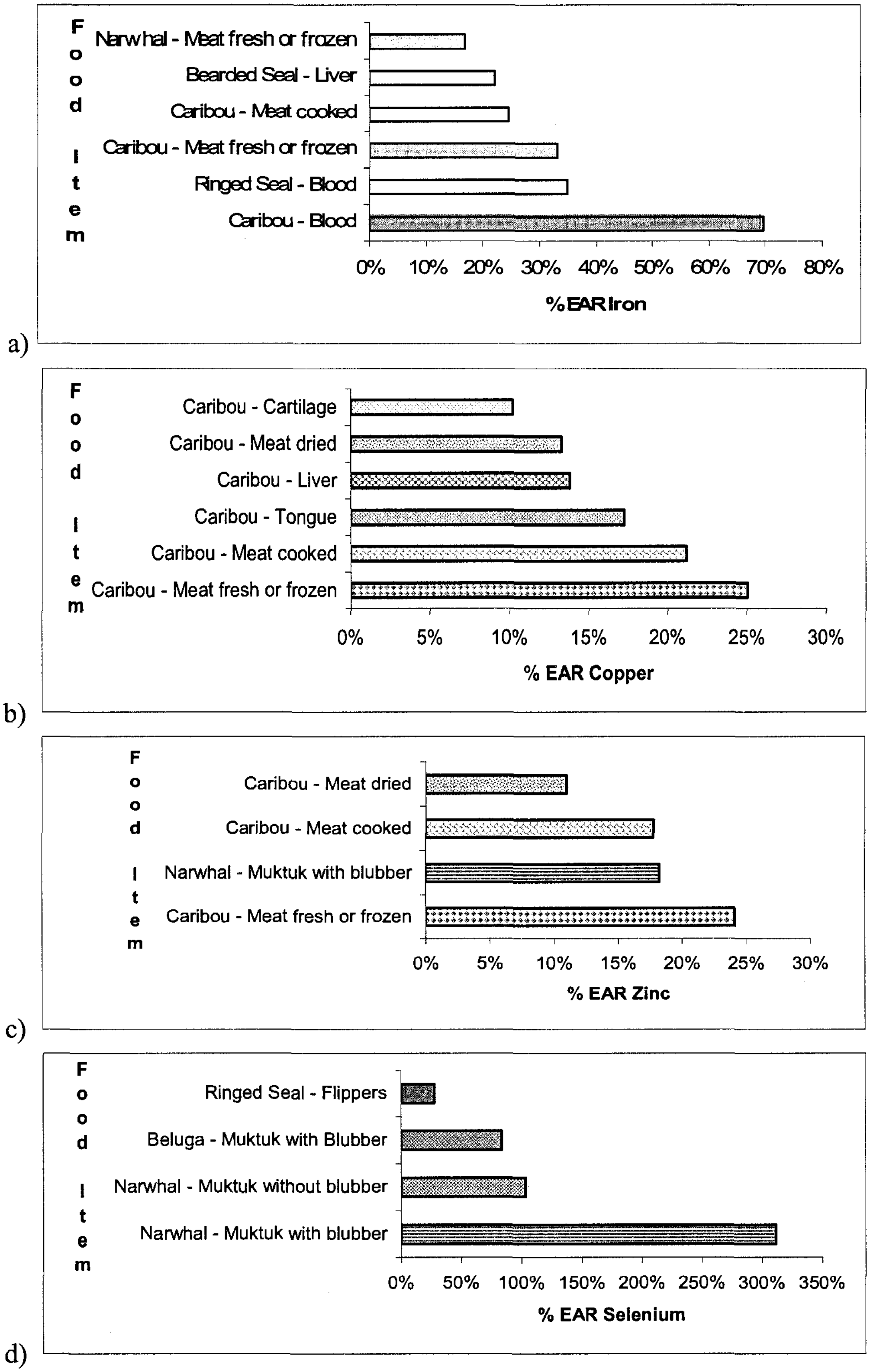


Figure 4.6 Top country food items contributing to mineral intake in Repulse Bay: a) iron b) copper c) zinc d) selenium.

Marine mammal fats, skin, and meats and land mammal organs made up 23 food items that provide abundant selenium to participants. Narwhal muktuk with and without blubber, beluga muktuk with blubber, and ringed seal flippers all provided the total population well over the EAR for selenium (Figure 4.6d).

4.6 Discussion

Country food is an extremely important part of the Inuit culture with very significant nutritional and health benefits. This analysis reported specific nutritional information regarding country food consumption in Repulse Bay, Nunavut. Consumption is widespread amongst community members, which in turn, boosts intake of nearly all nutrients studied, some quite substantially. Of the twelve species included in the study, each one was found to contribute a variety of nutrients to the population.

The frequency with which country food is consumed in the community is generally lower than that which was reported for the Kivalliq region in an Arctic-wide report, involving 18 Inuit communities by Kuhnlein and co-authors in 2000 (*5*). Approximately one-third of the food items are comparable (within 5 days/year), while the present study reports lower frequencies of country food consumption for the other two-thirds. Frequencies were comparable for char meat, narwhal, polar bear, ptarmigan, ringed seal meat and walrus organs. Consumption frequencies for bearded seal, beluga, caribou organs and fat, king eider meat, ringed seal organs and soup, swan, trout and walrus meat were all found to be lower than reported in Kuhnlein et al. (*5*). The only food item with a higher reported frequency of consumption in this study was caribou meat.

In contrast, the present study reports much higher percentages of the population as consumers. Approximately 75% of the food items were reported to be consumed by a higher, (in some cases much higher), percentage of the population. These two tendencies balanced out to give similar mean g/day intakes of country food. It is important to consider that the 2000 study's assessment of the Kivalliq region did not include Repulse Bay. It is possible that Repulse Bay country food consumption patterns are different than the region reported in 2000. In addition, the sample size of the present study was smaller than the 2000 study (n=83 vs.

n=355). Nevertheless, there is implied evidence that since 2000, a higher number of Repulse Bay community members eat country food at a lower frequency.

Lawn and Harvey reported mean daily intake (using a FFQ) in Repulse Bay from 1992 and 1997 (*8*). This report, compared with the present study suggests that country food consumption has increased since 1997. The present study reports both higher mean daily intake and also higher nutrient contribution by all nutrients. The nutrients reported in Lawn and Harvey are on average 37% of the nutrient intake in the present study. It is possible that Repulse Bay residents are now eating more country food. However, it is more likely that surveying tools produced dissimilar results. Lawn and Harvey used a FFQ that covered only the month prior to the study. The present study used a FFQ that covered one year, which considered seasonal food changes. The variety of food that is harvested in one month will differ entirely from another month, due to seasonal changes and harvesting patterns. Thus, a survey which accounted for just one month would not represent the total country food diet (recognized by the authors). Furthermore, it appears that Lawn and Harvey did not ask respondents about different parts of the animals, rather concentrated just on meats and some fats. Although this makes up a large portion of consumption, other animal parts (i.e.: skin, organs, muktuk) make vital nutrient contributions to Repulse Bay community members. This may explain some of the discrepancies between the two studies.

Although methods of preservation exist in Repulse Bay, consumption of country food is still dependent on harvesting times and availability of game, which may help to explain the variety in individual intake (*79*).

The nutritional importance of country food in Repulse Bay was demonstrated, considering the many nutrients that were found to have median intakes of over 100% of the Estimated Average Requirement (EAR) or the Adequate Intake (AI) for both men and women. These nutrients included protein, vitamin A, vitamin B6, iron, copper, zinc, phosphorus, selenium and riboflavin. The EAR cannot be used to assess group adequacy, rather it is an indication that the daily requirements of 50% of healthy individuals are met (*28*). Group adequacy must be assessed by considering the shape and variation of the intake distribution *(28)*. Assuming good health, there is evidence that country food alone provides for the needs of half of the population for the afore-mentioned nutrients. Furthermore, we can assume that more than 50% of the population are adequately covered, for those nutrients to which country food provides more than 100% of the EAR. Those community members with intakes in the 3rd quartile for selenium, exceeded the Tolerable Upper Intake Level (UL). This was also reported in older Inuit age groups in Kuhnlein et al. (*80*).

Almost all of the previously mentioned nutrients were also found to be adequate in the Canadian Inuit population in a recently published study by Kuhnlein et al. (*80*). Although the survey included market food, it was their association with country meats that the authors mentioned as the probable reason for adequacy.

Protein is essential to the body, providing structure to all the body's cells. In addition, it acts as an enzyme, and a transport mechanism and as a hormone (*78*). Vitamin A is needed for vision, reproduction, growth, gene expression, embryonic development, and immune system function. Animal sources contain preformed vitamin A (*29*). Vitamin B6 acts as a coenzyme for a multitude of enzymes used in metabolism (*77*). Iron is essential in oxygen transport in the blood for normal metabolic function (*29*). Copper acts as a catalyst for the reduction of molecular oxygen (*29*). Zinc is used in the body's metabolic processes, is indispensable for growth and development (*29*) and is important for healthy birth outcomes and normal immune function and growth in children (*81*). Phosphorus is distributed throughout the body and is a part of all living bodies (*76*). Selenium functions as an anti-oxidant, regulates thyroid hormones and is highly bioavailable in food (*30*). Riboflavin is a coenzyme in a variety of the body's redox reactions (*77*).

When the EAR cannot be defined for a nutrient, the AI is used. It is defined as an intake level believed to meet the dietary needs of almost all healthy individuals (*28*). It is evident that the daily requirements of ω-3 fatty acids (AI nutrient) for almost all healthy community members are met just through country food alone. Omega-3 fatty acids (especially eicosapentanoic acid [EPA] and docosahexanoic acid [DHA]) are thought to reduce the risk of cardiovascular diseases and be protective against some cancers through cancer cell apoptosis, inhibition of cell proliferation and angiogenesis (*28*).

Low usual group intake of ω-6 fatty acids, calcium, magnesium, vitamins C and E, and folate, were reported in Kuhnlein et. al. (*80*), which was consistent with the present study. Vitamin C and folate are higher on days where only market food is consumed, due to fortification of beverages and cereals (*82*).

The Recommended Dietary Allowance (RDA) is an intake level that is set to meet the requirements of nearly all individuals in that group (*28*). Using this criterion, the present study showed evidence that 50% or more of individuals achieved over 100% of their daily needs for protein, ω-3 fatty acids, vitamins A, D, B6, riboflavin, iron, copper, zinc and selenium from country food use alone. Vitamin D is responsible for absorption of calcium and phosphorus possible in the body, as well, it functions as a hormone in other organs systems (*76*). Clearly, country food is of major importance to the diet of Repulse Bay community members despite only contributing between 6 and 40% to energy intake across Inuit communities (*82*).

Although many of the nutrients were reported to be consumed in quantities above the recommended level, and some even above the Tolerable Upper Intake Level (UL), one can not draw the conclusion that if even if climate change were to lower intake of some nutrients, Inuit dietary nutrient status and well-being would not be affected. The Inuit have been relying a certain level of nutrients associated with country food for centuries and may have different requirements than the general population. Present intakes are less than what has been consumed in the past and so further reduction of vital nutrients would not be welcome. Reduction of protein, although above recommended levels for most groups, would decrease the important nutrients with which it is associated.

Not surprisingly, out of all species surveyed, caribou was the most frequently consumed food and is the major contributor to many important nutrients including protein, vitamins A and B6, riboflavin, iron, copper and zinc. This is consistent with results from other studies examining diet in the Arctic (*5, 8, 82*). Narwhal is the second most consumed species (by weight); its fat and meat contributing to three very important nutrients: ω-3 fatty acids, selenium and zinc.
Arctic char is the third most consumed species and contributes greatly to vitamin D status in Inuit, and is a top contributor of ω-3 fatty acids. Ringed seal provides valuable ω-3 fatty acids, vitamin A, and after caribou, is the highest provider of iron. Beluga is a top supplier of ω-3 fatty acids and selenium.

Each species contributes vital nutrients to the Repulse Bay population. The variety of species eaten ensures an abundance of nutrients for consumers. Furthermore, the practice of eating a variety of parts of the animal, rather than just the meat, increases diet diversity and nutrient variety.

Conclusion

4.6.1 Limitations

Food frequency questionnaires may tend to overestimate consumption as respondents may have difficulty recalling food consumption over a period of time (*9*). In this study, the FFQ was carried out in just one season with recall over the entire year, thus participants may have over-estimated intake over the other seasons in which data collection was not carried out. However, in an effort to minimize error, recall times were broken down into weeks, months, and year. To increase validity of combining two data sets, the same questionnaire was used in 2005 as in the 2003. Furthermore, the surveys were conducted only two years apart.

Often in dietary studies, an FFQ is accompanied with a comparative 24-hour recall of what participants have consumed. In this study, 24-hour recalls were not conducted. However, the mean intakes (g/day) found for this study were comparable to another study that performed 24-hour recalls for the same region (*5*).

Reporting results on the total population did not give an accurate picture of the whole community. Because of a nutrition transition, diets of different age and gender groups are quite varied. The dietary habits of those participants aged 41 and above are not well represented by data depicting the entire sample population. This is because the 19-40 age group was approximately double the sample size of the older two age groups combined, reflecting the demographics of Repulse Bay. Therefore, when reporting on the total population, data were likely biased towards the younger age group. Reporting the data from all age and gender groups was beyond the scope of this study, although the data were collected and compiled.

Another limitation of this study was the use of daily intake values without the consideration of seasonality. Nutrient intakes were averaged over one year, from which was calculated the daily value. The intake of seasonal food items such as narwhal, beluga, walrus, and birds is possibly very high over the course of 2-3 months, then drops sharply when not in season. Thus, the value reported in this thesis, averaged over one year, may be lower, on a daily basis, than actual intake. However, taking seasonality into account was beyond the scope of this study as it requires knowledge of frequency of use per person and inquiry into family food freezing habits.

Due to time and budget constraints, we were able to conduct a dietary survey of just one community. However, the results of this study can be extrapolated in some ways to any Arctic community consuming country food.

4.6.2 Conclusion

Country food supplies invaluable nutrients to community members of Repulse Bay. Comparison of group median intakes to the EAR or AI has shown that at least 50% of the population is likely receiving daily required amounts of protein, ω-3 fatty acids, vitamin A and B6, riboflavin, iron, copper, zinc, phosphorus and selenium from their intake of country food alone. On an individual basis, 50% or more of the participants met 100% their Recommended Daily Allowances for protein, ω-3 fatty acids, Vitamins A, D and B6, riboflavin, iron, copper, zinc and selenium. Animals flesh, fat, skin, and organs all contributed differently to different nutrients. The Inuit tendency to eat most parts of the animal allows them access to exceptional nutrients.

In many Inuit communities in Arctic Canada, a trend towards obesity and chronic diseases is becoming apparent. Substituting market food for country food, coupled with decreased physical activity is likely leading to obesity (*10, 31, 33*), and is associated with increased risks of cardiovascular disease, cancer, and diabetes in Baffin Island Inuit (*33*). Furthermore, the high cost and often poor quality of market food makes healthy choices more difficult. Poverty and food insecurity are decreased by access to country food. Country food is a way to supplement diet with nutrient-dense low cost food. Thus threats to harvesting ability may further decrease food security.

A multitude of contaminants have been found in Arctic animals, including cadmium, lead, methyl-mercury, chlordane, PCBs, toxaphene, DDT, among others. These are bioaccumulated and biomagnified with increased trophic level. The issue of contaminants in country food is complex and use of country food must be considered as a benefit/risk scenario. The benefits and risks of eating country food have been reviewed extensively (*83*) and include weighing the stellar nutritional and health benefits, as well as cultural and economic importance with the possibility of ill effects from synergistic contaminant exposure. It is certain that Arctic food species must continue to be monitored by the scientific community and government bodies.

Both the Canadian and Nunavut governments must work together to increase social and financial support for hunters and communities harvesting wildlife. Initiatives may include funding for community harvests, hunting equipment and community freezers, and meaningful environmental assessments to protect Arctic species from exploitation. On a global scale, policy must support green technologies in order to curb fossil fuel emissions and thereby hinder climate warming in the Arctic. Country food is extremely important to Inuit communities across the Arctic, the access of which must be encouraged and supported.

5 Thesis Summary and Future Impacts on Inuit Diet

5.1 Community Outputs

To maximize the benefits of this research project, material given to the community will be in a format that is accessible and motivational, not just for the Hamlet council, but for the general community. Thus, community output will include a bound copy of the completed thesis, an executive summary in plain language, and a one-page poster for public spaces detailing the highlights of the results.

5.2 Potential Climate Change Impacts on Nutrient Intake in the North

Traditional or country food, as it is colloquially named in Nunavut, has been giving vital sustenance to Inuit for thousands of years. Despite the introduction of market food in recent decades, country food continues to contribute significantly to daily required amounts of important nutrients. Inuit communities Arctic-wide are experiencing climate change in various ways (*11-17*). Kugaaruk and Repulse Bay, Nunavut both provided evidence of current climate changes in their communities that are affecting country food harvesting. These include changes to ice, snow, water, weather, and changes in species. There is a large body of evidence that anticipates greater impacts from increasing climate change in the future (*18*), which will further impact country food harvest. Repulse Bay and most other Inuit communities rely heavily on country food for their daily intake of key macro and micronutrients. How will climate change impact nutrient status in Nunavut? The following discussion summarizes how observed climate changes, related to each key species, may impact Inuit diet. This will be done by using information about projected climate change, combined with nutrient data from Repulse Bay.

Kugaaruk and Repulse Bay reported many observed climate changes that are leading to changes in the caribou harvest. Earlier boat use due to earlier break-up of ice, access to new islands as a result of the lowered water table, increased vegetation for forage, ease of stalking due to more rain, and a decrease in caribou insect harassment due to increased winds may all benefit Inuit caribou hunters. However, there are many changes taking place that may harm the caribou harvest. As reported by the two communities, increased snow and the formation of ice layers as a result of freeze-thaw events and a decrease in vegetation quality all reduce access to caribou forage. A greater number of parasites decrease quality of meat. Loss of caribou fat and drying difficulties due to increased sun intensity diminish food availability.

Caribou is the most important food species in Repulse Bay. Firstly, caribou represents seven out of the eight top country food items by weight, and just over half of the total intake for the total population comes from caribou. Due to its high intake and valuable nutrient content, caribou is the top contributor of protein, vitamins A and B6, riboflavin, iron, copper and zinc.

An increase in the ability to hunt caribou would not necessarily mean an increase in consumption. This thesis reports very high intakes of caribou and since both communities have reported that caribou populations are currently abundant, they may be hunting enough to allow everyone in the community daily access to caribou. Thus, climate changes that allow easier access to caribou may not increase nutrients in the diet, but would perhaps facilitate hunting. However, climate changes that would decrease the availability of caribou to the community could have serious consequences for Inuit micronutrient status.

In 1997, Lawn and Harvey reported that store bought meat was much less important to Repulse Bay community members than country food (77 g/day vs. 139 g/day) (*8*). The quality of store bought meats was described as being low in iron and high in saturated fats, the number one consumed item being frozen fried breaded chicken. Therefore, less caribou could possibly mean higher intake of saturated fats and a decrease in many important nutrients.

Narwhal and beluga muktuk and meat are the second and fifth most consumed food item by weight and are great contributors to Repulse Bay resident's selenium and ω-3 fatty acid status. Narwhal also contributes to zinc status of consumers. The participants mentioned that the narwhal population and/or proximity was increasing. This may be a result of a longer open water season, which would allow more access to whales. If this trend continues, more of the whales' valuable nutrients would be available for consumption.

Arctic char is the third most consumed species by weight and is the number one contributor to vitamin D. Repulse Bay women and men receive 53% and 75% of the EAR for vitamin D respectively from median country food intake. Of this, Arctic char provides 47% of the EAR, while lake trout provides 11% EAR to the total population. Communities discussed positive changes affecting the Arctic fish population. These include current population abundance and like caribou, the ability to use the boat earlier to fish due to earlier break up of ice. An increase of Arctic fish due to climate change would not necessarily lead to an increase in nutrients for community members. Since Arctic fish populations are presently reported to be in abundance, Repulse Bay is likely harvesting at desired capacity. However, if it did lead to increased consumption, this would mean a welcome increase in vitamin D.

Respondents from the two communities also noted climate changes that may decrease access and availability of Arctic fish. Local streams have dried up, making fishing impossible in those areas, more intense sun has led drying fish to spoil more often, and residents have noticed that the quality of fish meat has declined. If climate change were to diminish fish consumption in Nunavut communities, important nutrient losses could occur. The most important of these is vitamin D, since Arctic fish contributes so completely to the population's status. Since it is rare that fortified dairy beverages are consumed (*66*), and winter months are spent with little vitamin D-producing sunshine, a decrease in Arctic fish may decrease vitamin D intake.

Consumption of ringed seal is 6th overall, yet still contributes highly to ω-3 fatty acids, vitamin A, and after caribou, is the top contributor to iron status for the total population. Ringed seal population is reported to shift according to the floe edge proximity, and the abundance and proximity of orca whale and polar bear populations. If all other factors remained the same, and thinning ice and thus earlier boating allowed easier access to ringed seals, intake by consumers and thus nutrients may increase. All of the nutrients for which ringed seal is a top contributor, were estimated to be well over 100% of the EAR for median intake of the total population. Thus, an increase in ringed seal would ensure greater coverage for those nutrients and perhaps give a much needed boost to nutrients such as folate and vitamin D.

Community respondents observed climate changes that could possibly decrease ringed seal availability. Increased rotten ice making hunting more dangerous and increased orca whale population could reduce seal numbers. Also, a reported decline in liver quality and thus animal health, loss of fat and decrease in population size or proximity may also diminish the ringed seal hunt. Scientists agree that shrinking ice cover is linked to failure to breed, increased predation, and decreased pup survival rate (*18, 53*) and that ringed seal survival is unlikely is ice-free summer conditions prevail as is predicted (*47*). Loss of ringed seal in the Inuit diet has important cultural implication and may mean a loss of important nutrients such as iron, ω-3 fatty acids and vitamin A.

Loss or decline in intake of certain key species must be replaced with healthy alternatives to maintain optimum nutrition. Alternatives include other species that may enter the hunting area, as well as healthy market foods. Over the century, as ranges of Arctic animals shrink and southern animals expand their territory, new possibility of wild-crafted sustenance may be possible. The North is expected to undergo a 100% increase in species richness (*1*). As the tree line shifts northward, woodland species such as moose, deer and black bears will likely shift with it. Salmon are predicted to move their ranges northward (*18*). These may be viable alternatives if the present species are threatened.

The availability of healthy market food must continue to be improved. Nutrition education about the importance of country food and healthy market food must start at a young age to help Inuit make healthy food choices at the supermarket (*84*). Furthermore, healthy market food must be available to Inuit communities at a reduced cost. Government initiatives such as the Food Mail Program should be updated and expanded to improve nutrition and health.

According to respondents from the two study communities, most species are currently being impacted in both positive and negative ways. It is never certain how climate change will affect Arctic animals, but the large body of scientific evidence points out that caribou, ringed seal, polar bears, walrus and Arctic char will be seriously stressed or may even become extinct over the next century (*1, 18*). Losing one species may impact nutrient levels, but losing several species without adequate replacements may seriously put Inuit communities in a state of nutritional deficiency. Current initiatives must include adaptation plans that explore nutritional alternatives, considering both healthy market food choices and the possibility of harvesting incoming species from the south.

Inuit communities need financial and social support to improve the country food harvest. Funding for hunting equipment, community harvests and community freezers, as well as programs aimed at reducing the impacts of climate change on nutrition are recommended.

There are a multitude of other factors that reduce country food intake including fear of contaminants, environmental degradation, changing social patterns, and global influences. Much media and governmental attention has been placed on climate change, which may be an advantage to Inuit. Climate change may bring more awareness to the importance of country food and its significant nutritional value. An example of this is Inuit initiatives, as from the Inuit Circumpolar Conference, to alert global polluters to damages being accrued by the Arctic ecosystem. Movements like this could inspire youth, elders, and other community members to work towards reducing impacts of climate change and promoting country food.

Traditional food systems are vital to Indigenous communities worldwide. Country food is a fundamental part of Inuit culture, economy, and well-being and provides stellar nutrient enrichment to consumers. Inuit communities stand to lose valuable nutrients due to climatic changes impacting on their traditional food system. Efforts to reduce the source and impacts of climate change are imperative. Nutrient-rich market food alternatives must be available in the face of loss of species, as well, harvesting of existing and incoming species should be promoted and financially supported. Partnerships between Inuit communities, scientists, and governments should be aimed at reduction of the impacts of climate change, safeguarding the cultural importance of country food and maintaining good health and nutrition.

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7 Appendices

7.1 Appendix 1: Co-Author Permission Forms (Manuscript 1 and 2)

7.2 Appendix 2: Ethics Consent Certificate

7.3 Appendix 3: Community Research Agreements showing signatures from Repulse Bay and Kugaaruk respectively

Centre for Indigenous Peoples' Nutrition and Environment

Environmental Change, Key Traditional Food Species, and Health in Nunavut-plans for adaptation

CINE RESEARCHERS COLLABORATION AGREEMENT
April 2005

The Centre for Indigenous Peoples' Nutrition and Environment (CINE), in partnership with the community of Repulse Bay agree to create a proposal and if successful, to conduct the named research project with the following understandings:

1. The purpose of this research project, as discussed with and understood with the researchers (Laurie Chan and Tanya Nancarrow), is:

To investigate the potential health impacts of climate change on traditional food and to develop strategies for adaptation to minimize potential impacts by using scientific and Inuit Qaujimajatuqangit.

2. The scope of this research project (that is, what issue, events, or activities are to be involved, and the degree of participation by community residents), as discussed with and understood with this researcher, is:

1. Key personnel at the community level will discuss with the researchers in winter/spring of 2005 on the availability of traditional food items including harvesting practice, seasonality, transport and distribution, storage and preparation methods. Elders' knowledge and hunters' experience is essential for the focus group. Up to 15 elders and hunters will be invited to participate in a 2 days focus group meeting to be held in on April 7th and 8th 2005. The community will provide translation service.
2. Youth/students in the community will be trained to get involved in the project.
3. Research project is scheduled for two years. Research period will take place in the April of 2005. Analysis by researchers will take place during the following year along with community consultation at all stages. Results will be given for community approval at the end of the project period.
4. An honorarium of $150 per day will be given to participants of focus groups.

3. Methods to be used, as agreed by the researchers are:

We would like to hold a two day group workshop with people knowledgeable about traditional foods (Elders, hunter, processors). Traditional knowledge, observations on recent environmental change and food availability will be documented. As well, a Food Frequency

In concert with Indigenous Peoples, CINE will undertake community-based research and education related to traditional food systems. The empirical knowledge of the environment inherent in indigenous societies will be incorporated in all of its efforts.

Assembly of First Nations
Council of Yukon First Nations
Dene Nation
Inuit Circumpolar Conference
Inuit Tapirisat of Canada
Métis Nation of the NWT
Mohawk Council of Kahnawake

Host:
Mohawk Council
of Kahnawake
P.O. Box 720
Kahnawake, Qc J0L 1B0

McGill
Macdonald Campus
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Questionnaire will be given to a portion of the community. This will take approximately five days.

4. **Community training and participation, as agreed, is to include:**

A community coordinator will be hired for $30 per hour. This person will be responsible for organizing meetings between researchers and local people, hiring community members to carry out questionnaires, and for arranging for translation during the workshop.

A local student will be trained to be involved in the project.

5. **Information collected is to be shared, distributed, and stored in these agreed ways:**

The data collected is confidential and no name is attached to a record. Copies will be kept at CINE where the data will be converted to an electronic form. Confidentiality of participants will be respected. Where appropriate, data will be kept on diskettes in the community and at CINE. The researcher team will be available to answer questions and assist community members should community members decide to use these data for different purposes, A final report will be distributed after consultation with the community by the researchers (to include communities involved in the research).

6. **Informed consent of individual participants is to be obtained in these agreed ways:**

An individual consent form will be read by the researcher to the participants/interviewer to the respondent. A copy of the consent form will be left with the respondent where the addresses of each researcher can be used at any time, should the respondent wish to contact the researchers for additional information.

7. **The names of participants and the community are to be protected in these agreed ways:**

As mentioned on the consent form, the information collected from the workshop/interviews or other research methods are confidential. In no instance will the name of a respondent be attached to a record.

Before submission of a proposal or distribution of the final report, or any publication, or contact with the media, the researchers will consult with each other and with the community of Repulse Bay once again as to whether the community agrees to participate and share data in that particular way.

8. **Project progress will be communicated to the community in these agreed ways:**

The development of this project is based on sincere communication between community members and researchers. All efforts will be made to incorporate and address local concerns and recommendations at each step of the project.

The researchers and the community of Repulse Bay will communicate and update on the progress of the project throughout the study. Results of the study will be presented to the community in an open forum. A final report will also be presented to the community at the end of the project period. The researchers will participate in final community meetings to discuss the results of the analysis with community members.

9. **Communication with the media and other parties (including funding agencies) outside the named researchers and the community will be handled in these agreed ways:**

Information will only be released with the consent from both research team members and the community.

FUNDING, BENEFITS, & COMMITMENTS

Funding

The main researchers seek or have acquired funding and other forms of support for this research project from:

ArcticNet
Natural Science and Engineering Research Council (NSERC)

The funding agency has imposed the following criteria, disclosures, limitations, and reporting responsibilities on the main researchers.

Annual progress reports and final reports. Final results to be published in joint publications and in scientific journals after review by the research team and the community of Repulse Bay.

Benefits

The main researchers wish to use this research project for benefit in these ways (for instance, by publishing the report and articles about it):

The researchers will publish a final report for the funding agency. Scientific presentations in peer-reviewed conferences and joint-publications will be made. The final report will be reviewed by the research team and the community prior to publication. Scientific presentations and articles will be published after discussion with the research team and respective communities' leaders and the community. The names of CINE researchers and CINE's name will be used only with consent of CINE researchers.

Benefits likely to be gained by the community through this research project are:

Educational and informational benefits.

Commitments

The community of Repulse Bay's commitment to the researcher team is to:

- Work collaboratively with CINE researchers

-Recommend capable and reliable community members to collaborate/be employed in this project.

-Keep informed on the project progress, and help in leading the project toward meaningful results.

-The community authorizes Dr. Chan the use of the dietary data collected by the Centre of Indigenous Peoples' Nutrition and Environment for the project titled "Assessment of Dietary Benefit/Risk in Inuit Communities" in 2000 for the purpose of this project.

7.4 Appendix 4: Community Consent Forms

ᐊᖏᕐᓂᕐᒧᑦ ᑕᑎᕆᐊᓕᒃ

ᖃᐅᔨᓴᐅᑎᐅᔪᐃᑦ ᐃᓚᖃᖅᑐᓐ ᐃᓄᓐᓂᑦ, ᐱᑕᖃᕆᐊᖃᕐᖓᑕ ᑎᑎᕋᖅᓯᒪᔪᓂᑦ ᐊᖏᕐᓂᕐᒧᑦ ᖃᐅᔨᓴᖅᑕᐅᓂᕐᒧᑦ ᖃᐅᔨᓴᖅᑕᐅᔪᒥᑦ. **ᒪᒋᐅ ᐃᓕᓐᓂᐊᕐᕕᐊᓄᒃ ᐊᒻᒪ ᑐᓂᓯᔪᖅ ᓱᓕᕆᕕᐅᔪᖅ (ᐋᒃᑎᒃᓂᐊᑦ)** ᓱᓕᔪᖅᓴᕐᒪᑕ ᐃᒻᒥᒎᖅᑐᓕᒫᓐ ᑕᐃᒪᐃᑕᐅᔭᕆᐊᖃᕐᒪᑕ ᐃᓱᒪᒋᔭᐅᑦᑎᐊᓂᕐᒥᑦ. ᑕᒪᓐᓇ ᐱᓪᓗᒍ, ᑖᒃᑯᐊ ᐊᖏᖃᑎᒌᒍᑏᑦ ᖃᐅᔨᓴᖅᑎᒧᑦ ᐊᒻᒪ ᐃᓚᐅᔪᒧᑦ ᐊᑐᕆᐊᖃᖅᑎᑕᐅᔪᖅ.

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ᖃᐅᔨᓴᖅᑎᐅᔪᑦ ᒪᒋᐅᑉ ᐃᓕᓐᓕᓂᐊᕐᕕᐊᓗᒻᒥᑦ ᐊᒻᒪ ᐃᓕᓐᓂᑦ ᐃᓇᒃᓯᔪᒪᕗᑦ ᐃᓚᐅᕐᒍᓪᓗᑎᓐ ᐊᑕᐅᓯᕐᒧᑦ ᐊᕐᖁᒧᑦ ᓱᓕᕆᐊᒧᑦ ᑮᓇᐅᔭᖃᖅᑎᑕᐅᔪᖅ ᑳᓇᑕᐅᑉ ᒐᕕᒪᒃᑯᖏᓐᓄᑦ.

ᑎᑭᑕᐅᓇᓱᐊᖅᑐᖅ ᓱᓕᕆᐊᒧᑦ ᖃᐅᔨᒐᓱᐊᓐᓂᖅ ᖃᓄᐃᑎᑦᑎᓂᖕᒐᓂᑦ ᐊᕙᑎᐅᑉ ᐊᓯᔾᔨᐸᓕᐊᓂᖕᒐ ᓂᕿᒋᕙᑦᑕᖏᓐᓄᑦ ᓄᓇᖕᒥ ᓄᓇᓕᐅᔪᐃᑦ ᐊᒻᒪ ᖃᓄᖅ ᖃᓄᐃᑎᑦᑎᒻᒪᖕᒐᓐ ᓄᓇᓕᓐᓂᑦ ᐊᒻᒪ ᐃᒻᒥᒎᖅᑐᐃᑦ ᖃᓄᐃᖏᑎᐊᓐᓂᖏᓐᓄᑦ. ᐃᓕᓐᓂᑦ ᐃᑲᔪᓐᓂᐊᖅᑐᑦ ᐱᕕᕙᓕᐊᑎᑦᑎᔪᓐᓇᕐᒍᓪᓗᑎᓐ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᐱᓕᕆᐊᒥᑦ ᐃᓚᒋᓕᐅᔾᔨᓂᐊᖅᑐᒥᑦ ᓄᓇᓕᓐᓂ ᐊᒻᒪ ᑕᐃᓱᒪᓂᑐᖃᖅ ᐊᕙᑐᑎᒥᑦ ᖃᐅᔨᒪᓂᕐᒧᑦ. ᐊᐱᕆᖃᑦᑕᓂᐊᖅᑐᑦ ᐊᐱᖁᓯᐅᔪᓂᑦ ᐱᓪᓗᒍ ᐊᖑᓇᓱᐊᖃᑦᑕᕐᓃᑦ, ᖃᖓᒃᑯᓐ ᐊᖑᓇᓱᐊᖃᑦᑕᓪᒪᖓᕐᐱᓐ ᐊᔾᔨᒌᖏᑦᑐᓂᑦ ᓂᕐᔪᑎᓂᑦ, ᐊᒻᒪ ᐅᔾᔨᕆᔭᑎᓐ ᓯᓚᐅᑉ ᐊᓯᔾᔨᐸᓕᐊᓂᖕᒐᓄᑦ.

ᓴᐳᑎᓯᒪᓂᐊᕐᑕᕗᓐ ᒪᐅᖓᑐᐃᓐᓇᖅ ᐅᖃᐅᓯᐅᔭᕆᐊᖃᖏᓐᓃᑦ ᑭᓇᐅᓂᓐᓄᑦ. ᐃᓱᒪᒋᔭᑐᐊᑎᓐ ᐅᖃᐅᓯᐅᓚᔭᖅᑐᓐ ᐊᒻᒪ ᖃᐅᔨᔭᐅᔪᐃᑦ ᐊᑐᖅᑕᐅᓂᐊᖅᑐᐃᑦ ᐅᖃᐅᔾᔨᒋᐊᕐᓂᕐᒧᑦ ᓚᕙᒪᒃᑯᓐᓂᑦ ᐊᓯᔾᔨᔪᓐᓇᕐᒍᓪᓗᒋᑦ ᐊᑐᐊᓚᖁᑎᖏᓐᓂᑦ ᑲᒪᒋᔭᖃᕈᓐᓇᓂᕐᒧᑦ ᐱᕕᕙᓕᑎᑦᑎᓚᓱᐊᓐᓂᕐᒥᑦ ᓂᕿᒃᓴᓇᔭᖏᓐᓂᑦ ᓄᓇᖕᒥᐅᑕᐃᑦ. ᓴᓂᕐᕙᓯᒪᓂᐊᕐᑕᕗᓐ ᑐᑭᓯᒃᑲᓂᕈᑎᒃᓴᐅᔪᐃᑦ ᓄᐊᑕᕗᓐ ᐸᕐᓇᓇᐃᕐᓯᒪᔪᒥ(ᑮᒃᓯᒪᔪᒧᑦ) ᐃᑦᑎᕕᖕᒥ ᓄᓇᒃᓯᓐᓃᑎᓪᓗᑕ. ᑐᑭᓯᒃᑲᓂᕈᑎᒃᓴᐅᔪᐃᑦ ᖃᖅᓴᐅᔭᕐᓄᑦ ᑎᑎᕋᖅᑕᐅᓂᐊᖅᑐᐃᑦ ᐊᒻᒪ ᑕᑯᔭᒃᓴᐅᔭᓐᓇᓂᐊᖅᑐᓐ ᑭᓯᐊᓂ ᓘᒃᑖᖅ ᓗᐊᕆ ᓵᓐ ᐊᒻᒪ ᐃᓕᓐᓂᐊᑎᓪᒪᕆᕗᑦ, ᑖᓐᔭ ᓇᓐᑭᐅᕈ ᒪᒋᐅ ᐃᓕᓐᓂᐊᕐᕕᐊᓗᓪᒥ. ᑭᓇᑐᐃᓐᓇᖅ ᓄᓇᒃᓯᓐᓂᑦ ᑕᑯᔪᓐᓇᔫᖏᑦᑐᖅ ᑐᑭᓯᒃᑲᓂᕈᑎᒃᓴᓂᑦ ᐅᕙᑦᑎᓐᓄᑦ ᐅᖃᐅᓯᕆᔭᓐᓂᑦ.

ᐃᓕᓐᓄᑦ ᐊᐅᓪᓚᑎᑦᑏᖅᑐᒧᑦ ᓯᕗᓪᓕᕐᐹᒥ ᑎᑎᕋᖅᑕᐅᓯᒪᔪᐃᑦ ᐊᔾᔨᖏᓐᓂᑦ ᖃᐅᔨᓴᓐᓂᕐᒧᑦ ᖃᐅᔨᔭᐅᔪᓂᑦ ᓯᕗᓂᐊᒍᑦ ᓴᖅᑭᑎᑕᐅᓚᐅᖏᓐᓂ, ᖃᐅᔨᒪᑦᑎᐊᕈᓐᓇᖁᓪᓗᑎᓐ ᖃᓄᐃᓕᖓᓂᖏᓐᓂᑦ ᑐᑭᓯᓇᖅᓯᑎᑦᑕᕗᓐ; ᐊᒻᒪ ᖁᕕᐋᒃᑲᔭᕐᒥᔪᑦ ᐃᓕᓐᓄᑦ ᑐᔪᐃᔭᕆᐊᒥᑦ ᐊᔾᔨᖏᓐᓂᑦ ᓴᖅᑭᑎᑕᐅᔪᐃᑦ ᓴᖅᑭᑐᒥᓃᑦ ᐃᓕᓐᓂᑦ ᐊᐱᕐᓱᑎᓪᓗᑕ. ᕿᓚᓈᕐᐳᑦ ᐃᓕᓐᓄᑦ ᐱᓕᕆᖃᑕᐅᔭᓐᓇᓂᕐᒧᑦ, ᐊᒻᒪ ᐃᓕᒃᑲᓂᕐᓂᕐᒧᑦ ᖃᓄᖅ ᐱᕕᕙᓕᐊᑎᑦᑎᔪᑎᒃᓴᒥᑦ ᑲᒪᒋᔭᖃᕈᓐᓇᓂᕐᒧᑦ ᖃᓄᐃᑎᑦᑎᓂᖕᒐᓂᑦ ᓯᓚᐅᑉ ᐊᓯᔾᔨᓂᖕᒐᓄᑦ.

ᐃᓕᓐᓄᑦ ᑐᓂᓯᓂᐊᖅᑐᒧᑦ ᐊᔾᔨᖕᒐᓂᑦ ᓄᓇᖕᒥ ᓱᓇᑐᐃᓐᓇᕐᓃᑦ ᖃᐅᔨᓴᕐᕕᐅᑉ ᖃᐅᔨᓴᕐᓂᕐᒧᑦ ᐊᖏᖃᑎᒌᒍᑎᓂᑦ ᐊᒻᒪ ᒪᒋᐅᑉ ᐃᓕᓐᓂᐊᕐᕕᐊᓘᑉ ᐊᑐᖅᑕᐅᔭᓇᐸᖅᑐᓄᑦ ᐊᖏᓐᓂᖏᓐᓄᑦ ᑖᒃᓱᒧᖓ ᖃᐅᔨᓴᓐᓂᕐᒧᑦ ᑐᒃᓯᕋᕕᐅᑎᓪᓗᒋᑦ. ᖃᐅᔨᒋᐊᑦᑕᐃᓚᒪᑦᑕᐃᓛᓐ ᓇᓪᓕᐊᑐᐃᓐᓇᖏᓐᓂ ᓱᓕᕆᕕᐅᔫᒃ ᐊᐱᖁᓯᓴᖃᕈᕕᓐ ᐅᕕᕙᑐᓐᓃᑦ ᐃᓱᓖᑐᑎᕈᕕᓐ (ᑕᑯᓗᒋᑦ ᖃᐅᔨᒋᐊᕐᕕᓴᐅᔪᐃᑦ ᐊᑖᓂ).

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ᐅᖃᓪᒫᖅᓯᒪᔭᒃᑲ ᖁᓛᓃᑐᓐ ᑐᑭᓯᒃᑲᒥᓂᕈᑎᒃᓴᐃᑦ ᐅᕕᕙᑐᓐᓃᑦ ᐊᓯᓐᓄᑦ ᐅᖃᓪᒫᖅᑕᐅᓯᒪᔪᓐ ᓂᐱᖃᖅᑐᓂ, ᐊᒻᒪ ᑐᑭᓯᔪᖕᒐ ᐱᔪᓇᐅᑎᒋᔭᓐᓂᑦ ᐃᓚᐅᑎᓪᓗᖕᒐ, ᐱᔾᔪᑎᖕᒐᓂᑦ ᖃᐅᔨᓴᓐᓂᐅᑉ; ᐊᒻᒪ ᑭᓇᒥᑦ ᐅᖃᖃᑎᖃᕆᐊᖃᒪᖕᒐ ᑐᑭᓯᒃᑲᓂᕈᒪᓂᕈᒪ. ᐃᓚᐅᑎᓪᓗᖕᒐ ᖃᐅᔨᓴᕐᓂᕐᒧᑦ ᐊᖏᕐᐳᖕᒐ ᑭᐅᖃᑦᑕᕈᒪᓂᕐᒥᑦ ᐊᐱᖁᑕᐅᔪᓂᑦ ᐱᓪᓗᒍ

ᐊᑐᖄᑦᑕᖅᓯᒪᔪᒃ ᐃᓗᐊᓂ ᐊᒻᒪ ᖃᓂᒋᔮᓂ ᓄᓇᑦᑕ, ᓂᐱᓕᐅᖅᑕᐅᓂᐊᖅᑐᐃᑦ ᓂᐱᓕᐅᕈᒻᒧᑦ. ᖃᐅᔨᒪᔭᕗᑦ ᐊᑭᓕᖅᓯᑕᐅᓂᐊᕐᓂᕐᓂᑦ 4150}ᐅᓪᓗᖅ ᐃᓚᐅᓂᖓᓄᑦ. ᑎᑎᕋᖅᓯᒪᔭᖓ ᐅᕙᑉᐸᓘᓐᓃᑦ ᓂᐱᓕᐅᖅᑕᐅᓯᒪᔭᖓ ᐃᑲᔪᓐᓂᐊᕐᖓᑕ ᑎᑎᕋᖅᑎᐅᔪᒥᑦ ᖃᐅᔨᓴᓐᓂᕐᒧᑦ ᐊᒻᒪ ᐃᖅᑯᓕᐅᑕᐅᔪᓐᓇᖅᑐᖓ ᑖᒃᓯᒧᖓ, ᐊᑎᕋ ᐅᖃᐅᓯᐅᔾᔫᖓᑦᑐᖅ ᐅᖃᐅᓯᐅᕐᑯᖓᑯᒃᑯ. ᐊᑎᓕᐅᖅᑐᖓ ᑳᒃᑯᓂᖓ ᑕᑕᑎᓇᐊᓕᖓᓂᕐ, ᓴᒃᑯᐃᔪᒃ ᐱᔭᓐᓇᐅᑎᒃ ᑳᒃᑯᓄᖓ. ᐊᖏᕐᐳᖓ ᐃᓚᐅᓂᕐᒧᑦ ᖃᐅᔨᓴᓐᓂᕐᒧᑦ; **ᐊᐸᑎᐅᑉ ᐊᓯᔾᔨᓂᖓᓄᑦ, ᑕᐃᒪᖓᓂᑐᖅ ᓂᕿᕆᔪᐅᔭᐃᑦ ᓂᕐᔪᑏ, ᐊᒻᒪ ᑎᒥᐅᑉ ᖃᓄᐃᖕᓂᖓ ᓄᓇᒥ, ᐊᑖᑦ ᖃᐅᔨᓴᓐᓂᖓᑕ ᖃᐅᔨᒪᔪᒪᓇᒃ ᐃᓕᓐᓂᐊᑎᑦᑎᔾ ᓗᐊᓇ ᓵ; ᐱᓕᓇᖅᑕᐅᔪᖅ ᖃᐅᔨᒪᔪᒪᓇᒃ ᐃᓕᓐᓂᐊᑎᑦᑎᔾ, ᑲᑎᖄᑦᑕᕐᓯᐅᔪᖅ ᓄᓇᖃᖅᑲᖅᑐᒥᓂᕐᓄᑦ ' ᓂᓇᕐᑎᐊᕋᐃᑦ ᐊᒻᒪ ᐊᐸᑎᐅᔭᖅ, ᒪᒋᐅᓪ ᐃᓕᓐᓂᐊᕐᓯᐊᓗᒃ, 21, 111 ᓚᐃᒃᓯᐊ, ᓯᑦ ᐋᓐ}ᑎ}ᐱᓕᕗ, ᑯᐸᐃᒃ, ᒍᓪᐸ ᖁᕐᓪ.**

ᑐᑭᓯᕙᕗᑦ ᑲᒪᒋᔭᕆᐊᖃᖅᑐᖅ ᐱᓪᓗᒍ ᒪᐅᖓᑐᐃᓐᓇᖅ ᐅᖃᐅᓯᐅᔭᕆᐊᖃᕐᖏᓐᓂᖅ ᐃᓯᒪᒋᔭᐅᕐᑎᐊᓂᐊᕐᖓᓐ ᐃᒪᓐᓇ ᐊᑖᓂ ᓇᓗᓇᐃᖅᑕᐅᓯᒪᔭᐃᑦ:

ᐊᖏᕐᐳᖓ ᓇᓗᓇᐃᖅᑕᐅᓂᕐᒧᑦ ᐊᐱᖅᓱᑕᐅᔪᓐᓇᐊᕐᒥᑦ ------

ᐊᖏᕐᐳᖓ ᓇᓗᓇᐃᖅᑕᐅᓂᕐᒧᑦ ᐊᐱᖅᓱᑕᐅᔪᓐᓇᐊᕐᒥᑦ ᑭᓯᐊᓂ ᑭᖑᓂᐊᒍᑦ ᐅᒪ ᐅᓪᓘᒻ

ᓇᓗᓇᐃᖅᑕᐅᕐᑯᖏᑕᖅ ᑭᓇᐅᓂᖅ ᐊᐱᖅᓱᑕᐅᑎᓪᓗᖓ ------

ᐃᓯᒪᒋᒃᑲᓂᕈᓐᓇᖅᑕᖅ ᑖᓇ ᐊᑐᕈᒪᓂᖅ ᖃᖓᑐᐃᓐᓇᖅ, ᐊᒻᒪ ᐊᓯᔾᔨᕐᓗᒍ ᐊᑲᐅᓯᒋᔭᒃᑯᓐ; ᐊᕙᑉᐳᑎᔭᓐᓇᕐᒥᔭᕗᑦ ᖃᐅᔨᓴᕐᓂᕐᒥᑦ ᖃᖓᑐᐃᓐᓇᖅ.

ᐊᒻᒪᓱᓕᒃᑲᓐᓂᖅ, ᐱᔭᓐᓇᖅᑐᖅ ᑐᑭᓯᒃᑲᓂᕈᑎᒃᓴᓂᑦ ᖃᐅᔨᓴᕐᑎᒥᑦ, ᓘᒃᑖᖅ ᓵ; ᐊᒻᒪᑕᐅᖅ ᐅᖃᐅᓯᓇᓗᒥᑦ ᐃᓯᒪᒋᔪᒃ ᑖᒃᓯᒧᖓ. ᑕᑯᓗᒥᑦ ᖃᐅᔨᒥᐊᕐᓯᓴᐅᔭᐃᑦ ᐊᑖᓂ.

ᐃᓚᐅᔪᖅ--

ᐅᓪᓗᖓ -------------------

ᖃᐅᔨᓴᖅᑎ --------------------------------------

ᖃᐅᔨᒥᐊᕐᓯᓴᐅᔭᐃᑦ ᐅᖄᓚᐅᑎᖏᑦ

ᓘᒃᑖᖅ ᓗᐊᓇ ᓵ, ᒪᒋᐅᓪ ᐃᓕᓐᓂᐊᕐᓯᐊᓗᒃ: (514)398-7765

ᓄᓇᕗᑦ ᓱᓇᑐᐃᓐᓇᕐᓂᑦ ᖃᐅᔨᓴᕐᓯᒃ: (867)979-779

ᒪᒋᐅᓪ ᖃᓄᐃᒥᐊᖃᕐᓂᐅᔭᓄᑦ ᑲᑎᒪᔩᐅᔭᐃᑦ } ᖃᐅᔨᒥᐊᕐᓯᓴᒃ

ᓘᒃᑖᖅ ᐲᑕ ᔮᓐᓴ (514)398-7547

ᐃᓄᐃᑦ ᑕᐱᕇᑦ ᑲᓇᑕᒥ } ᖃᐅᔨᒥᐊᕐᓯᓴᒃ ᓘᒃᑖᖅ ᓯᑳᑦ ᓂᑯᓪᓴ (613)238-8181

CONSENT FORM

Studies involving human subjects require the written consent of participants. **McGill University and granting institutions (ArcticNet)** believe that all individuals are entitled to this respect. Therefore, this agreement between the researcher and participant has been made mandatory.

****

We are researchers from McGill University and we would like to invite you to participate in a one year project funded by the Federal Government of Canada.

The objective of this project is to investigate the impacts of environmental change on the food supply of Nunavut communities and in turn how this affects community and individual health. We will help you to develop a management program that will integrate local and traditional ecological knowledge. We will ask you questions about your hunting practice, the times when you hunt different animals, and your observations on climate change.

We will protect the confidentiality of your identity. Only your opinions will be reported and the results will be used to advise the governments to make changes to their policies to facilitate the improvement of food supply in Nunavut. We will store all the information we gather in a locked briefcase while in you community. The information will be entered into a computer and will be accessible only to Dr. Laurie Chan and his Master's student, Tanya Nancarrow of McGill University. No one from your community will have access to the information that you share with us.

We will send you draft copies of our research results before it is published, in order to assure you of the validity of our interpretations; and we would be happy to send you a copy of any publications that result from our interview. We look forward to having your cooperation, and to learning more about how to develop a way to deal with the impact of climate change.

We will present you with a copy of the Nunavut Research Institute (NRI) research agreement and McGill University ethics approval for this study upon request. Please feel free to contact either of these institutions if you have any questions or concerns (See contact information below).

****

I have read the above information or someone has read it aloud, and I understand my rights as a participant, the purpose of the study, and who to contact if I need information. In participating in the study I agree to answer questions about my experiences in and around my community, which will be tape recorded. I am aware that I will be paid an honorarium of $150/day for this participation. The written or recorded material will help the author in the analysis and may be *quoted by him/her, although my name will be withheld if I so request. In signing this form, I am relinquishing my rights to this material.*

I agree to take part in this study, ***Environmental Change, key traditional food species, and health in Nunavut,*** *under the supervision of* ***Professor Laurie Chan, Associate Professor, Centre for Indigenous Peoples' Nutrition and Environment, McGill University, 21,111 Lakeshore, Ste. Anne-de-Bellevue, Quebec, H9X 3V9.***

It is understood that my requirements regarding anonymity will be respected in the manner specified below:

I agree to be identified as the interview subject ______

I agree to be identified as the interview subject only
after the following date ______

I do not want to be identified as the interview subject ______

I may reconsider this commitment at any time, and change it as I see fit; I may also withdraw from this study at any time.

Furthermore, I can obtain information from the researcher, Dr. Chan, and also express my opinion to him. See Contact numbers below.

Participant ____

Date ____________________

Researcher ____

Contact Numbers:

Dr. Laurie Chan, McGill University: (514) 398-7765

Nunavut Research Institute: (867) 979-7279

McGill Ethics Board- contact Dr. Peter Jones: (514) 398-7547

Inuit Tapiriit Kanatami- contact Dr. Scot Nickels: (613) 238-8181

7.5 Appendix 5: Food Frequency Questionnaire

Food Frequency Questionnaire				ᓂᕆᒐᔪᒃᐱᐅᑦ	ᖃᓄᖅ ᐊᖏᑎᒋᔭᒥ
ᓂᕿᓪᓚᑦᑕ ᓂᕆᔭᐅᕙᓐᓂᖏᓐᓄ ᐊᐱᖅᑯᑎᑦ				Frequency	Portion Size
Beluga ᕿᓚᓗᒐᖅ ᖃᐅᓪᓗᖅᑐᖅ ᕿᓚᓗᒐᖅ ᖃᐅᓪᓗᖅᑐᖅ YES / NO	1	Meat fresh or frozen	ᓂᕿ		
	2	cooked			
		dried			
		Muktuk with blubber	ᒪᒃᑕᖅ ᐅᖅᓱᓚᒃ		
	3	Muktuk without blubber	ᒪᒃᑕᖅ ᐅᖅᓱᖃᙱᑦᑐᖅ		
	4	Blubber	ᐅᖅᓱᖓ		
	5	Flippers	ᓴᖅᐱᐅᔭᖅ		
	6	Other (specify):	ᐊᓯᖏᓪᓚ		
Narwhal ᕿᓚᓗᒐᖅ ᕿᕐᓂᑕᖅ ᕿᓚᓗᒐᖅ ᕿᕐᓂᑕᖅ YES / NO	7	Meat fresh or frozen	ᓂᕿ		
	8	cooked			
		dried			
		Muktuk with blubber	ᒪᒃᑕᖅ ᐅᖅᓱᓚᒃ		
	9	Muktuk without blubber	ᒪᒃᑕᖅ ᐅᖅᓱᖃᙱᑦᑐᖅ		
	10	Blubber	ᐅᖅᓱᖓ		
	11	Flippers	ᓴᖅᐱᐅᔭᖅ		
	12	Other (specify):	ᐊᓯᖏᓪᓚ		
Walrus ᐊᐃᕕᖅ YES / NO	13	Meat fresh or frozen	ᓂᕿᖓ		
	14	cooked			
		dried			
		Liver	ᑎᖑᒃ		

	15	Heart	ᐅᒻᒪᑎ		
	16	Intestines	ᐃᓇᓗᐊᖅ		
	17	Stomach and contents	ᐊᕿᐊᕈᐊ ᐃᓗᓕᖏᓪᓗ		
	18	Flippers	ᓯᖁᐊᖅ		
	19	Blubber	ᐅᖅᓱᖓ		
	20	Oil	ᒥᓯᕋᖅ		
	21	Soup/broth	ᖃᔪᖓ		
	22	Other (specify):	ᐊᓯᖏᓪᓚ		
				ᓂᕆᓚᔪᒃᐱᐅᑦ	ᖃᓄᖅ ᐊᖏᑎᒋᔪᒥ
				Frequency	Portion Size
Polar Bear ᓇᓄᖅ Yᕆ> ᔭ NO	23	Meat fresh or frozen	ᓂᕿᖓ		
	24	cooked			
		dried			
		Feet	ᐃᓯᒐᖓ		
	25	Fat/oil	ᐅᖅᓱᖓ		
	26	Soup/broth	ᖃᔪᖓ		
	27	Other (specify):	ᐊᓯᖏᓪᓚ		
Ringed Seal ᓇᑎᖅ _ᕆ> / NO	28	Meat fresh or frozen	ᓂᕿ		
	29	cooked			
		dried			
		Liver	ᑎᖑᒃ		
	30	Kidney	ᑕᖅᑐ		
	31	Heart	ᐅᒻᒪᑎ		
	32	Lungs	ᐳᕙᒃ		
	33	Brain	ᖃᕆᑕᖅ		
	34	Eyes	ᐃᔨ		
	35	Intestines	ᐃᓇᓗ		

	36	Flippers	ᓯᕐᑯᐊᖅ		
	37	Blood	ᐊᐅᖓ		
	38	Fat/oil	ᐅᖅᓱᖓ		
	39	Cartilage	ᖃᕐᑯᓚᖅ		
	40	Soup/broth	ᖃᔪᖓ		
	41	Other (specify):	ᐊᓯᖏᓪᓕ		
Bearded Seal	42	Meat fresh or frozen	ᓂᕿ		
ᐅᒡᔪᒃ	43	cooked			
_ᕆᐳ / NO		dried			
		Liver	ᑎᖑᒃ		
	44	Heart	ᐅᒻᒪᑎ		
	45	Intestines	ᐃᓇᓗᐊᖅ		
	46	Fat/oil	ᐅᕐᑯ		
	47	Cartilage	ᖃᕐᑯᓚᖅ		
	48	Soup/broth	ᖃᔪᖓ		
	49	Other (specify):	ᐊᓯᖏᓪᓕ		
Caribou	50	Meat fresh or frozen	ᓂᕿᖓ	ᓂᕆᒐᔪᒃᐱᐅᑦ	ᖃᓄᖅ ᐊᖏᑎᒋᔫᒥ
ᑐᒃᑐ		cooked		Frequency	Portion Size
YES / NO	51 52	dried			
	53	Liver	ᑎᖑᒃ		
		Kidneys	ᑕᖅᑐ		
		Heart	ᐅᒻᒪᑎ		
	54	Lungs	ᐳᕙᒃ		
	55	Stomach and contents	ᐊᕿᐊᕈᐊ ᐃᓗᓕᖏᓪᓗ		
	56	Intestines	ᐃᓇᓗᐊᖅ		
	57	Nose	ᕿᖓᖓ		

	58	Tongue	ᐅᖃᖓ		
	59	Eyes	ᐃᔨᖏᑦ		
	60	Brain	ᖃᕆᑕᖓ		
	61	Bone marrow	ᐸᑎᖓ		
	62	Fat	ᑐᓐᓄᖓ		
	63	Cartilage	ᖃᕐᑯᓚᖓ		
	64	Blood	ᐊᐅᖓ		
	65	Broth/soup stew	ᖃᔪᖓ		
	66	Other (specify):	ᐊᓯᖏᓪᓚ		
King Eider/ ᒥᑎᖅ	67	Meat	ᓂᕿᖓ		
	68	Gizzard/Stomach	ᐊᕿᐊᕈᐊ ᐃᓗᓕᖏᓪᓗ		
YES / NO	69	Soup/Broth	ᖃᔪᖓ		
	70	Eggs	ᒪᓐᓂᖏ		
	71	Other (specify):	ᐊᕿᒡᒋᖅ		
Swans/ ᖃᖑᖅ	72	Meat	ᓂᕿᖓ		
	73	Gizzard/Stomach	ᐊᕿᐊᕈᐊ ᐃᓗᓕᖏᓪᓗ		
YES / NO	74	Soup/Broth	ᖃᔪᖓ		
	75	Eggs	ᒪᓐᓂᖏ		
	76	Other (specify):	ᐊᕿᒡᒋᖅ		
Ptarmigan/ ᐊᕿᒡᒋᖅ	77	Meat	ᓂᕿᖓ	ᓂᕆᒐᔪᒃᐱᐅᑦ	ᖃᓄᖅ ᐊᖏᑎᒋᔪᒥ
	78	Gizzard/Stomach	ᐊᕿᐊᕈᐊ ᐃᓗᓕᖏᓪᓗ	Frequency	Portion Size
YES / NO	79	Soup/Broth	ᖃᔪᖓ		
	80	Eggs	ᒪᓐᓂᖏ		

	81	Other (specify):	ᐊᕿᒡᒋᖅ		
Trout/ ᐃᓘᕋᖅ	82	Meat fresh or frozen	ᓂᕿᖓ		
		cooked			
YES / NO	83 84	dried			
	85	Soup/broth	ᖃᔪᖓ		
		Eggs/roe	ᓱᕙᖓ		
		Other (specify):	ᐊᓯᖏᓪᓗ		
Char / ᑕᕆᐅᕐᒥᐅᑕᖅ	86	Meat fresh or frozen	ᓂᕿᖓ		
		cooked			
YES / NO	87 88	dried			
	89	Soup/broth	ᖃᔪᖓ		
		Eggs/roe	ᓱᕙᖓ		
		Other (specify):	ᐊᓯᖏᓪᓚ		
Other Fish/Seafood	90	Specify:	ᓇᓗᓇᐃᕐᓗᒍ		
	91	Specify:	ᓇᓗᓇᐃᕐᓗᒍ		
	92	Specify:	ᓇᓗᓇᐃᕐᓗᒍ		
	93	Specify:	ᓇᓗᓇᐃᕐᓗᒍ		

7.6 Appendix 6: Harvest Calendar

<table>
<tr><th>Apr</th><th>My</th><th>Jn</th><th>Jl</th><th>Ag</th><th>Sept</th><th>Oc</th><th>Nov</th><th>Dec</th><th>Jan</th><th>Feb</th><th>Mr</th></tr>
<tr><th colspan="3">Spring</th><th colspan="2">Summer</th><th colspan="2">Fall</th><th colspan="5">Winter</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td colspan="2">ᕿᓚᓗᒐᖅᖃᐅᓪᓗᖅᑐᖅ / Beluga</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td colspan="2">ᕿᓚᓗᒐᖅ ᕿᕐᓂᑕᖅ/ Narwhal</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="12">ᓇᑎᖅ / Ringed Seal</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>ᐊᐃ/ᖅ/ Walrus</td><td></td><td></td><td></td><td></td></tr>
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<tr><td colspan="2">ᓇᓄᖅ / Polar Bear</td><td></td><td></td><td></td><td colspan="7">ᓇᓄᖅ / Polar Bear</td></tr>
<tr><td colspan="12">ᑐᒃᑐ / Caribou</td></tr>
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<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="3">ᑎᖕᒥᐊᑦ / Birds</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="12">ᑕᓴᐅᕐᒥᐅᑕᖅ / Arctic Char</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

7.7 Appendix 7: Substitutions for Food Items for which no Nutrient Data were Available

Food item	**Nutrient Replacement**
Beluga-cooked	Beluga-raw
Narwhal -raw	Beluga-raw
Narwhal-cooked	Beluga-raw
Narwhal flippers	Beluga flippers
Narwhal Muktuk with blubber	Beluga muktuk with blubber
Walrus Heart	Ringed seal heart
Walrus stomach/contents	Caribou stomach/contents
Walrus flipper	Beluga flippers
polar bear -raw	polar bear- cooked
Ringed seal brain	Caribou brain
Ringed seal intestine	Bearded seal intestine
Bearded seal liver	Ringed seal liver
Bearded seal heart	Ringed seal heart
Bearded seal soup/broth	Ringed seal soup/broth
Swan eggs	Duck eggs
King Eider eggs	Duck eggs
Goose eggs	Duck eggs
Spur eggs	Duck eggs
Ptarmigan eggs	Duck eggs
King Eider gizzard	Ptarmigan gizzard
Swan gizzard	Ptarmigan gizzard
Swan meat	Ptarmigan meat
Caribou eyes	Ringed seal eyes
All bird soups	Homemade chicken stock
Trout, Char soup	Alaskan native fish soup