What's in your freezer?
Traditional Food Use and Food Security in Two Yukon First Nations Communities

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Abstract

Traditional foods are central to Aboriginal well-being; however the trend of decreasing use can pose risks of chronic diseases. This study collected information on the frequency and quantity of traditional foods consumed and level of food security of 29 Vuntut Gwitchin adults from Old Crow and 33 Teslin Tlingit adults in Yukon, Canada. Traditional foods were shown to be an important part of the diet, although challenges in access to and availability of foods were reported.

There are limited data on mercury in caribou, a principal food source of the Vuntut Gwitchin. Seventy-five caribou muscle, 63 kidney and 3 liver samples were analyzed for total mercury. Estimated total mercury and methylmercury exposure and nutrient intake was calculated by combining mercury and nutrient levels with reported dietary information. Caribou issues were found to contribute high levels of important nutrients to the diet and pose minimal health risk from mercury exposure.

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Contribution of Authors

This is a manuscript-based thesis and includes two manuscripts to be submitted for publication (Chapter 2 and Chapter 3). Chapter 2 is authored by Roseanne Schuster and co-authored by Eleanor E. Wein, Cindy Dickson and Laurie Hing Man Chan. Chapter 3 is authored by Roseanne Schuster and co-authored by Mary Gamberg and Laurie Hing Man Chan. The contributions of each of the authors for the manuscripts are stated below:

In respect to Chapter 2, Roseanne Schuster developed the study methodology, collected the 2007-2008 data, performed the statistical analysis and communicated results with the communities. Eleanor Wein supported the method development and shared the 1991-1992 food frequency data. Cindy Dickson of the Council of Yukon First Nations facilitated community engagement. Laurie Hing Man Chan initiated the project and advised the work of Roseanne Schuster.

In respect to Chapter 3, Roseanne Schuster analyzed the caribou muscle samples for mercury content and performed all data analyses for estimated mercury exposure and nutrient intake. Mary Gamberg was responsible for the collection of all caribou samples and analysis of mercury levels in the liver and kidney samples. Laurie Hing Man Chan initiated the project and supervised the work of Roseanne Schuster.

INTRODUCTION

While traditional foods are recognized to contribute to the health and well-being of Aboriginal Peoples, there is an increasing inclusion of market foods in the diet (Batal *et al.*, 2005; Deutch *et al.*, 2007; Wein, 1994b). The replacement of nutrient-rich traditional foods with market foods high in carbohydrates and saturated fats has been identified as a risk factor for increased occurrences of chronic disease associated with the rapid nutrition transition (Damman *et al.*, 2007; Kuhnlein *et al.*, 2004; Popkin, 2009). This shift in diet has occurred due to a combination of socio-economic and environmental pressures that threaten food security in northern communities (Guyot *et al.*, 2006; Lambden *et al.*, 2006; Willows, 2005).

The chemical contamination of traditional food sources has also become a food security issue in recent decades. The developmental neurotoxin methylmercury has been well-documented in fish and marine mammals, raising concern about prenatal exposure through Aboriginal mothers' traditional diet (Gabrielsen *et al.*, 2003; Kuhnlein & Chan, 2000; Muckle *et al.*, 2001). Caribou is one of the traditional foods most frequently consumed among by Yukon First Nations (Wein & Freeman, 1995), yet there are gaps in the literature surrounding mercury in these terrestrial animals (Gamberg, 2004, 2007; Gamberg *et al.*, 2005). It is important to assess the safety of caribou as even low levels of mercury can pose human health risk if frequency and quantity of consumption are sufficiently large.

Rationale

In 1991-1992, Wein & Freeman (1995) surveyed three Yukon First Nations living in four communities for frequency of traditional food use. Traditional foods, particularly caribou, moose and salmon, were found to be important components of the daily diet of Yukon First Nations. The Vuntut Gwitchin First Nation community of Old Crow consumed and the Tlingit community of Teslin reported the highest frequencies of traditional food use. Since then, environmental and socio-economic pressures have continued to pose challenges to traditional lifestyles, and communities across the north have reported concerns for the integrity of their traditional food systems (Bird *et al.*, 2008). Recent studies (Kuhnlein *et al.*, 2006; Kuhnlein & Receveur, 2007; Kuhnlein *et al.*, 2004; Nakano *et al.*, 2005b) have been conducted on the frequency of traditional food use and nutrient intake among adults in other Yukon First Nations communities but have not included the original four surveyed by Wein and Freeman (1995). Identifying potential trends in traditional food consumption patterns is an important aspect of food security.

The chemical contamination of traditional food sources is a concern reported by many northern communities. The Vuntut Gwitchin have sustained a unique relationship with the Porcupine Caribou Herd for centuries, and the caribou is central to both the diet and culture of the Vuntut Gwitchin. Investigating mercury levels in the caribou, which is the most frequently consumed traditional food in Old Crow, is important for the Vuntut Gwitchin First Nation's maintenance of traditional lifestyle, health and well-being.

Research Questions

There are two main objectives to this thesis. The first is to evaluate traditional food consumption patterns in the context of food security in Vuntut Gwitchin households in Old Crow and Tlingit households in Teslin. The second goal is to investigate mercury levels in archived caribou samples. In order to address these objectives, the following research questions have been asked and will be addressed within this thesis:

- Has there been a change in traditional food consumption among adults in Vuntut Gwitchin and Tlingit households in Old Crow and Teslin between 1991-1992 and 2007-2008?
  - Are there differences between age groups and genders?
- What, if any, are the challenges to food security in each community?
- Does mercury exposure through consumption caribou muscle, kidney and liver pose a health risk to consumers?
- What nutritional benefits do Vuntut Gwitchin adults receive through consuming caribou meat, kidney and liver?

Organization

This thesis is organized in a manuscript format, with the two middle chapters presenting study results written as manuscripts that will be further prepared for publication. The first chapter positions this thesis among the literature on northern food security, nutrition and chemical contaminants in traditional food sources. The second chapter answers the first two research questions and the third chapter addresses the third and fourth research questions in manuscript format. The concluding chapter integrates the main points from the two manuscripts and the literature review.

CHAPTER 1: LITERATURE REVIEW

Traditional foods can be defined as culturally accepted foods available from local natural resources that constitute the food systems, with food systems encompassing the socio-cultural implications, harvesting, preparation, use, composition and nutritional consequences for people using the food (Kuhnlein *et al.*, 2001). Traditional food systems vary according to the geography and culture of Indigenous Peoples. Throughout this thesis, traditional foods will be used to refer to the general food systems of Aboriginal Peoples (First Nations, Inuit and Métis) and when specified will focus on the foods systems of a particular group.

The health benefits of traditional foods are widely recognized by Aboriginal Peoples. When asked about the most important advantage of traditional foods, the most common answer of Dene/Métis, Yukon First Nations and Inuit across the Arctic is its contribution to physical health and nutritional well-being (Kuhnlein *et al.*, 2000; Lambden *et al.*, 2007). Almost half (42%) of Inuit mothers interviewed in Nunavik reported increasing their traditional food consumption during pregnancy, with 26% for reasons of perceived health benefits for mother and/or child (Muckle *et al.*, 2001). In a survey of Yukon First Nations, 24% of 802 male and female respondents chose healthy and nutritious as the most important advantage of traditional foods (Receveur *et al.*, 1998). Yukon First Nations have also expressed the belief that the consumption of moose, salmon and caribou is important for health (Wein, 1994a). In interviews on the benefits of traditional foods, Dene/Métis, Inuit, and Yukon First Nations have made comments to the effect that "[traditional food] makes your blood strong" (Lambden *et al.*, 2007, p. 312). Furthermore, regular engagement in hunting, fishing, berry picking and plant harvesting contribute to fitness and overall health

(Deutch *et al.*, 2007; Kuhnlein & Receveur, 1996; Lambden *et al.*, 2007; Wilson & Rosenberg, 2002).

However, the harvesting, preparation and consumption of traditional foods represent much more than physical health and nutrition to Aboriginal Peoples (Kuhnlein & Receveur, 1996; Muckle *et al.*, 2001; Van Oostdam *et al.*, 2005; Wein & Freeman, 1992). The cultural values inherent in these food-centered activities form the basis for societal well-being and cultural identity (Egede, 1995; Kuhnlein *et al.*, 2000; Wein & Freeman, 1992). Comments from Dene/Métis, Yukon First Nations and Inuit women on the importance of traditional foods have included "keeps our tradition," "brings people together" and "involves family in food prep[aration]" (Lambden *et al.*, 2007, p. 312). Harvesting and preparation activities facilitate intergenerational knowledge transfer between elders and youth and maintain the spiritual connection with the land (Kuhnlein *et al.*, 2000; Richmond & Ross, 2009; Wheatley, 1994). Furthermore, the circumpolar Survey of Living Conditions in the Arctic (SLCiA) showed a strong relationship between levels of subsistence activities and overall satisfaction with life (Poppel *et al.*, 2007). The societal and spiritual health benefits of harvesting and using traditional foods are important to individual and community well-being.

Food Security

Food security has been defined as existing "when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (Food and Agriculture Organization, 1996, para. 1). The World Health Organization notes that availability, access and appropriate use are the three pillars of food security (World Health Organization, 2008). Evaluating food security among Aboriginal Peoples must take into consideration their culturally specific relationships with the land and the central role food plays in culture (Lambden *et al.*, 2007; Power, 2008). Food security in a northern and Aboriginal context has been modified to include "the continual and predictable availability and access to food derived from northern environments through Indigenous cultural practices (Paci *et al.*, 2004, p. 1). Factors affecting Yukon First Nations' food security include environmental changes, prohibitive costs, and lack of adequate and functional equipment for harvesting country foods as well as access to and availability of imported market foods (Lambden *et al.*, 2006; Wein, 1994a).

Factors Affecting Traditional Food Security

Modification of the environment, chemical contamination and climate change are principal among environmental stresses affecting traditional food security (Loring & Gerlach, 2008; Willows, 2005). Disrupted water flows, changes in animal populations, and local chemical contamination can result from industrial activities (Willows, 2005). In addition to local industries, naturally occurring sources and long-range oceanic and atmospheric transport contribute to the presence of contaminants such as metals and organochlorines in the Arctic and subarctic (Arctic Monitoring and Assessment Programme, 2004; Brooks *et al.*, 2005). Many of these contaminants bioaccumulate, building up in plants and animals in the environment. Some contaminants biomagnify, meaning that their levels increase according to the animals' position in the food chain, with highest levels in top-level trophic animals. The bioaccumulative properties of these contaminants have raised concerns for the safety of traditional foods for Aboriginal consumers. While this concern may be warranted for consumers of high trophic level animals, such as the Inuit whose diet consists of large quantities of seals and whales, contaminant exposure is generally less for other Aboriginal populations who consume primarily terrestrial herbivorous animals (Berti *et al.*, 1998; Chan & Receveur, 2000; Hansen & Gilman, 2005). However, the perception of high health risk due to contamination is pervasive, as well as the confusion about which foods are safe and which are unsafe (Chan & Receveur, 2000; Usher *et al.*, 1995). The lack of comprehensive exposure assessments and improper or ineffective communication of information are among the reasons for this confusion and have led to unnecessary changes in food consumption patterns (Berti *et al.*, 1998; Myers & Furgal, 2006; Usher *et al.*, 1995; Wheatley, 1997; Willows, 2005).

Climate change has raised concerns that the predictability, availability and quality of traditional foods will be affected (Loring & Gerlach, 2008; Paci *et al.*, 2004). Effects of climate-related changes differ between communities based on location and baseline climate, but overall trends show decreases in ice thickness and/or cover, fluctuations in precipitation and an increased unpredictability in weather (Guyot *et al.*, 2006; Nancarrow, 2007). Changes in species presence and migration patterns have affected the length and calendar time of hunting season (Guyot *et al.*, 2006). This changed hunting period combined with fluctuations in ice cover and snow melt have made personal safety an issue in deciding when to go out on the land to harvest (Guyot *et al.*, 2006; Nancarrow, 2007).

Time and income can act as barriers in a economy where both wage employment and subsistence activities are pursued (Chan *et al.*, 2006; Kruse, 1991). Individuals engaged in regular wage-earning jobs may not have the time required to make harvesting trips to far destinations as was traditionally done. For example, in an Inupiat community where residents reported working more months at wage jobs than surrounding communities, households were observed to derive less food from subsistence activities (Kruse, 1991). Inuit in Nunavut have reported restricting harvesting activities to weekends and relying on elders to feed younger generations as results of time demands (Chan *et al.*, 2006). Still, the issue is more complex than a subsistence-wage economy trade-off. For instance, subsistence activities themselves have become more technologically enhanced, and money is necessary to purchase and maintain equipment including snow machines, gas, and ammunition (Loring & Gerlach, 2008; Poppel *et al.*, 2007). Women in Yukon First Nations, Dene/Métis, and Inuit households have reported not having enough equipment for hunting and fishing, as well as perceiving these activities as cost-prohibitive (Lambden *et al.*, 2006). Those belonging to the highest income bracket of Northern Alaskan Inupiat households most frequently reported obtaining over half their food from subsistence activities (Kruse, 1991). However, the circumpolar SLCiA failed to establish a relationship between number of subsistence activities and wage work as measured by income, suggesting there are factors in addition to time and money that are involved in this dynamic relationship (Poppel *et al.*, 2007). Those factors may include proximity to harvesting areas and type and expense of equipment required for the particular harvesting.

Factors Affecting Market Food Security

Market foods now account for a larger proportion of First Nation Peoples' diets than previous decades, and obtaining and choosing nutritious market foods can be challenging (Lawn & Harvey, 2003; Wein, 1994a; Willows, 2005). In northern and remote communities, cost is often a prohibitive factor in obtaining nutritious market foods (Chan *et al.*, 2006; Lambden *et al.*, 2006; Wein, 1994a). In a survey of 1771 women across 44 Arctic Dene/Métis, Yukon First Nations and Inuit communities, between 26% and 58.3% reported not being able to afford all food items their household needed from the store (Lambden *et al.*, 2006).

High prices in stores in remote and northern communities result from the expense of transporting goods long distances by truck, ship or air as well as the monopolies involved. In comparing four Yukon communities, Wein (1994) found prices increased in the following order: Whitehorse, Teslin, Haines Junction and Old Crow. The first three are accessible along the Alaska Highway, while goods must be flown into Old Crow (Indian and Northern Affairs Canada, 2007). Using information from the 1990 Northern Food Basket, which represents the cost of a nutritionally adequate diet for one week for a family of four, prices in Whitehorse, Teslin and Old Crow were 117%, 134% and 318% the cost of the same Northern Food Basket in Edmonton (Wein, 1994a). The Revised Northern Food Basket was released in 2007 to reflect market food consumption patterns of northern communities, and healthier alternatives were exchanged for previously included items, such as skim milk for 2% evaporated milk (Lawn & Hill, 2007). In 2008, the price of the Revised Northern Food Basket was $207 and $496 in Whitehorse and Old Crow, respectively (Indian and Northern Affairs Canada, 2009). The cost of market foods in Old Crow has been consistently at least two and a half times that in Whitehorse, a reflection of the challenges communities face in obtaining nutritious market foods in northern and remote locations.

The Canadian Government began the Food Mail Program in 1993 in an effort to address the high shipping costs foods going to remote locations. This program subsidizes transportation costs so that recipients pay $0.75 per parcel in addition to $0.80/kg and $2.15/kg for perishable and non-perishable foods, respectively (Indian and Northern Affairs Canada, 2007). This represents a decrease from 1992 prices, which shipped perishables for $1.50/kg (Indian and Northern Affairs Canada, 2007). Old Crow is the only Yukon community to which the Food Mail Program is offered; however the local store does not utilize the Food Mail program for non-perishables as it would not significantly reduce the cost (Indian and Northern Affairs Canada, 2009). Some community members order foods from Whitehorse on their own (Vuntut Gwitchin First Nation, 2006); still, there are perceived problems with accessing the Food Mail Program, including the need for a credit card, planning ahead, and the delay in shipments from Whitehorse due to weather and overweight planes (Community member, personal communication, March 2008).

Additional factors influencing the availability of market foods in stores in northern communities include limited selection, poor nutritional quality and poor condition of perishables (Bird *et al.*, 2008; Chan *et al.*, 2006; Deutch *et al.*, 2007; Wein, 1994a). To minimize losses from spoilage of perishable foods, stores tend to import foods with a longer shelf-life, just as families with low incomes may choose foods that can be stored longer (Tobin, 2007). Together these factors mean that the foods made available in remote locations tend to be higher in preservatives, carbohydrates and saturated fats (Milburn, 2004). Selection and quality of perishables is particularly limited in more remote locations. For example, the actual shipment of goods to Old Crow depends on availability of space in the transporting aircraft (Wein, 1994a). Coupled with limitations in inventory space in small stores, limited selection results in desirable foods disappearing from shelves soon after delivery (Wein, 1994a).

Food Use and Nutrition

Frequency of traditional food use has been shown to vary with geography, season, sex, age and identity of the Aboriginal community (Batal *et al.*, 2005; Kuhnlein *et al.*, 1996; Receveur *et al.*, 1997; Wein & Freeman, 1995). Consumption of traditional foods increases with northern latitudes and remoteness, and seasonal availability dictates species representation in the diet (Kuhnlein *et al.*, 1994; Nakano *et al.*, 2005b; Receveur *et al.*, 1997; Wein & Freeman, 1995). In Yukon First Nations, terrestrial animals make up the largest group of traditional foods, with moose and caribou the most frequently consumed species (Batal *et al.*, 2005; Nakano *et al.*, 2005b; Wein & Freeman, 1995). Men generally consume more traditional foods than women, and older individuals tend to consume more traditional foods than younger individuals; however there is not a clear pattern when age and gender are considered together (Kuhnlein *et al.*, 2004; Receveur *et al.*, 1997; Wein *et al.*, 1991). In a study of 44 Dene/Métis, Yukon First Nations and Inuit communities, men aged 20-40 consumed more traditional food than women of the same age group (Kuhnlein *et al.*, 2004). The same study showed that traditional foods accounted for 10-36% of total energy intake. Traditional food consumption is lower still for children. In a study of children from three Dene/Métis and two Yukon First Nations communities, traditional foods accounted for 4.5% of total energy intake, with the highest rate in Old Crow (10.7%) and the lowest in Carcross (0.4%) (Nakano *et al.*, 2005a). Fat and sweets made up 21% and 20% of the children's energy intake from market food consumption, with grains and then fruit and vegetables accounting for 20% and 8%, respectively (Nakano *et al.*, 2005a).

Still, First Nations have reported a preference for traditional foods over their market equivalents (Wein, 1996; Wein & Freeman, 1992). In reporting their perceived ideal diet when both traditional and market foods are abundant, respondents from four Yukon First Nations communities chose foods that would result in a diet lower in energy from fat as well as higher in iron and vitamins A and C when compared with their actual diet (Wein, 1996). Over one-third (37%) of individuals from all communities interviewed noted that they would prefer to eat more or mostly traditional foods, with other frequent comments supporting a preference for more wild meat and an increased variety of both traditional and market foods (Wein, 1996). Yukon First Nations value the purity and natural characteristics of traditional foods, expressing concern for the chemical preservatives and additives in market foods (Lambden *et al.*, 2007; Wein, 1996).

Aboriginal Peoples' high regard for the purity of traditional foods is one aspect of their spiritual connection with traditional foods and the land. The *Haudenosaunee Runner* (2000, p.2) compares food to medicine, and notes "Food is a sacred gift of Creation meant to nourish our mind and bodies." This sentiment is shared by others, with Ship (1997a, para. 2) agreeing that food is eaten "not only to nourish our bodies but also to nourish our souls." Aboriginal Peoples believe that spiritual energy is associated and transferred with food. Therefore the individual must be in a good frame of mind while planting, nurturing, harvesting, and preparing the food because his or her energy goes into the food, and this energy will transfer to those who consume it (Elder G. Rossetti, personal communication, May 8 2008).

Nutrition

Traditional foods, particularly animal foods, are important sources of the critical vitamins and nutrients necessary for good health (Hidiroglou *et al.*, 2008; Kuhnlein *et al.*, 1994; Kuhnlein *et al.*, 2002; Kuhnlein & Receveur, 2007; Kuhnlein *et al.*, 2004; Moses *et al.*, 2009). Even when consumed in low quantities, traditional foods contribute large amounts of important nutrients so that individuals have significantly higher micronutrient intakes in days when traditional foods are consumed than in days where traditional foods are not part of the diet (Deutch *et al.*, 2007; Kuhnlein *et al.*, 2006; Kuhnlein & Receveur, 1996, 2007; Kuhnlein *et al.*, 2004; Receveur *et al.*, 1997; Receveur *et al.*, 1998). Although traditional foods contributed an average of just 17% of daily energy in four Yukon First Nations communities, they were responsible for 50% or more of daily intakes of protein, vitamin B12, riboflavin, niacin, iron and zinc (Wein, 1995). Consumption of meat and fish are important sources of iron, protein and n-3 fatty acids (Kuhnlein *et al.*, 2008; Kuhnlein *et al.*, 1996).

Cheap market foods tend to be low in nutrients and high in saturated fats, and their increased inclusion in the daily diet has generated concern that Aboriginal Peoples are lacking the critical nutrients found in a diet of mainly traditional foods. Low levels of magnesium, folate, calcium, fiber, and vitamins A, D, and E have been reported in Aboriginal diets across Canada (Kuhnlein *et al.*, 2006; Kuhnlein *et al.*, 2008; Wein, 1995). Close to 100% of all age and gender groups of Dene/Métis, Yukon First Nations and Inuit surveyed fell below the estimated average requirement (EAR) for Vitamin E, with almost 100% of all Dene/Métis below recommendations for Vitamin A as well (Kuhnlein *et al.*, 2006). Age-related differences in vitamin A intake among Inuit have been linked with differences in consumption of traditional foods, with younger Inuit consuming foods that are rich in vitamin A (Egeland *et al.*, 2004).

Among Yukon First Nations, no consistent age or gender pattern was observed with levels of vitamins A, D and E (Kuhnlein *et al.*, 2006). Older women (> 40) and young men (< 40) had better status with vitamin A, with only 15% and 0% falling below the EAR, respectively. All gender and age groups had a high percentage falling below the EAR for vitamin D, this time with 100% of both older women and young men below the EAR, and all individuals in the four groups below EAR for vitamin E. In studies with children from two Yukon First Nations and three Dene/Métis communities, average intake levels showed more than 50% of children aged 10-12 had levels below the EAR for calcium, phosphorous, dietary fiber, ω-6- fatty acids, ω-3 fatty acids and vitamins A,D and E, and girls alone were likely inadequate for magnesium (Nakano *et al.*, 2005a).

Chronic Diseases

The global nutrition transition created by shifts in diet and activity patterns has been characterized by the emergence of chronic diseases such as obesity, diabetes and cardiovascular diseases and has disproportionally affected Indigenous Peoples (Popkin, 2009). During the past half-century Indigenous Peoples have experienced a relatively rapid change in lifestyle, with a dietary trend shifting towards increased consumption of foods high in carbohydrates and saturated fats while simultaneously receiving less nutritional benefits due to decreased consumption of traditional foods (Damman *et al.*, 2007; Kuhnlein & Receveur, 1996; Milburn, 2004). While there is a global trend of increasing nutrition-related chronic diseases, Indigenous Peoples are recognized to have higher rates of obesity, diabetes and cardiovascular diseases compared with national averages (Johnson *et al.*, 2002; Kuhnlein *et al.*, 2004; Kuperberg & Evers, 2006; Milburn, 2004; Popkin, 2009).

The Aboriginal Peoples of Canada are part of this rapid nutrition transition and, in addition, are reporting higher poverty and hunger rates than non-Aboriginals in Canada (Willows, 2005). Poverty is a predictor of poor nutrition among adults, as individuals with low incomes tend to purchase cheap and filling foods characterized by low nutrient content and high levels of saturated fat and refined carbohydrates (Bhattacharya *et al.*, 2004; Damman *et al.*, 2007; Drewnowski & Specter, 2004). This, coupled with additional aspects of food insecurity discussed in previous sections, places Aboriginals at high risk for obesity (Damman *et al.*, 2007; Kuhnlein *et al.*, 2004). Mid-1990s prevalence of obesity for 41-60 year old Yukon First Nations and Inuit women (31% and 38%, respectively) greatly exceeded the prevalence for all Canadian women of 12% (Kuhnlein *et al.*, 2004). The prevalence of childhood obesity among First Nations is also higher than the Canadian average (Nakano *et al.*, 2005a; Willows *et al.*, 2007). First Nations youth and adults identified the social factors of low literacy levels and disempowerment as barriers to healthy eating and physical activity in addition to high cost and access to healthy market foods (Skinner *et al.*, 2006).

In the past fifty years, the endocrine disease diabetes mellitus has emerged from an essentially nonexistent disease among Aboriginal populations to one of primary health concern (Johnson *et al.*, 2002). Risk factors for diabetes include obesity, sedentary lifestyle, high cholesterol, high blood pressure and age (Health Canada, 2000; Public Health Agency of Canada, 2003). Type 2 diabetes, characterized by the body's resistance to insulin or insufficient insulin production, is the form of diabetes most commonly afflicting Aboriginal Peoples (Young *et al.*, 2000). The prevalence of diabetes among First Nations is three to five times the national average, with all age groups displaying high rates (Dannenbaum *et al.*, 2008; Health Canada, 2000). It is not just the high rates that are of concern; rather the combination with early onset, severity at diagnosis, high rates of complications, lack of accessible services, increasing trends and increasing prevalence of risk factors have contributed to this epidemic (Health Canada, 2000). Studies have shown a north-south gradient among First Nations populations, with a higher prevalence of diabetes in more southerly communities (Green *et al.*, 2003; Johnson *et al.*, 2002; Martens *et al.*, 2007). This can be inversely linked with a north-south gradient in traditional food use and accompanying nutritional benefits, with lower amounts of traditional foods consumed in more southern communities. However, type 2 diabetes is poised to become a greater concern in northern and remote communities as medical surveillance improves and socio-cultural and dietary changes continue to occur (Green *et al.*, 2003).

Mercury in Traditional Foods

The contamination of arctic biota with mercury from anthropogenic sources has become an issue of concern for Aboriginal food safety. Recent mercury levels measured in northern Aboriginal Peoples' teeth and hair are comparable to or higher than historic levels even though current populations rely less on subsistence food, corresponding to an increase in global anthropogenic mercury releases (Braune *et al.*, 2005; Egeland *et al.*, 2009). Mercury has a residence time of one to two years in the atmosphere, which allows it to be transported long distances via oceanic and atmospheric processes (Brooks *et al.*, 2005; Pacyna, 2005). Atmospheric elemental mercury (Hg^0) undergoes oxidation to Hg^{2+} and is removed from the atmosphere by dry deposition or precipitation in the forms of rain, snow, and fog (Brooks *et al.*, 2005). In rivers and oceans, sediment bacteria convert Hg^{2+} into methylmercury (CH_3Hg^+), the most toxic form of mercury and the one that readily bioaccumulates and biomagnifies in organic tissues (Hansen & Gilman, 2005). In the terrestrial environment, soil microorganisms can reduce the deposited mercury back into volatile compounds which return to the atmosphere (Hansen & Gilman, 2005).

Methylmercury and Aboriginal Peoples

Methylmercury is a well-known neurotoxin that targets the brain and kidneys (United Nations Environmental Programme, 2002). Retrospective cohorts of adults exposed to high doses of methylmercury in Iraq and Japan have exhibited a high prevalence of mental and neurological disorders including paresthesia and sensory disturbances (Bakir *et al.*, 1973; Harada, 1995). Studies also suggest methylmercury is a potential carcinogen and contributor to adverse effects on the cardiovascular system (United Nations Environmental Programme, 2002). The half-life of methylmercury in the human body averages 46 days for lactating women, 70 days for adults, and 90 days for children (Swartout & Rice, 2000).

Methylmercury is of particular concern in fetal development. Two prospective cohorts investigating effects of prenatal methylmercury exposure via environmental dietary exposures have yielded conflicting results. A cohort of 900 prenatally exposed children in the Faroe Islands, where the main source of mercury exposure was pilot whales, exhibited measured neuropsychological and neurophysiological deficits at 7 years of age (Grandjean *et al.*, 1997). Another large-scale cohort in the Seychelles Islands, where the main source of mercury exposure was fish, showed no association between prenatal mercury exposure and neurological effects at 66 months and 9 years (Davidson *et al.*, 1998; Myers *et al.*, 2003). It has been suggested that nutrients such as selenium in the fish may attenuate the effects of mercury (Hansen & Gilman, 2005; Moses *et al.*, 2009; Van Oostdam *et al.*, 2005). In addition, *n* -3 fatty acids from fish are being investigated for their potential to offset risk of cardiovascular heart diseases hypothesized to result from exposure to methylmercury (Smith *et al.*, 2008).

Since methylmercury bioaccumulates and biomagnifies, Aboriginal consumers of high trophic level animals are at risk. The main source of human exposure to methylmercury is large predatory fish and marine mammals, as these organisms are at the top of the long aquatic food chain with more opportunity for mercury biomagnification to occur (Van Oostdam *et al.*, 2005). Risk of mercury exposure in non-coastal northern communities is comparably less since people consume more herbivorous terrestrial animals which are part of a shorter food chain and methylmercury is less bioavailable in the terrestrial environment than in the marine (Hansen & Gilman, 2005). Still, the terrestrial food chain has been suggested to be an important pathway of mercury accumulation in the ecosystem (Poissant *et al.*, 2008). Cross-sectional studies have found mercury levels to be low in liver and kidney of caribou and moose (Elkin & Bethke, 1995; Larter & Nagy, 2000); however caribou meat has been identified as a major source of dietary mercury intake due to its high frequency of consumption in Inuit communities (Kuhnlein *et al.*, 2000). Unfortunately, the literature lacks a comprehensive picture of contaminants in northern terrestrial mammals, including long-term data sets for mercury trends (Braune *et al.*, 2005; Gamberg, 2007).

Mercury targets the kidneys and accumulates in the liver; these organs generally have higher mercury levels than the meat and have thus been most often used to assess animal levels (Berti *et al.*, 1998; Gamberg, 2004; United Nations Environmental Programme, 2002). Seasonality can dictate contaminant burden, as organ weights are hypothesized to fluctuate due to changes in diet composition and environmental and biological stressors (Robillard *et al.*, 2002). The proportion of mercury-accumulating lichens in the diet may affect mercury levels, and caribou have been shown to have higher renal mercury levels than moose, likely due to their preference of mercury-accumulating lichen (Gamberg *et al.*, 2005).

The Arctic Caribou and Moose Contaminant Monitoring Program began is the first to annually sample caribou herds in an effort to create temporal and geographic trends of contaminant burden (Gamberg, 2007). Under this program, the Porcupine Caribou Herd is one of two barren-ground caribou herds to be sampled annually, with an additional five caribou herds and two moose populations to be sampled every five years (Gamberg, 2007). Renal mercury concentrations have been shown to increase over time in both male and female Porcupine Caribou (Gamberg, 2008); however levels in caribou muscle meat have not been reported.

Assessing mercury levels in terrestrial mammals is important since caribou and moose top the list of frequently consumed foods in many northern Aboriginal communities and are the two most frequently consumed traditional foods in the Yukon (Batal *et al.*, 2005; Kuhnlein *et al.*, 1994; Kuhnlein *et al.*, 2000; Nakano *et al.*, 2005b; Wein & Freeman, 1995). Among Yukon First Nations children, 86% of energy derived from traditional food comes from terrestrial animals (Nakano *et al.*, 2005b). Four Yukon First Nations communities reported consuming caribou an average of 71.3 times per year with a maximum high of 540 times and reported consuming moose an average of 94.8 times per year with a maximum of 365 (Wein & Freeman, 1995). The relationship of the Vuntut Gwitchin First Nation with the Porcupine Caribou Herd was apparent as Old Crow reported the highest mean frequency ($\pm$ standard deviation) of caribou use with 240.9 $\pm$ 136.4 (Wein & Freeman, 1995).

Benefit Risk Assessments of Traditional Food Consumption

Dietary exposure assessments for many non-marine northern Aboriginal communities have often concluded that continued consumption of traditional foods is in the best interest of the community's well-being (Berti *et al.*, 1998; Receveur *et al.*, 1998). These assessments have evaluated the risks of consuming contaminants in traditional foods while simultaneously evaluating the risks associated with increased consumption of market foods and the loss of benefits from consumption of traditional foods (Receveur *et al.*, 1998). In addition to physical aspects, it is essential to consider the detrimental socio-cultural effects of discontinued consumption of traditional foods and associated activities (Arquette *et al.*, 2002; Curtis, 1992; Elias & O'Neil, 1995; Richmond & Ross, 2009). In communities where traditional foods have been reported to be contaminated by methylmercury, socio-cultural effects have been devastating (Ship, 1997b). In the 1960s mercury was found to be released from a pulp and paper mill upstream of the Ojibwa community of Grassy Narrows in northwestern Ontario and fish in the river were consequently deemed unsafe for human consumption (Erikson, 1994). The community lost their principal food source, important form of economic income and the ability to exercise traditional knowledge and skills, and consequently increased cases of child neglect, solvent sniffing by young children, family violence and alcohol-related violent deaths and suicides were reported in the years following the mercury contamination (Erikson, 1994). A breakdown of traditional roles associated with traditional lifestyles resulted in the Mohawk community of Akwesasne from fear generated by the contamination of fish in St. Lawrence River with mercury and other chemicals discharged from industrial activities in the mid-1900s (Wheatley, 1997). Unemployment and the number of individuals receiving social assistance increased, as did gambling, violent crime and drug and alcohol abuse (Wheatley, 1997).

Overall, dietary exposure assessments of 10 Yukon First Nations and 16 Northwest Territories Dene/Métis communities have shown limited contaminant exposure and few associated health risks (Berti *et al.*, 1998; Receveur *et al.*, 1998). Only a few individuals who frequently ate organs from large terrestrial mammals and particularly contaminated fish species exceeded the provisional tolerable daily intake for mercury set by Health Canada, and these individuals were not likely to exceed the provisional tolerable weekly intake (Receveur *et al.*, 1997). Although one meal of a caribou kidney or liver may exceed the daily recommendations (Robillard *et al.*, 2002), an individual's annual average daily intake is a more realistic measure of assessing tolerable intake (Kuhnlein *et al.*, 2000; Larter & Nagy, 2000). Therefore a blanket warning against consuming these foods is not generally issued; the cultural and physical health benefits involved in traditional food harvesting, preparation and consumption outweigh health risks posed by mercury (Berti *et al.*, 1998; Muir *et al.*, 2005).

Aboriginal Perspectives on Contamination

Even with current benefit risk assessments accounting for socio-economic effects, a major gap in the literature exists in regards to the Aboriginal understanding and perspective of contamination, which is important in effectively assessing risk and communicating results. The literature includes an extensive and ever-expanding discourse on Western scientific knowledge of contaminants, and Aboriginal writings recognize many of the same physical health and socio-economic risks as the Western scientific community (Cole, 1997; Penn, 2006; Ship, 1997a, 1997b). Chemical contamination and other forms of environmental damage have been identified as a violation of Aboriginal holistic well-being, as human health and well-being are recognized to be intimately connected with that of the environment (Ship, 1997b). However, writings and recordings from the Aboriginal perspectives on the implications of contamination are limited.

The gap in the Western understanding of the Aboriginal perspective of contamination has created confusion in risk communication in previous decades, especially in communities where a word for the specific effects did not exist. For example, the Cree Nation of James Bay developed the term *nemasahkosiwin*, which means "the fish is sick" in the face of the mid-1970s large-scale mercury exposure (Penn, 2006). *Nemasahkosiwin* intimates that the initial Cree understanding of mercury was that it would go away, similar to other infectious diseases that afflict aquatic life (Penn, 2006). The Ojibwa of Grassy Narrows used the term *pijibowin*, meaning poison, to refer to the mercury exposure described above that rendered fish inedible and led to chaos in the community (Erikson, 1994). After noting that one cannot taste, feel, see or smell mercury, an Ojibwa elder explained his confusion about mercury with "you know that it can hurt you, make your limbs go numb, make your spirit sick. But I don't understand it. I don't understand how the land can turn against us" (Erikson, 1994, p. 38). As mercury is naturally occurring in the environment, Aboriginal Peoples have long been exposed to background levels (Penn, 2006). However, there was no experience from which to draw traditional understanding for the large-scale mercury exposures that resulted from anthropogenic industrial activities, and this inability to comprehend and address the issues through traditional knowledge brought confusion and fear to the communities affected (Erikson, 1994; Penn, 2006).

Myers and Furgal (2006) report that risk perception and communication may be affected by differences in language, both in respect to the actual language (e.g. English vs. Athapaskan) and in the differences in terminology and way of explaining between Western science and traditional ecological knowledge (TEK). For example, Inuit community members identified noise, modern technology, consumer goods, tourists and scientists as sources of contaminants along with motor vehicles, garbage and air pollution (Myers & Furgal, 2006), highlighting the differences between Inuit and Western understanding of contamination. The gradient probability of risk and the uncertainties of direct health effects reported in Western contaminant assessments are difficult to convey and may be counterintuitive for communities that have traditionally relied on their senses, spiritual understanding and TEK to evaluate the health of the environment (Erikson, 1994; Myers & Furgal, 2006). Closing this gap in language and communication has been the motive of partnerships and community consultations when conducting recent risk assessments. The partnership of the Council of Yukon First Nations with the researchers at the Center for Indigenous People's Nutrition and Environment for the assessment of the 10 Yukon First

Nations communities' dietary risks and benefits (Receveur *et al.*, 1998) is one example, and this type of collaboration is now considered essential.

Summary

It has been established through the literature that food security in northern Aboriginal communities is a complex situation affected by socio-economic and environmental factors. Chronic diseases that are the hallmarks of the rapid nutrition transition can result from a heavy reliance on market foods that are high in carbohydrates and saturated fats and low in the nutrients that would have been previously obtained from traditional foods. Chapter 2 will evaluate food consumption patterns in the context of food security for two Yukon First Nations communities. Chapter 3 will evaluate estimated mercury exposure and nutrient intake through caribou consumption among Vuntut Gwitchin First Nation adults. As discussed, careful integration of Western and Aboriginal perspectives is important in conducting a comprehensive benefit risk assessment. However, since the objective of Chapter 3 is to provide estimated mercury exposure and nutrient intake for the appropriate bodies to conduct a comprehensive assessment, a Western paradigm has been used with the recognition that exploring the Aboriginal understanding of contamination, beyond just chemical contamination, is imperative in accurately addressing and communicating the issue of chemical contaminants in northern communities.

CHAPTER 2

Manuscript 1: Importance of traditional foods for the food security of two First Nations communities in Yukon, Canada

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Introduction

Traditional foods are central to the health and culture of Aboriginal Peoples and are widely recognized as contributing to physical, social and spiritual well-being (Lambden *et al.*, 2007; Receveur *et al.*, 1998). Harvesting and preparation activities bring the community together, helping to maintain social relationships, facilitate intergenerational knowledge transfer and sustain spiritual connections with the land (Egede, 1995; Lambden *et al.*, 2007). Regular engagement in hunting, fishing, berry picking and plant harvesting contributes to fitness and overall health (Deutch *et al.*, 2007; Kuhnlein & Receveur, 1996; Lambden *et al.*, 2007). Even when consumed in small quantities, traditional foods supply large amounts of essential nutrients to the diet so that individuals have significantly higher micronutrient intakes on days when traditional foods are consumed than days where traditional foods are not part of the diet (Bersamin *et al.*, 2006; Deutch *et al.*, 2007; Kuhnlein *et al.*, 2006; Kuhnlein & Receveur, 1996, 2007; Kuhnlein *et al.*, 2004; Receveur *et al.*, 1997; Receveur *et al.*, 1998; Wein, 1995).

Food security has been defined as existing "when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (Food and Agriculture Organization, 1996, para. 1). Availability, access and appropriate use are considered to be the three pillars of food security (World Health Organization, 2008). There are two levels of food insecurity; moderate food insecurity involves not having the kinds and variety of foods that an individual wants, while severe food insecurity occurs when an individual does not have enough food to eat. A 2001 Health Canada study identified that 10% of all Yukon households were severely food insecure and another 11% moderately food insecure for a total of 21%, significantly higher than the Canadian average of 15% (Ledrou & Gervais, 2005).

In respect to the culturally specific role that foods play in Aboriginal communities, food security in a northern and First Nations context can be defined as "the continual and predictable availability and access to food derived from northern environments through Indigenous cultural practices" (Paci *et al.*, 2004, p. 1). Factors affecting traditional food security include but are not limited to climate change, changes in species populations and migration patterns, real and perceived environmental contamination, modification of the land from industrial activities and the related barriers of having enough time to get out on the land to harvest and the cost of modern harvesting equipment (Loring & Gerlach, 2008). While a switch to market foods can be an adaptation strategy to supplement decreasing traditional food use, it can also be a health concern when the replacement foods are high in preservatives, sodium, carbohydrates and saturated fats (Kuhnlein *et al.*, 2004).

The nutrition transition which has been shown to disproportionately affect Indigenous Peoples including Aboriginal Peoples is believed to be a significant risk factor for the global rise in chronic diseases (Damman *et al.*, 2007; Popkin, 2009). The shift from a diet composed solely of traditional foods to one with a large proportion of market foods high in carbohydrates and saturated fats has increased the risk of obesity, diabetes and cardiovascular diseases among Aboriginal Peoples (Damman *et al.*, 2007; Jørgensen & Young, 2008; Kuhnlein *et al.*, 2004; Young *et al.*, 2000). The mid-1990s obesity prevalence for female Yukon First Nations (31%) and Inuit (38%) aged 41-60 greatly exceeded the Canadian female prevalence of 12% (Kuhnlein *et al.*, 2004), and prevalence of childhood obesity among First Nations also exceeds the Canadian average (Nakano *et al.*, 2005a; Willows *et* *al.*, 2007). The prevalence of type 2 diabetes mellitus among First Nations is three to five times the national average, with all age groups displaying high rates (Dannenbaum *et al.*, 2008; Health Canada, 2000; Martens *et al.*, 2007). Diabetes prevalence is higher in more southerly and urban communities and has been suggested to be inversely related to adherence to traditional lifestyle activities and consumption of traditional foods (Green *et al.*, 2003; Johnson *et al.*, 2002; Martens *et al.*, 2007).

There are limited baseline data on the temporal patterns of traditional food use within Canada. Wein and Freeman (1995) documented the frequency of traditional food use of three Yukon First Nations living in four communities from fall 1991-summer 1992. Frequency of food use was found to be highest in the Vuntut Gwitchin First Nation community of Old Crow and the Tlingit community of Teslin. The study concluded that traditional foods, particularly caribou, moose and salmon, are important components in the diet of Yukon First Nations. Continuing environmental and socio-economic changes in the Canadian north are creating concern for the integrity of traditional food systems.

This study seeks to evaluate food consumption patterns in the context of food security in the Yukon First Nations communities of Teslin and Old Crow. The quantity in which traditional foods are consumed in 2007-2008 will be described and the frequency will be compared to the early 1990s data (Wein & Freeman, 1995) in order to identify a potential temporal trend in traditional food consumption as part of the rapid nutrition transition. Other aspects of food security including access to and availability of traditional foods will be will be explored as well.

Methods

Communities

Old Crow is the home of the Vuntut Gwitchin First Nation and is the northernmost community in the Yukon, located 128 kilometers north of the Arctic Circle (Vuntut Gwitchin First Nation, 2008b). Traditionally a nomadic people following the migrations of the Porcupine Caribou Herd, the Vuntut Gwitchin have occupied Crow Flats for centuries, and their permanent settlement on the banks of the Porcupine River since the 1950s continues to provide access to the semi-annual migration of the Porcupine Caribou (Vuntut Gwitchin First Nation, 2008a; Yukon Community Profiles, 2004a). Old Crow is accessible only by aircraft and by river for certain windows in the summer and has thus has remained remote (Vuntut Gwitchin First Nation, 2008a). The population of Old Crow numbers 253 (Yukon Bureau of Statistics, 2006).

The Tlingit community of Teslin is located in the southern Yukon, 183 km southeast of the territorial capital of Whitehorse along the Alaska Highway (Teslin Tlingit Council, 2003). Known as Dakh-ka or Inland Tlingit, the ancestors of the Teslin Tlingit moved inland from the Pacific coast in the 18th century and became instrumental in trade between their coastal relatives and Europeans (Yukon Community Profiles, 2004b). The settlement of Teslin began as a trading post in the early 1900s and became permanent after the completion of the Alaska Highway in 1942 (Teslin Tlingit Council, 2003). Today Teslin receives many tourists due to its easily accessible location and the recreational opportunities at the junction of Teslin Lake and Nisutlin Bay. Teslin Village has a population of 297 (Yukon Bureau of Statistics, 2006).

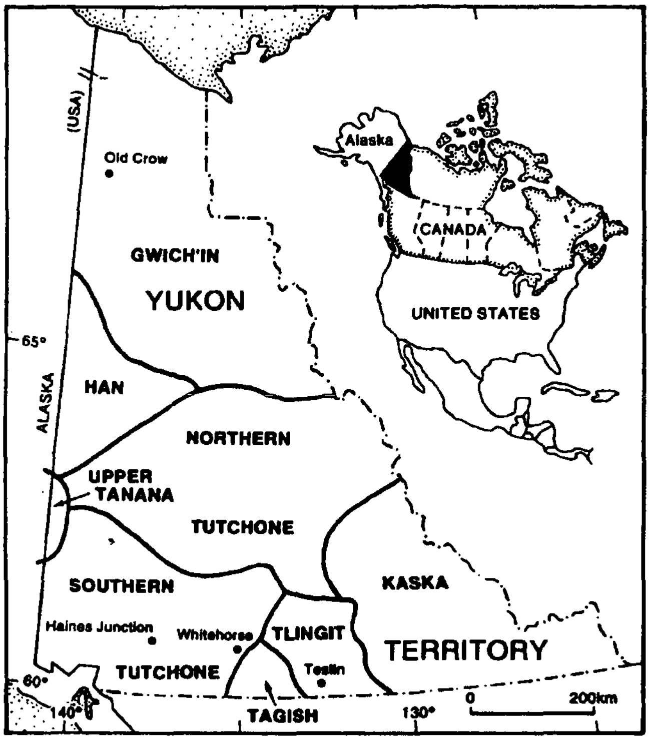

Fig. 2.1. First Nations traditional territory map of the Yukon (Wein & Freeman, 1995, p. 162; Reprinted with permission from the Arctic Institute of North America).

Ethics and Research Agreements

Research followed the Canadian Institutes for Health Research Guidelines for Health Research Involving Aboriginal Peoples (Canadian Institutes of Health Research, 2007), and ethical approval for the study was obtained through the University of Northern British Columbia's Review Ethics Board (Appendices 1 and 2). A research agreement was signed between the researchers and the Vuntut Gwitchin Government (Appendix 3) and a contract was signed with the Teslin Tlingit Council. It is important to recognize that this study was invited by the Vuntut Gwitchin Government as part of a larger food security initiative during the International Polar Year project *Yeendoo Nanh Nakhweenjit K'atr'ahanahtyaa*, "Looking after the land for the future." Individual informed consent forms were used to describe in detail participant rights and researcher responsibilities (Appendix 4). After reading through the consent form with the participant, the research assistant asked if the participant understood each of eight separate points central to granting informed consent. Results were reported back to each community in January 2009, and the communities' comments and feedback are included in the discussion of this paper.

Data Collection

Interviews were conducted in the spring (March-May) of 2008 in Old Crow and in the summer (June-August) of 2008 in Teslin by three research assistants from the respective communities. Thirty-three households in each community were randomly selected from lists provided by the community governments, and one eligible male and one eligible female were invited to participate from each household. Eligibility criteria were age of 19 or older, written consent and membership in either a Vuntut Gwitchin household in Old Crow or Tlingit household in Teslin. Due to difficulties in making contact with households in Teslin, an additional 24 households were randomly selected for a total of 57 households in Teslin only. Interviews were comprised of a food frequency questionnaire (FFQ) and additional questions on access to traditional foods and food security (Appendix 5). The interviews were conducted in English, coded for confidentiality and took approximately one hour to complete.

Food Frequency Questionnaires

The study methods were intended to yield food frequency data directly comparable to that collected fall 1991 through summer 1992 by Wein & Freeman (1995), and methodological differences are explicitly stated. The FFQ utilized the same list of traditional foods developed by focus groups of Yukon First Nations elders and leaders for use in 1991-1992. The FFQ asked how often the participant consumed each of 78 foods from five traditional food groups (mammals, birds, fish, berries, other plants) in each of the four seasons in order to capture seasonal variability. To facilitate recall, participants were asked about consumption starting in the most recent season working backwards (winter 2008, fall 2007, summer 2007, spring 2007). The FFQ invited participants to add a food not listed and inquired separately about muscle meat, liver, and kidney for caribou and moose only. Participants were first asked if they had consumed the food during the previous year, and then how many times per each season. Seasons were divided into equal lengths (90 days), so a frequency response of "once a day" for each of the four seasons would be 360 times per year. In addition to reporting frequency of food use, the FFQ asked participants for their average portion size for each traditional food in order to calculate the quantity of foods consumed. Food models were used as a guide for standardized portion sizes, and color photographs of each species were available to assist in participant recall.

Food Security

Participants were asked six yes or no questions based on the methods of Lambden *et al.* (2006) and then additional questions on access to traditional foods. A multi-step coded question asked participants their perception of their own traditional food consumption patterns now compared to fifteen years ago. In the final section, participants were asked the eighteen multiple choice questions of the Households Food Security Survey Module (HFSSM) that have been used in the Canadian Community Health Survey (Ledrou & Gervais, 2005; Office of Nutrition Policy and Proportion, 2007).

Data Analysis

All data were entered into Epi Info v. 3.4.3 (Centers for Disease Control and Prevention; Atlanta, United States) data entry files were then analyzed by the statistical software package SPSS v. 16.0 (SPSS, Inc., Chicago, United States). Grams per person per day (g/person/day) for each food was calculated by multiplying the individual's annual frequency of consumption by their average reported portion size and dividing by 360 days. Descriptive statistics for g/person/day consumption were reported in terms of all participants surveyed as well as for consumers only. Three outliers (participants reporting in excess of three times the standard deviation of their respective community's average of g/person/day) were excluded from the data analysis. When two individuals from one household participated, only the female's response was included in the analysis of the food security sections, in which participants were asked to speak on behalf of their entire household.

Frequency and quantity (g/person/day, all participants and consumers only) of consumption were compared for caribou meat, liver and kidney, each of the five traditional food groups and total food consumption by age groups (19-40, 41-60, 61^{+}) and genders using the nonparametric Kruskall-Wallis and Mann-Whitney U tests, respectively. One male declined to give his age and is therefore not included in age-specific analyses. The comparison of frequency of food consumption between that reported in Wein & Freeman (1995) and the collected data was performed using the Mann-Whitney U test. The frequency of consumption for moose and caribou used in the comparison was calculated by adding the frequency of consumption for the meat, liver and kidney. Age-analysis for six questions on access to traditional food use was conducted using the Chi-Square test, and two older age groups were combined into a 41^{+}age group to meet the parameters for this analysis. A *p*-value of 0.05 was used as the criteria for significance in all statistical tests performed.

Results

Participants

Nearly one-third of First Nations households in each community participated in the study (Table 2.1). Twenty-nine individuals (15 males, 14 females) representing 27 Vuntut Gwitchin households and 33 individuals (19 males, 14 females) representing 27 Teslin Tlingit households participated in the interviews, and demographic information was similar in both communities (Table 2.2).

Table 2.1. Household Participation

	Old Crow	Teslin
First Nations households in the community (n)	92	90
First Nations households randomly selected (n)	33	57
Households contacted (n)	28	30
Households interviewed (n)	27	27
Refusals (n)	1	3
Non-responsive households (n)	5	27
Participation rate (households interviewed/ households randomly selected)	82%	47%
Participation rate (households interviewed/ households contacted)	96%	90%
% of First Nations households represented (households interviewed/households in the community)	29%	30%

Table 2.2. Participant demographics

	Old Crow	Teslin
Total no. participants	29	33
Gender [No. (%)]		
Male	15 (52)	19 (58)
Female	14 (48)	14 (42)
Age (years, mean ± SD)	49.7 ± 16.0	43. 7 ± 17.6
Number of persons in household [Mean ± SD (Range)]	2.5 ± 1.6 (1, 6)	2.4 ± 1.4 (1, 7)
No. of individuals in the household per age group [Mean ± SD, (Range)]		
0-12	0.6 ± 0.9 (0, 3)	0.6 ± 1.0 (0, 4)
12-18	0.3 ± 0.7 (0, 2)	0.2 ± 0.4 (0, 1)
19-40	0.7 ± 0.9 (0, 3)	0.8 ± 1.0 (0, 3)
41-60	0.6 ± 0.8 (0, 2)	0.6 ± 0.8 (0, 2)
61^+	0.4 ± 0.6 (0, 2)	0.3 ± 0.6 (0, 2)

Food frequency

Forty-five traditional foods were reported to be consumed in Old Crow (Table 2.3a) and sixty in Teslin (Table 2.3b). All participants in both communities reported consuming at least one food from the groups of wild game and fish during the year surveyed, and nearly all participants reported having berries. Caribou meat, blueberry, chinook (king, spring) salmon, salmonberry and low bush cranberry were the foods consumed in the largest quantities (g/person/day, all participants) in Vuntut Gwitchin households. Foods eaten in the largest quantities by participants in Tlingit households were moose meat, lake trout, caribou meat, chinook salmon and blackberry.

Table 2.3a. Quantity of traditional food consumed by adults in Vuntut Gwitchin households (n=26)

Traditional food	Consumers [n (%)]	g/person/day – all Median	g/person/day – all Mean ± SD	g/person/day - consumers Median	g/person/day - consumers Mean ± SD	g/meal Mean ± SD
Total	26 (100)	259	372 ± 271	259	372 ± 271	-
Mammals	26 (100)	90.7	124 ± 99.9	90.7	124 ± 99.9	-
Caribou meat	26 (100)	75.4	86.9 ± 81.7	75.4	86.9 ± 81.7	204 ± 185
Moose meat	24 (92)	3.1	15.8 ± 35.8	3.2	16.5 ± 35.5	211 ± 164
Caribou kidney	19 (73)	3.1	6.6 ± 8.6	7.4	9.0 ± 8.9	130 ± 143
Caribou liver	16 (62)	1.2	5.6 ± 9.5	5.4	9.0 ± 10.8	150 ± 159
Rabbit	19 (73)	1.0	3.1 ± 5.2	2.1	4.2 ± 5.6	258± 151
Muskrat	12 (46)	0.0	2.6 ± 3.8	5.1	5.7 ± 3.8	244 ± 119
Moose kidney	10 (39)	0.0	1.8 ± 4.1	1.9	4.6 ± 5.7	147 ± 105
Moose liver	7 (27)	0.0	1.6 ± 4.1	3.0	5.8 ± 6.5	128 ± 91.4
Porcupine	8 (31)	0.0	0.2 ± 0.4	0.6	0.7 ± 0.3	135 ± 70.1
Beaver	4 (15)	0.0	0.1 ± 0.4	0.8	0.9 ± 0.4	185 ± 76.5
Black bear	1 (4)	0.0	0.1 ± 0.3	1.5	1.5	177
Arctic ground squirrel	1 (4)	0.0	0.0 ± 0.1	0.5	0.5	94.7
Birds	19 (73)	8.4	28.6 ± 35.1	24.6	39.1 ± 35.8	-
Duck	17 (65)	5.9	15.3 ± 22.8	15.8	23.4 ± 24.8	335 ± 172
Goose	14 (54)	1.0	8.3 ± 13.5	10.3	15.4 ± 15.3	278 ± 169
Grouse	4 (15)	0.0	3.5 ± 17.4	1.0	23.0 ± 48.9	338 ± 264
Ptarmigan	6 (23)	0.0	1.4 ± 3.5	4.6	6.1 ± 5.0	217 ± 30.6
Fish	26 (100)	72.6	112 ± 109	72.6	112 ± 109	-
All Salmon	26 (100)	38.1	56.6 ± 52.1	38.1	56.6 ± 52.1	-
Chinook (king)	26 (100)	16.1	27.8 ± 27.3	16.1	27.8 ± 27.3	202 ± 80.4
Coho (silver)	18 (69)	3.6	12.5 ± 19.9	8.3	18.1 ± 21.8	207 ± 87.9
Chum (dog)	16 (62)	3.2	9.7 ± 16.9	8.6	15.8 ± 19.2	186 ± 49.7
Sockeye (red)	4 (15)	0.0	6.6 ± 25.4	21.7	42.7 ± 57.6	169 ± 46.2

continued on next page

Table 2.3a - *continued*

Traditional food	Consumers [n (%)]	g/person/day – all Median	g/person/day – all Mean ± SD	g/person/day - consumers Median	g/person/day - consumers Mean ± SD	g/meal Mean ± SD
Other fish	22 (84)	34.2	55.1 ± 77.8	39.2	65.1 ± 80.7	-
Lake whitefish	15 (58)	3.7	12.1 ± 20.6	17.9	21.0 ± 23.7	160 ± 62.5
Fish eggs	19 (73)	3.5	11.9 ± 17.9	13.3	16.3 ± 19.2	154 ± 99.2
Burbot (ling cod)	8 (31)	0.0	11.5 ± 43.7	6.6	37.3 ± 75.6	178 ± 131
Arctic grayling	15 (58)	1.4	7.8 ± 12.1	8.4	13.6 ± 13.3	189 ± 95.1
Fish liver	13 (50)	0.2	7.4 ± 13.1	10.3	14.8 ± 15.4	200 ± 161
Broad whitefish	5 (19)	0.0	2.2 ± 8.6	3.0	11.2 ± 18.2	254 ± 226
Round whitefish	3 (12)	0.0	1.5 ± 5.9	7.9	12.6 ± 15.2	118 ± 0.00
Inconnu	3 (12)	0.0	0.4 ± 1.3	2.6	3.1 ± 2.8	143 ± 84.2
Long nose sucker	2 (8)	0.0	0.3 ± 1.3	4.3	4.3 ± 2.8	94.7 ± 0.00
Jackfish (N. pike)	1 (4)	0.0	0.0 ± 0.2	0.8	0.8	143
Berries	25 (96)	64.8	81.0 ± 85.0	71.0	84.3 ± 85.1	-
Blueberry	24 (93)	18.7	27.9 ± 27.9	21.7	30.3 ± 27.8	281 ± 184
Salmonberry	25 (96)	19.2	27.1 ± 28.1	20.7	28.2 ± 28.1	269 ± 186
Low bush cranberry	18 (69)	8.9	22.1 ± 30.8	28.6	35.9 ± 32.4	233 ± 87.0
Rosehip	7 (27)	0.0	2.8 ± 7.6	12.2	10.4 ± 12.2	180 ± 120
Strawberry	1 (4)	0.0	0.3 ± 1.7	8.9	8.9	118
Raspberry	2 (8)	0.0	0.3 ± 1.3	4.4	4.4 ± 2.1	237 ± 167
Black currant	2 (8)	0.0	0.2 ± 0.9	3.2	3.2 ± 1.7	118 ± 83.6
Red currant	3 (12)	0.0	0.1 ± 0.4	0.5	1.0 ± 0.9	138 ± 68.3
Other Plants	24 (92)	12.0	22.2 ± 31.8	12.0	24.0 ± 32.5	-
Arctic dock (Old Crow rhubarb)	18 (69)	6.9	12.9 ± 24.0	11.8	18.6 ± 28.0	335 ± 141
Wild onion	9 (35)	0.0	4.2 ± 12.6	3.9	12.1 ± 19.8	87.2 ± 63.7
Labrador tea	24 (92)	2.0	3.6 ± 4.8	2.0	3.9 ± 4.9	18.8 ± 11.6
Spruce	13 (50)	0.0	1.2 ± 2.4	1.1	2.4 ± 3.0	15.8 ± 11.0
Mushroom	2 (8)	0.0	0.2 ± 0.7	2.5	2.5 ± 0.7	148 ± 41.8
Willow	2 (8)	0.0	0.1 ± 0.4	1.2	1.2 ± 1.0	59.1 ± 0.1
Balsam fir	1 (4)	0.0	0.0 ± 0.0	0.1	0.1	2.0

Table 2.3b. Quantity of traditional foods consumed by adults in Teslin Tlingit households (n=32)

Traditional food	Consumers [n (%)]	g/person/day – all Median	g/person/day – all Mean ± SD	g/person/day - consumers Median	g/person/day - consumers Mean ± SD	g/meal Mean ± SD
Total	32 (100)	182	185 ± 105	182	185 ± 105	-
Mammals	32 (100)	82.2	104 ± 79.8	82.2	104 ± 79.8	-
Moose meat	32 (100)	77.0	87.6 ± 64.5	76.9	87.6 ± 64.5	228 ± 147
Caribou meat	20 (63)	1.3	10.2 ± 21.5	2.5	16.3 ± 25.5	290 ± 139
Moose kidney	23 (72)	0.8	1.2 ± 1.8	1.1	1.6 ± 2.0	181 ± 118
Mountain sheep	13 (41)	0.0	1.1 ± 2.2	1.3	2.7 ± 2.8	166 ± 80.0
Beaver	22 (69)	0.7	0.9 ± 1.0	0.7	1.3 ± 1.0	227 ± 181
Moose liver	16 (50)	0.0	0.6 ± 0.7	0.3	1.1 ± 0.7	187 ± 133
Black bear	6 (19)	0.0	0.4 ± 1.4	0.2	2.1 ± 2.9	98.6 ± 107
Porcupine	14 (44)	0.0	0.4 ± 0.6	0.7	0.9 ± 0.7	253 ± 207
Groundhog	10 (31)	0.0	0.4 ± 0.6	1.0	1.2 ± 0.6	323 ± 205
Rabbit	10 (31)	0.0	0.3 ± 0.7	0.7	1.1 ± 0.8	272 ± 254
Caribou kidney	5 (16)	0.0	0.1 ± 0.3	0.7	0.8 ± 0.5	171 ± 89.3
Caribou liver	5 (16)	0.0	0.1 ± 0.3	0.7	0.7 ± 0.4	171 ± 89.3
Muskrat	2 (6)	0.0	0.1 ± 0.4	1.2	1.2 ± 1.2	414 ± 418
Arctic ground squirrel	5 (16)	0.0	0.1 ± 0.4	1.3	0.9 ± 0.5	238 ± 143
Elk	1 (3)	0.0	0.1 ± 0.3	2.0	2.0	237
Deer	2 (6)	0.0	0.1 ± 0.2	0.9	0.9 ± 0.3	181 ± 78.0
Lynx	1 (3)	0.0	0.0 ± 0.2	1.3	1.3	473
Birds	27 (84)	1.0	4.6 ± 10.4	1.3	5.4 ± 11.2	-
Duck	19 (59)	0.5	2.6 ± 6.8	0.8	4.3 ± 8.5	296 ± 267
Geese	10 (31)	0.0	1.3 ± 4.0	1.5	4.2 ± 6.4	384 ± 322
Grouse	19 (59)	0.2	0.5 ± 0.7	0.7	0.9 ± 0.8	196 ± 195
Ptarmigan	4 (13)	0.0	0.1 ± 0.5	1.2	1.2 ± 0.9	418 ± 337
Gull eggs	1 (3)	0.0	0.0 ± 0.0	0.1	0.1	47.3
Fish	32 (100)	19.4	42.2 ± 43.1	19.4	42.2 ± 43.1	-
Salmon	27 (84)	4.1	10.2 ± 13.0	4.3	12.1 ± 13.4	-
Chinook	22 (69)	2.0	7.8 ± 12.3	2.3	11.3 ± 13.5	252 ± 194
Sockeye	8 (25)	0.0	1.6 ± 4.6	4.2	6.5 ± 7.6	158 ± 50.3
Chum	10 (31)	0.0	0.7 ± 1.5	1.7	2.2 ± 2.1	145 ± 48.4
Coho	4 (13)	0.0	0.1 ± 0.4	0.5	0.8 ± 0.8	149 ± 58.5
Other fish	32 (100)	11.4	32.0 ± 38.2	11.4	32.0 ± 38.2	-
Lake trout	32 (100)	6.6	16.8 ± 26.3	6.6	16.8 ± 26.3	236 ± 163
Lake whitefish	20 (63)	2.0	5.5 ± 10.0	2.8	8.8 ± 11.6	275 ± 233
Fish eggs	23 (72)	0.6	5.2 ± 13.7	1.0	7.2 ± 15.8	137 ± 135
Arctic grayling	17 (53)	0.2	1.2 ± 3.1	0.7	2.3 ± 4.0	170 ± 134
Broad whitefish	10 (31)	0.0	0.9 ± 2.2	2.0	2.9 ± 3.1	147 ± 44.9

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Table 2.3b - *continued*

Traditional food	Consumers [n (%)]	g/person/day – all Median	g/person/day – all Mean ± SD	g/person/day - consumers Median	g/person/day - consumers Mean ± SD	g/meal Mean ± SD
Inconnu	14 (44)	0.0	0.5 ± 0.9	0.7	1.2 ± 1.0	171 ± 58.9
Dolly varden	2 (6)	0.0	0.5 ± 2.8	8.1	8.1 ± 10.9	296 ± 251
Burbot	5 (16)	0.0	0.5 ± 1.5	3.9	3.2 ± 2.5	207 ± 160
Fish liver	7 (22)	0.0	0.3 ± 1.1	0.5	1.2 ± 2.2	47.3 ± 25.1
Round whitefish	3 (9)	0.0	0.2 ± 0.6	2.0	2.0 ± 0.0	123 ± 0.0
Jackfish	5 (16)	0.0	0.2 ± 0.7	2.0	1.5 ± 1.1	143 ± 51.2
Rainbow trout	4 (13)	0.0	0.1 ± 0.3	0.7	0.8 ± 0.3	206 ± 58.5
Arctic char	1 (3)	0.0	0.0 ± 0.1	0.7	0.7	118
Halibut	1 (3)	0.0	0.0 ± 0.1	0.3	0.3	118
Berries	30 (94)	16.4	33.1 ± 43.3	16.7	35.3 ± 43.9	-
Blackberry	27 (84)	2.3	7.6 ± 13.1	3.0	9.0 ± 13.9	155 ± 106
Raspberry	27 (84)	1.0	5.2 ± 13.4	1.8	6.1 ± 14.4	130 ± 130
Low bush cranberry	18 (56)	0.2	5.0 ± 9.6	5.0	8.9 ± 11.4	91.4 ± 97.8
Strawberry	22 (69)	0.2	4.5 ± 10.4	1.0	6.5 ± 12.0	98.5 ± 115
High bush cranberry	16 (50)	0.0	4.2 ± 8.3	4.2	8.4 ± 10.2	140 ± 138
Blueberry	15 (47)	0.0	3.2 ± 6.5	4.9	6.8 ± 8.2	172 ± 77.2
Soapberry	19 (59)	0.4	2.1 ± 3.0	3.0	3.5 ± 3.2	140 ± 109
Saskatoon	6 (19)	0.0	0.7 ± 1.6	3.8	3.5 ± 1.8	118 ± 80.3
Rosehip	7 (22)	0.0	0.5 ± 1.5	1.4	2.2 ± 2.7	68.8 ± 74.7
Red currant	2 (6)	0.0	0.2 ± 0.7	2.5	2.5 ± 1.5	185 ± 199
Black currant	3 (9)	0.0	0.1 ± 0.3	0.7	0.7 ± 0.6	5.0 ± 2.5
Other plants	21 (66)	0.1	2.0 ± 4.5	0.8	2.9 ± 5.2	-
Wild rhubarb	6 (19)	0.0	1.2 ± 4.1	3.1	6.6 ± 7.9	256 ± 142
Labrador tea	7 (22)	0.0	0.4 ± 1.5	0.1	1.9 ± 2.8	10.4 ± 9.9
Balsam fir	16 (50)	0.0	0.1 ± 0.2	0.0	0.2 ± 0.3	3.8 ± 3.6
Mushroom	5 (16)	0.0	0.1 ± 0.5	0.7	1.1 ± 1.3	65.6 ± 59.9
Spruce	4 (13)	0.0	0.0 ± 0.2	0.3	0.3 ± 0.4	1.4 ± 0.9
Pine	3 (9)	0.0	0.0 ± 0.2	0.6	0.5 ± 0.2	7.7 ± 12.2
Dandelion	1 (3)	0.0	0.0 ± 0.2	1.0	1.0	355
Bear root	2 (6)	0.0	0.0 ± 0.1	0.3	0.3 ± 0.4	126 ± 157
Birch	1 (3)	0.0	0.0 ± 0.0	0.0	0.01	4.3

Comparison between 1991-1992 and 2007-2008

In 2008 members of Vuntut Gwitchin households reported consuming traditional foods a median of 443 times per year, not significantly different from the frequency reported in 1992 (Table 2.4a). Caribou meat, Labrador tea, chinook salmon, blueberry and salmonberry were the most frequently consumed foods in 2008 by median, with caribou (all parts), blueberry, moose (all parts), Labrador tea and broad whitefish the most frequently consumed in 1992. Frequency of consumption of salmon, all fish, berries and other plants was shown to significantly increase in Old Crow between 1992 and 2008. Frequency of consumption of beaver, rabbit and bird eggs decreased, but mammals and birds as a category did not change. There was a decrease in frequency of broad whitefish consumption, but increases in lake whitefish and chinook salmon led to an increase in overall frequency of fish consumption. Statistically significant increases in salmonberry, spruce and Labrador tea contributed to the increases in the categories of berries and other plants.

Table 2.4a. Frequency of food use by adults in Vuntut Gwitchin households in 1992 and 2008

	1992 Annual Frequency		2008 Annual Frequency	
Traditional Food	Median	Mean ± SD	Median	Mean ± SD
All traditional foods	443	529.2 ± 345	582	749 ± 558
Mammals	285	298 ± 186	193	245 ± 160
Caribou	264	241 ± 136	162	204 ± 136
Meat	-	-	156	167 ± 103
Kidney	-	-	18.0	21.2 ± 26.5
Liver	-	-	3.5	16.0 ± 32.9
Moose	12.0	29.3 ± 41.8	10.5	31.7 ± 49.0
Meat	-	-	6.0	23.5 ± 41.6
Kidney	-	-	0.0	4.2 ± 9.1
Liver	-	-	0.0	4.0 ± 9.5
Muskrat	1.0	6.6 ± 18.0	0.0	4.3 ± 6.2
Rabbit**	6.0	18 ± 35.3	1.0	4.2 ± 5.7
Porcupine	0.0	1.0 ± 2.3	0.0	0.7 ± 1.4
Beaver*	0.0	1.3 ± 1.9	0.0	0.3 ± 0.8
Black bear	0.0	0.2 ± 0.6	0.0	0.1 ± 0.6
Arctic ground squirrel	0.0	0.4 ± 0.8	0.0	0.1 ± 0.4
Lynx	0.0	0.1 ± 0.6	0.0	0.0 ± 0.0
Groundhog	0.0	0.0 ± 0.2	0.0	0.0 ± 0.0
Birds	12.0	26.6 ± 31.8	15.0	31.9 ± 43.0
Duck	6.0	14.3 ± 16.7	8.0	15.7 ± 21.5
Geese	1.0	8.6 ± 17.1	1.5	11.9 ± 21.1
Ptarmigan	0.0	3.1 ± 6.5	0.0	2.3 ± 5.5
Grouse	0.0	0.1 ± 0.5	0.0	2.0 ± 8.8
Bird eggs*	0.0	0.8 ± 2.0	0.0	0.0 ± 0.0
All fish**	45.0	83.1 ± 96.4	138	200 ± 174
All salmon**	24.0	28.1 ± 35.6	67.5	90.4 ± 77.1
Chinook**	6.0	16.4 ± 32.8	30.0	47.6 ± 41.4
Coho	3.0	7.0 ± 8.6	7.5	19.8 ± 26.9
Chum	2.0	4.4 ± 6.5	6.0	19.2 ± 30.1
Sockeye	0.0	0.2 ± 1.1	0.0	3.7 ± 15.9

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Table 2.4a - *continued*

Traditional Food	1992 Annual Frequency Median	1992 Annual Frequency Mean ± SD	2008 Annual Frequency Median	2008 Annual Frequency Mean ± SD
Other fish	24.0	55.0 ± 83.5	66.5	110 ± 118
Lake whitefish**	0.0	0.8 ± 2.0	6.0	26.3 ± 37.8
Fish eggs	3.0	13.7 ± 25.4	15.0	26.2 ± 28.5
Fish liver	3.0	9.0 ± 15.7	0.5	18.8 ± 34.8
Arctic grayling	0.0	4.0 ± 9.5	3.0	16.5 ± 22.8
Burbot	0.0	6.5 ± 14.6	0.0	13.2 ± 35.3
Round whitefish	0.0	0.0 ± 0.0	0.0	4.4 ± 18.1
Broad whitefish**	6.0	20.2 ± 32.8	0.0	2.0 ± 5.6
Inconnu	0.0	0.2 ± 1.1	0.0	1.4 ± 5.9
Long nose sucker	0.0	0.4 ± 1.3	0.0	1.3 ± 5.0
Jackfish (N. pike)	0.0	0.1 ± 0.4	0.0	0.8 ± 0.4
Arctic char	0.0	0.1 ± 0.4	0.0	0.0 ± 0.0
Berries**	39.0	50.2 ± 48.5	87.0	138 ± 156
Blueberry	24.0	23.1 ± 21.0	36.0	44.8 ± 49.3
Salmonberry**	3.0	6.8 ± 12.5	36.0	44.6 ± 49.4
Low bush cranberry	6.0	16.5 ± 19.4	16.5	37.4 ± 52.5
Rosehip	0.0	1.4 ± 4.4	0.0	7.6 ± 21.4
Strawberry	0.0	0.0 ± 0.0	0.0	1.0 ± 5.3
Black currant	0.0	0.0 ± 0.2	0.0	0.8 ± 2.9
Red raspberry	0.0	0.4 ± 1.3	0.0	0.8 ± 3.6
Red currant	0.0	1.6 ± 6.0	0.0	0.5 ± 2.4
Blackberry	0.0	0.2 ± 0.8	0.0	0.0 ± 0.0
Soapberry	0.0	0.1 ± 0.5	0.0	0.0 ± 0.0
Other plants*	24.0	71.4 ± 111	93.0	134 ± 184
Labrador tea*	6.0	57.9 ± 107	46.5	71.3 ± 82.4
Spruce[a]	0.0	0.7 ± 2.3	0.5	32.2 ± 80.8
Wild onion	0.0	5.1 ± 13.9	0.0	15.1 ± 39.1
Arctic dock	3.0	7.4 ± 9.4	7.5	13.3 ± 19.6
Willow	0.0	0.0 ± 0.0	0.0	0.6 ± 2.4
Balsam	0.0	0.0 ± 0.2	0.0	0.6 ± 2.9
Mushroom	0.0	0.0 ± 0.0	0.0	0.5 ± 1.9
Bear root	0.0	0.2 ± 1.1	0.0	0.0 ± 0.0
Birch	0.0	0.1 ± 0.5	0.0	0.0 ± 0.0

* Significant difference, $p < 0.05$, Mann-Whitney U

** Significant difference, $p < 0.01$, Mann-Whitney U

In 2008 members of Tlingit households consumed traditional foods a median of 386 times per year, with moose muscle meat, lake trout, raspberry, chinook salmon and low bush cranberry the most frequently consumed foods (Table 2.4b). The daily frequency did not significantly differ from the 1992 average, when moose (all parts), chinook salmon, blackberry, lake trout and lake whitefish were the most frequently consumed traditional foods. Frequency of consumption decreased between 1992 and 2008 within the categories of salmon, other fish and all fish, marked by decreases in consumption of chinook salmon, lake whitefish, arctic grayling, burbot, round whitefish, jackfish and least cisco. There was a decrease in frequency of consumption of other plants marked decreases in spruce, rhubarb, bear root, wild onion and willow. Frequency of consumption of rabbit, bird eggs, blackberry and red currant decreased but there was no statistically significant change in the categories of mammals, birds and berries.

Table 2.4b. Frequency of traditional food use by adults in Teslin Tlingit households between 1992 and 2008

Traditional food	1992 Annual Frequency Median	1992 Annual Frequency Mean ± SD	2008 Annual Frequency Median	2008 Annual Frequency Mean ± SD
Total	498	593 ± 452	386	496 ± 490
Mammals	217	233 ± 158	165	170 ± 95.9
Moose	186	202 ± 123	150	148 ± 79.5
Meat	-	-	144	144 ± 78.7
Kidney	-	-	2.0	2.2 ± 2.8
Liver	-	-	0.5	1.3 ± 1.8
Caribou	0.0	5.7 ± 13.4	1.0	14.2 ± 28.9
Meat	-	-	1.0	13.7 ± 28.2
Kidney	-	-	0.0	0.3 ± 0.7
Liver	-	-	0.0	0.3 ± 0.6
Mountain sheep	0.0	8.5 ± 25.9	0.0	3.0 ± 6.3
Beaver	2.0	7.9 ± 24.0	1.0	1.7 ± 2.2
Black bear	0.0	0.8 ± 2.6	0.0	0.9 ± 2.3
Porcupine	0.0	1.3 ± 2.3	0.0	0.6 ± 1.0
Rabbit**	1.0	4.6 ± 10.6	0.0	0.5 ± 0.9
Groundhog	0.0	1.2 ± 2.2	0.0	0.5 ± 0.9
Arctic ground squirrel	0.0	1.0 ± 1.7	0.0	0.2 ± 0.6
Elk	0.0	0.0	0.0	0.1 ± 0.6
Deer	0.0	0.0	0.0	0.1 ± 0.5
Muskrat	0.0	0.0 ± 0.0	0.0	0.1 ± 0.2
Lynx	0.0	0.4 ± 0.2	0.0	0.0 ± 0.2
Mountain goat	0.0	0.4 ± 0.2	0.0	0.0 ± 0.0
Birds	4.0	13.3 ± 26.4	2.0	5.0 ± 7.6
Duck	1.0	6.3 ± 18.0	1.0	2.8 ± 6.6
Grouse	1.0	3.2 ± 5.6	1.0	1.1 ± 1.5
Geese	0.0	1.8 ± 3.8	0.0	1.0 ± 2.0
Ptarmigan	0.0	1.1 ± 2.5	0.0	0.1 ± 0.3
Bird eggs*	0.0	0.8 ± 2.2	0.0	0.0 ± 0.2
Swan	0.0	0.12 ± 0.6	0.0	0.0 ± 0.0
All fish*	101	123 ± 106	49.5	72.6 ± 83.1
Salmon*	27.0	38.4 ± 32.1	10.0	20.6 ± 30.5
Chinook**	24.0	32.7 ± 28.8	4.0	15.3 ± 28.3
Sockeye	0.0	3.3 ± 9.0	0.0	3.4 ± 8.1
Chum*	0.0	0.5 ± 2.4	0.0	1.6 ± 2.9
Coho	0.0	1.9 ± 5.7	0.0	0.3 ± 1.1
Other fish*	58.0	84.7 ± 89.2	22.0	52.0 ± 63.1
Lake trout	15.0	19.7 ± 20.3	9.5	23.7 ± 35.7
Lake whitefish*	9.00	22.6 ± 42.3	3.00	8.7 ± 16.4
Fish eggs	6.00	8.4 ± 8.9	2.00	8.3 ± 17.0
Fish liver	0.00	1.6 ± 2.3	0.00	2.8 ± 13.2

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Table 4b - *continued*

	1992 Annual Frequency		2008 Annual Frequency	
	Median	Mean ± SD	Median	Mean ± SD
Broad whitefish	0.0	12.4 ± 41.3	0.0	2.3 ± 5.7
Arctic grayling**	3.0	5.4 ± 5.9	1.0	1.9 ± 2.8
Burbot**	1.0	2.1 ± 2.3	0.0	1.4 ± 5.6
Inconnu	0.0	1.1 ± 1.6	0.0	1.2 ± 2.0
Round whitefish*	0.0	6.2 ± 23.9	0.0	0.6 ± 1.8
Jackfish*	0.0	1.6 ± 2.7	0.0	0.6 ± 1.6
Dolly varden	0.0	1.7 ± 5.3	0.0	0.4 ± 2.1
Rainbow trout	0.0	1.2 ± 4.8	1.0	0.2 ± 0.8
Arctic char	0.0	0.0 ± 0.0	0.0	0.1 ± 0.4
Halibut	0.0	0.0 ± 0.0	0.0	0.0 ± 0.2
Least cisco**	0.0	0.7 ± 2.4	0.0	0.0 ± 0.0
Long nose sucker	0.0	0.0 ± 0.2	0.0	0.0 ± 0.0
Berries	70.0	166 ± 242	149	162 ± 185
Low bush cranberry	0.0	27.9 ± 76.9	4.0	33.7 ± 62.9
High bush cranberry	3.0	15.6 ± 30.3	0.5	27.5 ± 61.1
Raspberry	2.0	24.8 ± 38.6	7.5	27.3 ± 42.7
Strawberry	3.0	14.0 ± 26.0	2.5	25.2 ± 50.6
Blackberry*	24.0	28.6 ± 28.5	10.0	13.7 ± 14.8
Rosehip	0.0	5.6 ± 19.5	0.0	9.4 ± 35.3
Blueberry	0.0	5.2 ± 8.8	0.0	7.9 ± 16.0
Soapberry	4.0	18.8 ± 50.0	2.5	6.5 ± 8.3
Black currant	0.0	11.4 ± 31.2	0.0	6.1 ± 23.6
Saskatoonberry	0.0	1.6 ± 4.3	0.0	4.3 ± 17.0
Red currant**	0.0	11.0 ± 26.5	0.0	0.5 ± 2.2
Bristly black currant	0.0	1.4 ± 7.2	0.0	0.0 ± 0.0
Bearberry	0.0	0.0 ± 0.2	0.0	0.0 ± 0.0
Bog cranberry	0.0	0.0 ± 0.2	0.0	0.0 ± 0.0
Other plants*	12.0	57.1 ± 123	5.0	86.8 ± 299
Balsam fir	0.0	31.4 ± 101	0.5	29.0 ± 88.2
Spruce**	1.0	6.1 ± 20.0	0.0	22.7 ± 88.5
Pine	0.0	0.6 ± 1.5	0.0	22.7 ± 88.5
Labrador tea	0.0	7.3 ± 19.8	0.0	9.7 ± 35.3
Wild rhubarb**	1.0	8.7 ± 20.4	0.0	1.8 ± 5.2
Mushroom	0.0	0.6 ± 2.4	0.0	1.0 ± 2.8
Bear root*	0.0	0.4 ± 0.7	0.0	0.1 ± 0.2
Dandelion	0.0	0.0 ± 0.0	0.0	0.0 ± 0.2
Birch	0.0	0.1 ± 0.4	0.0	0.0± 0.2
Willow*	0.0	0.3 ± 0.8	0.0	0.0 ± 0.0
Wild onion**	0.0	1.5 ± 4.9	0.0	0.0 ± 0.0
Rice root	0.0	0.0 ± 0.2	0.0	0.0 ± 0.0
Wild mint	0.0	0.0 ± 0.2	0.0	0.0 ± 0.0

* Significant difference, $p < 0.05$, <Mann-Whitney U

** Significant difference, $p < 0.01$, Mann-Whitney U

Age and Gender

There was no statistically significant difference in total quantity of consumption (g/person/day) of all traditional foods by age and gender in either community (Table 2.5). Annual frequency of consumption of birds in Old Crow was the only category shown to differ significantly with both age and gender, with frequency increasing with age within each gender (data not shown). A statistically significant difference was found between genders for frequency and quantity (all participants) of caribou liver consumption, with Vuntut Gwitchin men consuming more than women (Table 2.6a). Frequency of bird consumption, quantity of bird consumption (all participants) and quantity of plant consumption (all participants) was shown to increase with age in Old Crow (Table 2.6b). In Teslin, men consumed significantly more birds (consumers only) than women. Women consumed more berries more frequently and in greater quantities (consumers only). There was a statistically significant difference in age-related consumption of birds, with those aged 41-60 consuming more than those 19-40 and those 61+ consuming the least amount.

Table 2.5. Median, mean and standard deviation g/day of traditional food consumption for adults in Old Crow and Teslin

Gender/Age	Old Crow (g/person/day)			Teslin (g/person/day)		
	n	Median	Mean $\pm$ SD	n	Median	Mean $\pm$ SD
Women						
19-40	5	172	259 $\pm$ 229	7	210	198 $\pm$ 84.2
40-60	3	399	334 $\pm$ 153	3	169	165 $\pm$ 72.2
61+	6	479	479 $\pm$ 340	4	142	159 $\pm$ 114
Men						
19-40	3	254	482 $\pm$ 483	10	163	196 $\pm$ 127
40-60	5	133	240 $\pm$ 232	5	257	188 $\pm$ 153
61+	3	492	490 $\pm$ 6.3	3	187	172 $\pm$ 51
Total	**26[a]**	**259**	**367 $\pm$ 271**	**32**	**182**	**185 $\pm$ 105**

[a] One male from Old Crow declined to give his age and therefore is only included in the total analysis

2.6a. Median, mean and standard deviation for foods where there was a significant differences between genders

	Old Crow					Teslin								
	Frequency of caribou liver consumption*			g/person/day caribou liver consumption (all)**		g/person/day bird consumption (consumers only)*			Frequency of berry consumption*			g/person/day berry consumption (consumers only)*		
Gender	n	Median	Mean ± SD	Median	Mean ± SD	n	Median	Mean ± SD	n	Median	Mean ± SD	n	Median	Mean ± SD
Female	12	0.0	16.4 ± 43.2	0.0	6.0 ± 12.5	13	1.0	1.1 ± 0.7	14	171	215 ± 185	13	29.5	50.7 ± 48.7
Male	14	10.5	15.6 ± 15.8	4.0	5.1 ± 4.5	14	3.2	9.4 ± 14.7	18	77.5	121 ± 180	13	11.4	23.5 ± 37.0

*Significant difference, $p < 0.05$, Mann-Whitney U

**Significant difference, $p < 0.01$, Mann-Whitey U

Table 2.6b. Median, mean and standard deviation for foods where there was a significant differences between age groups

	Old Crow							Teslin		
		Frequency of bird consumption**		g/person/day bird consumption (all)*		g/person/day plant consumption (all)*		g/person/day bird consumption (consumers only)*		
Age Group	n[a]	Median	Mean ± SD	Median	Mean ± SD	Median	Mean ± SD	n	Median	Mean ± SD
19-40	8	0.0	6.6 ± 15.8	0.0	11.5 ± 31.2	3.2	10.5 ± 17.7	15	2.0	5.1 ± 6.7
41-60	8	19.5	37.9 ± 59.3	16.3	35.3 ± 41.2	9.3	21.2 ± 40.5	5	1.6	12.8 ± 23.4
61+	9	52.0	51.1 ± 36.6	34.2	40.5 ± 30.7	23.3	33.8 ± 34.2	7	0.7	0.7 ± 0.5

[a] The male who declined to give his age in Old Crow is not included in this age analysis

* Significant difference, $p < 0.05$, Kruskal-Wallis

**Significant difference, $p < 0.01$, Kruskal-Wallis

Food Security

When asked their perception of their own consumption of traditional foods, the majority of households in Old Crow said they ate the same amount of mammals, ducks and geese, fish, berries and barks and saps in spring 2007-winter 2008 as they did 15 years ago (Fig. 2.2a). The percentage reporting consuming less traditional foods than they did 15 years ago was greater than those who reported consuming more. The largest self-reported decreases in traditional food use among groups came from mammals, ducks and geese, and ptarmigan and grouse. Two households reported a decrease in all animal groups due to absence of a hunter or fisherman in the household, and another two households reported concern for contaminants as their reason for decreased consumption of mammals, ducks and geese, and ptarmigan and grouse. One household reported decreased availability or unavailability as their reason for decreased consumption of ptarmigan and grouse and two households reported this as their reason for decreased consumption of ducks and geese. A large percentage of households reported not eating foods from the groups of wild greens, bark and saps, roots and mushrooms, due to not liking the foods as the main reason. Two households reported concern for safety as their reason for not eating roots and bark and saps, while one household reported this as their reason for not consuming mushrooms and another for not eating wild greens. Two participants were not living in Old Crow fifteen years ago, so the sample size for this analysis was 25 households.

In Teslin, the majority of households reported that they consumed the same amounts of mammals, ducks and geese, fish, berries and barks and saps as they did fifteen years ago (Fig. 2.2b). The largest decreases in perceived consumption occurred in mammals, ducks and geese, ptarmigan and grouse, fish and berries. The fraction of households reporting the reason for decreased consumption was that foods were less or not available are 3/7 for mammals, 2/8 for ducks and geese, 6/11 for ptarmigan and grouse, 4/7 for fish and 4/8 for berries. Many households reported not eating wild greens, bark and sap, roots and mushrooms, with reasons behind this reported as not liking the foods, never having tried it and, for mushrooms, uncertainty on which types are safe. One household reported an increase in all categories because it is better to eat "natural foods," and another participant reported an increase in all categories except for wild greens and roots, giving the reason that there is now a family to provide for. One participant reported a decrease in consumption of all categories except roots because harvesting equipment was unaffordable.

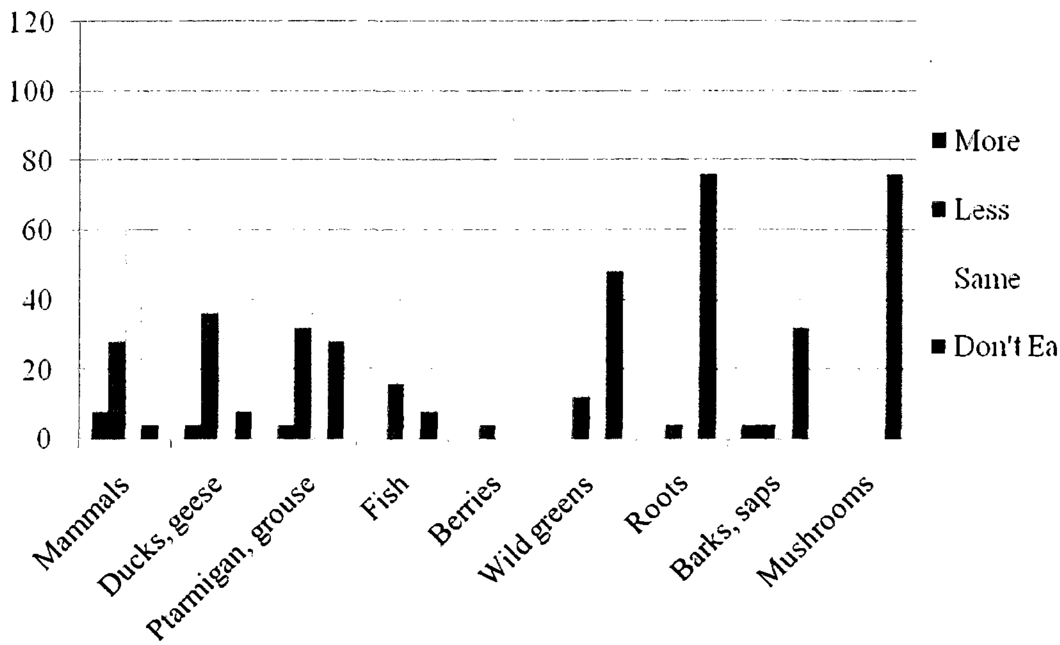

Figure 2.2a. Self-observed changes in diet of traditional foods categories by adults in Vuntut Gwitchin households (n=25)

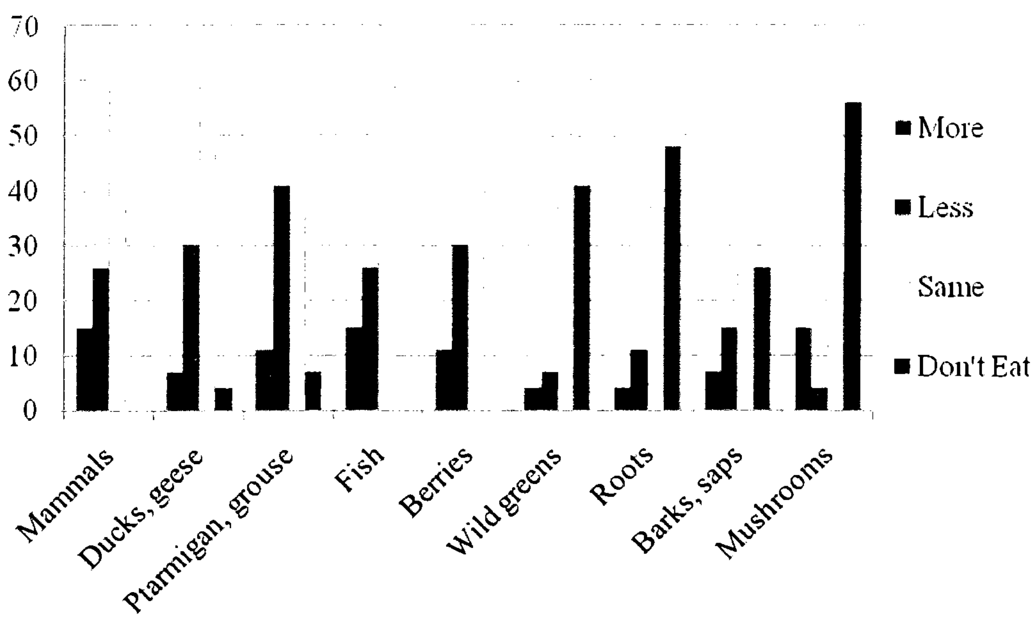

Figure 2.2b. Self-observed changes in diet of traditional foods categories by adults in Teslin Tlingit households (n=27)

The vast majority of households in Teslin and Old Crow reported having a fisherman and/or a hunter or trapper in the household, however households in both communities reported difficulties in obtaining enough harvesting equipment (Table 2.7). Forty percent of Tlingit households reported not having enough hunting and/or trapping equipment to fulfill the family's food needs, with a truck, four-wheeler, snowmobile, gas and guns among the equipment needed, and 22% of households in both communities did not have enough fishing equipment. Access to hunting and/or trapping and fishing equipment was found to be age-related in Teslin, with those aged 19-40 years significantly more likely to report not having enough equipment than those over 40 years of age. No age-related differences were found in Old Crow. Eighty-five percent of Vuntut Gwitchin households reported that their traditional foods come from within their household or immediate family, while 15% reported others in the community are their main source of traditional foods. In Teslin, all households reported providing their own traditional foods, with half (52%) also receiving traditional foods from other households in the community and 15% purchasing traditional foods, specifically salmon, from an outfitter or another First Nation.

Seventy-four percent of households in both communities reported obtaining all the traditional foods that their household wanted. Of the other 26% of households in Old Crow, all wanted more caribou. In addition, one household wanted more geese, ducks, whitefish, and berries and another reported wanting more moose meat. In Teslin, 15% of households reported wanting more berries, 11% more caribou and 4% moose organs, sheep, porcupine, ducks, salmon, fish, water fowl and "all of them." When participants in Old Crow were asked what prevents their household from obtaining all the traditional foods that they want, two responded not having money for equipment and one reported not having money to hire someone to hunt for them. In Teslin, four households responded that they had no time to harvest, two that harvesting is too strenuous and one that harvesting restrictions are obstacles.

The HFSSM identified that only half (52%) of Vuntut Gwitchin households in Old Crow are food secure, with 37% experiencing moderate food insecurity and 11% experiencing severe food insecurity. Eight households in Teslin declined to answer enough questions of the HFSSM for their level of food security to be assessed. Out of the nineteen households that did complete this section, 95% were identified to be food secure and 5% moderately food insecure.

Table 2.7. Access to traditional foods

Households	Old Crow (%)[a]	Teslin (%)[b]
With hunter and/or trapper	89	93
With enough hunting and/or trapping equipment to fulfill the family's food needs	82	60
With functioning hunting and/or trapping equipment	78	89
With a fisherman in the household	82	93
With enough fishing equipment to fulfill the family's food needs	78	78
With functioning fishing equipment	78	100
That obtain traditional foods from:		
Self/Immediate household	85	100
Community	15	52
Other	0	15
Another First Nation		11
Outfitter		4
That obtain all the traditional foods its members want		
Yes	74	74
No	26	26

[a] n= 27 for households in Old Crow

[b] n=27 for households in Teslin

Discussion

Limitations

The exclusion criterion of exceeding three times the standard deviation for total g/person/day traditional food consumption may artificially eliminate high end consumers of traditional foods; however this criterion was employed as the best method to protect against the biases presented by self-reporting and use of the food models. Reporting bias in traditional food studies tends towards an overestimation of the frequency (Lawn & Harvey, 2006). The food models were used as a tool to represent the individual's usual or average portion size, and when faced with the various model sizes, individuals may have a tendency to chose a larger portion size (e.g. a steak size) than the quantity in which they most often consume that food (e.g., snack portion of jerky).

Validity of Comparison

The percentage of First Nations households interviewed in Teslin and Old Crow was comparable to the percentage interviewed by Wein & Freeman (1995). The phrasing of the FFQ question to establish frequency per season in this study was "How often did *you* eat [each traditional food per each season]?" The phrasing of the question in Wein & Freeman's (1995) study asked "How often does *anyone in your household* eat [each traditional food per each season]?" in order to obtain the maximum frequency of any individual in the household. This introduces limitations with the comparison, as it may be difficult to recall another person's food consumption. However, the respondent may likely have answered with his or her own food use, making the information directly comparable.

Frequency of Food Use

There was no decline in frequency of traditional food use in Old Crow; rather the frequency of consumption of certain categories was shown to increase. Consumption of traditional foods is generally higher in more remote communities such as Old Crow, which have maintained more facets of a traditional lifestyle (Nakano *et al.*, 2005a; Wein & Freeman, 1995). Market foods in Old Crow are a minimum of two and a half to three times the price as in the Yukon capital of Whitehorse (Indian and Northern Affairs Canada, 2009; Wein, 1994a), which may be a factor in the maintenance of traditional foods in the diet. At the community meeting in Old Crow, the frequency results for mammals and birds were confirmed, but differing views were expressed on the apparent increase in frequency of consumption of fish and berries.

The overall frequency of traditional food use in Teslin did not change; however frequency of the groups all fish, salmon, other fish and other plants did decrease. At the meeting, community members reported being concerned about declining salmon populations for the past two decades. This increasing community concern has manifested in individuals voluntary reducing their salmon catch and the Teslin Tlingit Council's implementation of 48-hour net closures beginning in 1994 (K. Melton, TTC Fish & Wildlife Officer, personal communication, April 28 2009). These are likely factors in the decreased frequency of consumption of chinook salmon found between 1992 and 2008 as well as why 15% of households obtained salmon from outfitters or other First Nations. The results of the FFQ were confirmed at the community meeting in Teslin.

Only three plants other than berries (Labrador tea, spruce, arctic dock) were consumed by half or more of the participants in Old Crow and only one (balsam fir) was consumed by half of Teslin participants. Many participants in both communities reported not eating foods from the categories of wild greens, bark & saps, roots and mushrooms. Of the individuals who did consume plants, many reported having them on a very regular basis. It was not the intent of this study to collect information on traditional medicines, and so plants that individuals specified were for medicinal use were not included in the analysis. However, participants were not asked to differentiate between medicinal use and consumption, as traditional foods, particularly plants, are consumed for multiple reasons and it is difficult and counterintuitive to separate out their purpose (Kuhnlein & Receveur, 1996; Wheatley, 1994). Thus, plants and other foods used for medicinal purposes may still be included in the collected FFQ information.

Frequency of traditional food use has been found to be higher among males and increase with age in both genders (Kuhnlein *et al.*, 2004; Receveur *et al.*, 1997; Wein *et al.*, 1991), although clear trends have not been found when evaluating age and gender together. This study identified a few age and gender related differences in traditional food consumption, such as a greater frequency and quantity of berry consumption by women in Teslin compared to men and increasing quantity of plant consumption with age in Old Crow. However, general trends for either age or gender were not identified.

One theme that emerged from the community meetings, particularly in Old Crow, is the importance of recognizing that variability in environmental conditions affects the availability of traditional food sources. The Porcupine Caribou has been the principal cultural and dietary resource of the Vuntut Gwitchin, and their irregular 2007 fall migration left families without their average stock of caribou for the winter of 2008. As a result, some families reported turning towards fish as a main protein source, which supports the increase in frequency of fish consumption between 1991-1992 and 2007-2008. Community members emphasized that this was an anomaly and not a general trend towards increased fish use; during the following summer of 2008 there was a Yukon-wide restriction on the First Nations subsistence harvest of chinook salmon. In fact, the Vuntut Gwitchin Government bought and distributed chinook salmon to community members in order to supplement the meager seven fish that had been caught due to the abnormally low run and high water levels (S. Graupe, VGG Director of Natural Resources, personal communication, March 31 2009). Community members also noted that higher levels of precipitation resulted in more berries present than usual in 2007, and naturally people will harvest the foods that are readily available.

Food Security

Households in Teslin and Old Crow experienced challenges in obtaining and maintaining enough hunting and/or trapping and fishing equipment to fulfill the family's food needs. This is a problem in other northern communities, as women in Yukon First Nations, Dene/Métis and Inuit households have reported not having enough equipment for hunting and fishing, as well as perceiving these activities as cost-prohibitive (Lambden *et al.*, 2006). Harvesting activities often utilize modern equipment including snow machines, boats, four-wheelers, gasoline, guns and ammunition, all of which require money for purchase and upkeep (Loring & Gerlach, 2008; Poppel *et al.*, 2007). The money necessary to fund harvesting activities can be generated by participating in the wage economy; however employment is limited in many communities. In Teslin, the 40% of participants that reported their household did not have enough hunting or trapping equipment, such as vehicles required to go far enough out on the land to access animals, were significantly younger than those who reported having enough equipment. Age-related differences in food security have been reported in the 2001 Canadian Community Health Survey, which noted that younger individuals were more likely to experience food insecurity and hypothesized that this may be due to financial responsibilities of young families or the low incomes of students or those entering the workforce (Ledrou & Gervais, 2005). Not having enough time to harvest was mentioned by 15% of Teslin households as an obstacle to obtaining all the traditional foods that they want. This is an issue in communities where members participate in some form of a wage economy, as the work week limits harvesters' ability to get out on the land (Chan *et al.*, 2006; Kruse, 1991).

Twenty-six percent of households in both Teslin and Old Crow reported not getting all the traditional foods that they want, which is a manifestation of moderate food insecurity. The 48% of Vuntut Gwitchin households identified as food insecure by the HFSSM is well above both the 2001 Yukon-wide average of 21% (Ledrou & Gervais, 2005) and the 2004 data for Aboriginals off-reserve of 33% (Office of Nutrition Policy and Proportion, 2007). The overall food insecurity level in Old Crow is comparable to that experienced in Nunavut (56%), where the environmental and socio-economic challenges to traditional lifestyles are similar. Only one household in Teslin was identified as moderately food insecure by the HFSSM; however the eight households that declined to answer the HFSSM section may have done so because they were experiencing food insecurity and found it is difficult to discuss. Had they answered, the reported percentage of Tlingit households experiencing food insecurity in Teslin would likely be higher. The food security results for both Old Crow and Teslin were validated at their respective community meeting.

The physical health benefits of continued consumption of traditional foods are important to the well-being of Aboriginal communities, especially when considering food security in terms of market foods. Market food security in northern and remote communities is affected by poor nutritional quality, limited selection, poor condition of perishables and prohibitive cost (Chan *et al.*, 2006; Wein, 1994a). Obtaining nutritious market foods in the north can be expensive, as transportation, monopolies in the supply chain and risk of spoilage are factored into the high prices (Wein, 1994a). To minimize losses from spoilage of perishable foods, stores tend to import foods with a longer shelf-life, just as families with low incomes may choose foods that can be stored longer (Tobin, 2007). Together these factors mean that the foods made available in remote locations tend to be higher in carbohydrates, saturated fats, sugar and salt, which increases the risk posed by chronic diseases marking this current nutrition transition (Milburn, 2004; Popkin, 2009).

Conclusion

Traditional foods continue to be an important component of the diet of First Nation communities in the Yukon. Food security in northern First Nation communities is affected by environmental and socio-economic changes, and the availability of traditional foods is critical to maintaining their food security. Additional research is needed in order to identify trends in traditional food use, particularly as yearly environmental variability plays a large role in which foods are available and accessible.

Connecting Bridge

Chapter 2 demonstrated the importance of traditional foods in the daily diet of Yukon First Nations. Adults in the Vuntut Gwitchin First Nation community of Old Crow reported consuming traditional foods a median of one and a half times a day, and the single most frequently consumed food was caribou muscle meat. This study also identified some of the challenges to food security faced by both communities, such as the availability of particular foods and having enough equipment to fulfill the family's traditional food needs. Another food security concern among northern communities is the contamination of traditional food sources with chemical pollutants such as mercury. Although mercury levels are generally low in terrestrial mammals, there is limited information on mercury in caribou muscle meat, which is a vital component of the Vuntut Gwitchin culture and diet. The Arctic Caribou and Moose Contaminant Monitoring Program annually samples the Porcupine Caribou Herd, and so with information collected from the food frequency questionnaires, it was possible to estimate mercury exposure of Vuntut Gwitchin adults through consumption of caribou tissues. Chapter 3 evaluates mercury exposure and nutrient intake through consumption of Porcupine Caribou muscle, liver and kidney using the dietary information collected in the food use study of Chapter 2.

CHAPTER 3

Manuscript 2: Assessing risk of mercury exposure and nutritional benefits of consumption of caribou (*Rangifer tarandus*) in the Vuntut Gwitchin First Nation community of Old Crow, Yukon, Canada

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Introduction

Foods from the land represent the fundamental connection between Aboriginal Peoples and their surrounding environment (Richmond & Ross, 2009; Wheatley, 1994) and are an important part of maintaining social cohesion (Egede, 1995; Poppel *et al.*, 2007). The preparation and sharing of traditional foods brings individuals in the community together and provides a forum for which stories are shared and knowledge is passed down to younger generations (Lambden *et al.*, 2007). Regular engagement in harvesting activities contributes to overall fitness, and the nutritional benefits that traditional foods provide are important to Aboriginal health (Kuhnlein & Receveur, 1996; Kuhnlein *et al.*, 2001). Even when eaten in small quantities, traditional foods contribute high levels of essential nutrients to the diet, which is critical as traditional food consumption is decreasing in Aboriginal communities across Canada (Kuhnlein & Receveur, 1996, 2007; Kuhnlein *et al.*, 2004; Receveur *et al.*, 1997; Receveur *et al.*, 1998). Low intake of traditional foods presents health risks when the replacement market foods are high in refined carbohydrates and saturated fats, which increases the risk for chronic diseases such as obesity and diabetes that are manifestations of the global nutrition transition (Damman *et al.*, 2007; Dannenbaum *et al.*, 2008; Green *et al.*, 2003; Johnson *et al.*, 2002; Kuhnlein *et al.*, 2004; Popkin, 2009; Young *et al.*, 2000).

Caribou (*Rangifer tarandus*) is an important part of the traditional diet for Indigenous Peoples of the circumpolar north, and Aboriginal Peoples in the Canadian Arctic have relied upon caribou as a source of nutritional and cultural sustenance for centuries. The Porcupine Caribou Herd has been a significant cultural and dietary resource for the Vuntut Gwitchin First Nation for centuries, and caribou is the single most frequently consumed traditional food in the Vuntut Gwitchin community of Old Crow (Vuntut Gwitchin First Nation, 2008b;

Wein & Freeman, 1995). Caribou is a valuable source of several nutrients: the muscle is high in protein and low in total and saturated fats, the liver provides high levels of Vitamins A and E and a moderate level of Vitamin D, and the kidney is a moderate source of Vitamins A and E (Kuhnlein *et al.*, 2006).

Although the health benefits of consuming traditional foods such as caribou are well-recognized, socio-economic and environmental changes including chemical pollution can affect food security in the north (Chan *et al.*, 2006; Loring & Gerlach, 2008). Mercury (Hg), present in the environment from both natural and an increasing amount of anthropogenic sources, is one of the contaminants of concern. Once emitted into the atmosphere, Hg has a residence time of one to two years, which allows it to be transported long distances via oceanic and atmospheric processes into northern environments considered to be pristine (Brooks *et al.*, 2005; Pacyna, 2005). Hg cycles throughout the environment, and its organic form methylmercury (MeHg) is a well-documented neurotoxin that bioaccumulates and biomagnifies within the food chain (Hansen & Gilman, 2005). Increasing Hg levels in the Arctic tundra have been reported (Poissant *et al.*, 2008), but the significance of potential impacts on public health and food safety has not been fully characterized.

The main source of human exposure to MeHg is large predatory fish and marine mammals, as these organisms feed at high levels on the long aquatic food chain where MeHg is readily bioavailable (Derome *et al.*, 2005; Hansen & Gilman, 2005). Therefore much research with northern Inuit communities has been conducted to assess the risks posed by contaminants in marine food sources (Deutch *et al.*, 2007; Muir *et al.*, 2005). Risk of mercury exposure in non-coastal northern communities is comparably less since diets in these areas include more herbivorous terrestrial animals (Chan & Receveur, 2000; Hansen &

Gilman, 2005). However, clear temporal and geographic patterns for mercury levels in terrestrial mammals have not been established (Braune *et al.*, 2005; Gamberg, 2007; Gamberg *et al.*, 2005). It has recently been shown that the terrestrial food chain may also be an important pathway of accumulation in the ecosystem (Poissant *et al.*, 2008) and there is evidence of increasing renal mercury levels in Porcupine Caribou (Gamberg, 2008). Therefore, it is important to assess the safety of consumption of caribou in terms of mercury exposure as caribou are among the most frequently consumed traditional foods in the Yukon (Batal *et al.*, 2005; Nakano *et al.*, 2005b; Wein & Freeman, 1995).

This paper reports the estimated mercury exposure and nutrient intake of adults in Vuntut Gwitchin households in Old Crow through consumption of Porcupine Caribou muscle meat, kidney and liver. The overall objective is to provide information for the Vuntut Gwitchin First Nation and the relevant public health professionals to conduct a risk assessment for mercury exposure in the context of the importance of caribou in the diet of the Vuntut Gwitchin community of Old Crow in the Yukon territory of Canada.

Methods

Community

The Vuntut Gwitchin First Nation community of Old Crow is the northernmost in the Yukon, located 128 km north of the Arctic Circle (Vuntut Gwitchin First Nation, 2008b). Historically a nomadic people, the Vuntut Gwitchin settled in a location on the Porcupine River that is central to the semi-annual migration of the Porcupine Caribou (Vuntut Gwitchin First Nation, 2008a). Old Crow is accessible only by aircraft or by river during the summer months and its remote location has allowed community members to continue many aspects of traditional life (Vuntut Gwitchin First Nation, 2008b). The population in Old Crow numbers 253 individuals (Yukon Bureau of Statistics, 2006), and there are 835 beneficiaries of the First Nation (T. Rispin, VGFN Enrolment Officer, personal communication, May 28, 2009).

Ethics

Research followed the Canadian Institutes for Health Research Guidelines for Health Research Involving Aboriginal Peoples, and ethical approval for the study was obtained through the University of Northern British Columbia's Review Ethics Board. Group consent was acquired through a research agreement signed between the researchers and the Vuntut Gwitchin Government. Individual informed consent forms were used to describe in detail participant rights and researcher responsibilities.

Food Frequency Questionnaires

Thirty-three Vuntut Gwitchin households in Old Crow were randomly selected from a community list provided by the Vuntut Gwitchin Government, and one male and one female adult over the age of eighteen was invited to participate from each household. Three trained community research assistants interviewed twenty-nine individuals (15 male, 14 female) representing 27 Vuntut Gwitchin households in the spring of 2008. The interviews consisted of a food frequency questionnaire (FFQ) and additional sections on food security, and methodology has been detailed in the previous chapter. Briefly, the FFQ asked how often during spring 2007-winter 2008 the participant consumed each of 78 foods from a list that had been generated by Yukon First Nations elders and leaders for use in a 1991-1992 study (Wein & Freeman, 1995). To facilitate recall, participants were asked about consumption starting in the most recent season working backwards (winter 2008, fall 2007, summer 2007, spring 2007). Seasons were divided into equal lengths of 90 days, and so a frequency response of "every day" for each season would be 360 times per year. In addition to reporting frequency of food use, the FFQ asked participants for their average portion size for each traditional food in order to calculate the quantity of foods consumed. Color photographs of each species were available to participants to assist in recall, and food models were used as a guide for reporting standardized portion sizes. This study utilized the FFQ information on the average daily quantity (g/person/day) with which caribou muscle meat, liver and kidney was consumed during spring 2007-winter 2008.

Mercury Analysis of Caribou Tissues

Seventy-five muscle, 63 kidney and 3 liver samples from the Porcupine Caribou were collected during the fall hunting season by local hunters and territorial biologists as part of the Arctic Caribou and Moose Contaminant Monitoring Program of the Northern Contaminants Program. The average age of the caribou was 5.0 years. Kidneys were thoroughly homogenized before being analyzed. Kidney and liver samples were analyzed for total mercury using cold vapour atomic absorption spectroscopy at NLET (Environment Canada) or by the inductively coupled plasma technique with mass spectroscopy by Elemental Research Inc., Vancouver, BC.

Total mercury (THg) in freeze-dried raw meat muscle samples was analyzed at the University of Northern British Columbia using the commercial MA-2000 (Nippon Instruments, Osaka, Japan) that integrates combustion, collection of mercury by gold amalgamation and detection by atomic absorption spectrometry (C-GA-AAS). The instrument detection limit was 0.2 ng THg, and sample sizes of approximately 100mg dry weight were used. The detection limit for this THg determination method was 0.002 mg/kg dry weight or 0.0004 mg/kg wet weight. A standard curve was produced using commercial Hg standards before each run. Blanks were run with each batch of samples. The standard reference materials Dolt-4 dogfish liver (National Research Council Canada, Ottawa, Canada) and SRM 8414 bovine muscle (collaboration of U.S. National Institute of Standards and Technology, Gaithersburg, United States with Agriculture Canada, Ottawa, Canada) were also run with each batch of samples. Recovery was within ± 12% of the mean value for Dolt-4 and ± 30% of the mean for bovine muscle and both were within the SD of the certified value. Samples were run in triplicate except when tissue quantity was limited to allow for only duplicate (21 cases) and singular sample (12 cases) analyses.

To estimate MeHg intake, all THg found in the raw caribou meat was assumed to be MeHg, following the conservative values of percent methylmercury found in flesh of other large mammals (Moses *et al.*, 2009; Wagemeann *et al.*, 1997). MeHg has been found to comprise a range of 19.9-20.4% and 2.7-26.4% of THg in mammalian kidney and liver, respectively (Moses *et al.*, 2009; Wagemeann *et al.*, 1998). For this study, 20% of THg in the kidney and 26% of THg in liver was calculated to be MeHg.

Exposure from each caribou tissue was estimated by multiplying the g/person/day consumption by the THg or MeHg level for that tissue and dividing by an average body weight of 70kg. Each participant's total estimated THg or MeHg exposure was then calculated by adding the exposure from each tissue. The estimated THg and MeHg intakes (μg/kg body weight/day) were compared to guidelines recognized by Health Canada (Health Canada, 2007). Women aged 19-40 were considered women of childbearing age, and their levels were compared to the appropriate guidelines. Hazard Quotients were calculated by dividing the weekly estimated THg or MeHg intake by the Health Canada guideline levels.

Nutritional Analysis

Nutritional benefits from consumption of caribou meat and liver were determined using the Canadian Nutrient File (Health Canada, 2008) for cooked meat and baked liver and supplemented with Vitamin A and E values from Kuhnlein *et al.* (2006) for boiled meat, baked liver and cooked kidney and with niacin equivalent values from Hidiroglou *et al.* (2008) for cooked kidney. Intake of energy, total fat, protein, iron, phosphorous, zinc, selenium, niacin equivalent, and vitamins A, B12 and E were calculated for each tissue by combining the available database levels with the g/person/day consumption reported in the FFQ. The total percent contribution of the combined tissues towards the estimated energy requirement (EER) based on medium (low active) activity levels and estimated average requirement (EAR) for all other nutrients were calculated using Health Canada's Dietary Reference Intakes, with the more stringent requirement in place for collapsed age groups (Health Canada, 2006).

Results

Consumption of Caribou Muscle Meat, Liver and Kidney

Dietary information from 26 individuals (12 male, 14 females) representing 25 households in Old Crow was collected and analyzed. Information collected from three males initially interviewed was excluded from the analysis, as their reported g/person/day of total traditional food consumption exceeded three times the standard deviation for the entire population. All participants reported consuming caribou meat, 92% of men and 57% of women ate kidney, and 92% of men and 29% of women had liver. Women of child-bearing age reported a lower median g/person/day intake of caribou muscle, kidney and liver than all other adults (Table 3.1).

Table 3.1. Reported consumption (g/person/day) of Porcupine Caribou muscle, kidney and liver

		Muscle		Kidney		Liver	
	n	Median	90th %	Median	90th %	Median	90th %
Women 19-40	5	71.5	396	0	11.8	0	0
All except women 19-40	21	75.8	161	3.15	23.3	2.45	29.0

Mercury

THg levels in muscle, kidney and liver were found to be very low (Table 3.2). Estimated intake of both THg and MeHg using g/person/day consumption of tissues were below their respective provisional weekly tolerable intakes for women of child-bearing age and all other adults (Table 3.3). The Hazard Quotients including those for high end consumers (90^{th} percentile) were well below 1, indicating minimal risk.

Table 3.2. THg and MeHg concentrations in Porcupine Caribou muscle, kidney and liver

Tissue	n	THg Mean ± SD (mg/kg wet weight)	THg Range (mg/kg wet weight)	MeHg Mean (mg/kg wet weight)
Muscle	71	0.003 ± 0.002	0.001, 0.006	0.003
Kidney	63	0.360 ± 0.12	0.110, 0.640	0.073
Liver	3	0.120 ± 0.07	0.060, 0.190	0.032

Table 3.3. THg and MeHg exposure from the consumption of Porcupine Caribou muscle, kidney and liver

		Weekly THg Exposure				Weekly MeHg Exposure			
		Median	90th %	Hazard Quotient[ab]		Median	90th %	Hazard Quotient[cd]	
Group	n	(μg/kg bw/week)		Median/PTWI	90^{th}/PTWI	(μg/kg bw/week)		Median/PTWI	90^{th}/PTWI
Women 19-40	5	0.12	0.42			0.06	0.12	0.05	0.08
All except women 19-40	2 1	0.22	1.20	0.04	0.24	0.07	0.30	0.02	0.09

[a] There is not a THg Provisional Tolerable Weekly Intake (PTWI) specifically for women of childbearing age
[b] 5 μg/kg bw/week THg PTWI for adults other than women of childbearing age
[c] 1.4 μg/kg bw/week MeHg PTWI for women of childbearing age
[d] 3.3 μg/kg bw/week MeHg PTWI for adults other than women of childbearing age

Nutrients

The g/person/day consumption of caribou muscle, liver and kidney contributed to nearly two-thirds of the EAR for protein and zinc, half of the EAR for iron and one-third of the EAR for phosphorous in women (Table 3.4a). The niacin intake was close to the EAR, and the B12 intake was two and a half times the EAR. In men, caribou tissues contributed to approximately half of EAR for protein and zinc, two-thirds for vitamin A, nearly all for iron, and two and a half times for B12 (Table 3.4b). Caribou muscle, kidney and liver also contributed low amounts of copper, calcium, sodium, magnesium, manganese, potassium and vitamins C and D (data not shown) to the diets of both women and men.

Table 3.4a. Contribution of caribou muscle, kidney and liver to nutrient intake in women (n=14)

Nutrient	Mean ± SD				EAR	Total % of EAR[b]
	Muscle	Kidney[a]	Liver[a]	Total		
Energy (kCal)	147 ± 157	-	8.7 ± 18.2	155 ± 161	2100/2000/1850[c]	6.1
Protein (g)	28.8 ± 30.9	-	1.4 ± 3.0	30.2 ± 31.5	38	64
Iron (mg)	5.1 ± 5.5	-	1.2 ± 2.5	6.3 ± 6.3	8.1/8.1/5.0[c]	54
Phosphorous (mg)	202 ± 216	-	22.0 ± 46.2	224 ± 228	580	29
Zinc (mg)	5.0 ± 5.4	-	0.4 ± 0.8	5.4 ± 5.6	6.8	62
Selenium (µg)	9.0 ± 9.7	-	-	9.0 ± 9.7	45	17
Niacin equivalent (mg)	12.1 ± 13.0	0.6 ± 0.6	-	12.9 ± 13.1	11	93
B12 (µg)	6.0 ± 6.4	-	-	6.0 ± 6.4	2.0	251
Vitamin A (µg)	11.3 ± 12.1	7.3 ± 11.6	599 ± 1256	618 ± 1268	500	2.9
Vitamin E (mg)	0.5 ± 0.5	0.0 ± 0.0	118 ± 246	1.7 ± 2.6	12	3.5

[a] Data not available for certain nutrients in caribou kidney and liver
[b] Median % contribution to reference intake
[c] Reference intakes different for each age groups (19-40/41-60/61+)

Table 3.4b. Contribution of caribou muscle, kidney and liver to nutrient intake in men (n=12)

Nutrient	Mean + SD				EAR	Total % of EAR[b]
	Meat	Kidney[a]	Liver[a]	Total		
Energy (kCal)	136 ± 105	-	7.4 ± 6.5	143 ± 104	2700/2600/2350[c]	5.1
Protein (g)	26.6 ± 20.6	-	1.2 ± 1.1	27.9 ± 20.4	46	56
Iron (mg)	4.7 ± 3.6	-	1.0 ± 0.9	5.7 ± 3.6	6	92
Phosphorous (mg)	186 ± 144	-	18.8 ± 16.5	205 ± 142	580	33
Zinc (mg)	4.7 ± 3.6	-	0.3 ± 0.3	5.0 ± 4.6	9.4	49
Selenium (µg)	8.3 ± 6.4	-	-	8.3 ± 6.4	45	17
Niacin Equivalent (mg)	11.2 ± 8.6	0.7 ± 0.6	-	11.9 ± 8.4	12	91
B12 (µg)	5.53± 4.3	-	-	5.5 ± 4.3	2.0	252
Vitamin A (µg)	10.4 ± 8.0	6.7 ± 5.5	512 ± 448	529 ± 450	625	66
Vitamin E (mg)	0.5 ± 0.35	0.0 ± 0.0	101 ± 88.0	1.5 ± 0.9	12	9.9

[a] Data not available for certain nutrients in caribou kidney and liver

[b] Median % contribution to reference intake

[c] Reference intakes different for each age groups (19-40/41-60/61+)

Discussion

Nearly all parts of a harvested caribou are used by the Vuntut Gwitchin; however only the muscle, liver and kidney were evaluated in this study since the organs are targets for MeHg accumulation and the meat is consumed in large quantities. The estimated average daily THg and MeHg exposure of adults in Vuntut Gwitchin households through consumption of caribou muscle, liver and kidney is low and therefore minimal risk of toxic Hg effects exists from consumption of caribou in this community. Even the THg and MeHg intake of high end consumers (top 90^{th} percentile) was below Health Canada guideline levels. The calculated Hazard Quotients were well below 1, suggesting the health risk for Hg exposure from this route is minimal. Cooking methods, which have been shown to affect THg and MeHg in tissues (Moses *et al.*, 2009), were not taken into account in this analysis; however since the estimated exposures were well below the guideline levels, the variations caused by different preparation methods would likely not affect the results of the assessment.

Levels of THg in caribou organs generally increase with animal age and vary with season, as seasonality dictates both the size of the organs and the proportion of mercury-accumulating lichens in the caribou diet (Robillard *et al.*, 2002). THg levels in Porcupine Caribou kidney have been shown to be higher in spring harvested animals compared with those harvested in the fall and higher in females than in males (Gamberg, 2008). Samples analyzed for this study were collected only from male caribou during the fall hunting season. Although the harvesting both males and females is allowed, the Porcupine Caribou Management Board is encouraging the hunting of male caribou as a strategy to maintain a healthy herd population (Porcupine Caribou Management Board, 2009). Therefore the sampled male caribou can be considered representative of fall harvested animals. The estimated exposure may increase a minimal amount if samples from spring harvested caribou were included; however individuals would still not surpass guideline levels for THg and MeHg. In addition, a conservative approach was employed to estimate the proportion of MeHg in the tissue samples, and actual MeHg levels may be even lower.

Even though caribou tissues (muscle, liver and kidney combined) only contributed a median of 5-6% of the EER, they contributed half or more of the median EAR for protein, iron, zinc, B12 and niacin equivalent for both men and women. Total B12 intake exceeded the EAR by two and half times for both men and women; however there is not an upper limit (UL) for vitamin B12 as available research does not suggest adverse effects from high levels of consumption. Men and women were both close to the EAR for niacin but are not in danger of exceeding the UL, which is set for synthetic forms such as supplements and fortified foods. Men had a median percent reference intake of vitamin A twenty times higher than that of women due to their significantly greater consumption of liver. Since only a small number of women consumed liver and two of those women consumed a relative large amount, there is a positive skew for mean nutrient intakes for those nutrients present in high levels in the liver.

Nutrient intake in Aboriginal communities has been found to be higher on days when traditional foods are part of the diet than on days when market foods are consumed exclusively (Kuhnlein *et al.*, 1996; Receveur *et al.*, 1997). A survey of four Yukon First Nations communities that included Old Crow found that even when traditional foods comprise 17% of the daily energy, they contribute 50% or more of daily intakes of protein, vitamin B12, riboflavin, niacin, iron and zinc (Wein, 1995). These results suggest that caribou tissues are critical in maintaining the nutrient requirement of individuals in this community. The transition from traditional foods to market foods may decrease dietary quality and increase risk for diabetes, obesity and cardiovascular diseases (Damman *et al.*, 2007; Kuhnlein *et al.*, 2004; Kuhnlein *et al.*, 1996; Martens *et al.*, 2007).

The study results resonate with comprehensive risk-benefit assessments conducted with other northern First Nations communities. A 1995 study found mercury levels to be low in Yukon wildlife and freshwater fish with the exception of loche, suggesting that mercury exposure is not a significant problem in Yukon First Nations communities (Receveur *et al.*, 1998). A study of 16 Dene/Métis communities in the Northwest Territories including the Teetl'it Gwich'in community of Fort McPherson similarly reported low risk from dietary mercury exposure (Berti *et al.*, 1998). Continued consumption of traditional foods was encouraged, as the nutritional benefits were considered important to the health of the communities and contaminant risk was low.

Conclusion

Consumption of Porcupine Caribou in Vuntut Gwitchin households in Old Crow contributes high levels of nutrients to the diet. The average daily risk posed by mercury exposure is low when evaluated on a g/person/day consumption basis of all tissues. Results were discussed with the community to inform dietary choice and reported to the local health authorities for the development of regional and culturally appropriate nutritional policy and risk management. This paper examines contamination through a Western lens since the objective is to contribute only estimate of mercury levels and nutrient intake from caribou muscle, kidney and liver to a comprehensive risk assessment. A comprehensive risk assessment would explore the concept of contamination from an Aboriginal perspective and situate the assessment within the cultural understanding and implications of the contamination.

CHAPTER 4: CONCLUSIONS

Traditional foods have been demonstrated to be an important part of the contemporary diet of two First Nations communities, the Vuntut Gwitchin of Old Crow and Teslin Tlingit. Forty-five traditional foods were reported to be consumed in Old Crow a median of 582 times per year. Due to its more southerly location and increased species diversity (Wein, 1995), a wider span of 60 different traditional foods was consumed in Teslin, albeit at a lower median of 386 times per year. Traditional foods are important to nutrition and physical health as well as to the spiritual and social well-being of the communities, especially since the foods reported to be consumed in this survey are high in protein, poly-unsaturated fatty acids, iron, zinc and vitamins A, B12, C, and E.

Even though traditional foods are frequently consumed, both communities reported challenges to food security that stem from environmental variability. Twenty-six percent of households in Old Crow and Teslin reported not getting all the traditional foods that they want, which is a manifestation of moderate food insecurity. All of these Vuntut Gwitchin households wanted more caribou, due to the irregular fall migration of the Porcupine Caribou that left families without their normal stock for the winter. Caribou migration patterns can be affected by climate change, snow depth and hardness and access to and availability of preferred food sources such as lichen (Duquette, 1988; Manning, 2009). Tlingit households mentioned wanting more salmon in the survey, and those at the community meeting made it clear that the low salmon runs were affecting their community. Participants even reported resorting to obtaining salmon from outfitters and other First Nations, and the Teslin Tlingit Council purchased salmon from elsewhere and delivered it to community households in need, beginning with elders, single parents and large families. Salmon harvests are affected by overfishing, water levels of the harvest area, changes to the freshwater habitat and variability in ocean conditions (Bradford & Irvine, 2000). The low 2008 salmon run in Old Crow coupled with high water levels led to the harvest of only seven chinook salmon and the Vuntut Gwitchin Government's purchasing of salmon to distribute to the community (S. Graupe, VVG Director of Natural Resources, personal communication, March 31 2009).

Contamination of traditional food sources is another environmental issue threatening food security. Two participants in Old Crow reported decreasing their consumption of traditional foods because they were concerned about the foods' safety, specifically contaminants in the liver and meat of animals. This study did not qualitatively explore the community's perception of contamination and therefore it does not claim to have comprehensively addressed these concerns. From the Western perspective, one common scientific contaminant of concern, mercury, was measured and found to be of minimal risk through consumption of the frequently eaten caribou muscle meat and the commonly consumed mercury-accumulating organs, kidney and liver. The average daily nutrient intakes through consumption of caribou muscle, liver and kidney were identified as important factors in physical health, and the socio-cultural benefits of caribou and other traditional food consumption are recognized as contributing to holistic well-being.

Reported socio-economic challenges to food security include not having enough time to hunt, money to hire someone to hunt for them, a hunter/trapper or fisherman in the household and enough and functioning equipment to fulfill the family's food needs. In Teslin 40% of households did not have enough hunting/trapping equipment, and this was found to be more of an issue with those under 40 years of age. In Old Crow, only 52% of households were identified as food secure by the HFSSM, a number well below the Canadian and Yukon averages. That statistic incorporates both traditional and market food insecurity and is likely affected by the extremely high price of market foods in Old Crow due to its remote location. Although this study did not evaluate potential social aspects of changing diets that have been reported in other communities, such as the convenience of purchasing market foods at the store, education and media influences, changing tastes of younger generations and challenges in intergenerational knowledge transfer (Chan *et al.*, 2006; Kuhnlein *et al.*, 1996; Wein *et al.*, 1993), these are factors to be considered in a comprehensive discussion of food security in the north.

Communities and regional health networks are seeking to address the challenges to food security that are facing the north. Future work based on this thesis and other food security studies include the development of adaptation strategies in Teslin and Old Crow in partnership with the respective First Nation governments, the Council of Yukon First Nations and the Arctic Health Research Network Yukon. In order to support these initiatives and disseminate information to community members, it is crucial to clearly communicate the study results. Therefore community-specific one page bullet-form summaries have already been distributed during the community meetings, and a plain-language executive summary report will be provided to community leadership and appropriate organizations.

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Appendix 1

UNIVERSITY OF NORTHERN BRITISH COLUMBIA

RESEARCH ETHICS BOARD

MEMORANDUM

To: Laurie Chan
CC: Pam Tobin

From: Greg Halseth, Acting Chair
Research Ethics Board

Date: October 2, 2007

Re: **E2007.0911.098**
Adaptation strategies to effects of climate change and impacts on diet and health

Thank you for submitting the above-noted research proposal and requested changes to the Research Ethics Board (REB). Your proposal has been approved.

We are pleased to issue approval for the above named study for a period of 12 months from the date of this letter. Continuation beyond that date will require further review and renewal of REB approval. Any changes or amendments to the protocol or consent form must be approved by the Research Ethics Board.

Good luck with your research.

Sincerely,

Greg Halseth

Appendix 2

UNIVERSITY OF NORTHERN BRITISH COLUMBIA

RESEARCH ETHICS BOARD

MEMORANDUM

To: Laurie Chan
CC: Pam Tobin

From: Greg Halseth, Chair
Research Ethics Board

Date: April 22, 2008

Re: **E2008.0221.041**
Adaptation strategies to effects of climate change and impacts on diet and health

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Thank you for submitting the above-noted research proposal and requested amendments to the Research Ethics Board. Your proposal has been approved.

We are pleased to issue approval for the above named study for a period of 12 months from the date of this letter. Continuation beyond that date will require further review and renewal of REB approval. Any changes or amendments to the protocol or consent form must be approved by the Research Ethics Board.

Good luck with your research.

Sincerely,

Greg Halseth

Appendix 4

	Dr. Laurie Chan, BC Leadership Chair for Aboriginal Environmental Health 3333 University Way Prince George, BC V2N 4Z9 Tel: 250-960-5237 Email: lchan@unbc.ca

Principal Investigator: Laurie Chan Ph.D., University of Northern British Columbia
Responsible Institution: University of Northern British Columbia, Prince George, BC
Funding Organizations: Natural Sciences and Engineering Research Council of Canada, Canadian Institute of Health Research

Purpose: To find out the kinds and amounts of traditional foods eaten by Vuntut Gwitchin adults in Old Crow. This will be compared with information from fifteen years ago to show if there has been changes in traditional food use.

Description of the research: You will be asked to complete a questionnaire that will ask you about your use of traditional foods over the past four seasons (winter, fall, summer, spring). You will also be asked some questions about your level of food security and access to traditional foods. If you would like to participate in this study, it will take about 1 hour.

Anonymity and Confidentiality: Each questionnaire will have an identification number. No names or addresses will appear on the questionnaire so that no one can identify you from the questionnaire. The interviewer will have a separate profile form with the identification number and your name in order to keep track of participants but this form will not be shared with any individual or group.

The collected interviews will be held in confidence by the Principle Investigator, Laurie Chan, and his researcher, Roseanne Schuster, for up to two years in a secured data laboratory at the University of Northern British Columbia (UNBC). At this time, after all the data are analyzed and reports published, the material will be destroyed. A set of the data will be held by VGG and will be administered under the VGG Access Policy.

Potential Risks and Benefits: There are no risks associated with the interview. The diet information will help your community leadership have a record of traditional food consumption and develop public health promotion programs.

Volunteer Status: Your participation is voluntary. You can choose to withdraw at any time, and your information will be destroyed.

Research Results: The data will be co-owned by the community and the University of Northern British Columbia. Results of the study will be communicated to participants within one year. We will not release the individual results as only the collective results will be useful.
Paper and electronic copies of the results will be presented to the VGG. Results will also be used to estimate nutrient and contaminant intake in the community. Final results will be published in a thesis and scientific journal and also used for public health planning.

If you have any questions about this project please do not hesitate to contact Dr. Laurie Chan, Principle Investigator, UNBC Community Health Program, 250-960-5237 or lchan@unbc.ca.

Complaints: If you have any complaints about this project they should be directed to UNBCs Office of Research at 250-960-5820 or by email at officeofresearch@unbc.ca.

Traditional Food Use in Old Crow and Teslin

Informed Consent Form

Informed Consent

By signing this form, I agree that:

• The study has been explained to me	Yes	No
• All my questions were answered	Yes	No
• I agree to participate in the Traditional Food Use study	Yes	No
• I understand I can withdraw my participation at any time and the information I provided will be destroyed	Yes	No
• I have the choice of not answering specific questions	Yes	No
• I am free now, and in the future, to ask questions	Yes	No
• I have been told that my personal information will be kept confidential.	Yes	No
• I understand that I will receive a signed copy of this consent form.	Yes	No

______________________	______________________	__/__/__
Printed name	Signature	Date (m/d/y)
______________________	______________________	__/__/__
Name of person who obtained consent	Signature	Date (m/d/y)

Appendix 5 Participant ID ___ / ___ ___ / ___ ___ ___

Frequency of Traditional Food Use in Old Crow and Teslin
Interview Questionnaire

Interviewer ID ___ Date __ / __ / __
M D Y

There will be three parts to this study. The first part has one question asking the number of people in your household. The second will ask how often you have eaten traditional foods in the last year and how much you usually eat. The third will ask questions about your household's food security, or the availability and access to nutritious and culturally appropriate foods.

I. HOUSEHOLD DEMOGRAPHICS

This first part is very short. In order to describe the group of people who took part in the study, I will ask one question about your household.

HD_Q1: How many people total, including yourself, live in your household? _____

How many

a) Children 0 to 12 years ________
b) Teenagers 13 to 18 years ________
c) Adults 19 to 40 years ________
d) Adults 41 to 60 years ________
e) Adults 61 years and over ________

II. FOOD FREQUENCY QUESTIONNAIRE

I will now ask you how often you ate several traditional food species in the past four seasons, winter (December-February); fall (September-November); summer (June-August); and spring (March-May). I will ask about muscle, liver, and kidneys separately for moose and caribou only. I will also ask how often you ate fish livers and bird and fish eggs. For all other species, when I ask how often you ate that bird, fish, or mammal, it includes all parts of the animal: the meat, organs, marrow, etc. Then I will ask approximately how much of each food you usually ate. I have food models here to help you estimate the portion size.

				Frequency										
		Eaten in past year?		Winter (Dec-Jan-Feb)		Fall (Sep-Oct-Nov)		Summer (Jun-Jul-Aug)		Spring (Mar-Apr-May)		Description of Portions		
TF#	**Traditional food**	**Yes**	**No**	**# per W/M**	**# per Season**	**# per W/M**	**# per Season**	**# per W/M**	**# per Season**	**# per W/M**	**# per Season**	**# of portions**	**Model**	**Thickness**
MAMMALS														
TF1	Caribou meat													
TF2	Caribou kidney													
TF3	Caribou liver													
TF4	Moose meat													
TF5	Moose kidney													
TF6	Moose liver													
TF7	Mountain sheep													
TF8	Mountain goat													
TF9	Black bear													
TF10	Grizzly bear													
TF11	Lynx													
TF12	Hare													
TF13	Muskrats													
TF14	Beaver													
TF15	Porcupine													
TF16	Groundhog (hoary marmot, whistler)													
TF17	Gopher (Arctic ground squirrel)													
TF18	Any other? ____________													

				Frequency										
		Eaten in past year?		Winter (Dec-Jan-Feb)		Fall (Sep-Oct-Nov)		Summer (Jun-Jul-Aug)		Spring (Mar-Apr-May)		Description of Portions		
TF#	**Traditional food**	**Yes**	**No**	**# per W/M**	**# per Season**	**# per W/M**	**# per Season**	**# per W/M**	**# per Season**	**# per W/M**	**# per Season**	**# of portions**	**Model**	**Thickness**
BIRDS														
TF19	Ducks													
TF20	Geese													
TF21	Swans													
TF22	Duck eggs													
TF23	Goose eggs													
TF24	Gull eggs													
TF25	Grouse (spruce, blue, ruffed)													
TF26	Ptarmigan (willow rock)													
TF27	Any other bird? ________________													
FISH														
TF28	Lake whitefish													
TF29	Broad whitefish													
TF30	Round whitefish													
TF31	Least cisco (herring)													
TF32	Inconnu (coney, sheefish)													

				Frequency										
		Eaten in past year?		Winter (Dec-Jan-Feb)		Fall (Sep-Oct-Nov)		Summer (Jun-Jul-Aug)		Spring (Mar-Apr-May)		Description of Portions		
TF#	**Traditional food**	**Yes**	**No**	# per W/M	# per Season	# per W/M	# per Season	# per W/M	# per Season	# per W/M	# per Season	**# of portions**	**Model**	**Thickness**
TF33	Chinook (king) salmon													
TF34	Sockeye salmon (incl. kokanee)													
TF35	Coho (silver) salmon													
TF36	Chum (dog) salmon													
TF37	Lake trout													
TF38	Dolly varden													
TF39	Arctic char (incl. stocked from lakes)													
TF40	Rainbow trout													
TF41	Cutthroat trout													
TF42	Arctic grayling													
TF43	Northern pike, (jackfish)													
TF44	Burbot (ling cod, loche)													
TF45	Long nose sucker													
TF46	Fish livers													
TF47	Fish eggs													
TF48	Any other fish? ________													

				Frequency										
		Eaten in past year?		Winter (Dec-Jan-Feb)		Fall (Sep-Oct-Nov)		Summer (Jun-Jul-Aug)		Spring (Mar-Apr-May)		Description of Portions		
TF#	Traditional food	Yes	No	# per W/M	# per Season	# per W/M	# per Season	# per W/M	# per Season	# per W/M	# per Season	# of portions	Model	Thickness
WILD BERRIES														
TF49	Black currants													
TF50	Bristly black currants (swamp gooseberry)													
TF51	Gooseberry													
TF52	Red currant													
TF53	Strawberry													
TF54	Saskatoon berry													
TF55	Rosehips													
TF56	Red raspberry													
TF57	Cloudberry (salmonberry)													
TF58	Crowberry (mossberry, blackberry)													
TF59	Soapberry													
TF60	Bearberry (stoneberry, kinnikinnick)													
TF61	Blueberry													
TF62	High bush cranberry													

				Frequency										
		Eaten in past year?		Winter (Dec-Jan-Feb)		Fall (Sep-Oct-Nov)		Summer (Jun-Jul-Aug)		Spring (Mar-Apr-May)		Description of Portions		
TF#	**Traditional food**	**Yes**	**No**	# per W/M	# per Season	# per W/M	# per Season	# per W/M	# per Season	# per W/M	# per Season	**# of portions**	**Model**	**Thickness**
TF63	Low bush cranberry													
TF64	Bog cranberry													
TF65	Any other wild berry? ________													
WILD GREENS (Shoots, leaves, stems, buds)														
TF66	Wild onion, wild chive													
TF67	Wild rhubarb													
TF68	Arctic dock													
TF69	Fireweed shoots													
TF70	Labrador tea													
TF71	Wild mint													
TF72	Dandelion greens													
TF73	Willow buds													
ROOTS														
TF74	Rice root													
TF75	Bear root													
TREE FOODS														
TF76	Spruce bark or sap													

				Frequency										
		Eaten in past year?		Winter (Dec-Jan-Feb)		Fall (Sep-Oct-Nov)		Summer (Jun-Jul-Aug)		Spring (Mar-Apr-May)		Description of Portions		
TF#	**Traditional food**	**Yes**	**No**	**# per W/M**	**# per Season**	**# per W/M**	**# per Season**	**# per W/M**	**# per Season**	**# per W/M**	**# per Season**	**# of portions**	**Model**	**Thickness**
TF77	Balsam fir bark or sap													
TF78	Jackpine													
TF79	Poplar sap or syrup													
TF80	Birch sap or syrup													
TF81	Any other plant food? ________													
FUNGI, LICHENS														
TF82	Mushrooms													
TF83	Caribou moss													
TF84	Any other food? ____________													

End of Food Frequency Section

III. FOOD SECURITY

Now we are starting the final part of the interview. I would like to ask you a few questions about your access to traditional foods and if you are getting the quantity of traditional foods that you want.

PF_Q1: Where do you get your traditional foods from?

[ ] a) Self or immediate family in household

[ ] b) Friends or family in community

[ ] c) Other, please specify ____

____

PF_Q2: Do you get all the traditional foods you want?

[ ] Yes

[ ] No

[ ] DK / Refused

PF_Q2a: If no, what traditional food(s) would you want to eat more of if you could get more?

Food 1 ______________________________ (code PFQ2a1)

Food 2______________________________(code PFQ2a2)

Food 3______________________________(code PFQ2a3)

PF_Q2b: If no, why can't you get all the traditional foods that you want? ______________

____

____

____

____

PF_Q3: Compared to fifteen years ago, do you eat more, less, or the same amount of each of the following traditional foods? If you are eating more, less, or don't eat any of these foods, can you tell me why?

Compared to fifteen years ago, are you eating . . .

Traditional Food	**More**	**Less**	**Same**	**Don't Eat**	**Reason #**	**Other Explanation**
Mammals (wild game)	1	2	3	4		
Waterfowl (duck, geese)	1	2	3	4		
Ptarmigan, grouse	1	2	3	4		
Fish	1	2	3	4		
Berries	1	2	3	4		
Wild Greens	1	2	3	4		
Roots	1	2	3	4		
Tree Foods (Bark for tea, sap)	1	2	3	4		
Mushrooms	1	2	3	4		

Number codes for reasons:

1. More available
2. Not available
3. Less available
4. Concern over safety
5. Store food too expensive
6. Don't like
7. No hunter/fisher in the family
8. Can't afford equipment/gas
9. Don't know
10. Other; write in explanation

AC_Q1: Is there a hunter or trapper, in your household (including part time) ?

(Circle correct response) a. Yes b. No

AC_Q2: Does your family have enough equipment to go hunting or trapping for the family's food needs? (Circle correct response) a. Yes b. No

AC_Q3: Is the hunting and trapping equipment working?

(Circle correct response) a. Yes b. No

AC_Q4: Is there a fisherman in your household (including part time) ?

(Circle correct response) a. Yes b. No

AC_Q5: Does your family have enough equipment to go fishing for the family's food needs? (Circle correct response) a. Yes b. No

AC_Q6: Is the fishing equipment working?

(Circle correct response) a. Yes b. No

For the next set of questions, I will read you a statement and some responses. Please choose the response that most accurately describes your situation. These questions may be sensitive and difficult to answer, so I want to remind you that you have the right to refuse to answer questions that you choose, and that all information will be kept confidential.

HH_Q1. Which of these statements best describes the food eaten in your household in the last 12 months:

[ ] a) We had enough of the kinds of food we want to eat

[ ] b) We had enough but not always the kinds of food we wanted

[ ] c) Sometimes we did not have enough to eat

[ ] d) We often did not have enough to eat

[ ] e) DK or Refused

Household Stage 1: Questions HH_Q2-HH_Q4 (asked of all households; begin scale items).

HH_Q2: Now I'm going to read you several statements that people have made about their food situation. For these statements, please tell me whether the statement was often true, sometimes true, or never true for (you/your household) in the last 12 months—that is, since last (name of current month).

The first statement is "(I/We) worried whether (my/our) food would run out before (I/we) got money to buy more." Was that often true, sometimes true, or never true for (you/your household) in the last 12 months?

[ ] a) Often true

[ ] b) Sometimes true

[ ] c) Never true

[ ] d) DK or Refused

HH_Q3: “The food that (I/we) bought just didn’t last, and (I/we) didn’t have money to get more.” Was that often, sometimes, or never true for (you/your household) in the last 12 months?

[ ] a) Often true

[ ] b) Sometimes true

[ ] c) Never true

[ ] d) DK or Refused

HH_Q4: “(I/we) couldn’t afford to eat healthy meals.” Was that often, sometimes, or never true for (you/your household) in the last 12 months?

[ ] a) Often true

[ ] b) Sometimes true

[ ] c) Never true

[ ] d) DK or Refused

Screener for Stage 2 Adult-Referenced Questions: If response [c] or [d] to question FS_Q1 OR affirmative response (i.e., "often true" or "sometimes true") to one or more of Questions HH_Q2-HH_Q4 continue to ***Adult Stage 2;***
otherwise, if children under age 18 are present in the household, skip to ***Child Stage 1,***
if no children under 18, skip to ***End of Food Security Module.***
Adult Stage 2: Questions AD_Q1-AD_Q4 (asked of households passing the screener for Stage 2 adult-referenced questions).

AD_Q1: In the last 12 months, since last (name of current month), did (you/you or other adults in your household) ever cut the size of your meals or skip meals because there wasn't enough money for food?

[ ] a) Yes

[ ] b) No (Skip AD1a)

[ ] c) DK or Refused (Skip AD1a)

AD_Q1a: [IF YES ABOVE, ASK] How often did this happen—almost every month, some months but not every month, or in only 1 or 2 months?

[ ] a) Almost every month

[ ] b) Some months but not every month

[ ] c) Only 1 or 2 months

[ ] d) DK or Refused

AD_Q2: In the last 12 months, did you ever eat less than you felt you should because there wasn't enough money to buy food?

[ ] a) Yes

[ ] b) No

[ ] c) DK or Refused

AD_Q3: In the last 12 months, were you every hungry but didn't eat because there wasn't enough money for food?

[ ] a) Yes

[ ] b) No

[ ] c) DK or Refused

AD_Q4: In the last 12 months, did you lose weight because there wasn't enough money for food?

[ ] a) Yes

[ ] b) No

[ ] c) DK or Refused

<u>Screener for Stage 3 Adult-Referenced Questions:</u> If affirmative response to one or more of questions AD_Q1 through AD_Q4, then continue to ***Adult Stage 3;***
otherwise, if children under age 18 are present in the household, skip to ***Child Stage 1,***
if no children under 18 skip to ***End of Food Security Module.***

Adult Stage 3: Questions AD_Q5-AD_Q5a (asked of households passing screener for Stage 3 adult-referenced questions).

AD_Q5: In the last 12 months, did (you/you or other adults in your household) ever not eat for a whole day because there wasn't enough money for food?

[ ] a) Yes

[ ] b) No (Skip AD_Q5a)

[ ] c) DK or Refused (Skip AD_Q5a)

AD_Q5a: [IF YES ABOVE, ASK] How often did this happen—almost every month, some months but not every month, or in only 1 or 2 months?

[ ] a) Almost every month

[ ] b) Some months but not every month

[ ] c) Only 1 or 2 months

[ ] d) DK or Refused

Child Stage 1: Questions CH_Q1-CH_Q3 (Transitions and questions CH_Q1 and CH_Q2 are administered to all households with children under age 18)
Households with no child under age 18, skip to ***End of Food Security Module.***

SELECT APPROPRIATE FILLS DEPENDING ON NUMBER OF ADULTS AND NUMBER OF CHILDREN IN THE HOUSEHOLD.

Transition into Child-Referenced Questions:

Now I'm going to read you several statements that people have made about the food situation of their children. For these statements, please tell me whether the statement was OFTEN true, SOMETIMES true, or NEVER true in the last 12 months for (your child/children living in the household who are under 18 years old).

CH_Q1: "(I/we) relied on only a few kinds of low-cost food to feed (my/our) child/the children) because (I was/we were) running out of money to buy food." Was that often, sometimes, or never true for (you/your household) in the last 12 months?

[ ] a) Often true

[ ] b) Sometimes true

[ ] c) Never true

[ ] d) DK or Refused

CH_Q2: "(I/We) couldn't feed (my/our) child/the children) a healthy meal, because (I/we) couldn't afford that." Was that often, sometimes, or never true for (you/your household) in the last 12 months?

[ ] a) Often true

[ ] b) Sometimes true

[ ] c) Never true

[ ] d) DK or Refused

CH_Q3: "(My/Our child was/The children were) not eating enough because (I/we) just couldn't afford enough food." Was that <u>often</u>, <u>sometimes</u>, or <u>never</u> true for (you/your household) in the last 12 months?

[ ] a) Often true

[ ] b) Sometimes true

[ ] c) Never true

[ ] d) DK or Refused

<u>**Screener for Stage 2 Child Referenced Questions:**</u> If affirmative response (i.e., "often true" or "sometimes true") to one or more of questions CH1-CH3, then continue to ***Child Stage 2;*** otherwise skip to ***End of Food Security Module.***

Child Stage 2: Questions CH_Q4-CH_Q7 (asked of households passing the screener for stage 2 child-referenced questions).

CH_Q4: In the last 12 months, since (current month) of last year, did you ever cut the size of (your child's/any of the children's) meals because there wasn't enough money for food?

[ ] a) Yes

[ ] b) No

[ ] c) DK or Refused

CH_Q5: In the last 12 months, did (CHILD'S NAME/any of the children) ever skip meals because there wasn't enough money for food?

[ ] a) Yes

[ ] b) No (Skip CH5a)

[ ] c) DK or Refused (Skip CH5a)

CH_Q5a: [IF YES ABOVE ASK] How often did this happen—almost every month, some months but not every month, or in only 1 or 2 months?

[ ] a) Almost every month

[ ] b) Some months but not every month

[ ] c) Only 1 or 2 months

[ ] d) DK or Refused

CH_Q6: In the last 12 months, (was your child/were the children) ever hungry but you just couldn't afford more food?

[ ] a) Yes

[ ] b) No

[ ] c) DK or Refused

CH_Q7: In the last 12 months, did (your child/any of the children) ever not eat for a whole day because there wasn't enough money for food?

[ ] a) Yes

[ ] b) No

[ ] c) DK or Refused

End of Food Security Section

END OF QUESTIONNAIRE